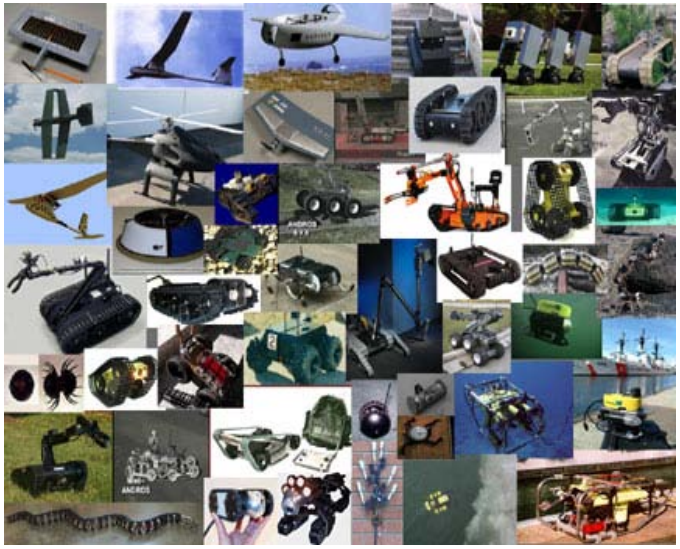
NIST
National Institute of Standards and Technology
Technology Administration, U.S. Department of Commerce

RESPONSE ROBOTS

DHS/NIST Sponsored Evaluation Exercises

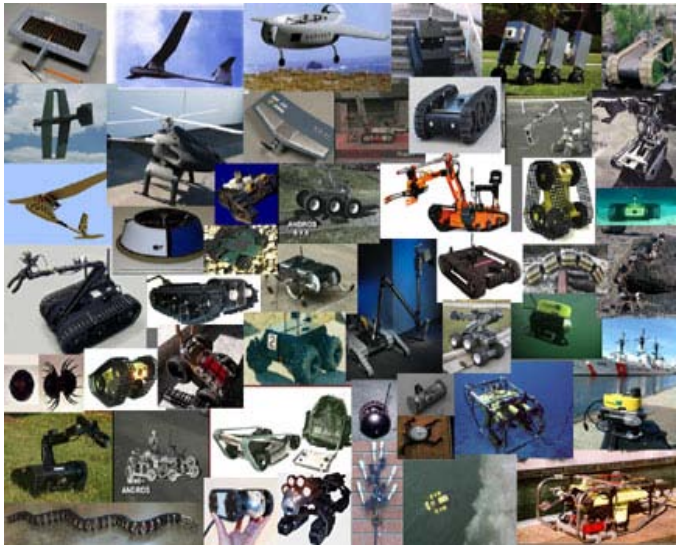


Pocket Guide
Version
2009.2

NIST
National Institute of Standards and Technology
Technology Administration, U.S. Department of Commerce

RESPONSE ROBOTS

DHS/NIST Sponsored Evaluation Exercises



Pocket Guide
Version
2009.2

Certain commercial equipment, instruments, or materials are identified in this document. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the products identified are necessarily the best available for the purpose.

All data will be published once the test method has gone through the standards process.

Certain commercial equipment, instruments, or materials are identified in this document. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the products identified are necessarily the best available for the purpose.

All data will be published once the test method has gone through the standards process.

2

Contacts

Intelligent Systems Division
Manufacturing Engineering Laboratory
National Institute of Standards and Technology
100 Bureau Drive, MS8230
Gaithersburg, MD 20899

Contacts

Intelligent Systems Division
Manufacturing Engineering Laboratory
National Institute of Standards and Technology
100 Bureau Drive, MS8230
Gaithersburg, MD 20899

Program Overview

Application-specific robot standards and repeatable performance testing with objective performance metrics will accelerate the development and deployment of mobile robotic tools for US&R responders, enhancing the effectiveness of these teams while reducing the risks to personnel during disaster response. Currently, no such standards or performance metrics exist.

In order to address this need, the DHS Science and Technology (S&T) Directorate initiated an effort in fiscal year 2004 with the National Institute of Standards and Technology (NIST) to develop comprehensive standards related to the development, testing, and certification of effective robotic technologies for US&R applications. These standards will address robot mobility, sensing, navigation, planning, integration into operational caches, and human factors. Such standards will allow DHS to provide guidance to local, state, and federal homeland security entities regarding the purchase, deployment, and use of robotic systems for US&R applications.

This standards development effort focuses on fostering collaboration between US&R responders, robot vendors, and robot developers to generate consensus standards for task specific robot capabilities and interoperability of components. Furthermore, the effort includes the development and administration of technology readiness level (TRL) assessment exercises. These exercises will generate statistically significant performance data for developmental and fieldable robotic systems.

Program Overview

Application-specific robot standards and repeatable performance testing with objective performance metrics will accelerate the development and deployment of mobile robotic tools for US&R responders, enhancing the effectiveness of these teams while reducing the risks to personnel during disaster response. Currently, no such standards or performance metrics exist.

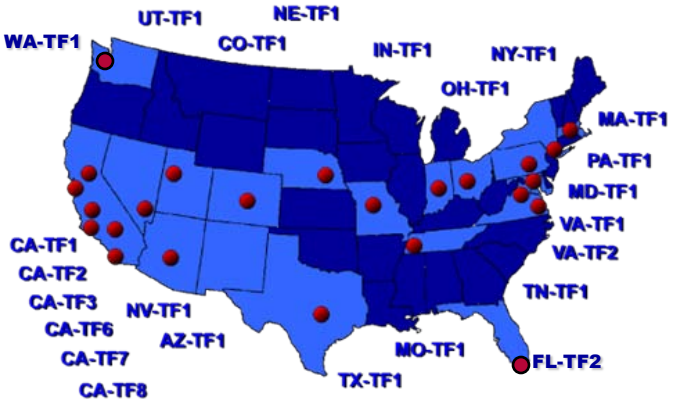
In order to address this need, the DHS Science and Technology (S&T) Directorate initiated an effort in fiscal year 2004 with the National Institute of Standards and Technology (NIST) to develop comprehensive standards related to the development, testing, and certification of effective robotic technologies for US&R applications. These standards will address robot mobility, sensing, navigation, planning, integration into operational caches, and human factors. Such standards will allow DHS to provide guidance to local, state, and federal homeland security entities regarding the purchase, deployment, and use of robotic systems for US&R applications.

This standards development effort focuses on fostering collaboration between US&R responders, robot vendors, and robot developers to generate consensus standards for task specific robot capabilities and interoperability of components. Furthermore, the effort includes the development and administration of technology readiness level (TRL) assessment exercises. These exercises will generate statistically significant performance data for developmental and fieldable robotic systems.

4

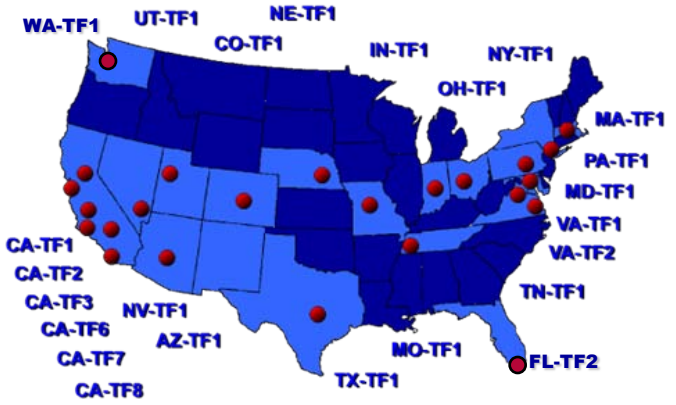
These response robot evaluation exercises for US&R teams introduce emerging robotic capabilities to emergency responders within their own training facilities, while educating robot developers regarding the necessary performance requirements and operational constraints to be effective. Emerging standard test methods and usage guides for US&R robot performance are under development within the ASTM International Committee on Homeland Security, Operational Equipment (E54.08.01). These events help refine the proposed standard test methods and fixtures/props that developers can use to practice critical capabilities and measure performance in ways that are relevant to emergency responders. These events are conducted in US&R training scenarios to help correlate the proposed standard test methods with envisioned deployment tasks and to lay the foundation for usage guides identifying a robot's applicability to particular response scenarios.

TASK FORCE PARTICIPATION



These response robot evaluation exercises for US&R teams introduce emerging robotic capabilities to emergency responders within their own training facilities, while educating robot developers regarding the necessary performance requirements and operational constraints to be effective. Emerging standard test methods and usage guides for US&R robot performance are under development within the ASTM International Committee on Homeland Security, Operational Equipment (E54.08.01). These events help refine the proposed standard test methods and fixtures/props that developers can use to practice critical capabilities and measure performance in ways that are relevant to emergency responders. These events are conducted in US&R training scenarios to help correlate the proposed standard test methods with envisioned deployment tasks and to lay the foundation for usage guides identifying a robot's applicability to particular response scenarios.

TASK FORCE PARTICIPATION



5

Disaster City
November 17 - 21, 2008

Disaster City
November 17 - 21, 2008

Homeland Security
NIST
Response Robot Evaluation Exercise
FEMA US&R Task Force Training Facility (TX-TF1)
Disaster City, College Station, TX
November 17-21, 2008
(including an ASTM E54.08.01 standards committee meeting Friday morning)
Sponsor: Bert Coursey, Science &Technology Directorate, DHS www.isd.mel.nist.gov/us&r_robot_standards
Test Director: Adam Jacoff, Intelligent Systems Division, NIST usar.robots@nist.gov
TEEX
TEXAS A&M SYSTEM
SPAWAR
SwRI
PENNSTATE ARL
UMASS
LAKE SCENARIO
[SHORING, BREACHING, LIFTING]
HAZMAT TRAIN WRECK (#116)
MAIN STREET
PASSENGER TRAIN WRECK (#126)
RUBBLE PILE 2 (#132)
HOUSE OF PANCAKES (#135)
RUBBLE PILE 1 (#128)
STEEL STRUCTURE (#133)
LAKE STREET
1ST STREET
STRIP MALL (#127)
DWELLING (#129)
WOOD PILE (#136)
THEATER (#134)
ROBOTS
ROBOTS
ROBOTS
NIST
CHECK-IN
ICP
OPERATIONAL STANDOFF 100+ METERS (300+ FEET)
LUNCH
TENT
PARKING
HAZMAT SCENARIO OPERATOR STATION
GATE [E]
DISASTER CITY

6

Event Introduction

The fifth in a series of DHS/NIST Response Robot Evaluation Exercises for FEMA urban search and rescue (US&R) teams is hosted at the Texas Task Force 1 (TX-TF1) training facility known as **Disaster City** located at Texas A&M University, College Station, TX. All applicable robots were invited to take part in this exercise, which will capture robot performance data within emerging standard robot test methods and operationally relevant practice scenarios. Practice scenarios feature ground robots working in confined spaces within a partially collapsed structure along with down-range reconnaissance of two train wrecks; one a hazardous materials train and the other a passenger train from an operational stand-off greater than 150m/500ft. Other practice scenarios will also be available.

The robots used in these scenarios should deploy any or all appropriate sensors such as: color cameras, two-way audio, thermal imagers, chemical sensors, 3D mapping, GPS/GIS location, and/or other useful capabilities such as payloads, manipulators, etc. General descriptions of the robots that were sought are as follows, but are not limited to:

- Ground based portable robots that can circumnavigate large unknown situations
- Highly agile, man-packable robots that can lead responders through complex environments
- Confined space accessible robots for deployment into sub-human size voids or be thrown into/over inaccessible area
- Aquatic vehicles with sonar and/or other sensors to search and identify underwater environments
- Quad-rotor aerial vehicles (under 2kg/4.4lbs) deploying sensors to perform horizontal and vertical station keeping in front of windows.

Event Introduction

The fifth in a series of DHS/NIST Response Robot Evaluation Exercises for FEMA urban search and rescue (US&R) teams is hosted at the Texas Task Force 1 (TX-TF1) training facility known as **Disaster City** located at Texas A&M University, College Station, TX. All applicable robots were invited to take part in this exercise, which will capture robot performance data within emerging standard robot test methods and operationally relevant practice scenarios. Practice scenarios feature ground robots working in confined spaces within a partially collapsed structure along with down-range reconnaissance of two train wrecks; one a hazardous materials train and the other a passenger train from an operational stand-off greater than 150m/500ft. Other practice scenarios will also be available.

The robots used in these scenarios should deploy any or all appropriate sensors such as: color cameras, two-way audio, thermal imagers, chemical sensors, 3D mapping, GPS/GIS location, and/or other useful capabilities such as payloads, manipulators, etc. General descriptions of the robots that were sought are as follows, but are not limited to:

- Ground based portable robots that can circumnavigate large unknown situations
- Highly agile, man-packable robots that can lead responders through complex environments
- Confined space accessible robots for deployment into sub-human size voids or be thrown into/over inaccessible area
- Aquatic vehicles with sonar and/or other sensors to search and identify underwater environments
- Quad-rotor aerial vehicles (under 2kg/4.4lbs) deploying sensors to perform horizontal and vertical station keeping in front of windows.

7

Event Robots - 2008

Robot Name (by size)	Company
Ground Robots	
Active Scope Camera	Tohoku University
Pointman (LRV)	ARA
VGTV	Inuktun
Dragon Runner SUGV	Foster-Miller/Automatika
Versatrax 100	Inuktun
Marv	Mesa Robotics
G2Bot	Mesa Robotics
Jacobs Rugg.Robot	Jacobs University
Hero	First-Response Robotics
Super Kenaf	IRS
PackBot EOD	iRobot
PackBot Explorer	iRobot
Robbie 6	University Koblenz-Landau
Matilda	Mesa Robotics
Matilda II	Mesa Robotics
NuTech-R4	Nagaoka Univ. Tech.
Versatrax 150	Inuktun
Modular Log. Platform	Segway
Talon Gen IV	Foster-Miller/Qinetiq
Talon Hazmat	Foster-Miller/Qinetiq
TeleMAX	TeleRob
HD-1	Remotec
RMP 400	Segway
Aerial Robots	
AirRobot	AirRobot

Event Robots - 2008

Robot Name (by size)	Company
Ground Robots	
Active Scope Camera	Tohoku University
Pointman (LRV)	ARA
VGTV	Inuktun
Dragon Runner SUGV	Foster-Miller/Automatika
Versatrax 100	Inuktun
Marv	Mesa Robotics
G2Bot	Mesa Robotics
Jacobs Rugg.Robot	Jacobs University
Hero	First-Response Robotics
Super Kenaf	IRS
PackBot EOD	iRobot
PackBot Explorer	iRobot
Robbie 6	University Koblenz-Landau
Matilda	Mesa Robotics
Matilda II	Mesa Robotics
NuTech-R4	Nagaoka Univ. Tech.
Versatrax 150	Inuktun
Modular Log. Platform	Segway
Talon Gen IV	Foster-Miller/Qinetiq
Talon Hazmat	Foster-Miller/Qinetiq
TeleMAX	TeleRob
HD-1	Remotec
RMP 400	Segway
Aerial Robots	
AirRobot	AirRobot

8

Event Robots - 2008

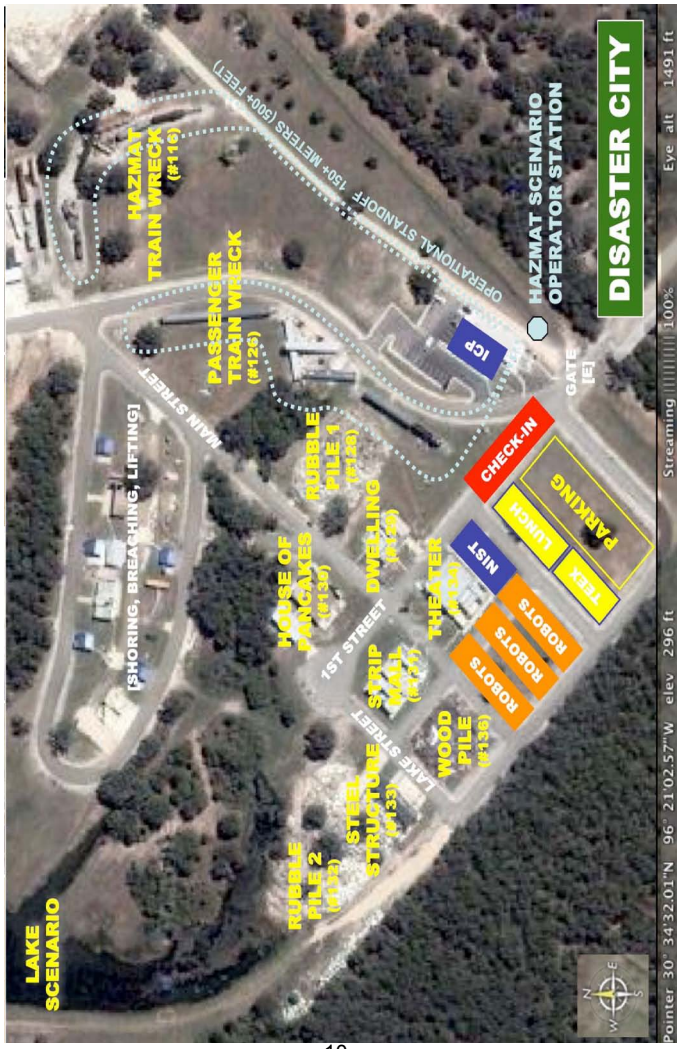
Robot Name (by size)	Company
Aquatic Robots	
VideoRay Pro 3	VideoRay
LBV200L2	SeaBotix
LBV150SE-5	SeaBotix
Sensors	
dcMap	University of Freiburg
High Speed 3D Scanner	Tohoku University
Multibeam Imaging Sonar	
MBI350-45	BlueView Tech.
P450E-15	BlueView Tech.
P900E-20	BlueView Tech.
Multibeam Imaging Sonar	BlueView Tech.
Swiss Ranger 4000	Mesa Imaging

Event Robots - 2008

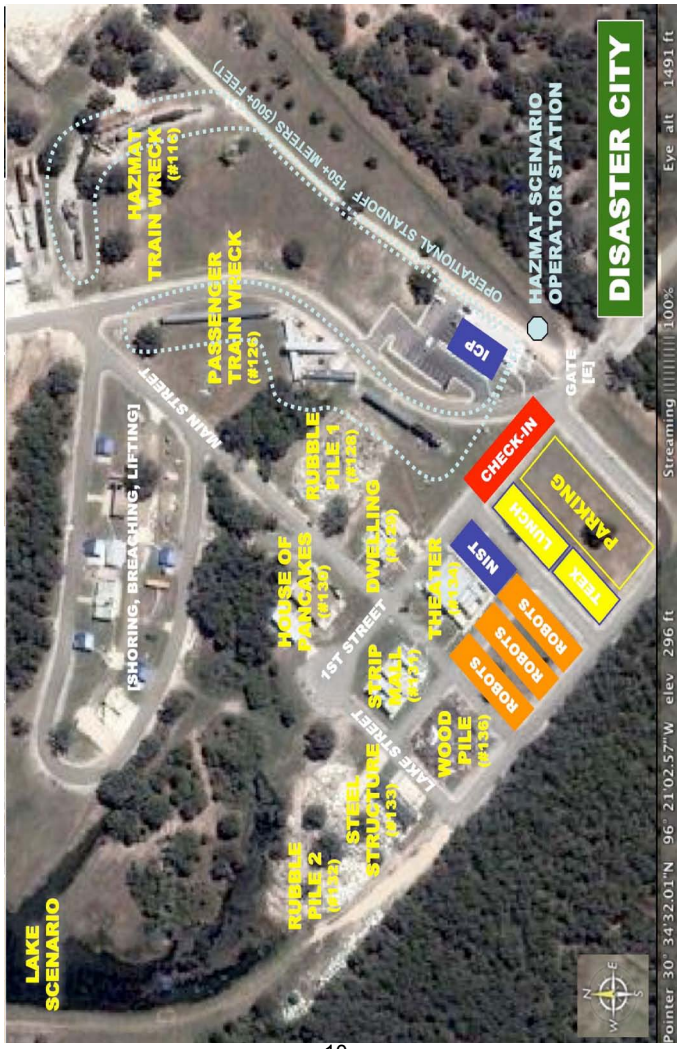
Robot Name (by size)	Company
Aquatic Robots	
VideoRay Pro 3	VideoRay
LBV200L2	SeaBotix
LBV150SE-5	SeaBotix
Sensors	
dcMap	University of Freiburg
High Speed 3D Scanner	Tohoku University
Multibeam Imaging Sonar	
MBI350-45	BlueView Tech.
P450E-15	BlueView Tech.
P900E-20	BlueView Tech.
Multibeam Imaging Sonar	BlueView Tech.
Swiss Ranger 4000	Mesa Imaging

9

Site Map



Site Map



10

#134
Multi-Purpose Building
Collapse/Theater Building

Dispatch Station/Robot Picture/Cache Packaging

Robot Navigation During Teleoperation (Random Maze)

#134
Multi-Purpose Building
Collapse/Theater Building

Dispatch Station/Robot Picture/Cache Packaging

Robot Navigation During Teleoperation (Random Maze)

Main Street

Visual Acuity/Field Of View/Spatial Awareness Test Method

#130 Annex
Covered Vehicle Port

Endurance Test Method

Main Street

Visual Acuity/Field Of View/Spatial Awareness Test Method

#130 Annex
Covered Vehicle Port

Endurance Test Method

12

#129
Dwelling Collapse

The House of Pancakes collapse scenario

#129
Dwelling Collapse

The House of Pancakes collapse scenario

#130
House of Pancakes

Dwelling collapse scenario

#130
House of Pancakes

Dwelling collapse scenario

13

#133
Municipal Building
Industrial Complex

Confined Space Test Method Incline Plane Test Method

Stairs

Step Gap Test Method

#133
Municipal Building
Industrial Complex

Confined Space Test Method Incline Plane Test Method

Stairs

Step Gap Test Method

14

#131
Strip Mall Collapse

Directed Perception and Grasping Dexterity Test Method

Near Hazmat Train Derailment

Towing Test Method

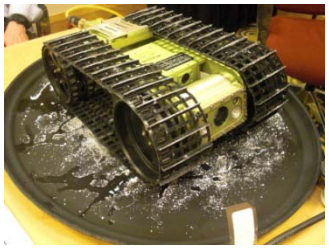
#131
Strip Mall Collapse

Directed Perception and Grasping Dexterity Test Method

Near Hazmat Train Derailment

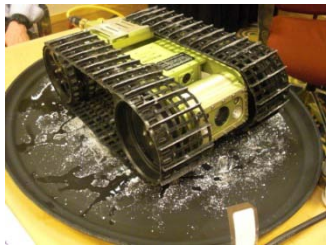
Towing Test Method

Hazmat Train Derailment



Decontamination Test Method

Hazmat Train Derailment

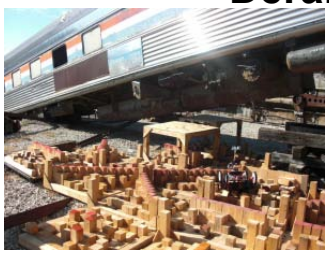


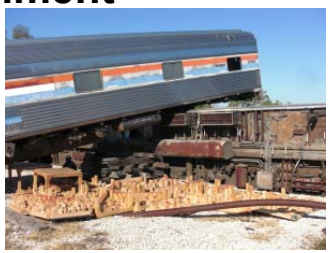
Decontamination Test Method

#128 Passenger Train Derailment

Passenger train derailment scenario

#128 Passenger Train Derailment

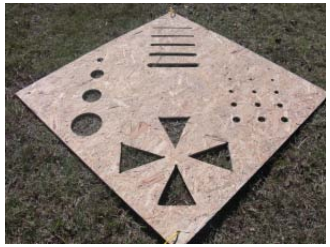




Passenger train derailment scenario

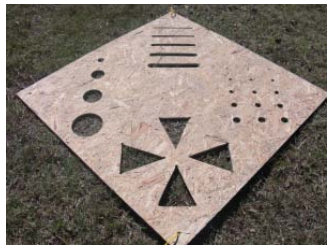
16

Lake / Dock



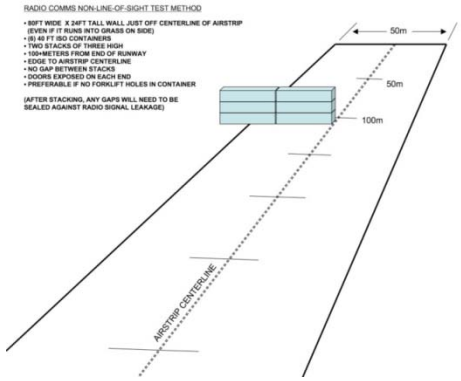
Underwater Scenario

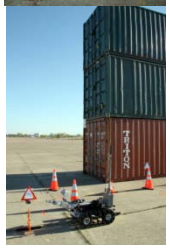
Lake / Dock



Underwater Scenario

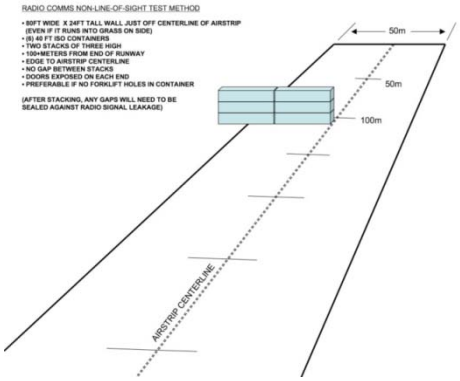
Off-Site
Riverside Airstrip

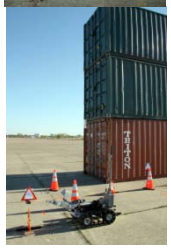




Radio Comms Non-line of Sight Test Method

Off-Site
Riverside Airstrip





Radio Comms Non-line of Sight Test Method

17

Mapping Scenarios

#134 Theater Building:
This building showcases two emerging test methods used to evaluate the performance of robotic mapping technologies. The Wall Maze and Tube Maze are testing apparatuses designed to challenge mapping technologies over potential failure conditions.

Wall Maze Test Method

Tube Maze Test Method

#130 Pancake House:
This building embeds the Tunnel Test Method, another emerging test method for robotic mapping, to create a scenario that evaluates a robots ability to map three-dimensional space in environments that may not contain distinguishable features.

Tunnel Test Method

Pancake House with Tunnel

Mapping Scenarios

#134 Theater Building:
This building showcases two emerging test methods used to evaluate the performance of robotic mapping technologies. The Wall Maze and Tube Maze are testing apparatuses designed to challenge mapping technologies over potential failure conditions.

Wall Maze Test Method

Tube Maze Test Method

#130 Pancake House:
This building embeds the Tunnel Test Method, another emerging test method for robotic mapping, to create a scenario that evaluates a robots ability to map three-dimensional space in environments that may not contain distinguishable features.

Tunnel Test Method

Pancake House with Tunnel

Mapping in Scenarios Cont.

#128 Passenger Train Derailment
The scenario combines emerging test methods used to evaluate the mobility of robotic platforms to assess how complex terrain in variable environmental conditions (indoor and outdoor) will impact the ability of a robot to make maps.

Passenger Train Derailment

Inside Passenger Train

#129 The Dwelling:
This building houses partial mazes in operationally relevant environments to create a scenario that explores the ability of a robot to create maps in unknown environments containing undefined features and shape primitives.

The Dwelling

Partial Mazes in Scenario

Mapping in Scenarios Cont.

#128 Passenger Train Derailment
The scenario combines emerging test methods used to evaluate the mobility of robotic platforms to assess how complex terrain in variable environmental conditions (indoor and outdoor) will impact the ability of a robot to make maps.

Passenger Train Derailment

Inside Passenger Train

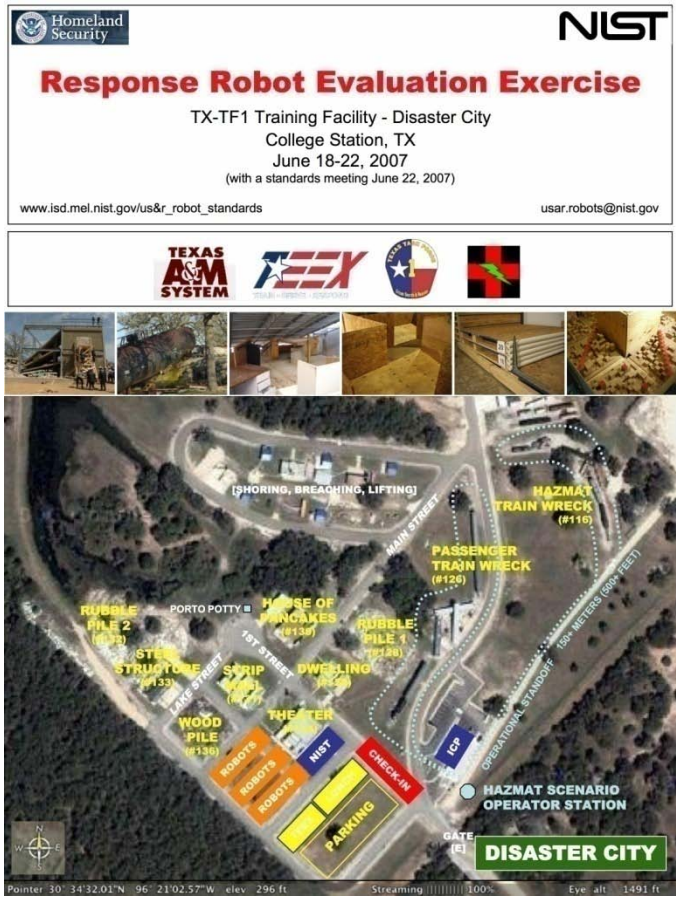
#129 The Dwelling:
This building houses partial mazes in operationally relevant environments to create a scenario that explores the ability of a robot to create maps in unknown environments containing undefined features and shape primitives.

The Dwelling

Partial Mazes in Scenarios

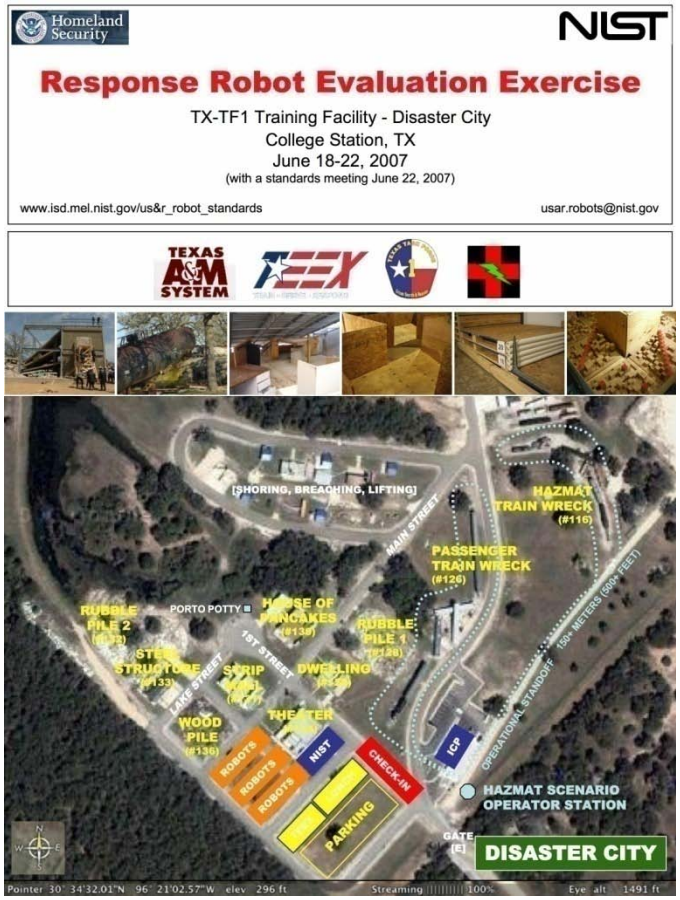
19

Disaster City
June 18-22, 2007



20

Disaster City
June 18-22, 2007



20

Event Introduction

The fourth in a series of DHS/NIST Response Robot Evaluation Exercises for FEMA urban search and rescue (US&R) teams is hosted at the Texas Task Force 1 (TX-TF1) training facility known as **Disaster City** located at Texas A&M University, College Station, TX. All applicable robots were invited to take part in this exercise, which will capture robot performance data within emerging standard robot test methods and operationally relevant practice scenarios. Practice scenarios feature ground robots working in confined spaces within a partially collapsed structure along with down-range reconnaissance of two train wrecks; one a hazardous materials train and the other a passenger train from an operational stand-off greater than 150m/500ft. Other practice scenarios will also be available.

The robots used in these scenarios should deploy any or all appropriate sensors such as: color cameras, two-way audio, thermal imagers, chemical sensors, 3D mapping, GPS/GIS location, and/or other useful capabilities such as payloads, manipulators, etc. General descriptions of the robots that were sought are as follows, but are not limited to:

- Ground based portable robots that can circumnavigate large unknown situations (i.e. around the train derailments).
- Highly agile, man-packable robots that can lead responders through complex environments (i.e. the buildings and rubble piles).
- Confined space accessible robots for deployment into sub-human size voids or be thrown into/over inaccessible area
- Wall climbing robots for surveillance from elevated vantage points

Event Introduction

The fourth in a series of DHS/NIST Response Robot Evaluation Exercises for FEMA urban search and rescue (US&R) teams is hosted at the Texas Task Force 1 (TX-TF1) training facility known as **Disaster City** located at Texas A&M University, College Station, TX. All applicable robots were invited to take part in this exercise, which will capture robot performance data within emerging standard robot test methods and operationally relevant practice scenarios. Practice scenarios feature ground robots working in confined spaces within a partially collapsed structure along with down-range reconnaissance of two train wrecks; one a hazardous materials train and the other a passenger train from an operational stand-off greater than 150m/500ft. Other practice scenarios will also be available.

The robots used in these scenarios should deploy any or all appropriate sensors such as: color cameras, two-way audio, thermal imagers, chemical sensors, 3D mapping, GPS/GIS location, and/or other useful capabilities such as payloads, manipulators, etc. General descriptions of the robots that were sought are as follows, but are not limited to:

- Ground based portable robots that can circumnavigate large unknown situations (i.e. around the train derailments).
- Highly agile, man-packable robots that can lead responders through complex environments (i.e. the buildings and rubble piles).
- Confined space accessible robots for deployment into sub-human size voids or be thrown into/over inaccessible area
- Wall climbing robots for surveillance from elevated vantage points

21

Event Robots - 2007

Robot Name (by size)	Company
Ground Robots	
Eyeball	Remington Tech
ToughBot	Omnitech Robotics
Active Scope Camera	Tohoku University
Dragon Runner	Automatika
BomBot	WVHTC
BomBot 2	WVHTC
Marv	Mesa Robotics
Hero	First-Response Robotics
PackBot EOD	iRobot
PackBot Explorer	iRobot
Matilda	Mesa Robotics
Modular Log. Platform	Segway
Talon	Foster-Miller
Talon Hazmat	Foster-Miller
RMP 200	Segway
RMP 400	Segway
TeleMax	TeleRob
Wall Climbers	
VMRP	Vortex
Aerial Robots	
AirRobot	AirRobot

Event Robots - 2007

Robot Name (by size)	Company
Ground Robots	
Eyeball	Remington Tech
ToughBot	Omnitech Robotics
Active Scope Camera	Tohoku University
Dragon Runner	Automatika
BomBot	WVHTC
BomBot 2	WVHTC
Marv	Mesa Robotics
Hero	First-Response Robotics
PackBot EOD	iRobot
PackBot Explorer	iRobot
Matilda	Mesa Robotics
Modular Log. Platform	Segway
Talon	Foster-Miller
Talon Hazmat	Foster-Miller
RMP 200	Segway
RMP 400	Segway
TeleMax	TeleRob
Wall Climbers	
VMRP	Vortex
Aerial Robots	
AirRobot	AirRobot

22

Site Map

Site Map

23

Maryland TF-1
August 19-21, 2006

Homeland Security

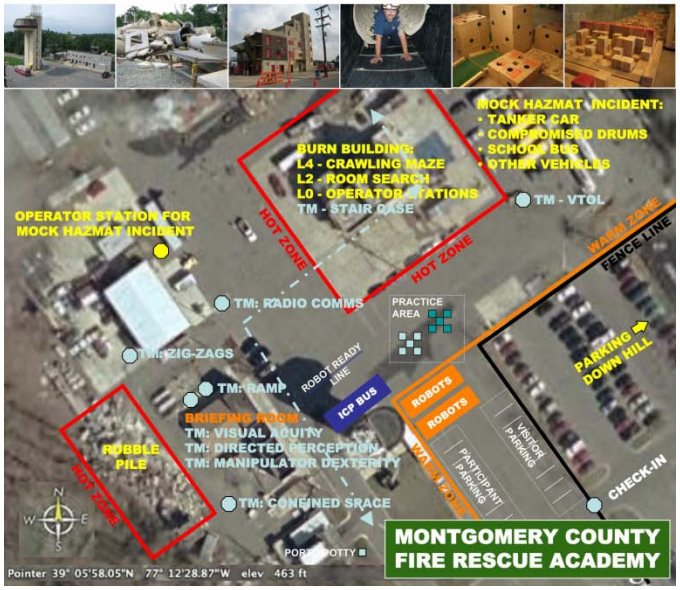
NIST

Response Robot Evaluation Exercise

MD-TF1 Training Academy
Rockville, MD
August 19-21, 2006
(with a standards meeting August 21, 2006)

www.isd.mel.nist.gov/us&r_robot_standards

usar.robots@nist.gov



Maryland TF-1
August 19-21, 2006

Homeland Security

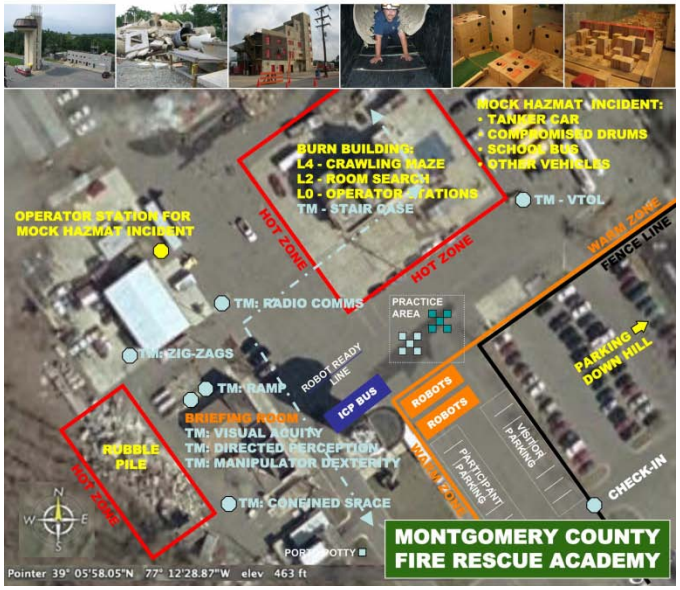
NIST

Response Robot Evaluation Exercise

MD-TF1 Training Academy
Rockville, MD
August 19-21, 2006
(with a standards meeting August 21, 2006)

www.isd.mel.nist.gov/us&r_robot_standards

usar.robots@nist.gov



Event Introduction

The third in a series of response robot informal evaluation exercises for DHS/FEMA US&R teams was hosted at the Montgomery County Fire Rescue Training Academy in Rockville, Maryland (near Washington DC). This event finalized the test methods targeted for the initial (Wave 1) set of standards as well as initiated experimentation with onboard payloads, especially for Chemical, Biological, Radiological, Nuclear, and Explosive (CBRNE) sensing. Therefore, emphasis was on (a) robots that could address the deployment categories relevant to Wave 1 standards and (b) deploying CBRNE sensors on these robots. The three robot deployment categories selected by responders to be emphasized in Wave 1 are: ground peek robots that are small and throwable, ground wide-area survey robots that can traverse non-collapsed structures or areas external to the collapse, and aerial survey or loiter robots. Manufacturers of robots, purchasable and/or developmental, that can address these areas, were invited to take part in this exercise, which will highlight operationally relevant US&R scenarios.

Maryland Task Force 1 Training Facility

Event Introduction

The third in a series of response robot informal evaluation exercises for DHS/FEMA US&R teams was hosted at the Montgomery County Fire Rescue Training Academy in Rockville, Maryland (near Washington DC). This event finalized the test methods targeted for the initial (Wave 1) set of standards as well as initiated experimentation with onboard payloads, especially for Chemical, Biological, Radiological, Nuclear, and Explosive (CBRNE) sensing. Therefore, emphasis was on (a) robots that could address the deployment categories relevant to Wave 1 standards and (b) deploying CBRNE sensors on these robots. The three robot deployment categories selected by responders to be emphasized in Wave 1 are: ground peek robots that are small and throwable, ground wide-area survey robots that can traverse non-collapsed structures or areas external to the collapse, and aerial survey or loiter robots. Manufacturers of robots, purchasable and/or developmental, that can address these areas, were invited to take part in this exercise, which will highlight operationally relevant US&R scenarios.

Maryland Task Force 1 Training Facility

25

Event Robots - 2006

Robot Name (by size)	Company
Ground Robots	
Eyeball	Remington Tech
ToughBot	Omnitech Robotics
Iris	Toin
LRV	Applied Research Assoc.
VGTV-Extreme	Inuktun
Dragon Runner	Automatika
BomBot	WVHTC
Marv	Mesa Robotics
Soryu	IRS
Soryu V	IRS
PackBot EOD	iRobot
PackBot Explorer	iRobot
Hibiscus	Toin
Cphea	Toin
Shinobi	Univer. Electro Comm.
Matilda	Mesa Robotics
ATRV mini	Idaho National Lab
Talon	Foster-Miller
Mini-Andros II	Remotec
Andros F6A	Remotec
Boz I	BOZ Robotics
Wall Climbers	
VMRP	Vortex
NanoMag	Inuktun
Aerial Robots	
Blimp	ARACAR
AirRobot	AirRobot
Yamaha Heliocoper	Skeyes Unlimited

Event Robots - 2006

Robot Name (by size)	Company
Ground Robots	
Eyeball	Remington Tech
ToughBot	Omnitech Robotics
Iris	Toin
LRV	Applied Research Assoc.
VGTV-Extreme	Inuktun
Dragon Runner	Automatika
BomBot	WVHTC
Marv	Mesa Robotics
Soryu	IRS
Soryu V	IRS
PackBot EOD	iRobot
PackBot Explorer	iRobot
Hibiscus	Toin
Cphea	Toin
Shinobi	Univer. Electro Comm.
Matilda	Mesa Robotics
ATRV mini	Idaho National Lab
Talon	Foster-Miller
Mini-Andros II	Remotec
Andros F6A	Remotec
Boz I	BOZ Robotics
Wall Climbers	
VMRP	Vortex
NanoMag	Inuktun
Aerial Robots	
Blimp	ARACAR
AirRobot	AirRobot
Yamaha Heliocoper	Skeyes Unlimited

26

Site Overview

Site Overview

27

Disaster City
April 4-6, 2006

Homeland Security

NIST

Response Robot Evaluation Exercise

TX-TF1 Training Facility - Disaster City
College Station, TX
April 4-6, 2006
(with a standards meeting April 7, 2006)

www.isd.mel.nist.gov/us&r_robot_standards usar.robots@nist.gov

TEXAS A&M SYSTEM TEEX

Disaster City
April 4-6, 2006

28

Event Introduction

The second in a series of response robot evaluation exercises for DHS/FEMA US&R teams was hosted at the TX-TF1 training facility known as Disaster City located at Texas A&M University, College Station, TX. All applicable robots and supporting technologies (e.g., sensors), purchasable and/or developmental, were invited to take part in this exercise, which highlighted operationally relevant US&R scenarios specifically devised for ground, aerial, and underwater response robots. Based on their experiences deploying robots within the training scenarios, responders selected three robot categories as being the focus deployment types for the development of the Wave 1 standards. These are small throw-able "peek bots;" wide-area ground survey robots; and aerial loiter/survey robots.

Event Introduction

The second in a series of response robot evaluation exercises for DHS/FEMA US&R teams was hosted at the TX-TF1 training facility known as Disaster City located at Texas A&M University, College Station, TX. All applicable robots and supporting technologies (e.g., sensors), purchasable and/or developmental, were invited to take part in this exercise, which highlighted operationally relevant US&R scenarios specifically devised for ground, aerial, and underwater response robots. Based on their experiences deploying robots within the training scenarios, responders selected three robot categories as being the focus deployment types for the development of the Wave 1 standards. These are small throw-able "peek bots;" wide-area ground survey robots; and aerial loiter/survey robots.

29

Event Robots - 2006

Robot Name (by size)	Company
Ground Robots	
Eyeball	Remington Tech
ToughBot	Omnitech Robotics
VGTV-Extreme	Inuktun
BomBot	WVHTC
Marv	Mesa Robotics
PackBot EOD	iRobot
PackBot Explorer	iRobot
Matilda	Mesa Robotics
Chaos	Autonomous Solutions, Inc.
Talon	Foster-Miller
Mini-Andros II	Remotec
Andros F6A	Remotec
TeleMax	TeleRob
PackBot Scout	iRobot
Sneaky	M-Bots
Wall Climbers	
VMRP	Vortex
NanoMag	Inuktun
Aerial Robots	
Blimp	ARACAR
Nighthawk	Applied Research Assoc.
Dragon Eye	AeroVironment, Inc.
CyberBug	Cyber Defense Systems, Inc.
Raven	AeroVironment, Inc.
Evolution-XTS	L-3 BAI Aerosystems, Inc
Flying Bassett	Univ. of AL – Huntsville
Wasp	AeroVironment, Inc.
Aquatic Robots	
Pro III	VideoRay, LLC

Event Robots - 2006

Robot Name (by size)	Company
Ground Robots	
Eyeball	Remington Tech
ToughBot	Omnitech Robotics
VGTV-Extreme	Inuktun
BomBot	WVHTC
Marv	Mesa Robotics
PackBot EOD	iRobot
PackBot Explorer	iRobot
Matilda	Mesa Robotics
Chaos	Autonomous Solutions, Inc.
Talon	Foster-Miller
Mini-Andros II	Remotec
Andros F6A	Remotec
TeleMax	TeleRob
PackBot Scout	iRobot
Sneaky	M-Bots
Wall Climbers	
VMRP	Vortex
NanoMag	Inuktun
Aerial Robots	
Blimp	ARACAR
Nighthawk	Applied Research Assoc.
Dragon Eye	AeroVironment, Inc.
CyberBug	Cyber Defense Systems, Inc.
Raven	AeroVironment, Inc.
Evolution-XTS	L-3 BAI Aerosystems, Inc
Flying Bassett	Univ. of AL – Huntsville
Wasp	AeroVironment, Inc.
Aquatic Robots	
Pro III	VideoRay, LLC

30

Site Map

Site Map

31

32

Safety 35

Test Methods 37

Ground Robots 71

Wall Climbers 157

Aerial Robots 163

Aquatic Robots 187

Sensors 191

Safety 35

Test Methods 37

Ground Robots 71

Wall Climbers 157

Aerial Robots 163

Aquatic Robots 187

Sensors 191

34

Safety

Safety

Safety of all personnel participating in this event is our first concern. The fact that we have robotics personnel generally unaccustomed to working within the hazardous environments at these US&R training sites is particularly problematic. Having emergency responders generally unaccustomed to working with robots is also a concern. Please follow these simple guidelines:

• Appropriate personal protective equipment (PPE) must be worn at all times while on site (see associated page on PPE). Compliance with PPE rules are mandatory.

• Rubble piles and other difficult scenarios present the most risk to novices. If your robot needs to be extracted, please ask your associated emergency responder to retrieve it.

• Always maintain awareness of others working within your scenario and communicate your intentions *before* doing whatever you have in mind.

• Robots can do unpredictable things; the bigger/heavier the robot the more space you should allow it when operating. Always verify that the robot is powered off before interacting with it. Never stick your fingers into wheels, tracks, manipulator pinch points, etc. while the robot is powered on. Remotely teleoperated robots may be the most dangerous because the remote operator may not know you decided to perform on-the-spot maintenance! Always familiarize yourself with the EMERGENCY STOP procedures first -- and last -- before interacting with or operating robots. Some implementations are more predictable than others.

• If you see anything you consider unsafe in our environment, please inform the Test Director or any emergency responder on site, and let's discuss it at the daily after action briefing to be sure every potential hazard is addressed.

• **Everybody on site is a safety officer!**

Safety

Safety

Safety of all personnel participating in this event is our first concern. The fact that we have robotics personnel generally unaccustomed to working within the hazardous environments at these US&R training sites is particularly problematic. Having emergency responders generally unaccustomed to working with robots is also a concern. Please follow these simple guidelines:

• Appropriate personal protective equipment (PPE) must be worn at all times while on site (see associated page on PPE). Compliance with PPE rules are mandatory.

• Rubble piles and other difficult scenarios present the most risk to novices. If your robot needs to be extracted, please ask your associated emergency responder to retrieve it.

• Always maintain awareness of others working within your scenario and communicate your intentions *before* doing whatever you have in mind.

• Robots can do unpredictable things; the bigger/heavier the robot the more space you should allow it when operating. Always verify that the robot is powered off before interacting with it. Never stick your fingers into wheels, tracks, manipulator pinch points, etc. while the robot is powered on. Remotely teleoperated robots may be the most dangerous because the remote operator may not know you decided to perform on-the-spot maintenance! Always familiarize yourself with the EMERGENCY STOP procedures first -- and last -- before interacting with or operating robots. Some implementations are more predictable than others.

• If you see anything you consider unsafe in our environment, please inform the Test Director or any emergency responder on site, and let's discuss it at the daily after action briefing to be sure every potential hazard is addressed.

• **Everybody on site is a safety officer!**

Personal Protective Equipment

Personal protective equipment (PPE) is required for working within any US&R scenario at the site. People in street clothes or without helmets/gloves/etc as shown below are limited to paved roads only. If you are working within a scenario, you must wear ALL the equipment shown below. Compliance with these personal protective equipment rules are mandatory - it is standard practice for US&R environments.

- **Helmet**
  Hard hats are okay. We have some to borrow or you can purchase at www.thefirestore.com for $75 and up.
- **Ear protection**
  We'll supply these.
- **Eye protection**
  Sunglasses are okay.
- **Long sleeve shirt**
- **Work gloves**
- **Long pants**
  Army surplus stores sell typical BDU and EMT pants.
- **Boots**
  Preferably steel toe.

Additional protective padding for knees and elbows is optional, but good for rubble piles.

Personal Protective Equipment

Personal protective equipment (PPE) is required for working within any US&R scenario at the site. People in street clothes or without helmets/gloves/etc as shown below are limited to paved roads only. If you are working within a scenario, you must wear ALL the equipment shown below. Compliance with these personal protective equipment rules are mandatory - it is standard practice for US&R environments.

- **Helmet**
  Hard hats are okay. We have some to borrow or you can purchase at www.thefirestore.com for $75 and up.
- **Ear protection**
  We'll supply these.
- **Eye protection**
  Sunglasses are okay.
- **Long sleeve shirt**
- **Work gloves**
- **Long pants**
  Army surplus stores sell typical BDU and EMT pants.
- **Boots**
  Preferably steel toe.

Additional protective padding for knees and elbows is optional, but good for rubble piles.

Test Methods

Test Methods

Test Methods/Practices and Suites:
Each is described in a form and organized into suites.

Standardization levels
- Standard Test Method
- Standard Practice, Terminology
- V Validating--may be indicated with an ASTM Work Item (WK) designation
- P Prototype
  * The majority progress from Practice to Test Method, but some are Practices or Terminology in nature, as specifically noted.

Terminology
- Version 2007a*

Logistics Suite
- Cache Packaging, Setup, Weight, Tools

Sensing Suite
- Video: Acuity and Field of View
- V Video: Directed Search
- V Video: Underpass Search
- V Audio: One/Two Way Audio
- P Laser Range: Mapping

Mobility Suite
- V Flat Dash and Tow (1 km)
- V Slalom: Flat Flooring (2, 4, 8 turns; 250m)
- V Slalom: Continuous Ramps (2, 4 , 8 turns; 250m)
- V Slalom: Crossing Ramps (2, 4 , 8 turns; 250m)
- V Slalom: Symmetric Stepfields (2, 4 turns; 250m)
- V Gap Crossing (10 - 100 cm)
- V Pipe Step (10 - 100 cm)
- V Stairs (30°, 35°, 40°, 45°; wood, steel)
- V Inclined Plane (30°, 45°)
- P Tow: Hitched Trailer (100m;1 turn)
- P Tow: Hitched Drag (100m;1 turn)
- P Tow: End-Effector Drag (100m;1 turn)
- V Confined Space (10 – 100 cm)

** The standard is Practice/Terminology in nature and not a Test Method.*

Test Methods/Practices and Suites:
Each is described in a form and organized into suites.

Standardization levels
- Standard Test Method
- Standard Practice, Terminology
- V Validating--may be indicated with an ASTM Work Item (WK) designation
- P Prototype
  * The majority progress from Practice to Test Method, but some are Practices or Terminology in nature, as specifically noted.

Terminology
- Version 2007a*

Logistics Suite
- Cache Packaging, Setup, Weight, Tools

Sensing Suite
- Video: Acuity and Field of View
- V Video: Directed Search
- V Video: Underpass Search
- V Audio: One/Two Way Audio
- P Laser Range: Mapping

Mobility Suite
- V Flat Dash and Tow (1 km)
- V Slalom: Flat Flooring (2, 4, 8 turns; 250m)
- V Slalom: Continuous Ramps (2, 4 , 8 turns; 250m)
- V Slalom: Crossing Ramps (2, 4 , 8 turns; 250m)
- V Slalom: Symmetric Stepfields (2, 4 turns; 250m)
- V Gap Crossing (10 - 100 cm)
- V Pipe Step (10 - 100 cm)
- V Stairs (30°, 35°, 40°, 45°; wood, steel)
- V Inclined Plane (30°, 45°)
- P Tow: Hitched Trailer (100m;1 turn)
- P Tow: Hitched Drag (100m;1 turn)
- P Tow: End-Effector Drag (100m;1 turn)
- V Confined Space (10 – 100 cm)

** The standard is Practice/Terminology in nature and not a Test Method.*

Radio Comms Suite
V Line-of-sight
V Non line-of-sight
P Structure & Tunnel Penetration
P Urban Canyon

Energy/Power Suite
V Endurance

Human-System Interaction (HSI) Suite
V Random Maze Search
V Random Maze Navigation
P Checklist Items

Mobile Manipulation Suite
V Perception
V Grasping
P Door Opening

Maneuvering-Aerial Suite
V VTOL Station Keeping

Maneuvering-Aquatic Suite
V Underwater Navigation and Search

Safety/Environment Suite
V Washdown/Decontamination

Radio Comms Suite
V Line-of-sight
V Non line-of-sight
P Structure & Tunnel Penetration
P Urban Canyon

Energy/Power Suite
V Endurance

Human-System Interaction (HSI) Suite
V Random Maze Search
V Random Maze Navigation
P Checklist Items

Mobile Manipulation Suite
V Perception
V Grasping
P Door Opening

Maneuvering-Aerial Suite
V VTOL Station Keeping

Maneuvering-Aquatic Suite
V Underwater Navigation and Search

Safety/Environment Suite
V Washdown/Decontamination

Test Methods

39

Purpose

The goal of this effort is to facilitate emergency responders evaluations and comparisons of robots based on quantitative and statistically significant performance data, captured via running the standard test methods, to help guide purchasing decisions and understand deployment capabilities. The test methods also support operator proficiency training and foster development and hardening of advanced mobile robot capabilities.

General Scope

These suites of test methods are developed to characterize the capabilities of robots to be operated in human-scale, complex environments that feature variable lighting, temperature, terrains, etc. Ground, aerial, and aquatic robots are covered. The robots shall be teleoperated via a remote operator control unit (OCU) out of sight and sound of the test apparatuses, relying solely on the robot's communications capability. A robot shall use a single configuration (in traction mechanisms, manipulators, payloads, batteries, communications, etc.), for all the suites of test methods. Any variation in the configuration shall cause the entire suites to be retested. Assistive or autonomous capabilities that particular robots may have quipped with can be used for improved performance, efficiency, and survivability during tests. While developed for emergency response robots, these test methods may be applicable to other remotely controlled devices and in other application domains.

Apparatuses

The NIST team strives to use readily available, inexpensive, and easily specifiable material to furnish each test method with an apparatus, many of which specify targets, terrains, and tasks that are intentionally abstract to facilitate repeatable and reproducible performance data as required for the standardization process. These artifacts can be modified or replaced with more operationally representative examples while generally conforming to the same apparatus and method for training, practice, and comparison of results. This approach allows direct comparisons across different robot models and particular configurations of similar robot models.

Purpose

The goal of this effort is to facilitate emergency responders evaluations and comparisons of robots based on quantitative and statistically significant performance data, captured via running the standard test methods, to help guide purchasing decisions and understand deployment capabilities. The test methods also support operator proficiency training and foster development and hardening of advanced mobile robot capabilities.

General Scope

These suites of test methods are developed to characterize the capabilities of robots to be operated in human-scale, complex environments that feature variable lighting, temperature, terrains, etc. Ground, aerial, and aquatic robots are covered. The robots shall be teleoperated via a remote operator control unit (OCU) out of sight and sound of the test apparatuses, relying solely on the robot's communications capability. A robot shall use a single configuration (in traction mechanisms, manipulators, payloads, batteries, communications, etc.), for all the suites of test methods. Any variation in the configuration shall cause the entire suites to be retested. Assistive or autonomous capabilities that particular robots may have quipped with can be used for improved performance, efficiency, and survivability during tests. While developed for emergency response robots, these test methods may be applicable to other remotely controlled devices and in other application domains.

Apparatuses

The NIST team strives to use readily available, inexpensive, and easily specifiable material to furnish each test method with an apparatus, many of which specify targets, terrains, and tasks that are intentionally abstract to facilitate repeatable and reproducible performance data as required for the standardization process. These artifacts can be modified or replaced with more operationally representative examples while generally conforming to the same apparatus and method for training, practice, and comparison of results. This approach allows direct comparisons across different robot models and particular configurations of similar robot models.

Performance Data Collections

Test methods are implemented as described in the Purposes, Apparatuses, Metrics, and Procedures sections. Performance data are collected through conducting the tests with statistically significant numbers of trials, using the associated evaluation forms. The numbers of trials are determined by ASTM with input from all participants, using statistical principles and considering operational practicality. The baseline performance data are obtained from testing "expert" operators, as designated by the robot developers. Performance data collected from novice populations are used to evaluate training requirements, they also provide average performance expectations in field practices.

Key Words

complete: when robot finishes the specified procedure, a traverse, repetition, or test and the footprint lands on the end point and the appendages are in the original, retracted positions.

corner: a path feature for testing ground robots, formed by two wall elements connecting on the edges by 90 degrees. A corner is visited when robot's position projects both wall elements.

flat floor element: a standardized unit of flat surface made of two OSB boards separated by 10 x 10 cm (4 x 4 in) solid wood posts, with the overall size of 1200 x 1200 x 10 cm (48 x 48 x 4 in).

OSB plywood board: OSB stands for Oriented Strand Board. The material provides a frictional surface similar to dust covered concrete. It is commonly available in U.S. in the size of 1200 x 2400 cm (48 x 96 in).

remote teleoperation: when teleoperating the robot from a non light-of-sight location and without the effect of sound.

ramp: a terrain type for testing ground robots where the floor elevation increases in a 15 degree angle. A ramp element is a standardized unit for ramp with the surface area of 1.2 x 1.2 m (4' x 4'). A half ramp element is also used where the elevating direction extends only half the distance, 60cm (2').

repetition: when robot completes all the tasks in the test once and is back on the ending point; is used typically when a test requires to be run multiple times to gain significance.

step field: a terrain type for testing ground robots where the floor is covered with rolls of 10 x 10 cm (4 x 4 in) solid wood posts. The heights of the wood posts vary with respect to designed patterns. The heights of the posts are standardized in 10, 20, and 40 cm. The size of a step field element or step field pallet is 1.2 x 1.2 m (4' x 4').

Performance Data Collections

Test methods are implemented as described in the Purposes, Apparatuses, Metrics, and Procedures sections. Performance data are collected through conducting the tests with statistically significant numbers of trials, using the associated evaluation forms. The numbers of trials are determined by ASTM with input from all participants, using statistical principles and considering operational practicality. The baseline performance data are obtained from testing "expert" operators, as designated by the robot developers. Performance data collected from novice populations are used to evaluate training requirements, they also provide average performance expectations in field practices.

Key Words

complete: when robot finishes the specified procedure, a traverse, repetition, or test and the footprint lands on the end point and the appendages are in the original, retracted positions.

corner: a path feature for testing ground robots, formed by two wall elements connecting on the edges by 90 degrees. A corner is visited when robot's position projects both wall elements.

flat floor element: a standardized unit of flat surface made of two OSB boards separated by 10 x 10 cm (4 x 4 in) solid wood posts, with the overall size of 1200 x 1200 x 10 cm (48 x 48 x 4 in).

OSB plywood board: OSB stands for Oriented Strand Board. The material provides a frictional surface similar to dust covered concrete. It is commonly available in U.S. in the size of 1200 x 2400 cm (48 x 96 in).

remote teleoperation: when teleoperating the robot from a non light-of-sight location and without the effect of sound.

ramp: a terrain type for testing ground robots where the floor elevation increases in a 15 degree angle. A ramp element is a standardized unit for ramp with the surface area of 1.2 x 1.2 m (4' x 4'). A half ramp element is also used where the elevating direction extends only half the distance, 60cm (2').

repetition: when robot completes all the tasks in the test once and is back on the ending point; is used typically when a test requires to be run multiple times to gain significance.

step field: a terrain type for testing ground robots where the floor is covered with rolls of 10 x 10 cm (4 x 4 in) solid wood posts. The heights of the wood posts vary with respect to designed patterns. The heights of the posts are standardized in 10, 20, and 40 cm. The size of a step field element or step field pallet is 1.2 x 1.2 m (4' x 4').

Cache Packaging, Setup, Weight, Tools

Logistics Suite

Purpose

This standard practice is intended to quantitatively evaluate the cache packaging attributes of deployable robotic systems intended to be compatible with transportation and storage procedures prescribed by the Federal Emergency Management Agency (FEMA) Urban Search & Rescue (US&R) Task Force Teams.

Metrics

Number of packets and weight, setup time, tools needed for repair and maintenance at the base of operation, downrange weight

E2592-07
Standard Practice for Evaluating Cache Packaged Weight and Volume of Robots for Urban Search and Rescue

Cache Packaging, Setup, Weight, Tools

Logistics Suite

Purpose

This standard practice is intended to quantitatively evaluate the cache packaging attributes of deployable robotic systems intended to be compatible with transportation and storage procedures prescribed by the Federal Emergency Management Agency (FEMA) Urban Search & Rescue (US&R) Task Force Teams.

Metrics

Number of packets and weight, setup time, tools needed for repair and maintenance at the base of operation, downrange weight

E2592-07
Standard Practice for Evaluating Cache Packaged Weight and Volume of Robots for Urban Search and Rescue

Apparatus

Packing cases or pallets qualified for use by FEMA US&R Task Forces.

Procedure

1. Note the number and type of packaging containers necessary for the robot to deploy for 10 days, without re-supply for the first 72 hours.
2. Time the setup process until ready to go down range.
3. Note the tools needed to perform setup and repair and take a picture of the tool set.
4. Weigh the robot and operator interface unit (OCU).
5. Take picture of robot and OCU in picture taking station.

Test Methods

Apparatus

Packing cases or pallets qualified for use by FEMA US&R Task Forces.

Procedure

1. Note the number and type of packaging containers necessary for the robot to deploy for 10 days, without re-supply for the first 72 hours.
2. Time the setup process until ready to go down range.
3. Note the tools needed to perform setup and repair and take a picture of the tool set.
4. Weigh the robot and operator interface unit (OCU).
5. Take picture of robot and OCU in picture taking station.

Visual Acuity and Field of View

Sensing Suite

Purpose

The purpose of this test method is to quantitatively evaluate the subject parameters isolated from the robot's remote teleoperation sensing capability. The following key parameters of the video systems are evaluated: visual acuity, field of view (FOV), and zooming.

Metrics

Distances in meters or Snelling fraction for visual acuity, total angular ranges in degrees for field of view.

E2566-08
Standard Test Method for Determining Visual Acuity and Field of View of On-Board Video Systems for Teleoperation of Robots for Urban Search and Rescue Applications

Visual Acuity and Field of View

Sensing Suite

Purpose

The purpose of this test method is to quantitatively evaluate the subject parameters isolated from the robot's remote teleoperation sensing capability. The following key parameters of the video systems are evaluated: visual acuity, field of view (FOV), and zooming.

Metrics

Distances in meters or Snelling fraction for visual acuity, total angular ranges in degrees for field of view.

E2566-08
Standard Test Method for Determining Visual Acuity and Field of View of On-Board Video Systems for Teleoperation of Robots for Urban Search and Rescue Applications

Apparatus

This test apparatus is implemented in a 12 x 2.4 m (40' x 8') standard ISO container . The far vision visual acuity Eye charts and HAZMAT labels are posted at the wall at the far side. The corresponding standard testing distance for far vision acuity tests, 6m, are marked on the floor. The near vision visual chart is portable and is to be placed along the marker and 40cm toward the side wall. The FOV lines are marked on the wall at the far side of the Container.

Procedure

0. Administrator note the robotic features as per the form, the lux level of lighted and dark charts.
1. Place the robot to behind the 20m line.
2. Read the aerial, far field, and near field charts. Circle the decimal equivalent for the smallest correct line read normally and with zoom lens in ambient light.
3. Operator teleoperate the robot to turn 90 degrees and read the near field chart.
4. Repeat 1-3 with illumination <1 lux.

Test Methods

Apparatus

This test apparatus is implemented in a 12 x 2.4 m (40' x 8') standard ISO container. The far vision visual acuity Eye charts and HAZMAT labels are posted at the wall at the far side. The corresponding standard testing distance for far vision acuity tests, 6m, are marked on the floor. The near vision visual chart is portable and is to be placed along the marker and 40cm toward the side wall. The FOV lines are marked on the wall at the far side of the Container.

Procedure

0. Administrator note the robotic features as per the form, the lux level of lighted and dark charts.
1. Place the robot to behind the 20m line.
2. Read the aerial, far field, and near field charts. Circle the decimal equivalent for the smallest correct line read normally and with zoom lens in ambient light.
3. Operator teleoperate the robot to turn 90 degrees and read the near field chart.
4. Repeat 1-3 with illumination <1 lux.

45

Directed Search

Sensing Suite

Purpose

The purpose of this test method is to quantitatively evaluate robot's ability to provide video and operator's subsequent ability to gain spatial awareness during teleoperation. Objects are displayed in a variety of spatial and temporal settings for evaluating the robot's video capability.

Metrics

Number of light sources that are correctly identified in the duration of 5 seconds of shining, number of objects that are correctly identified in the given 10 minutes

Directed Search

Sensing Suite

Purpose

The purpose of this test method is to quantitatively evaluate robot's ability to provide video and operator's subsequent ability to gain spatial awareness during teleoperation. Objects are displayed in a variety of spatial and temporal settings for evaluating the robot's video capability.

Metrics

Number of light sources that are correctly identified in the duration of 5 seconds of shining, number of objects that are correctly identified in the given 10 minutes

Apparatus

This test apparatus is implemented in a 12 x 2.4 m (40' x 8') standard ISO container . Two settings are to be implemented. First, a set of standardized objects is used and individual objects can be randomly ordered. Five equally spaced logical cross-sections along the depth of the Container are devised. A set of the objects is placed at each corner of each of the cross-section. Second, light bulbs are to be placed at the randomly selected corners. A 15 degree ramp is placed at the center of the Container.

Procedure

Test 1:

1. Operator teleoperate the robot to the center of the Container and on the ramp.
2. Administrator turn on the light bulbs located at the randomly pre-selected corners for 5 seconds. Operator to report the number of identified source.

Test 2:

1. Operator identify all the pre-located objects in terms of all the color and size settings, in dark.

Test Methods

Apparatus

This test apparatus is implemented in a 12 x 2.4 m (40' x 8') standard ISO container . Two settings are to be implemented. First, a set of standardized objects is used and individual objects can be randomly ordered. Five equally spaced logical cross-sections along the depth of the Container are devised. A set of the objects is placed at each corner of each of the cross-section. Second, light bulbs are to be placed at the randomly selected corners. A 15 degree ramp is placed at the center of the Container.

Procedure

Test 1:

1. Operator teleoperate the robot to the center of the Container and on the ramp.
2. Administrator turn on the light bulbs located at the randomly pre-selected corners for 5 seconds. Operator to report the number of identified source.

Test 2:

1. Operator identify all the pre-located objects in terms of all the color and size settings, in dark.

47

Underpass Search

Sensing Suite

Purpose

The purpose of this test method is to quantitatively evaluate robot's ability to provide video, in a dark environment that possesses minimal features, to facilitate operator's ability to gain spatial awareness and to conduct teleoperated search in the ceiling area.

Metrics

Number of holes visited; whether reaching the end point or not; time used; number of targets correctly and incorrectly identified, missed, or multiply identified.

Underpass Search

Sensing Suite

Purpose

The purpose of this test method is to quantitatively evaluate robot's ability to provide video, in a dark environment that possesses minimal features, to facilitate operator's ability to gain spatial awareness and to conduct teleoperated search in the ceiling area.

Metrics

Number of holes visited; whether reaching the end point or not; time used; number of targets correctly and incorrectly identified, missed, or multiply identified.

Apparatus

This test apparatus is a enclosed space of 6 x 2.4 x 0.6 m (20 x 8 x 2 ft) that is made from the OSB plywood boards for ceiling and floor that are separated with 10 x 5 cm (4 x 2 in) solid wood posts. The ceiling and internal wall are further covered with black felt for enhanced textual uniformity, thus providing minimal visual clues. The ceiling is implemented with N randomly-spaced holes of 15 cm diameter and hinged doors. A gallon-size metal paint container is used behind the hinged door for a sensory targets (HAZMAT signs, Snell Charts) to be placed for the search and identification testing purposes. All the material is inexpensive and commonly available.

Procedure

1. Operator to teleoperate the robot to the starting point.
2. Conduct search in the ceiling. Open the hinged door upon detecting one. Identify the object.
3. Conduct systematic traverse and repeat 2.
4. Complete the test once the end point is reached.

Test Methods

Apparatus

This test apparatus is a enclosed space of 6 x 2.4 x 0.6 m (20 x 8 x 2 ft) that is made from the OSB plywood boards for ceiling and floor that are separated with 10 x 5 cm (4 x 2 in) solid wood posts. The ceiling and internal wall are further covered with black felt for enhanced textual uniformity, thus providing minimal visual clues. The ceiling is implemented with N randomly-spaced holes of 15 cm diameter and hinged doors. A gallon-size metal paint container is used behind the hinged door for a sensory targets (HAZMAT signs, Snell Charts) to be placed for the search and identification testing purposes. All the material is inexpensive and commonly available.

Procedure

1. Operator to teleoperate the robot to the starting point.
2. Conduct search in the ceiling. Open the hinged door upon detecting one. Identify the object.
3. Conduct systematic traverse and repeat 2.
4. Complete the test once the end point is reached.

One/Two Way Audio

Sensing Suite

Purpose

The purpose of this test method is to quantitatively evaluate robot's ability to provide the operator with audio in teleoperation.

Metrics

Number of the words that are correctly identified in the 5 minute time limit.

One/Two Way Audio

Sensing Suite

Purpose

The purpose of this test method is to quantitatively evaluate robot's ability to provide the operator with audio in teleoperation.

Metrics

Number of the words that are correctly identified in the 5 minute time limit.

50

Apparatus

This test apparatus consists of sets of pre-recorded audio pronunciation of standardized rhyming words. Software program on a laptop is used to randomly select the words to be played. a speaker installed at near the door and at the other end of an 240 x 1600 cm (8'x40') ISO container, in which the robot is tested. A word sheet consisting 25 groups of 6 words.

Procedure

1. Robot is to be teleoperated to the center of the ISO container and stationed in the marked area.
2. Operator executes the software by hitting a key for a word to be randomly chosen, played, and transmitted back to the teleoperation station.
3. The operator is to circle correct word of a six words grouping on the sheet
4. Repeat 2 until the time expires.
5. Operator compare the answers to the record and mark correct/incorrect.

Test Methods

Apparatus

This test apparatus consists of sets of pre-recorded audio pronunciation of standardized rhyming words. Software program on a laptop is used to randomly select the words to be played. a speaker installed at near the door and at the other end of an 240 x 1600 cm (8'x40') ISO container, in which the robot is tested. A word sheet consisting 25 groups of 6 words.

Procedure

1. Robot is to be teleoperated to the center of the ISO container and stationed in the marked area.
2. Operator executes the software by hitting a key for a word to be randomly chosen, played, and transmitted back to the teleoperation station.
3. The operator is to circle correct word of a six words grouping on the sheet
4. Repeat 2 until the time expires.
5. Operator compare the answers to the record and mark correct/incorrect.

Mapping

Sensing Suite

Purpose

The purpose of this test method is to quantitatively evaluate robot's ability to acquire spatial awareness and develop maps for the areas that it is teleoperated to traverse.

Metrics

Completeness of the maps that the robot builds.

Mapping

Sensing Suite

Purpose

The purpose of this test method is to quantitatively evaluate robot's ability to acquire spatial awareness and develop maps for the areas that it is teleoperated to traverse.

Metrics

Completeness of the maps that the robot builds.

Apparatus

This test apparatus is composed of a set of courses with designed characteristics. The first one, called Distinctive Features, is shared with the HSI-Random Maze Search test method. The second course, called Minimum Features, is a tunnel that is made from the OSB plywood boards and further covered with black felt for enhanced textual uniformity, thus providing minimal visual clues. The third one, called Occluded Features, is a continuous ramp field (to introduce orientation complexity) with plastic pipes of random lengths that are vertically planted at randomly selected locations. The pipes are to provide challenging features.

Procedure

1. Robot to be teleoperated to the starting point of the test curse.
2. Robot to be teleoperated through out the entire course. The internal software is to build up the map of the test course as the robotic sensors detected.
3. Repeat 1 – 2 for the next test course until all courses are completed.

Test Methods

Apparatus

This test apparatus is composed of a set of courses with designed characteristics. The first one, called Distinctive Features, is shared with the HSI-Random Maze Search test method. The second course, called Minimum Features, is a tunnel that is made from the OSB plywood boards and further covered with black felt for enhanced textual uniformity, thus providing minimal visual clues. The third one, called Occluded Features, is a continuous ramp field (to introduce orientation complexity) with plastic pipes of random lengths that are vertically planted at randomly selected locations. The pipes are to provide challenging features.

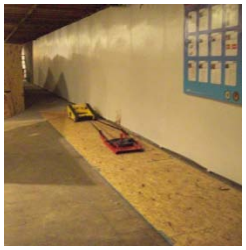
Procedure

1. Robot to be teleoperated to the starting point of the test curse.
2. Robot to be teleoperated through out the entire course. The internal software is to build up the map of the test course as the robotic sensors detected.
3. Repeat 1 – 2 for the next test course until all courses are completed.

53

Flat Dash and Tow

Mobility Suite



Purpose

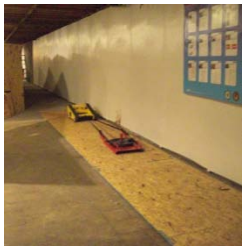
The purpose of this test method is to quantitatively evaluate a robot's speed on a flat surface, with or without a towing load and based on teleoperation.

Metrics

Complete or fail the traverse; the number of segments completed if fails; time spent to succeed each path

Flat Dash and Tow

Mobility Suite



Purpose

The purpose of this test method is to quantitatively evaluate a robot's speed on a flat surface, with or without a towing load and based on teleoperation.

Metrics

Complete or fail the traverse; the number of segments completed if fails; time spent to succeed each path

Apparatus

This test apparatus is flat-surface, straight path of 20m long, made either of concrete or the flat floor elements which, themselves, are made from 1200 x 1200 x 15 mm (or 48 x 48 x 19/32 in) oriented strand board (OSB) plywood boards. The OSB boards are inexpensive, commonly available, also provides a frictional surface similar to dust covered concrete.

A loading truck of 2.2 kg (5 lbs) with bottom fully in contact with the floor is used for towing . A set of standard weights of X kg

Procedure

1. Operator teleoperate the robot at the starting point.
2. Traverse straight with full speed until the entire footprint passes the end point. Note time.
3. Optionally, repeat 1-2 for 5 continuous trials. Note time.
4. Administrator and operator to put the tow truck and an increment of X kg load on the back of the robot. Repeat 1-3 until robot unsuccessful.

Test Methods

Apparatus

This test apparatus is flat-surface, straight path of 20m long, made either of concrete or the flat floor elements which, themselves, are made from 1200 x 1200 x 15 mm (or 48 x 48 x 19/32 in) oriented strand board (OSB) plywood boards. The OSB boards are inexpensive, commonly available, also provides a frictional surface similar to dust covered concrete.

A loading truck of 2.2 kg (5 lbs) with bottom fully in contact with the floor is used for towing . A set of standard weights of X kg

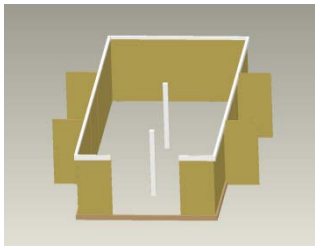
Procedure

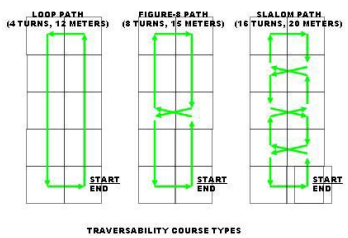
1. Operator teleoperate the robot at the starting point.
2. Traverse straight with full speed until the entire footprint passes the end point. Note time.
3. Optionally, repeat 1-2 for 5 continuous trials. Note time.
4. Administrator and operator to put the tow truck and an increment of X kg load on the back of the robot. Repeat 1-3 until robot unsuccessful.

55

Slalom: Flat Flooring

Mobility Suite





Purpose

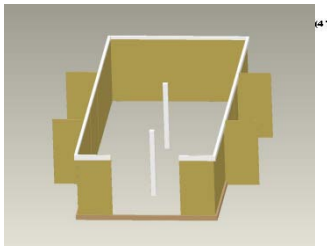
The purpose of this test method is to quantitatively evaluate a robot's ability to be teleoperated to traverse required paths with challenging floor types and tight space.

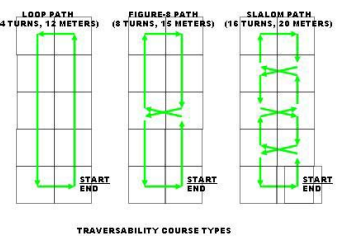
Metric

Complete or incomplete the path, time spent to succeed the traverse.

Slalom: Flat Flooring

Mobility Suite





Purpose

The purpose of this test method is to quantitatively evaluate a robot's ability to be teleoperated to traverse required paths with challenging floor types and tight space.

Metric

Complete or incomplete the path, time spent to succeed the traverse.

Apparatus

This test apparatus is flat-floor concrete course which is enclosed by wall to form an inside area of 2.4 x 12 m. The wall is made of OSB plywood boards.

Procedure

1. Place the robot the specified starting point.
2. Follow the path as specified.
3. If successful, repeat 1-2 for the next instructed path until completes all paths or when incompletes.

Test Methods

Apparatus

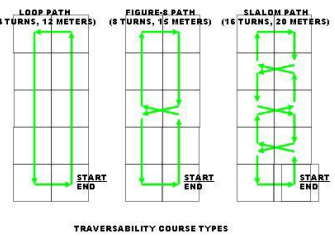
This test apparatus is flat-floor concrete course which is enclosed by wall to form an inside area of 2.4 x 12 m. The wall is made of OSB plywood boards.

Procedure

1. Place the robot the specified starting point.
2. Follow the path as specified.
3. If successful, repeat 1-2 for the next instructed path until completes all paths or when incompletes.

Slalom: Continuous Ramp

Mobility Suite



Purpose

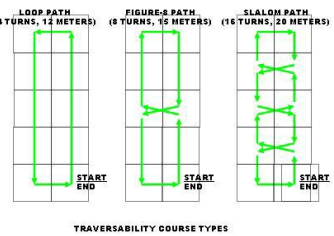
The purpose of this test method is to quantitatively evaluate a robot's ability to be teleoperated to traverse required paths with challenging floor types and tight space.

Metric

Succeed or fail the path and time spent to succeed the traverse

Slalom: Continuous Ramp

Mobility Suite



Purpose

The purpose of this test method is to quantitatively evaluate a robot's ability to be teleoperated to traverse required paths with challenging floor types and tight space.

Metric

Succeed or fail the path and time spent to succeed the traverse

Apparatus

This test apparatus is made of 15 degree ramps and the enclosing wall. The ramps are placed in a single row on the floor with the pitch direction along the direction of the long wall. The high end connects to the next ramp's high end and the low end connects to the previous ramp's low end, thus form a continuous, saw-tooth shape terrain. The floor is enclosed by wall made of the OSB plywood boards. The encloses area has the size of 2.4 x 12 m (8 x 40 ft).

Procedure

1. Place the robot the specified starting point.
2. Follow the path as specified.
3. If successful, repeat 1-2 for the next instructed path until completes all paths or when incompletes.

Test Methods

Apparatus

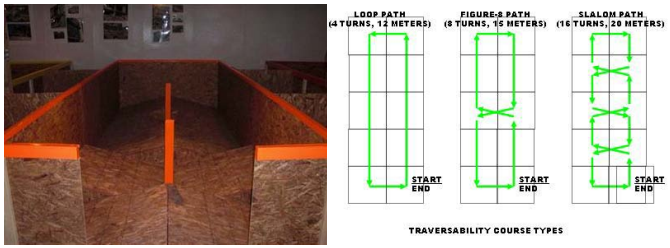
This test apparatus is made of 15 degree ramps and the enclosing wall. The ramps are placed in a single row on the floor with the pitch direction along the direction of the long wall. The high end connects to the next ramp's high end and the low end connects to the previous ramp's low end, thus form a continuous, saw-tooth shape terrain. The floor is enclosed by wall made of the OSB plywood boards. The encloses area has the size of 2.4 x 12 m (8 x 40 ft).

Procedure

1. Place the robot the specified starting point.
2. Follow the path as specified.
3. If successful, repeat 1-2 for the next instructed path until completes all paths or when incompletes.

Slalom: Crossing Ramp

Mobility Suite



Purpose

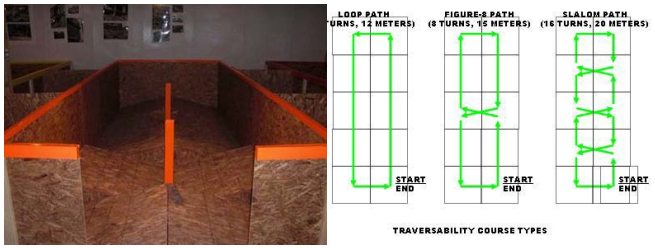
The purpose of this test method is to quantitatively evaluate a robot's ability to be teleoperated to traverse required paths with challenging floor types and tight space.

Metric

Succeed or fail the path and time spent to succeed the traverse

Slalom: Crossing Ramp

Mobility Suite



Purpose

The purpose of this test method is to quantitatively evaluate a robot's ability to be teleoperated to traverse required paths with challenging floor types and tight space.

Metric

Succeed or fail the path and time spent to succeed the traverse

Apparatus

This test apparatus is made of 15 degree ramps and the enclosing wall. The ramps are placed on the floor with the pitch direction along the direction of the short wall. There are two ramps per row, interchanging from connecting on the high ends and on the low ends (Figure A), thus form a discontinuous, crossing terrain. The floor is enclosed by wall made of the OSB plywood boards. The encloses area has the size of 2.4 x 12 m (8 x 40 ft).

Procedure

1. Place the robot the specified starting point.
2. Follow the path as specified.
3. If successful, repeat 1-2 for the next instructed path until completes all paths or when incompletes.

Test Methods

Apparatus

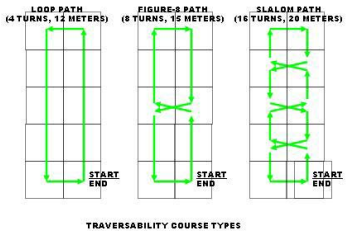
This test apparatus is made of 15 degree ramps and the enclosing wall. The ramps are placed on the floor with the pitch direction along the direction of the short wall. There are two ramps per row, interchanging from connecting on the high ends and on the low ends (Figure A), thus form a discontinuous, crossing terrain. The floor is enclosed by wall made of the OSB plywood boards. The encloses area has the size of 2.4 x 12 m (8 x 40 ft).

Procedure

1. Place the robot the specified starting point.
2. Follow the path as specified.
3. If successful, repeat 1-2 for the next instructed path until completes all paths or when incompletes.

Slalom: Symmetric Step Fields

Mobility Suite



Purpose

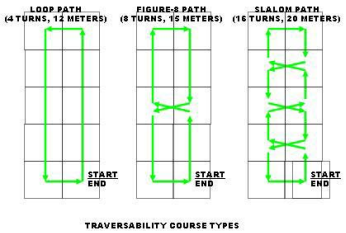
The purpose of this test method is to quantitatively evaluate a robot's ability to be teleoperated to traverse required paths with challenging floor types and tight space.

Metric

Succeed or fail the path and time spent to succeed the traverse

Slalom: Symmetric Step Fields

Mobility Suite



Purpose

The purpose of this test method is to quantitatively evaluate a robot's ability to be teleoperated to traverse required paths with challenging floor types and tight space.

Metric

Succeed or fail the path and time spent to succeed the traverse

Apparatus

This test apparatus is made of symmetrical step fields and the enclosing wall. The step fields are placed on the floor in order to cover the whole floor. The floor is enclosed by wall made of the OSB plywood boards. The encloses area has the size of 2.4 x 12 m (8 x 40 ft).

Procedure

1. Place the robot the specified starting point.
2. Follow the path as specified.
3. If successful, repeat 1-2 for the next instructed path until completes all paths or when incompletes.

Test Methods

Apparatus

This test apparatus is made of symmetrical step fields and the enclosing wall. The step fields are placed on the floor in order to cover the whole floor. The floor is enclosed by wall made of the OSB plywood boards. The encloses area has the size of 2.4 x 12 m (8 x 40 ft).

Procedure

1. Place the robot the specified starting point.
2. Follow the path as specified.
3. If successful, repeat 1-2 for the next instructed path until completes all paths or when incompletes.

Gap Crossing

Mobility Suite

Purpose

The purpose of this test method is to quantitatively evaluate a robot's ability to be teleoperated to cross horizontal gaps while traversing in tight space.

Metrics

Widest successful crossing (cm) for 5 continuous repetitions within a time limit (5 min)

Gap Crossing

Mobility Suite

Purpose

The purpose of this test method is to quantitatively evaluate a robot's ability to be teleoperated to cross horizontal gaps while traversing in tight space.

Metrics

Widest successful crossing (cm) for 5 continuous repetitions within a time limit (5 min)

64

Apparatus

This test apparatus is made of two flat floor elements that are placed side by side to form the gap, which is adjustable from 10cm through 100cm in 10cm increments.

Procedure

1. Place the robot on the starting platform facing the gap.
2. Cross the gap fully so that the entire robot is on the ending platform.
3. Return to the starting platform fully and at the starting position to complete one repetition.
4. Repeat 1-3 until all repetitions are completed.
5. Increase the gap until unsuccessful in one of the repetitions. Note the last fully successful gap crossing as the maximum.

Test Methods

Apparatus

This test apparatus is made of two flat floor elements that are placed side by side to form the gap, which is adjustable from 10cm through 100cm in 10cm increments.

Procedure

1. Place the robot on the starting platform facing the gap.
2. Cross the gap fully so that the entire robot is on the ending platform.
3. Return to the starting platform fully and at the starting position to complete one repetition.
4. Repeat 1-3 until all repetitions are completed.
5. Increase the gap until unsuccessful in one of the repetitions. Note the last fully successful gap crossing as the maximum.

Pipe Step

Mobility Suite

Purpose

The purpose of this test method is to quantitatively evaluate a robot's ability to be teleoperated to surmount vertical obstacles while traversing in limited space. This is a hard-terrain mobility capability that Responders require. Limited edge traction introduced by rotate-able pipes emphasizes how well robot's mobility mechanisms surmount the obstacles.

Metrics

Maximum successful elevation (cm) for 5 continuous repetitions within a time limit (5 min)

Pipe Step

Mobility Suite

Purpose

The purpose of this test method is to quantitatively evaluate a robot's ability to be teleoperated to surmount vertical obstacles while traversing in limited space. This is a hard-terrain mobility capability that Responders require. Limited edge traction introduced by rotate-able pipes emphasizes how well robot's mobility mechanisms surmount the obstacles.

Metrics

Maximum successful elevation (cm) for 5 continuous repetitions within a time limit (5 min)

66

Apparatus

This test apparatus is made from two stacks of flat floor elements . Each stack has overall dimensions of 1.2m (4ft) square. They are placed side by side to form a step. Additional flat floor elements increase the step level by 10 cm (4in) increments. Plastic pipes with a diameter of 10 cm (4in) are stacked along with each platform to reduce the edge traction. The plastic pipes are constrained against the elevated platforms but should be free to rotate.

Procedure

1. Place the robot on the lower platform facing the step obstacle.
2. Surmount the obstacle fully so that the entire robot is on the elevated platform, not overhanging the pipes.
3. Descend the step obstacle to the lower platform and return to starting position to complete one repetition.
4. Repeat 1-3 until all repetitions are completed.
5. Increase the elevation of the obstacle until unsuccessful in one of the repetitions. Note the last fully successful step elevation as the maximum.

Test Methods

Apparatus

This test apparatus is made from two stacks of flat floor elements . Each stack has overall dimensions of 1.2m (4ft) square. They are placed side by side to form a step. Additional flat floor elements increase the step level by 10 cm (4in) increments. Plastic pipes with a diameter of 10 cm (4in) are stacked along with each platform to reduce the edge traction. The plastic pipes are constrained against the elevated platforms but should be free to rotate.

Procedure

1. Place the robot on the lower platform facing the step obstacle.
2. Surmount the obstacle fully so that the entire robot is on the elevated platform, not overhanging the pipes.
3. Descend the step obstacle to the lower platform and return to starting position to complete one repetition.
4. Repeat 1-3 until all repetitions are completed.
5. Increase the elevation of the obstacle until unsuccessful in one of the repetitions. Note the last fully successful step elevation as the maximum.

67

Stairs

Mobility Suite

Purpose

The purpose of this test method is to quantitatively evaluate robot's ability to be teleoperated to traverse specified sets of stairs in a limited space.

Metrics

Within the allowed 20 min time limit: total time spent for 5 continuous repetitions of ascending and descending of each set of the stairs OR sets of stairs, numbers of repetitions, and numbers of steps traversed within the time limit

Stairs

Mobility Suite

Purpose

The purpose of this test method is to quantitatively evaluate robot's ability to be teleoperated to traverse specified sets of stairs in a limited space.

Metrics

Within the allowed 20 min time limit: total time spent for 5 continuous repetitions of ascending and descending of each set of the stairs OR sets of stairs, numbers of repetitions, and numbers of steps traversed within the time limit

Apparatus

This test apparatus is composed of three sets of stairs, with 30, 35, 40, and 45 degree slopes, respectively. Each contains L steps of M x N x L cm (m x n in) in size and is made from OSB plywood boards. 50x100 mm (2x4 in) solid wood posts are used to sufficiently support the OSB boards.

Procedure

1. Place the robot on the lower platform of the 30 degree stairs.
2. Complete the surmounting and descending for one repetition.
3. Repeat 1-2 for five continuous repetitions.
4. Move to the next steeper stairs. Repeat 2-3.
5. Repeat 2-4 until either completing all stairs or unsuccessful.

Test Methods

Apparatus

This test apparatus is composed of three sets of stairs, with 30, 35, 40, and 45 degree slopes, respectively. Each contains L steps of M x N x L cm (m x n in) in size and is made from OSB plywood boards. 50x100 mm (2x4 in) solid wood posts are used to sufficiently support the OSB boards.

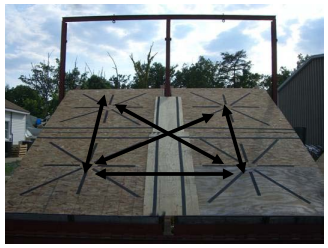
Procedure

1. Place the robot on the lower platform of the 30 degree stairs.
2. Complete the surmounting and descending for one repetition.
3. Repeat 1-2 for five continuous repetitions.
4. Move to the next steeper stairs. Repeat 2-3.
5. Repeat 2-4 until either completing all stairs or unsuccessful.

69

Inclined Plane

Mobility Suite



Purpose

The purpose of this test method is to quantitatively evaluate a robot's ability to be teleoperated to traverse specified paths on specified inclined planes with limited sizes.

Metrics

Complete or fail the traverse; the number of segments completed if fails; time spent to succeed each path

Inclined Plane

Mobility Suite

Purpose

The purpose of this test method is to quantitatively evaluate a robot's ability to be teleoperated to traverse specified paths on specified inclined planes with limited sizes.

Metrics

Complete or fail the traverse; the number of segments completed if fails; time spent to succeed each path

Apparatus

This test apparatus is made from OSB plywood boards and 50x100 mm (2x4 in) solid wood posts . The wood posts are used to sufficiently support the OSB boards to form the specified angles, 30°or 45°. Four key points are marked on center of each of the boards , with the lower, right mark, point A as the starting and ending positions. Multiple paths are devised for the test.

Procedure

1. Place the robot point A of the 30 degree plane.
2. Follow the path as specified.
3. If succeeds, follow the second path as specified.
4. If succeeds, place the robot point A of the 45 degree plane. Repeat 2-3 or until fails.

Test Methods

Apparatus

This test apparatus is made from OSB plywood boards and 50x100 mm (2x4 in) solid wood posts . The wood posts are used to sufficiently support the OSB boards to form the specified angles, 30°or 45°. Four key points are marked on center of each of the boards , with the lower, right mark, point A as the starting and ending positions. Multiple paths are devised for the test.

Procedure

1. Place the robot point A of the 30 degree plane.
2. Follow the path as specified.
3. If succeeds, follow the second path as specified.
4. If succeeds, place the robot point A of the 45 degree plane. Repeat 2-3 or until fails.

71

Tow: Hitch Trailer

Mobility Suite

Purpose

Metrics

Tow: Hitch Trailer

Mobility Suite

Purpose

Metrics

72

Apparatus

Procedure

Test Methods

Apparatus

Procedure

Tow: Hitch Drag

Mobility Suite

Purpose

Metrics

Tow: Hitch Drag

Mobility Suite

Purpose

Metrics

74

Apparatus

Procedure

Test Methods

Apparatus

Procedure

Tow: End-Effector Drag

Mobility Suite

Purpose

Metrics

Tow: End-Effector Drag

Mobility Suite

Purpose

Metrics

76

Test Methods

Apparatus

Procedure

Test Methods

Apparatus

Procedure

77

Confined Space

Mobility Suite

Purpose

The purpose of this test method is to quantitatively evaluate a robot's ability to be teleoperated to traverse in a tight spaces with challenging terrains and ceilings. This is a hard-terrain mobility capability that Responders require. This test method allows direct comparisons across different robot models and particular configurations of similar robot models.

Metrics

the heights of elevated terrain ridges on both floor and roof pallets; time and total pallets traversed

Confined Space

Mobility Suite

Purpose

The purpose of this test method is to quantitatively evaluate a robot's ability to be teleoperated to traverse in a tight spaces with challenging terrains and ceilings. This is a hard-terrain mobility capability that Responders require. This test method allows direct comparisons across different robot models and particular configurations of similar robot models.

Metrics

the heights of elevated terrain ridges on both floor and roof pallets; time and total pallets traversed

78

Apparatus

This test apparatus is straight path of 20m long, assembled with ten 1200 x 1200 cm (48 x 48 in) pallets for floor and ceiling. The pallets are made of OSB plywood boards and 5 x 10 cm (2 x 4") wood posts of 10, 20, 30, and 40 cm heights, randomly placed to tighten up the passage way.

Procedure

1. Place the robot at the starting point.
2. Traverse through the end and back or until fails.
3. Optionally, repeat 1-2 for 5 continuous trials. Note best time.

Test Methods

Apparatus

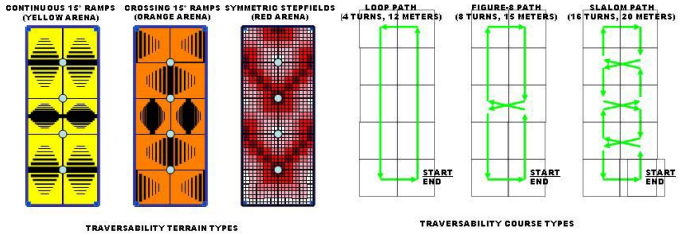
This test apparatus is straight path of 20m long, assembled with ten 1200 x 1200 cm (48 x 48 in) pallets for floor and ceiling. The pallets are made of OSB plywood boards and 5 x 10 cm (2 x 4") wood posts of 10, 20, 30, and 40 cm heights, randomly placed to tighten up the passage way.

Procedure

1. Place the robot at the starting point.
2. Traverse through the end and back or until fails.
3. Optionally, repeat 1-2 for 5 continuous trials. Note best time.

Terrain Traversability

Mobility



Purpose

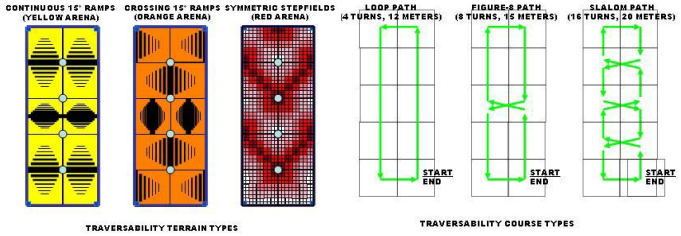
The purpose of this test method is to quantitatively evaluate a robot's ability to be teleoperated to traverse required paths with challenging floor types and tight space. This is a hard-terrain mobility capability that Responders require. This test method allows direct comparisons across different robot models and particular configurations of similar robot models.

Metric

1. Convention:
    a. A traverse of a specified terrain is when the robot is teleoperated from the starting point toward the end point. Such a traverse is complete or successful when the entire footprint of the robot performs the specified path and the footprint lands on the end point; also called a complete/successful repetition.
    b. Five continuous complete/successful repetitions are required to pass a path type. Completing all three path types passes a terrain type. A complete/successful terrain traversability test is when the robot succeeds all terrain types that it can.
2. Timing Constraint: different time limits are given for specified paths and floor types with different levels of difficulty. 2 minute incremental time limit are given for each added level of difficulty.
3. Metrics:
    a. succeed or fail the path
    b. Time spent to succeed the traverse

Terrain Traversability

Mobility



Purpose

The purpose of this test method is to quantitatively evaluate a robot's ability to be teleoperated to traverse required paths with challenging floor types and tight space. This is a hard-terrain mobility capability that Responders require. This test method allows direct comparisons across different robot models and particular configurations of similar robot models.

Metric

1. Convention:
    a. A traverse of a specified terrain is when the robot is teleoperated from the starting point toward the end point. Such a traverse is complete or successful when the entire footprint of the robot performs the specified path and the footprint lands on the end point; also called a complete/successful repetition.
    b. Five continuous complete/successful repetitions are required to pass a path type. Completing all three path types passes a terrain type. A complete/successful terrain traversability test is when the robot succeeds all terrain types that it can.
2. Timing Constraint: different time limits are given for specified paths and floor types with different levels of difficulty. 2 minute incremental time limit are given for each added level of difficulty.
3. Metrics:
    a. succeed or fail the path
    b. Time spent to succeed the traverse

Apparatus

This test apparatus is composed of two major floor types: 15 degree ramps and step fields. Ramp based floors are further subtyped as continuous, continuous but half and cross . Step field based floors contains types of diagonal, saddle, and corner . The material contains 1200 x 2400 x 15 mm (or 48 x 96 x 19/32 in) oriented strand board (OSB) plywood boards and 10x10 cm (4”x4” in) solid wood posts of 10, 20, 30, and 40 cm high. The material is inexpensive and commonly available. The OSB boards provides a frictional surface similar to dust covered concrete.

Procedure

1. Operator teleoperate the robot the starting point of a specified terrain type.
2. Follow the path as specified.
3. If successful, repeat 1-2 for the different path and floor types as instructed.

Test Methods

Apparatus

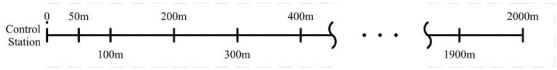
This test apparatus is composed of two major floor types: 15 degree ramps and step fields. Ramp based floors are further subtyped as continuous, continuous but half and cross . Step field based floors contains types of diagonal, saddle, and corner . The material contains 1200 x 2400 x 15 mm (or 48 x 96 x 19/32 in) oriented strand board (OSB) plywood boards and 10x10 cm (4”x4” in) solid wood posts of 10, 20, 30, and 40 cm high. The material is inexpensive and commonly available. The OSB boards provides a frictional surface similar to dust covered concrete.

Procedure

1. Operator teleoperate the robot the starting point of a specified terrain type.
2. Follow the path as specified.
3. If successful, repeat 1-2 for the different path and floor types as instructed.

Line of Sight (LOS)

Radio Comms Suite



Purpose

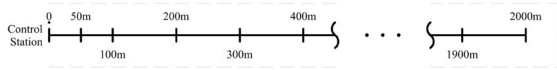
The purpose of this test method is to quantitatively evaluate a robot's radio (wireless) communication systems within a long range LOS or NLOS propagation environment during teleoperation.

Metrics

LOS: Distance downrange at which robot operation (video or control) fails.
Standoff distance of operator station from metal wall based on LOS performance.

Line of Sight (LOS)

Radio Comms Suite



Purpose

The purpose of this test method is to quantitatively evaluate a robot's radio (wireless) communication systems within a long range LOS or NLOS propagation environment during teleoperation.

Metrics

LOS: Distance downrange at which robot operation (video or control) fails.
Standoff distance of operator station from metal wall based on LOS performance.

Apparatus

- The test apparatus for the LOS test is a straight flat section of airstrip, roadway or similar surface at least 1 km long (longer if possible). The surface shall be consistent (e.g. asphalt or concrete) and be free of reflective objects at least 50 meters on either side of the centerline. A figure-8 path with 2.4 m (4 ft) diameter lobes and 4 visual charts, facing four directions, shall be located at test distances of 50 m, 100 m, 200 m, 300 m ... through the entire range of the test course.
- Operator station antennas shall be limited to a maximum of 2 m (6.5 ft) elevation above the ground.

Procedure

1. The radio systems shall be evaluated indirectly by monitoring video and control system relative to a reference LOS distance of 50 meters.
2. From the starting point of the test apparatus, the robot shall traverse the course in the prescribed direction and, at each test distance, navigate a figure-8 path and perform a nose-on visual chart read in each of the 4 compass directions relative to the direction of travel. The figure-8 shall allow 1.2 meters of clearance.

Test Methods

Apparatus

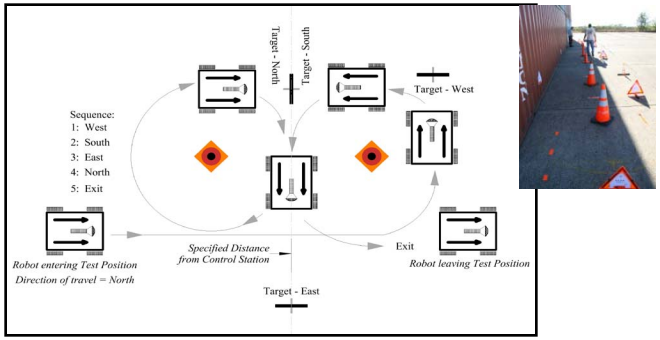
- The test apparatus for the LOS test is a straight flat section of airstrip, roadway or similar surface at least 1 km long (longer if possible). The surface shall be consistent (e.g. asphalt or concrete) and be free of reflective objects at least 50 meters on either side of the centerline. A figure-8 path with 2.4 m (4 ft) diameter lobes and 4 visual charts, facing four directions, shall be located at test distances of 50 m, 100 m, 200 m, 300 m ... through the entire range of the test course.
- Operator station antennas shall be limited to a maximum of 2 m (6.5 ft) elevation above the ground.

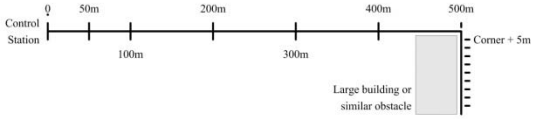
Procedure

1. The radio systems shall be evaluated indirectly by monitoring video and control system relative to a reference LOS distance of 50 meters.
2. From the starting point of the test apparatus, the robot shall traverse the course in the prescribed direction and, at each test distance, navigate a figure-8 path and perform a nose-on visual chart read in each of the 4 compass directions relative to the direction of travel. The figure-8 shall allow 1.2 meters of clearance.

Non-Line of Sight (NLOS)

Radio Comms Suite





Purpose

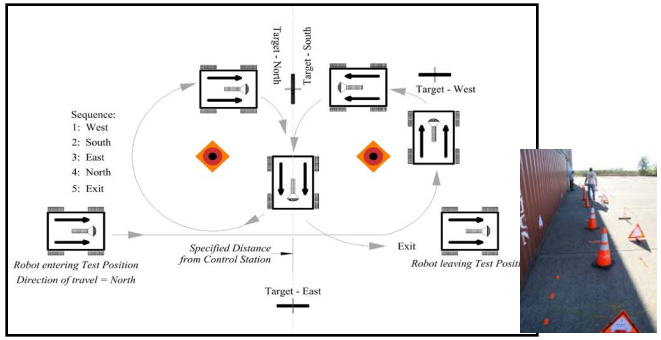
The purpose of this test method is to quantitatively evaluate a robot's radio (wireless) communication systems within a long range LOS or NLOS propagation environment during teleoperation.

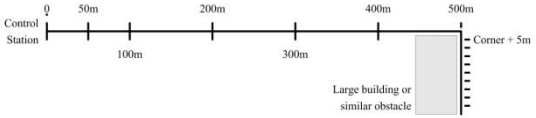
Metrics

NLOS: Distance behind metal wall at which robot operation (video or control) fails.

Non-Line of Sight (LOS)

Radio Comms Suite





Purpose

The purpose of this test method is to quantitatively evaluate a robot's radio (wireless) communication systems within a long range LOS or NLOS propagation environment during teleoperation.

Metrics

NLOS: Distance behind metal wall at which robot operation (video or control) fails.

Apparatus

- The test apparatus for the NLOS test is identical to the LOS except at a distance of 500 meters there is a wall made of ISO containers (7.3 m high x 24.4 m wide) with one edge aligned with the test course centerline and the long face perpendicular to the direction of robot travel . Three additional figure-8 paths are also located behind and tangent to the metal wall to test robot operations in the radio shadow.
- Operator station antennas shall be limited to a maximum of 2 m (6.5 ft) elevation above the ground.

Procedure

1. From the starting point of the test apparatus, the robot shall traverse the course in the prescribed direction and, at each test distance, navigate a figure-8 path and perform a nose-on visual chart read in each of the 4 compass directions relative to the direction of travel. The figure-8 shall allow 1.2 meters of clearance.
2. For the NLOS test, the LOS part is 500 meters or half the maximum distance achieved in the LOS test. At 500 meters (the back edge of the metal wall) the test point shall be defined as 1 meter from each surface at the corner or 1.414 meters diagonally from the container corner. The robot will then turn behind the container and proceed to a figure-8 test at 2, 5, and 12 meters from the corner. The 12 meter position is the center of the stack.

Test Methods

Apparatus

- The test apparatus for the NLOS test is identical to the LOS except at a distance of 500 meters there is a wall made of ISO containers (7.3 m high x 24.4 m wide) with one edge aligned with the test course centerline and the long face perpendicular to the direction of robot travel. Three additional figure-8 paths are also located behind and tangent to the metal wall to test robot operations in the radio shadow .
- Operator station antennas shall be limited to a maximum of 2 m (6.5 ft) elevation above the ground.

Procedure

1. From the starting point of the test apparatus, the robot shall traverse the course in the prescribed direction and, at each test distance, navigate a figure-8 path and perform a nose-on visual chart read in each of the 4 compass directions relative to the direction of travel. The figure-8 shall allow 1.2 meters of clearance.
2. For the NLOS test, the LOS part is 500 meters or half the maximum distance achieved in the LOS test. At 500 meters (the back edge of the metal wall) the test point shall be defined as 1 meter from each surface at the corner or 1.414 meters diagonally from the container corner. The robot will then turn behind the container and proceed to a figure-8 test at 2, 5, and 12 meters from the corner. The 12 meter position is the center of the stack.

85

Structure & Tunnel Penetration

Radio Comms Suite

Purpose

Metrics

Structure & Tunnel Penetration

Radio Comms Suite

Purpose

Metrics

86

Test Methods

Apparatus

Procedure

Test Methods

Apparatus

Procedure

87

Urban Canyon

Radio Comms Suite

Purpose

Metrics

Urban Canyon

Radio Comms Suite

Purpose

Metrics

88

Test Methods

Apparatus

Procedure

Test Methods

Apparatus

Procedure

89

Directed Perception
Manipulation

Purpose

The purpose of this test method is to quantitatively evaluate the robot's work volume in terms of providing video for certain specific locations where visual obstructions must be cleared.

Metrics

Number of perception tasks completed at tested levels; number of levels completed; average time/task within time limits, which are 30 min for the 0cm level and no barrier, 40 min with a barrier; increment 15 min per next higher level (i.e., 45/55 min for the 50cm level, without/with a barrier).

Directed Perception
Manipulation

Purpose

The purpose of this test method is to quantitatively evaluate the robot's work volume in terms of providing video for certain specific locations where visual obstructions must be cleared.

Metrics

Number of perception tasks completed at tested levels; number of levels completed; average time/task within time limits, which are 30 min for the 0cm level and no barrier, 40 min with a barrier; increment 15 min per next higher level (i.e., 45/55 min for the 50cm level, without/with a barrier).

Apparatus

The apparatus for this test method contains two stacks of shelves made from OSB boards to partition the working volume around the robot into discrete cells in which the perception tasks are to be performed. Each stack has shelves at the prescribed levels (0cm, 50cm, 100cm, 150cm, 200cm in heights). Each shelf is sub-divided into four quadrants. The quadrants contain vertically accessible circular holes of 15 cm diameter with hinged doors that are painted in blue . All but the ground level shelves also have two horizontally accessible front holes. A sensory target (visual, chemical, radiological) is placed on the wall inside a door. Three different barrier conditions are tested at each level: open above the shelf, reaching under a shelf barrier, or reaching over a façade barrier. Non-flat flooring conditions, either 15 degree roll ramps or symmetric stepfields pallets, provide complexity in robot orientation. The start/end line is at the end of the second flooring pallet from the testing pallet.

Procedure

Administrator:

0. Insert 15 degree roll ramps with the high sides toward the right shelves
0. Set the shelves and barriers to the next lowest elevation (0, 50, 100, 150, 200 cm) to be tested, starting at 0cm elevation.
0. Close all access doors.

Start with the robot behind start/end line

- Enter the test and identify sensory targets in the holes at the tested level, return to behind start/end line.

3. Repeat (0-1) with shelf barrier above the test surface.
4. Repeat (0-1) with façade barrier in front of the test surface.
5. Repeat (0-3) at the next higher level until all levels have been tested or the robot is no longer able to complete the next perception task.
6. Repeat (0-4) with symmetric stepfield pallets as flooring.

Apparatus

The apparatus for this test method contains two stacks of shelves made from OSB boards to partition the working volume around the robot into discrete cells in which the perception tasks are to be performed. Each stack has shelves at the prescribed levels (0cm, 50cm, 100cm, 150cm, 200cm in heights). Each shelf is sub-divided into four quadrants. The quadrants contain vertically accessible circular holes of 15 cm diameter with hinged doors that are painted in blue . All but the ground level shelves also have two horizontally accessible front holes. A sensory target (visual, chemical, radiological) is placed on the wall inside a door. Three different barrier conditions are tested at each level: open above the shelf, reaching under a shelf barrier, or reaching over a façade barrier. Non-flat flooring conditions, either 15 degree roll ramps or symmetric stepfields pallets, provide complexity in robot orientation. The start/end line is at the end of the second flooring pallet from the testing pallet.

Test Methods

Procedure

Administrator:

0. Insert 15 degree roll ramps with the high sides toward the right shelves
0. Set the shelves and barriers to the next lowest elevation (0, 50, 100, 150, 200 cm) to be tested, starting at 0cm elevation.
0. Close all access doors.

Start with the robot behind start/end line

- Enter the test and identify sensory targets in the holes at the tested level, return to behind start/end line.

3. Repeat (0-1) with shelf barrier above the test surface.
4. Repeat (0-1) with façade barrier in front of the test surface.
5. Repeat (0-3) at the next higher level until all levels have been tested or the robot is no longer able to complete the next perception task.
6. Repeat (0-4) with symmetric stepfield pallets as flooring.

91

Grasping Dexterity
Manipulation

Purpose

The purpose of this test method is to quantitatively evaluate the working volume in terms of providing video to allow teleoperating the manipulator to grasp objects and place them in specified locations.

Metrics

Number of grasping tasks completed at tested levels; number of levels completed; average time/task within time limits, which are 30 min for the 0cm level and no barrier, 40 min with a barrier; increment 15 min per next higher level (i.e., 45/55 min for the 50cm level, without/with a barrier).

Grasping Dexterity
Manipulation

Purpose

The purpose of this test method is to quantitatively evaluate the working volume in terms of providing video to allow teleoperating the manipulator to grasp objects and place them in specified locations.

Metrics

Number of grasping tasks completed at tested levels; number of levels completed; average time/task within time limits, which are 30 min for the 0cm level and no barrier, 40 min with a barrier; increment 15 min per next higher level (i.e., 45/55 min for the 50cm level, without/with a barrier).

Apparatus

The apparatus for this test method contains two stacks of shelves made from OSB boards to partition the working volume around the robot into discrete cells in which specified tasks are to be performed . Each stack has shelves at prescribed levels (0cm, 50cm, 100cm, 150cm, 200cm) with each shelf sub-divided into four quadrants. The quadrants contain vertically accessible circular holes of 15 cm diameter with hinged doors that are painted in blue . All but the ground level shelves also have two horizontally accessible front holes. An object of 10 cm block, made of solid wood post is to be placed in each hole for the tasking. Three different barrier conditions are tested while working at each level: open above the shelf, reaching under a shelf barrier, or reaching over a façade barrier. Non-flat flooring, either 15 degree roll ramps or symmetric stepfields pallets are used to provides complexity in robot orientation. The start/end line is at the end of the second flooring pallet from the testing pallet .

Procedure

Administrator:

0. Insert 15 degree roll ramps with the high sides toward the right shelves.
0. Set the shelves and barriers to the next lowest elevation (0, 50, 100, 150, 200 cm) to be tested, starting at 0cm elevation.
0. Close all access doors and replace blocks to initial conditions.

Start with the robot behind start/end line

1. Enter the test and pick and place blocks into holes within their quadrants.
2. Repeat (0-1) with shelf barrier above the test surface.
3. Repeat (0-1) with façade barrier in front of the test surface.
4. Repeat (0-3) at the next higher level until all levels have been tested or the robot is no longer able to complete the next grasping task.
5. Repeat (0-4) with symmetric stepfield pallets as flooring.

Apparatus

The apparatus for this test method contains two stacks of shelves made from OSB boards to partition the working volume around the robot into discrete cells in which specified tasks are to be performed . Each stack has shelves at prescribed levels (0cm, 50cm, 100cm, 150cm, 200cm) with each shelf sub-divided into four quadrants. The quadrants contain vertically accessible circular holes of 15 cm diameter with hinged doors that are painted in blue . All but the ground level shelves also have two horizontally accessible front holes. An object of 10 cm block, made of solid wood post is to be placed in each hole for the tasking. Three different barrier conditions are tested while working at each level: open above the shelf, reaching under a shelf barrier, or reaching over a façade barrier. Non-flat flooring, either 15 degree roll ramps or symmetric stepfields pallets are used to provides complexity in robot orientation. The start/end line is at the end of the second flooring pallet from the testing pallet .

Test Methods

Procedure

Administrator:

0. Insert 15 degree roll ramps with the high sides toward the right shelves.
0. Set the shelves and barriers to the next lowest elevation (0, 50, 100, 150, 200 cm) to be tested, starting at 0cm elevation.
0. Close all access doors and replace blocks to initial conditions.

Start with the robot behind start/end line

1. Enter the test and pick and place blocks into holes within their quadrants.
2. Repeat (0-1) with shelf barrier above the test surface.
3. Repeat (0-1) with façade barrier in front of the test surface.
4. Repeat (0-3) at the next higher level until all levels have been tested or the robot is no longer able to complete the next grasping task.
5. Repeat (0-4) with symmetric stepfield pallets as flooring.

93

Door Opening
Manipulation

Purpose

The purpose of this test method is to evaluate the robot's ability to be teleoperated to perform the door opening and traversing tasks.

Metrics

Completion of two subtasks: unlatching the door and traversing through it within the time limits; time spent to succeed the task; different time limits are given for different door mechanism types, starting at 30 sec and increment by 30 sec for each added level of difficulty.

Door Opening
Manipulation

Purpose

The purpose of this test method is to evaluate the robot's ability to be teleoperated to perform the door opening and traversing tasks.

Metrics

Completion of two subtasks: unlatching the door and traversing through it within the time limits; time spent to succeed the task; different time limits are given for different door mechanism types, starting at 30 sec and increment by 30 sec for each added level of difficulty.

Apparatus

The apparatus for this test method uses a set of common household 90cm (36”) entry doors that are installed on corresponding frames. The doors are to have the following types of handles and locks for opening: lever and knob. The opening task is to be performed at both the sides. The doors are not locked. The latches can be on either left or right side of the door. The starting line will be marked on the floor at 1m from and parallel to the door.

Procedure

Administrator:

0. Ensure that the door is latched.
   Start with the robot behind start/end line
1. Teleoperate robot to open the specified door.
2. If succeeds, teleoperate to the starting line for next door.
   Repeat 0-1.
3. Repeat 2 until fails or complete all the doors.

Test Methods

Apparatus

The apparatus for this test method uses a set of common household 90cm (36”) entry doors that are installed on corresponding frames. The doors are to have the following types of handles and locks for opening: lever and knob. The opening task is to be performed at both the sides. The doors are not locked. The latches can be on either left or right side of the door. The starting line will be marked on the floor at 1m from and parallel to the door.

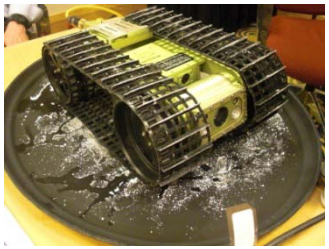
Procedure

Administrator:

0. Ensure that the door is latched.
   Start with the robot behind start/end line
1. Teleoperate robot to open the specified door.
2. If succeeds, teleoperate to the starting line for next door.
   Repeat 0-1.
3. Repeat 2 until fails or complete all the doors.

Washdown Decontamination

Safety/Environment



Purpose

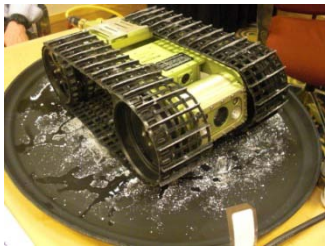
The purpose of this test method is to evaluate a robot's washdown vulnerabilities and identify specific design issues that hinder complete decontamination.

Metrics

Pass/Fail within a time limit of 5 minutes.

Washdown Decontamination

Safety/Environment



Purpose

The purpose of this test method is to evaluate a robot's washdown vulnerabilities and identify specific design issues that hinder complete decontamination.

Metrics

Pass/Fail within a time limit of 5 minutes.

Apparatus

This test apparatus uses a simulated contaminant administered in a controlled location along with a washdown tub, a rinsing tub, and an adjoining bridge. Low pressure water supply and a set of typical brushes and additional tools used by the emergency responder community, a hand-held ultra-violet light source (black light) is also used.

Procedure

1. Contaminate the robot with powder and/or liquid stimulants in a controlled space.
2. Transfer the robot onto the washdown stand for 5 minutes.
3. Administrator use the black light to examine the existence of the contaminants.

Test Methods

Apparatus

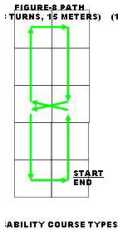
This test apparatus uses a simulated contaminant administered in a controlled location along with a washdown tub, a rinsing tub, and an adjoining bridge. Low pressure water supply and a set of typical brushes and additional tools used by the emergency responder community, a hand-held ultra-violet light source (black light) is also used.

Procedure

1. Contaminate the robot with powder and/or liquid stimulants in a controlled space.
2. Transfer the robot onto the washdown stand for 5 minutes.
3. Administrator use the black light to examine the existence of the contaminants.

Endurance

Energy/Power



Purpose

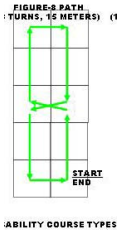
The purpose of this test method is to quantitatively evaluate a robot's battery capacity per charge cycle within a specified test apparatus and environmental condition.

Metrics

Distance per charge tested to inoperability (before and after benchtop cycling); time per charge tested to inoperability (before and after benchtop cycling); change in capacity in percent after 100 benchtop battery cycles.

Endurance

Energy/Power



Purpose

The purpose of this test method is to quantitatively evaluate a robot's battery capacity per charge cycle within a specified test apparatus and environmental condition.

Metrics

Distance per charge tested to inoperability (before and after benchtop cycling); time per charge tested to inoperability (before and after benchtop cycling); change in capacity in percent after 100 benchtop battery cycles.

Apparatus

This test apparatus is a figure-8 course constructed of OSB plywood boards . The overall dimensions are 6 x 2.4 m (20 x 8 ft). The wall is 1.2m (4ft) tall to constrain the robot path. There flooring is continuous 15° pitch/roll ramps in a prescribed configuration. One figure-8 lap is nominally 20m (66ft) long. This apparatus also includes an environmental chamber to house the figure-8 course to test for temperature at -20, 20, and 50 °C. The apparatus includes lighting control for testing at both ambient light and dark conditions. Several targets will be installed to provide a timed dwell task to provide a reconnaissance task. A beam break sensor can be used to count laps.

Procedure

1. Place the robot at the starting point. Traverse the course in the prescribed direction turning at every intersection to follow a figure-8 path until the batteries are depleted. Contact with the walls is allowed.
2. Every 10 laps (200 m) the operator shall dwell at the center point of the test apparatus for 1 minute while pointing cameras at known target locations. Each set of 10 laps will be conducted alternately in ambient light and near darkness.
3. Power/energy data logged over the first 20 laps (400 m) will be used to perform 100 benchtop depletion cycles unless the battery fails prior to that point.
4. Benchtop cycled batteries will be re-installed into the robot to perform one final battery depletion test.
5. Maintenance and repairs of the robot are allowed, but must be done in-situ within the test apparatus. Elapsed time for the repair will be noted and subtracted from the overall test duration. The repair time will be used to compute the mean-time-before-failure and time-to-repair data. The tools used to repair the robot will also be noted.

Apparatus

This test apparatus is a figure-8 course constructed of OSB plywood boards . The overall dimensions are 6 x 2.4 m (20 x 8 ft). The wall is 1.2m (4ft) tall to constrain the robot path. There flooring is continuous 15° pitch/roll ramps in a prescribed configuration. One figure-8 lap is nominally 20m (66ft) long. This apparatus also includes an environmental chamber to house the figure-8 course to test for temperature at -20, 20, and 50 °C. The apparatus includes lighting control for testing at both ambient light and dark conditions. Several targets will be installed to provide a timed dwell task to provide a reconnaissance task. A beam break sensor can be used to count laps.

Test Methods

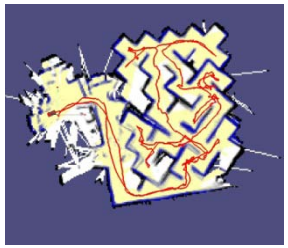
Procedure

1. Place the robot at the starting point. Traverse the course in the prescribed direction turning at every intersection to follow a figure-8 path until the batteries are depleted. Contact with the walls is allowed.
2. Every 10 laps (200 m) the operator shall dwell at the center point of the test apparatus for 1 minute while pointing cameras at known target locations. Each set of 10 laps will be conducted alternately in ambient light and near darkness.
3. Power/energy data logged over the first 20 laps (400 m) will be used to perform 100 benchtop depletion cycles unless the battery fails prior to that point.
4. Benchtop cycled batteries will be re-installed into the robot to perform one final battery depletion test.
5. Maintenance and repairs of the robot are allowed, but must be done in-situ within the test apparatus. Elapsed time for the repair will be noted and subtracted from the overall test duration. The repair time will be used to compute the mean-time-before-failure and time-to-repair data. The tools used to repair the robot will also be noted.

99

Random Maze Search

Human System Interaction



Purpose

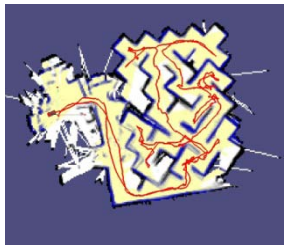
The purpose of this test method is to quantitatively evaluate an operator's ability to teleoperate a robot to completely negotiate and search an enclosed area with repetitive structural units that may be randomly arranged but contains minimum features otherwise. .

Metrics

Number of corners visited, multiply visited, and missed; whether returning to the starting point; time used; number of targets correctly identified, incorrectly identified (visual acuity), or multiply identified (loss of spatial awareness, or SA) or missed (field of view, loss of SA)

Random Maze Search

Human System Interaction



Purpose

The purpose of this test method is to quantitatively evaluate an operator's ability to teleoperate a robot to completely negotiate and search an enclosed area with repetitive structural units that may be randomly arranged but contains minimum features otherwise. .

Metrics

Number of corners visited, multiply visited, and missed; whether returning to the starting point; time used; number of targets correctly identified, incorrectly identified (visual acuity), or multiply identified (loss of spatial awareness, or SA) or missed (field of view, loss of SA)

Apparatus

This test apparatus is a random maze constructed with the OSB boards. The overall dimensions are nominally 15m (50ft) x 10m (33ft). The walls are 2.4m (8ft) tall forming 1.2m (4ft) hallways to constrain the robot path. The flooring is made of continuous ramps. Targets to identify are visual acuity charts and hazardous materials labels which are distributed throughout the maze in quantities unknown to the operator.

Procedure

1. Place the robot to the starting point.
2. Traverse the maze in directions to Operator's best judgment based on the video that the robot provides.
3. Along the traverse, operator is to find, identify, and map all visual acuity and hazardous materials labels. Note also the corners visited.
4. Robot return to the original starting point at the end of the test.

Test Methods

Apparatus

This test apparatus is a random maze constructed with the OSB boards. The overall dimensions are nominally 15m (50ft) x 10m (33ft). The walls are 2.4m (8ft) tall forming 1.2m (4ft) hallways to constrain the robot path. The flooring is made of continuous ramps. Targets to identify are visual acuity charts and hazardous materials labels which are distributed throughout the maze in quantities unknown to the operator.

Procedure

1. Place the robot to the starting point.
2. Traverse the maze in directions to Operator's best judgment based on the video that the robot provides.
3. Along the traverse, operator is to find, identify, and map all visual acuity and hazardous materials labels. Note also the corners visited.
4. Robot return to the original starting point at the end of the test.

101

Navigation

Human System Interaction

Purpose

The purpose of this test method is to quantitatively evaluate an robot's ability to be teleoperated to negotiate and find an exit in an enclosed area filled with repetitive structural units that may be randomly arranged but contains minimum features otherwise. It allows direct performance comparisons across different robot models and particular configurations of similar robot models.

Metrics

1. Convention: the end point shall be different from the starting point in this test method. Contact with the wall is allowed. Maintenance and repairs of the robot are not allowed during the test
2. Timing Constraint: 20 min time limit is allowed.
3. Metrics:
    a. whether traversing to the end point
    b. time that is used

Navigation

Human System Interaction

Purpose

The purpose of this test method is to quantitatively evaluate an robot's ability to be teleoperated to negotiate and find an exit in an enclosed area filled with repetitive structural units that may be randomly arranged but contains minimum features otherwise. It allows direct performance comparisons across different robot models and particular configurations of similar robot models.

Metrics

1. Convention: the end point shall be different from the starting point in this test method. Contact with the wall is allowed. Maintenance and repairs of the robot are not allowed during the test
2. Timing Constraint: 20 min time limit is allowed.
3. Metrics:
    a. whether traversing to the end point
    b. time that is used

Apparatus

This test apparatus is a random maze constructed with oriented strand board (OSB) to provide an inexpensive and common frictional surface similar to dust covered concrete. The overall dimensions are roughly 15m (50ft) x 10m (33ft) . The walls are 2.4m (8ft) tall forming 1.2m (4ft) hallways to constrain the robot path. The flooring is made of continuous 15° pitch/roll ramps in a prescribed configuration .

Procedure

1. Operator teleoperate the robot to the starting point of the test apparatus. Administrator close the opening.
2. Operator teleoperate the robot to traverse the maze, in directions to her/his best judgment based on the video that the robot provides, until she/he traverses to the end point or when time expires.

Test Methods

Apparatus

This test apparatus is a random maze constructed with oriented strand board (OSB) to provide an inexpensive and common frictional surface similar to dust covered concrete. The overall dimensions are roughly 15m (50ft) x 10m (33ft) . The walls are 2.4m (8ft) tall forming 1.2m (4ft) hallways to constrain the robot path. The flooring is made of continuous 15° pitch/roll ramps in a prescribed configuration .

Procedure

1. Operator teleoperate the robot to the starting point of the test apparatus. Administrator close the opening.
2. Operator teleoperate the robot to traverse the maze, in directions to her/his best judgment based on the video that the robot provides, until she/he traverses to the end point or when time expires.

103

Check List

Human System Interaction

Purpose

Metrics

Check List

Human System Interaction

Purpose

Metrics

104

Apparatus

Procedure

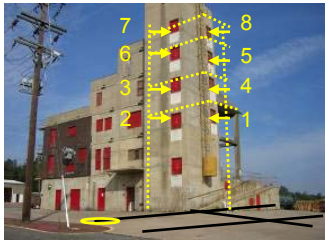
Test Methods

Apparatus

Procedure

Vertical Take-Off and Landing
VTOL/Robot Station Keeping

Maneuvering Aerial



Purpose

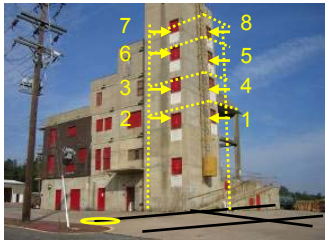
The purpose of this test method is to quantitatively evaluate a VTOL robot's ability to be teleoperated to conduct aerial surveys and searches by navigating specified paths, performing station keepings at required locations, and providing sufficient video for the operator perception requirements. It allows direct performance comparisons across different robot models and particular configurations of similar robot models.

Metrics

Number of targets that the operator correctly identified; time spent

Vertical Take-Off and Landing
VTOL/Robot Station Keeping

Maneuvering Aerial



Purpose

The purpose of this test method is to quantitatively evaluate a VTOL robot's ability to be teleoperated to conduct aerial surveys and searches by navigating specified paths, performing station keepings at required locations, and providing sufficient video for the operator perception requirements. It allows direct performance comparisons across different robot models and particular configurations of similar robot models.

Metrics

Number of targets that the operator correctly identified; time spent

Apparatus

The apparatus of this test method is a vertical structure that is used to hang sensory targets (HAZMAT signs, Snell Charts, or objects such as those used in the Spatial Awareness test method) at the levels of height of 0m, 3m, 6m, 9m, 12m, and 15m. At each level, at least two visually mutually exclusive locations are used for hanging the targets. The starting location is a 2m diameter circle 5m away from the target structure.

Procedure

1. Operator teleoperate the robot to take off. Do not leave the vertical area until she/he gain full control of robot.
2. Operator teleoperate the robot to next station-keeping location on the specified path, identify the target.
3. Repeat 2 for all locations at the level.
4. Repeat 2-3 for the next level.
5. Repeat 2-4 until completing the highest level.

Test Methods

Apparatus

The apparatus of this test method is a vertical structure that is used to hang sensory targets (HAZMAT signs, Snell Charts, or objects such as those used in the Spatial Awareness test method) at the levels of height of 0m, 3m, 6m, 9m, 12m, and 15m. At each level, at least two visually mutually exclusive locations are used for hanging the targets. The starting location is a 2m diameter circle 5m away from the target structure.

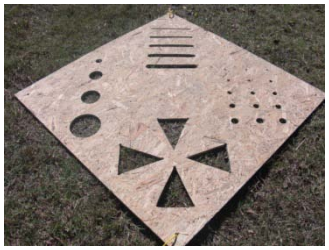
Procedure

1. Operator teleoperate the robot to take off. Do not leave the vertical area until she/he gain full control of robot.
2. Operator teleoperate the robot to next station-keeping location on the specified path, identify the target.
3. Repeat 2 for all locations at the level.
4. Repeat 2-3 for the next level.
5. Repeat 2-4 until completing the highest level.

107

Underwater Navigation and Search

Maneuvering Aquatic



Purpose

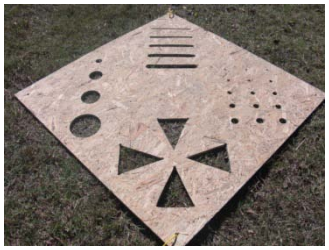
The purpose of this test method is to quantitatively evaluate robot's ability to provide video of a underwater environment to facilitate operator's ability to gain spatial awareness and to conduct teleoperated search. This test method allows direct comparisons across different robot models and particular configurations of similar robot models.

Metrics

Whether reaching the end point or not; time used; number of targets correctly and incorrectly identified, missed, or multiply identified

Underwater Navigation and Search

Maneuvering Aquatic



Purpose

The purpose of this test method is to quantitatively evaluate robot's ability to provide video of a underwater environment to facilitate operator's ability to gain spatial awareness and to conduct teleoperated search. This test method allows direct comparisons across different robot models and particular configurations of similar robot models.

Metrics

Whether reaching the end point or not; time used; number of targets correctly and incorrectly identified, missed, or multiply identified

108

Apparatus

This test apparatus is implemented in lake or river . A set of standardized objects is used and individual objects can be randomly ordered.

Procedure

1. Operator place the robot at the starting point.
2. Teleoperate robot underwater and search the pre-placed objects until all the objects are identified, time expires, or for any other reason when the robot is not able to continue the search.

Test Methods

Apparatus

This test apparatus is implemented in lake or river . A set of standardized objects is used and individual objects can be randomly ordered.

Procedure

1. Operator place the robot at the starting point.
2. Teleoperate robot underwater and search the pre-placed objects until all the objects are identified, time expires, or for any other reason when the robot is not able to continue the search.

109

110

Ground Robots

Ground Robots

111

EyeBall R1

O.D.F. Optronics
www.odfopt.com
336-302-9309/ilanit Gedalyoviche

Manufacturer's Specs:

- Circumference 3.25" (8.25 cm)
- Weight: 1.25 lbs (.566kg)
- Turning Diam: 0"
- Max Speed: rotates 4 RPM
- Power Source: battery
- Endurance: 3 hours
- Tether: none
- Control: eyes-on, remote teleop
- Sensors: camera
- Payload: N/A
- Manipulator: N/A

Radio Tx:	2400 MHz, 902-928MHz (RF)
Radio Rx:	2400 MHz, 902-928MHz (RF)

EyeBall R1

O.D.F. Optronics
www.odfopt.com
336-302-9309/ilanit Gedalyoviche

Manufacturer's Specs:

- Circumference 3.25" (8.25 cm)
- Weight: 1.25 lbs (.566kg)
- Turning Diam: 0"
- Max Speed: rotates 4 RPM
- Power Source: battery
- Endurance: 3 hours
- Tether: none
- Control: eyes-on, remote teleop
- Sensors: camera
- Payload: N/A
- Manipulator: N/A

Radio Tx:	2400 MHz, 902-928MHz (RF)
Radio Rx:	2400 MHz, 902-928MHz (RF)

EyeBall R1

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

EyeBall R1

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

113

Recon Scout

ReconRobotics, Inc.
http://www.reconrobotics.com

Manufacturer's Specs:

Width:	3 in (7.6 cm)
Length:	7.36 in (18.7 cm)
Height:	3 in (7.6 cm)
Weight:	1.2 lbs (544 g)
Locomotion:	Wheeled
Steering:	Two-wheel independent
Turning Diam:	0 in (0 cm)
Max Speed:	1 fps (0.3 mps)
Power Source:	11.4 V DC Lithium Polymer
Endurance:	60 minutes
Tether:	Wireless
Control:	Remote teleop
Sensors:	InfraRed, camera
Payload:	N/A
Manipulator:	N/A

* Has not attended any exercises to date

Radio Tx: 433 MHz / 250 mW (video), 75 MHz / 250 mW (command)
Radio Rx: 433 MHz / 250 mW (video), 75 MHz / 250 mW (command)

Recon Scout

ReconRobotics, Inc.
http://www.reconrobotics.com

Manufacturer's Specs:

Width:	3 in (7.6 cm)
Length:	7.36 in (18.7 cm)
Height:	3 in (7.6 cm)
Weight:	1.2 lbs (544 g)
Locomotion:	Wheeled
Steering:	Two-wheel independent
Turning Diam:	0 in (0 cm)
Max Speed:	1 fps (0.3 mps)
Power Source:	11.4 V DC Lithium Polymer
Endurance:	60 minutes
Tether:	Wireless
Control:	Remote teleop
Sensors:	InfraRed, camera
Payload:	N/A
Manipulator:	N/A

* Has not attended any exercises to date

Radio Tx: 433 MHz / 250 mW (video), 75 MHz / 250 mW (command)
Radio Rx: 433 MHz / 250 mW (video), 75 MHz / 250 mW (command)

Recon Scout

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Recon Scout

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

115

ToughBot

Omnitech Robotics International LLC
www.omnitech.com
303-922-7773/Dave Parish

Manufacturer's Specs:

- Width: 3.14" (8 cm)
- Length: 4.3" (11 cm)
- Height: 4.3" (11 cm)
- Weight: 2 lb (.9 kg)
- Turning Diam: 0"
- Max Speed: TBD
- Power Source: battery
- Endurance: 1 hour
- Tether: none
- Control: eyes-on, remote teleop
- Sensors: 2 camera (wide and narrow)
- Payload: N/A
- Manipulator: N/A

Radio Tx:	2400 MHz, 868MHz
Radio Rx:	2400 MHz, 868MHz

ToughBot

Omnitech Robotics International LLC
www.omnitech.com
303-922-7773/Dave Parish

Manufacturer's Specs:

- Width: 3.14" (8 cm)
- Length: 4.3" (11 cm)
- Height: 4.3" (11 cm)
- Weight: 2 lb (.9 kg)
- Turning Diam: 0"
- Max Speed: TBD
- Power Source: battery
- Endurance: 1 hour
- Tether: none
- Control: eyes-on, remote teleop
- Sensors: 2 camera (wide and narrow)
- Payload: N/A
- Manipulator: N/A

Radio Tx:	2400 MHz, 868MHz
Radio Rx:	2400 MHz, 868MHz

ToughBot

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

ToughBot

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

117

Active Scope Camera

Tohoku University, Tadokoro Laboratory
www.rm.is.tohoku.ac.jp

Manufacturer's Specs:

- Width: 1" (2.5cm)
- Length: 320" (80 cm)
- Height: 1" (2.5 cm)
- Weight: 10 lbs (5 kg)
- Turning Dia: 4" – 80" (10cm – 200 cm)
- Max Speed: .2 fps (6 cmps)
- Power Source: battery
- Endurance: 60 min
- Tether: body is the tether
- Control: teleop
- Sensors: CCD camera
- Payload: N/A
- Manipulator: N/A

Radio TX: Tethered
Radio RX:

Active Scope Camera

Tohoku University, Tadokoro Laboratory
www.rm.is.tohoku.ac.jp

Manufacturer's Specs:

- Width: 1" (2.5cm)
- Length: 320" (80 cm)
- Height: 1" (2.5 cm)
- Weight: 10 lbs (5 kg)
- Turning Dia: 4" – 80" (10cm – 200 cm)
- Max Speed: .2 fps (6 cmps)
- Power Source: battery
- Endurance: 60 min
- Tether: body is the tether
- Control: teleop
- Sensors: CCD camera
- Payload: N/A
- Manipulator: N/A

Radio TX: Tethered
Radio RX:

Active Scope Camera

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Active Scope Camera

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

119

Pointman (LRV)

Applied Research Associates
www.ARA.com
303-795-8106/Andrew Poulter

Manufacturer's Specs:

- Width: 20" (51 cm)
- Length: 14" (36 cm)
- Height: 6.5" (16 cm)
- Weight: 14 lbs (6.3 kg)
- Turning Diam: 20" (51 cm)
- Max Speed: 6 fps (1.8 mps)
- Power Source: 8.5 AH Lithium Polymer
- Endurance: 60-240 min
- Tether: Option
- Control: Remote tele-operation
- Sensors: Color / IR Cameras
- Payload: 1.2 lb(0.5 kg) , drag 20 lb (9 kg)
- Manipulator: N/A –future option, existing boom reach is 18 in (45 cm

Radio Tx: 75MHz(75mW), 900 MHz(100mW),2400MHz(200mW)
Radio Rx: 75 MHz , 900 MHz , 2400 MHz

Pointman (LRV)

Applied Research Associates
www.ARA.com
303-795-8106/Andrew Poulter

Manufacturer's Specs:

- Width: 20" (51 cm)
- Length: 14" (36 cm)
- Height: 6.5" (16 cm)
- Weight: 14 lbs (6.3 kg)
- Turning Diam: 20" (51 cm)
- Max Speed: 6 fps (1.8 mps)
- Power Source: 8.5 AH Lithium Polymer
- Endurance: 60-240 min
- Tether: Option
- Control: Remote tele-operation
- Sensors: Color / IR Cameras
- Payload: 1.2 lb(0.5 kg) , drag 20 lb (9 kg)
- Manipulator: N/A –future option, existing boom reach is 18 in (45 cm

Radio Tx: 75MHz(75mW), 900 MHz(100mW),2400MHz(200mW)
Radio Rx: 75 MHz , 900 MHz , 2400 MHz

Pointman(LRV)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Pointman(LRV)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

121

VGTV-Extreme

Inuktun
www.inuktun.com/
1-877-468-5886/ Derek Naughton

Manufacturer's Specs:

- Width: 10.9" (27.7 cm)
- Length: 16.8" (42.7 cm)
- Height: 5.5" (14 cm) Lowered
- Weight: 14-20 lbs(6.2-9.1kg)
- Turning Diam: 0" (0 cm)
- Max Speed: 1.5 fps (.45 mps)
- Power Source: lithium ion battery
- Endurance: >360 min
- Tether: power, comms
- Control: eyes-on, remote teleop
- Sensors: tilt camera 300º
- Payload: 10 lb (4.5 kg)
- Manipulator: N/A

Radio Tx: (tether only)
Radio Rx: (tether only)

VGTV-Extreme

Inuktun
www.inuktun.com/
1-877-468-5886/ Derek Naughton

Manufacturer's Specs:

- Width: 10.9" (27.7 cm)
- Length: 16.8" (42.7 cm)
- Height: 5.5" (14 cm) Lowered
- Weight: 14-20 lbs(6.2-9.1kg)
- Turning Diam: 0" (0 cm)
- Max Speed: 1.5 fps (.45 mps)
- Power Source: lithium ion battery
- Endurance: >360 min
- Tether: power, comms
- Control: eyes-on, remote teleop
- Sensors: tilt camera 300º
- Payload: 10 lb (4.5 kg)
- Manipulator: N/A

Radio Tx: (tether only)
Radio Rx: (tether only)

VGTV-Extreme

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

VGTV-Extreme

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Dragon Runner SUGV

Foster-Miller / Automatika
www.foster-miller.com/lemming.htm
781-684-3960/Joanne Armstrong

Manufacturer's Specs:

- Width: 12.2" (31 cm)
- Length: 16.6" (42 cm)
- Height: 6" (15.2 cm)
- Weight: 14 lbs (6.4 kg)
- Turning Diam: Zero-Turn; Swept
- Max Speed: 7.5 - 29 fps (5 - 20 mph)
- Power Source: battery (Li Ion)
- Endurance: 2 hours mph on flat ground
- Tether: none
- Control: remote teleop, loss-of-comms back-tracking, cruise-control
- Sensors: thermal (PIR), acoustic, visual (wide-angle FF lens; IR illuminator)
- Payload: 10 lb (4.5 kg)
- Manipulator: 2 or 3 degree of motion w/gripper

Radio Tx: Low S-Band MHz(1 – 1k mW)L-Band MHz (1–1K mW)
Radio Rx: n/a

Dragon Runner SUGV

Foster-Miller / Automatika
www.foster-miller.com/lemming.htm
781-684-3960/Joanne Armstrong

Manufacturer's Specs:

- Width: 12.2" (31 cm)
- Length: 16.6" (42 cm)
- Height: 6" (15.2 cm)
- Weight: 14 lbs (6.4 kg)
- Turning Diam: Zero-Turn; Swept
- Max Speed: 7.5 - 29 fps (5 - 20 mph)
- Power Source: battery (Li Ion)
- Endurance: 2 hours mph on flat ground
- Tether: none
- Control: remote teleop, loss-of-comms back-tracking, cruise-control
- Sensors: thermal (PIR), acoustic, visual (wide-angle FF lens; IR illuminator)
- Payload: 10 lb (4.5 kg)
- Manipulator: 2 or 3 degree of motion w/gripper

Radio Tx: Low S-Band MHz(1 – 1k mW)L-Band MHz (1–1K mW)
Radio Rx: n/a

Dragon Runner SUGV

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Dragon Runner SUGV

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

125

BomBot

WVHTC Foundation
www.wvhtf.org
304-333-6461/Brian Stolarik

Manufacturer's Specs:

- Width: 18" (45.72 cm)
- Length: 20" (50.8 cm)
- Height: 32" (81.28 cm)
- Weight: 15 lbs (6.8kg)
- Turning Diam: 2ft. (60.96 cm)
- Max Speed: 20 mph (32 km/hr)
- Power Source: battery
- Endurance: 3-4 hrs.
- Tether: none
- Control: eyes-on, remote teleop
- Sensors: none
- Payload: 10 lbs (4.5kg)
- Manipulator: N/A

Radio Tx: 2400 MHz
Radio Rx: 2400 MHz

BomBot

WVHTC Foundation
www.wvhtf.org
304-333-6461/Brian Stolarik

Manufacturer's Specs:

- Width: 18" (45.72 cm)
- Length: 20" (50.8 cm)
- Height: 32" (81.28 cm)
- Weight: 15 lbs (6.8kg)
- Turning Diam: 2ft. (60.96 cm)
- Max Speed: 20 mph (32 km/hr)
- Power Source: battery
- Endurance: 3-4 hrs.
- Tether: none
- Control: eyes-on, remote teleop
- Sensors: none
- Payload: 10 lbs (4.5kg)
- Manipulator: N/A

Radio Tx: 2400 MHz
Radio Rx: 2400 MHz

BomBot

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

Ground Robots

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

BomBot

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

Ground Robots

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

127

Versatrax 100

SeaTrepid
www.inuktun.com
Bob Christ

Manufacturer's Specs:

• Width:	Inline: 4" (10 cm)
•	Parallel: 5.5" (14cm)&larger
• Length:	Inline: 34.6" (87.88cm)
•	Parallel: 9.5" (24cm)
• Height:	Inline: 4" (10 cm)
•	Parallel: 5" (12.7 cm)
• Weight:	20 lbs (9 kg)
• Locomotion:	Tracked
• Steering:	Skid steering
• Turning Diam:	Various; depending on pipe diameters
• Max Speed:	32 fpm (10 mpm)
• Power Source:	88-264 VAC 50/60 Hz
• Endurance:	Continuous
• Tether:	Power and comms
• Control:	Remote teleop
• Sensors:	N/A
• Payload:	N/A
• Manipulator:	N/A

Radio TX:
Radio RX:

Versatrax 100

SeaTrepid
www.inuktun.com
Bob Christ

Manufacturer's Specs:

• Width:	Inline: 4" (10 cm)
•	Parallel: 5.5" (14cm)&larger
• Length:	Inline: 34.6" (87.88cm)
•	Parallel: 9.5" (24cm)
• Height:	Inline: 4" (10 cm)
•	Parallel: 5" (12.7 cm)
• Weight:	20 lbs (9 kg)
• Locomotion:	Tracked
• Steering:	Skid steering
• Turning Diam:	Various; depending on pipe diameters
• Max Speed:	32 fpm (10 mpm)
• Power Source:	88-264 VAC 50/60 Hz
• Endurance:	Continuous
• Tether:	Power and comms
• Control:	Remote teleop
• Sensors:	N/A
• Payload:	N/A
• Manipulator:	N/A

Radio TX:
Radio RX:

Versatrax 100

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Versatrax 100

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Marv

Mesa Robotics, Inc.
www.mesa-robotics.com
256-464-7252/Mike Cole

Manufacturer's Specs:

- Width: 13.5" (34.29 cm)
- Length: 20.5" (52.07 cm)
- Height: 12" (30.48 cm)
- Weight: 25 lbs (11.33 kg)
- Turning Dia: zero in
- Max Speed: 4 mph (6.4 km/hr)
- Power Source: 12VDC, NiMH battery
- Endurance: 60 – 120 min
- Tether: none
- Control: remote teleop
- Sensors: future option
- Payload: 10 lbs (4.5 kg)
- Manipulator: future option

Radio TX: 900 MHz control, 2400 MHz video
Radio RX: 900 MHz control, 2400 MHz video

Marv

Mesa Robotics, Inc.
www.mesa-robotics.com
256-464-7252/Mike Cole

Manufacturer's Specs:

- Width: 13.5" (34.29 cm)
- Length: 20.5" (52.07 cm)
- Height: 12" (30.48 cm)
- Weight: 25 lbs (11.33 kg)
- Turning Dia: zero in
- Max Speed: 4 mph (6.4 km/hr)
- Power Source: 12VDC, NiMH battery
- Endurance: 60 – 120 min
- Tether: none
- Control: remote teleop
- Sensors: future option
- Payload: 10 lbs (4.5 kg)
- Manipulator: future option

Radio TX: 900 MHz control, 2400 MHz video
Radio RX: 900 MHz control, 2400 MHz video

Marv

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Marv

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

131

G2Bot

Mesa Robotics, Inc.
www.mesa-robotics.com
256.258.2130/Toki Owens

Manufacturer's Specs:

- Width: 13.5" (34.29 cm)
- Length: 21" (53.34 cm)
- Height: 12" (30.48 cm)
- Weight: 25 lbs (11.33 kg)
- Turning Dia: 21" (53.34 cm)
- Max Speed: 4 mph (6.4 km/hr)
- Power Source: 12VDC, NiMH battery
- Endurance: 60 – 120 min
- Tether: none
- Control: rf 700 meters
- Sensors: Cameras
- Payload: 15 lbs (6.80 kg)
- Manipulator: none

Radio TX: 900 MHz control, 2400 MHz video
Radio RX: 900 MHz control, 2400 MHz video

G2Bot

Mesa Robotics, Inc.
www.mesa-robotics.com
256.258.2130/Toki Owens

Manufacturer's Specs:

- Width: 13.5" (34.29 cm)
- Length: 21" (53.34 cm)
- Height: 12" (30.48 cm)
- Weight: 25 lbs (11.33 kg)
- Turning Dia: 21" (53.34 cm)
- Max Speed: 4 mph (6.4 km/hr)
- Power Source: 12VDC, NiMH battery
- Endurance: 60 – 120 min
- Tether: none
- Control: rf 700 meters
- Sensors: Cameras
- Payload: 15 lbs (6.80 kg)
- Manipulator: none

Radio TX: 900 MHz control, 2400 MHz video
Radio RX: 900 MHz control, 2400 MHz video

G2Bot

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

G2Bot

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Soryu

International Rescue System Institute
www.rescuesystem.org
Shigeo Hirose

Manufacturer's Specs:

- Width: 5.9" (15 cm)
- Length: 47.2" (120 cm)
- Height: 5.1" (13 cm)
- Weight: 28.6 lbs (13 kg)
- Turning Diam: 1.0 m
- Max Speed: 0.3 mps
- Power Source: battery
- Endurance: 20 min
- Tether: comms
- Control: remote teleop
- Sensors: thermal, camera, GAS(CO, O2, SO, CH)
- Payload: none
- Manipulator: none

Radio Tx: (tether only)
Radio Rx: (tether only)

Soryu

International Rescue System Institute
www.rescuesystem.org
Shigeo Hirose

Manufacturer's Specs:

- Width: 5.9" (15 cm)
- Length: 47.2" (120 cm)
- Height: 5.1" (13 cm)
- Weight: 28.6 lbs (13 kg)
- Turning Diam: 1.0 m
- Max Speed: 0.3 mps
- Power Source: battery
- Endurance: 20 min
- Tether: comms
- Control: remote teleop
- Sensors: thermal, camera, GAS(CO, O2, SO, CH)
- Payload: none
- Manipulator: none

Radio Tx: (tether only)
Radio Rx: (tether only)

Soryu

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Soryu

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

BomBot 2

WVHTC Foundation
www.wvhtf.org
304-333-6461/Brian Stolarik

Manufacturer's Specs:

• Width:	19.5" (49.5 cm)
• Length:	22.8" (57.8 cm)
• Height:	10"- 23" (25.4 -58.4 cm)
• Weight:	30 lbs (13.6 kg)
• Turning Diam:	110 in (280 cm)
• Max Speed:	14.6 fps (4.5 mps)
• Power Source:	24VDC BB2590 or BB390 battery (2 vehicle, 1 OCU); 1.5V AA (4 in OCU)
• Endurance:	180 mins
• Tether:	none
• Control:	Remote teleoperation, line-of-sight
• Sensors: (modular	Wide-angle surveillance camera mission plate to adapt sensors)
• Payload: lbs	45 lbs (20.4 kg) on mission plate, 60 (27.2 kg) towed (optional wagon)
• Manipulator:	N/A

Radio TX: 2.4MHz/430MHz

BomBot 2

WVHTC Foundation
www.wvhtf.org
304-333-6461/Brian Stolarik

Manufacturer's Specs:

• Width:	19.5" (49.5 cm)
• Length:	22.8" (57.8 cm)
• Height:	10"- 23" (25.4 -58.4 cm)
• Weight:	30 lbs (13.6 kg)
• Turning Diam:	110 in (280 cm)
• Max Speed:	14.6 fps (4.5 mps)
• Power Source:	24VDC BB2590 or BB390 battery (2 vehicle, 1 OCU); 1.5V AA (4 in OCU)
• Endurance:	180 mins
• Tether:	none
• Control:	Remote teleoperation, line-of-sight
• Sensors: (modular	Wide-angle surveillance camera mission plate to adapt sensors)
• Payload: lbs	45 lbs (20.4 kg) on mission plate, 60 (27.2 kg) towed (optional wagon)
• Manipulator:	N/A

Radio TX: 2.4MHz/430MHz

BomBot 2

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

BomBot 2

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Soryu V

International Rescue System Institute
www.rescuesystem.org
Shigeo Hirose

Manufacturer's Specs:

- Width: 7.9" (20.2 cm)
- Length: 45.6" – 54.3" (116 - 138 cm)
- Height: 5.7" (14.5 cm)
- Weight: 37.47 lbs (17 kg)
- Turning Diam: 50.3" (128 cm)
- Max Speed: 0.25 mps
- Power Source: battery (14.4V, 7400mAh)
- Endurance: 40 min
- Tether: comms
- Control: remote teleop
- Sensors: Camera
- Payload: unknown
- Manipulator: none

Radio Tx: (tether only)
Radio Rx: (tether only)

Soryu V

International Rescue System Institute
www.rescuesystem.org
Shigeo Hirose

Manufacturer's Specs:

- Width: 7.9" (20.2 cm)
- Length: 45.6" – 54.3" (116 - 138 cm)
- Height: 5.7" (14.5 cm)
- Weight: 37.47 lbs (17 kg)
- Turning Diam: 50.3" (128 cm)
- Max Speed: 0.25 mps
- Power Source: battery (14.4V, 7400mAh)
- Endurance: 40 min
- Tether: comms
- Control: remote teleop
- Sensors: Camera
- Payload: unknown
- Manipulator: none

Radio Tx: (tether only)
Radio Rx: (tether only)

Soryu V

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Soryu V

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

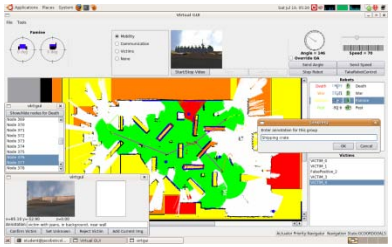
Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Jacobs Rugged Robot

Jacobs University, Robotics Group, Bremen, Germany
http://robotics.jacobs-university.de
Prof. Dr. Andreas Birk



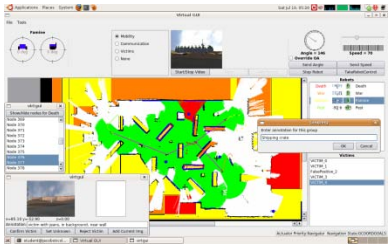
Manufacturer's Specs:

Width:	20.31" (51.6 cm)
Length:	21.06" (53.5 cm) -37.20" (94.5 cm)
Height:	19.69" (50 cm)
Weight:	39.68 lbs (18 kg)
Locomotion:	tracked
Steering:	skid
Turning Diam:	0
Max Speed:	2.8 m/s (10.1 Km/h)
Power Source:	LiPo Batteries, 173 Wh
Endurance:	2 hours
Tether:	optional, solely for communication
Control:	autonomous/teleoperation
Sensors:	Hokuyo/Sick /FLIR
Payload:	55.12 lbs (25kg)
Manipulator:	optional Neuronics Katana arm (6 DOF, 37.4" (95 cm) reach)

Radio Tx: 802.11 bg / a (2.4 GHz / 5.0 GHz)
Radio Rx: 802.11 bg / a (2.4 GHz / 5.0 GHz)

Jacobs Rugged Robot

Jacobs University, Robotics Group, Bremen, Germany
http://robotics.jacobs-university.de
Prof. Dr. Andreas Birk



Manufacturer's Specs:

Width:	20.31" (51.6 cm)
Length:	21.06" (53.5 cm) -37.20" (94.5 cm)
Height:	19.69" (50 cm)
Weight:	39.68 lbs (18 kg)
Locomotion:	tracked
Steering:	skid
Turning Diam:	0
Max Speed:	2.8 m/s (10.1 Km/h)
Power Source:	LiPo Batteries, 173 Wh
Endurance:	2 hours
Tether:	optional, solely for communication
Control:	autonomous/teleoperation
Sensors:	Hokuyo/Sick /FLIR
Payload:	55.12 lbs (25kg)
Manipulator:	optional Neuronics Katana arm (6 DOF, 37.4" (95 cm) reach)

Radio Tx: 802.11 bg / a (2.4 GHz / 5.0 GHz)
Radio Rx: 802.11 bg / a (2.4 GHz / 5.0 GHz)

Jacobs Rugged Robot

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Jacobs Rugged Robot

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

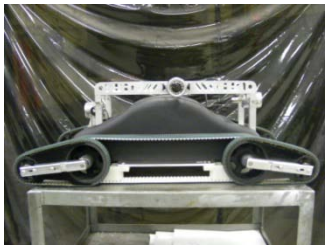
Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

141

Hero

First-Response Robotics, LLC
www.FirstResponseRobotics.com
513-752-6653 /Mike Cardarelli



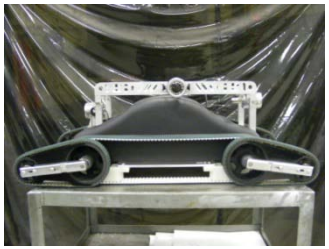
Manufacturer's Specs:

- Width: 21" (53 cm)
- Length: 36" (91 cm)
- Height: 17" (43 cm)
- Weight: 42 lbs (19 kg)
- Turning Diam: 0 m (0 cm)
- Max Speed: 10 fps (3 mps)
- Power Source: battery
- Endurance: 45 min
- Tether: none
- Control: remote teleop
- Sensors: radiation, biological
- Payload: 130 lb (59 kg)
- Manipulator: none

Radio TX: 72 MHz controller/1.0W (video), 2.4 MHz 900 MHz/0.5 W (telemetry), 1.2 MHz / 3W (video)

Hero

First-Response Robotics, LLC
www.FirstResponseRobotics.com
513-752-6653 /Mike Cardarelli



Manufacturer's Specs:

- Width: 21" (53 cm)
- Length: 36" (91 cm)
- Height: 17" (43 cm)
- Weight: 42 lbs (19 kg)
- Turning Diam: 0 m (0 cm)
- Max Speed: 10 fps (3 mps)
- Power Source: battery
- Endurance: 45 min
- Tether: none
- Control: remote teleop
- Sensors: radiation, biological
- Payload: 130 lb (59 kg)
- Manipulator: none

Radio TX: 72 MHz controller/1.0W (video), 2.4 MHz 900 MHz/0.5 W (telemetry), 1.2 MHz / 3W (video)

Hero

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Hero

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

143

Super Kenaf

International Rescue System Institute
www.rescuesystem.org
Eiji Koyanagi

Manufacturer's Specs:

Width:	16.9 in (43.0 cm)
Length:	37.0 (20.4)in (94.0(52.0) cm)
Height:	6.3 in (16.0 cm)
Weight:	43.3 lbs (19.0 kg)
Locomotion:	2;tracked,4;flipper arm
Steering:	skid
Turning Diam:	diagonal for skid steer 0 in (0 cm)
Max Speed:	11.6 fps (3.5 mps)
Power Source:	battery
Endurance:	40 min
Tether:	none
Control:	remote teleop
Sensors:	None
Payload:	None
Manipulator:	None

Radio Tx: 802.11A
Radio Rx: 802.11A

Super Kenaf

International Rescue System Institute
www.rescuesystem.org
Eiji Koyanagi

Manufacturer's Specs:

Width:	16.9 in (43.0 cm)
Length:	37.0 (20.4)in (94.0(52.0) cm)
Height:	6.3 in (16.0 cm)
Weight:	43.3 lbs (19.0 kg)
Locomotion:	2;tracked,4;flipper arm
Steering:	skid
Turning Diam:	diagonal for skid steer 0 in (0 cm)
Max Speed:	11.6 fps (3.5 mps)
Power Source:	battery
Endurance:	40 min
Tether:	none
Control:	remote teleop
Sensors:	None
Payload:	None
Manipulator:	None

Radio Tx: 802.11A
Radio Rx: 802.11A

Super Kenaf

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Super Kenaf

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

145

Kenaf

International Rescue System Institute
www.rescuesystem.org
Eiji Koyanagi

Manufacturer's Specs:

Width:	16.9 in (43.0 cm)
Length:	37.0 (20.4)in (94.0(52.0) cm)
Height:	7.7 in (19.5 cm)
Weight:	48.9 lbs (22.0 kg)
Locomotion:	2;tracked,4;flipper arm
Steering:	skid
Turning Diam:	diagonal for skid steer 0 in (0 cm)
Max Speed:	1.2 fps (0.4 mps)
Power Source:	battery
Endurance:	120 min
Tether:	none
Control:	remote teleoperation
Sensors:	CCD Camera, Fisheye Camera, 3D Scanner (2D URG + Pant Tilt base)
Payload:	None
Manipulator:	None

Radio Tx: 802.11A
Radio Rx: 802.11A

Kenaf

International Rescue System Institute
www.rescuesystem.org
Eiji Koyanagi

Manufacturer's Specs:

Width:	16.9 in (43.0 cm)
Length:	37.0 (20.4)in (94.0(52.0) cm)
Height:	7.7 in (19.5 cm)
Weight:	48.9 lbs (22.0 kg)
Locomotion:	2;tracked,4;flipper arm
Steering:	skid
Turning Diam:	diagonal for skid steer 0 in (0 cm)
Max Speed:	1.2 fps (0.4 mps)
Power Source:	battery
Endurance:	120 min
Tether:	none
Control:	remote teleoperation
Sensors:	CCD Camera, Fisheye Camera, 3D Scanner (2D URG + Pant Tilt base)
Payload:	None
Manipulator:	None

Radio Tx: 802.11A
Radio Rx: 802.11A

Kenaf

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Kenaf

Cache packaging, weight, setup, tools
Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space
Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:
Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):
Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:
LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:
Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:
Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:
Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

147

PackBot EOD

iRobot
www.irobot.com
781-345-0200/Jeff Ostazewski

Manufacturer's Specs:

- Width: 16"- 20" (40 - 50 cm)
- Length: 27" (69 cm)
- Height: 7.5" (19 cm)
- Weight: 48 lbs (22 kg)
- Turning Dia: 34" (86.36 cm)
- Max Speed: Variable 0 - 5 mph (0 - 8 km/hr)
- Power Source: battery
- Endurance: 2-12 hours / 6+ mi (10+ km)
- Tether: optional
- Control: Teleop
- Sensors: Zoom, FLIR cameras,omni direct mic
- Payload: 8 additional
- Manipulator: arm

Radio TX: 2400 MHz
Radio RX: 2400 MHz

PackBot EOD

iRobot
www.irobot.com
781-345-0200/Jeff Ostazewski

Manufacturer's Specs:

- Width: 16"- 20" (40 - 50 cm)
- Length: 27" (69 cm)
- Height: 7.5" (19 cm)
- Weight: 48 lbs (22 kg)
- Turning Dia: 34" (86.36 cm)
- Max Speed: Variable 0 - 5 mph (0 - 8 km/hr)
- Power Source: battery
- Endurance: 2-12 hours / 6+ mi (10+ km)
- Tether: optional
- Control: Teleop
- Sensors: Zoom, FLIR cameras,omni direct mic
- Payload: 8 additional
- Manipulator: arm

Radio TX: 2400 MHz
Radio RX: 2400 MHz

PackBot EOD

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

PackBot EOD

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

149

PackBot Explorer

iRobot
www.irobot.com
781-345-0200/Jeff Ostazewski

Manufacturer's Specs:

- Width: 16" - 20" (40 - 50 cm)
- Length: 27"(69 cm)
- Height: 7.5" (19 cm)
- Weight: 48 lbs (22 kg)
- Turning Dia: 34" (86.36 cm)
- Max Speed: Variable 0 - 5 mph (0 - 8 km/hr)
- Power Source: battery
- Endurance: 2-12 hours / 6+ mi (10+ km)
- Tether: optional
- Control: Teleop
- Sensors: Zoom & FLIR cameras, omni dirc mic
- Payload: Supports up to 8
- Manipulator: surveillance head is mounted on a 12" (.3m) mast with a 360° pan and 270° tilt

Radio TX: 2400 MHz
Radio RX: 2400 MHz

PackBot Explorer

iRobot
www.irobot.com
781-345-0200/Jeff Ostazewski

Manufacturer's Specs:

- Width: 16" - 20" (40 - 50 cm)
- Length: 27"(69 cm)
- Height: 7.5" (19 cm)
- Weight: 48 lbs (22 kg)
- Turning Dia: 34" (86.36 cm)
- Max Speed: Variable 0 - 5 mph (0 - 8 km/hr)
- Power Source: battery
- Endurance: 2-12 hours / 6+ mi (10+ km)
- Tether: optional
- Control: Teleop
- Sensors: Zoom & FLIR cameras, omni dirc mic
- Payload: Supports up to 8
- Manipulator: surveillance head is mounted on a 12" (.3m) mast with a 360° pan and 270° tilt

Radio TX: 2400 MHz
Radio RX: 2400 MHz

PackBot Explorer

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

PackBot Explorer

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

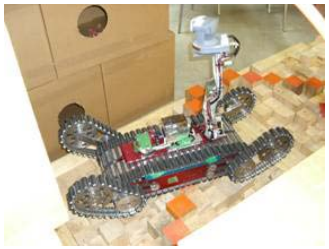
Visual Acuity:

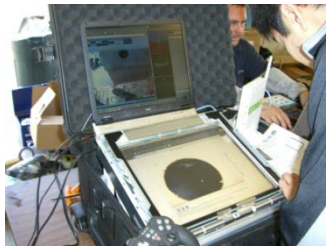
Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

151

Hibiscus

Toin University of Yokohama
Chiba Institute of Technology
koyanagi@furo.org





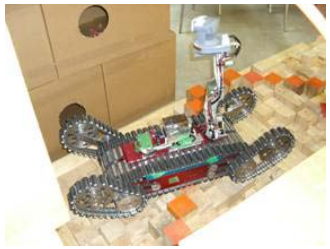
Manufacturer's Specs:

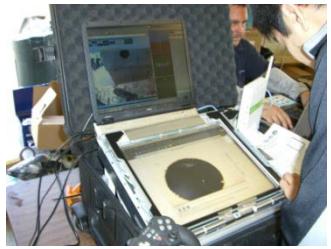
- Width: 14.5" (37 cm)
- Length: 38.5" (98 cm)
- Height: 7" (18 cm)
- Weight: 49.6 lbs (22.5 kg)
- Turn Diam: diagonal for skid steer
- Max Speed: .7 mph (1.2 km/ph)
- Power Source: battery
- Endurance: 60 min
- Tether: none
- Control Features: diagnostics, wall following, centering
- Sensors: URG,Heat, Voice
- Payload: none
- Manipulator: Sensor arm 4DOF: Length: 14.1" (36cm)

Radio TX: 2400 MHz
Radio RX: 2400 MHz

Hibiscus

Toin University of Yokohama
Chiba Institute of Technology
koyanagi@furo.org





Manufacturer's Specs:

- Width: 14.5" (37 cm)
- Length: 38.5" (98 cm)
- Height: 7" (18 cm)
- Weight: 49.6 lbs (22.5 kg)
- Turn Diam: diagonal for skid steer
- Max Speed: .7 mph (1.2 km/ph)
- Power Source: battery
- Endurance: 60 min
- Tether: none
- Control Features: diagnostics, wall following, centering
- Sensors: URG,Heat, Voice
- Payload: none
- Manipulator: Sensor arm 4DOF: Length: 14.1" (36cm)

Radio TX: 2400 MHz
Radio RX: 2400 MHz

Hibiscus

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Hibiscus

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

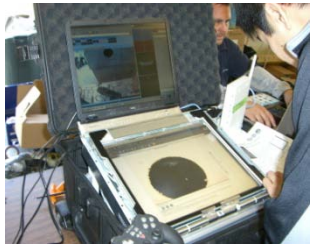
Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

153

Cphea

Toin University of Yokohama
Chiba Institute of Technology
koyanagi@furo.org



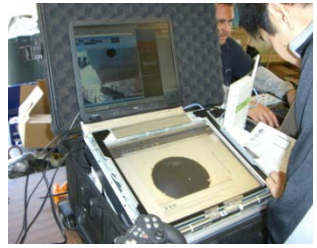
Manufacturer's Specs:

- Width: 20" (52 cm)
- Length: 40" (102 cm)
- Height: 9.4" (24 cm)
- Weight: 49.6 lbs (22.5 kg)
- Turn Diam: diagonal for skid steer
- Max Speed: .37 mph (0.6 km/ph)
- Power Source: battery
- Endurance: 60 min
- Tether: none
- Control: diagnostics, wall following, centering
- Sensors: URG,Heat, Voice
- Payload: none
- Manipulator: Sensor arm 2DOF: Length (30cm)

Radio TX: 2400 MHz
Radio RX: 2400 MHz

Cphea

Toin University of Yokohama
Chiba Institute of Technology
koyanagi@furo.org



Manufacturer's Specs:

- Width: 20" (52 cm)
- Length: 40" (102 cm)
- Height: 9.4" (24 cm)
- Weight: 49.6 lbs (22.5 kg)
- Turn Diam: diagonal for skid steer
- Max Speed: .37 mph (0.6 km/ph)
- Power Source: battery
- Endurance: 60 min
- Tether: none
- Control: diagnostics, wall following, centering
- Sensors: URG,Heat, Voice
- Payload: none
- Manipulator: Sensor arm 2DOF: Length (30cm)

Radio TX: 2400 MHz
Radio RX: 2400 MHz

Cphea

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Cphea

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

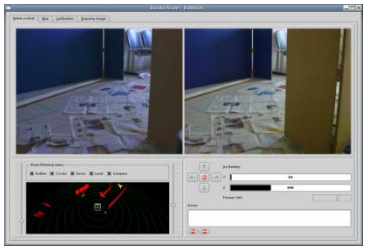
Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

155

Robbie 6

University of Koblenz-Landau, Germany
Johannes Pellenz, pellenz@uni-koblenz.de
www.uni-koblenz.de/agas



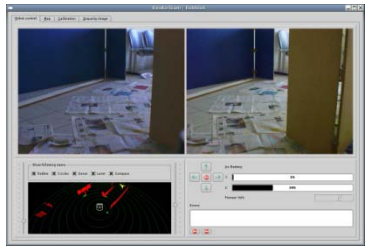
Manufacturer's Specs:

- Width: 19.3 in (49 cm)
- Length: 21.3 in (54 cm)
- Height: 29.5 in (75 cm)
- Weight: 55 lbs (25 kg)
- Locomotion: wheeled
- Steering: skid
- Min Turn Diam: 26.77 (68 cm)
- Max Speed: 2.52 kmph
- Power Source: battery
- Endurance: about 150 min
- Tether: none
- Control Features: none
- Sensors: Sonar, LRF, 3 FireWire Cameras, Compass
- Payload: none
- Manipulator: none

Radio TX: 802.11 a
Radio RX: 802.11 a

Robbie 6

University of Koblenz-Landau, Germany
Johannes Pellenz, pellenz@uni-koblenz.de
www.uni-koblenz.de/agas



Manufacturer's Specs:

- Width: 19.3 in (49 cm)
- Length: 21.3 in (54 cm)
- Height: 29.5 in (75 cm)
- Weight: 55 lbs (25 kg)
- Locomotion: wheeled
- Steering: skid
- Min Turn Diam: 26.7 (68 cm)
- Max Speed: 2.52 kmph
- Power Source: battery
- Endurance: about 150 min
- Tether: none
- Control Features: none
- Sensors: Sonar, LRF, 3 FireWire Cameras, Compass
- Payload: none
- Manipulator: none

Radio TX: 802.11 a
Radio RX: 802.11 a

Robbie 6

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Robbie 6

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

157

Shinobi

Univ Electo-Communications
www.hi.mce.uec.ac.jp/matsuno-lab/matsuno_eng.html
Noritaka Sato

Manufacturer's Specs:

- Width: 15. 74" (40 cm)
- Length: 31.49" (80 cm)
- Height: 15-74" – 31.49" (40cm- 80cm)
- Weight: 57.32 lbs (26 kg)
- Turning Dia: 0
- Max Speed: .21 mps (.33 kms)
- Power Source: battery
- Endurance: 60 min
- Tether: none
- Control: teleop
- Sensors: thermal , chemical (cO2)
- Payload: none
- Manipulator: none

Radio TX: 5200 MhZ (10mW)
Radio RX: 5200 MhZ (10mW)

Shinobi

Univ Electo-Communications
www.hi.mce.uec.ac.jp/matsuno-lab/matsuno_eng.html
Noritaka Sato

Manufacturer's Specs:

- Width: 15. 74" (40 cm)
- Length: 31.49" (80 cm)
- Height: 15-74" – 31.49" (40cm- 80cm)
- Weight: 57.32 lbs (26 kg)
- Turning Dia: 0
- Max Speed: .21 mps (.33 kms)
- Power Source: battery
- Endurance: 60 min
- Tether: none
- Control: teleop
- Sensors: thermal , chemical (cO2)
- Payload: none
- Manipulator: none

Radio TX: 5200 MhZ (10mW)
Radio RX: 5200 MhZ (10mW)

Shinobi

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Shinobi

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

159

Matilda

Mesa Robotics, Inc.
www.mesa-robotics.com
256-258-2130/Toki Owens

Manufacturer's Specs:

- Width: 21" (53.34 cm)
- Length: 30" – 34" (76.2cm- 86.36cm)
- Height: 12" (30.48 cm)
- Weight: 61 lbs (27.66 kg)
- Turning Dia: zero
- Max Speed: 2.0 mph
- Power Source: 12VCD battery, NiMH
- Endurance: 360 – 480 min
- Tether: fiber optic cable (data,video, audio)
- Control: remote teleop
- Sensors: biological, chemical, radiological
- Payload: 125 lbs
- Manipulator: 5 DOF with 44 in reach (adds 45lbs/20.4kg to weight)

Radio TX: 900 MHz control, 1800 MHz video, 469 MHz audio
Radio RX: 900 MHz control, 1800 MHz video, 469 MHz audio

Matilda

Mesa Robotics, Inc.
www.mesa-robotics.com
256-258-2130/Toki Owens

Manufacturer's Specs:

- Width: 21" (53.34 cm)
- Length: 30" – 34" (76.2cm- 86.36cm)
- Height: 12" (30.48 cm)
- Weight: 61 lbs (27.66 kg)
- Turning Dia: zero
- Max Speed: 2.0 mph
- Power Source: 12VCD battery, NiMH
- Endurance: 360 – 480 min
- Tether: fiber optic cable (data,video, audio)
- Control: remote teleop
- Sensors: biological, chemical, radiological
- Payload: 125 lbs
- Manipulator: 5 DOF with 44 in reach (adds 45lbs/20.4kg to weight)

Radio TX: 900 MHz control, 1800 MHz video, 469 MHz audio
Radio RX: 900 MHz control, 1800 MHz video, 469 MHz audio

Matilda

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Matilda

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

161

Matilda II

Mesa Robotics, Inc.
www.mesa-robotics.com
256-258-2130/Toki Owens

Manufacturer's Specs:

- Width: 21" (53.34 cm)
- Length: 30" – 34" (76.2cm- 86.36cm)
- Height: 12" (30.48 cm)
- Weight: 61 lbs (27.66 kg)
- Turning Dia: zero
- Max Speed: 2.0 mph
- Power Source: 12VCD battery, NiMH
- Endurance: 360 – 480 min
- Tether: fiber optic cable (data,video, audio)
- Control: remote teleop
- Sensors: biological, chemical, radiological
- Payload: 125 lbs
- Manipulator: 5 DOF with 44 in reach (adds 45lbs/20.4kg to weight)

Radio TX: 900 MHz control, 1800 MHz video, 469 MHz audio
Radio RX: 900 MHz control, 1800 MHz video, 469 MHz audio

Matilda II

Mesa Robotics, Inc.
www.mesa-robotics.com
256-258-2130/Toki Owens

Manufacturer's Specs:

- Width: 21" (53.34 cm)
- Length: 30" – 34" (76.2cm- 86.36cm)
- Height: 12" (30.48 cm)
- Weight: 61 lbs (27.66 kg)
- Turning Dia: zero
- Max Speed: 2.0 mph
- Power Source: 12VCD battery, NiMH
- Endurance: 360 – 480 min
- Tether: fiber optic cable (data,video, audio)
- Control: remote teleop
- Sensors: biological, chemical, radiological
- Payload: 125 lbs
- Manipulator: 5 DOF with 44 in reach (adds 45lbs/20.4kg to weight)

Radio TX: 900 MHz control, 1800 MHz video, 469 MHz audio
Radio RX: 900 MHz control, 1800 MHz video, 469 MHz audio

Matilda II

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Matilda II

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

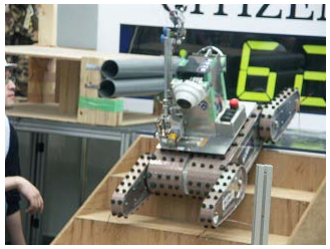
Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

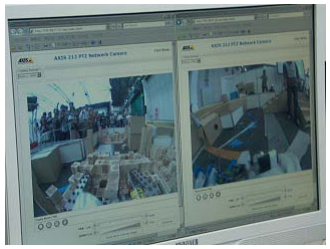
Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

NuTech-R4

Nagaoka Univ. of Tech. / Nagaoka TEKKO-SEIKEN (Joint Team)
http://sessyu.nagaokaut.ac.jp/~kimuralab/
Tetsuya KIMURA, kimura@mech.nagaokaut.ac.jp





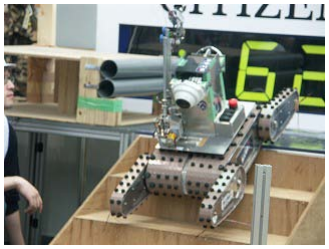
Manufacturer's Specs:

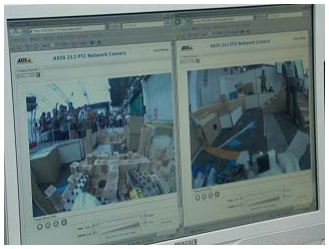
- Width: 16.93" (43 cm)
- Length: 24.41 (62 cm) 35.43 (90 cm with flipper extension)
- Height: 17.72" (45 cm)
- Weight: 77 lbs (35 kg)
- Locomotion: crawler with sub-crawler (flippers)
- Steering: skid
- Turning Diam: 29.53 (75 cm)
- Max Speed: 0.3 mps
- Power Source: battery
- Endurance: 30 min
- Tether: communication (optional)
- Control: remote tele-operation
- Sensors: thermal, sound, arm camera
- Payload: 3 kg (body), 300 g (manipulator)
- Manipulator: 5 DOFs, reach 39.37" (100 cm)

Radio TX: 802.11 a /g/n
Radio RX: 802.11 a /g/n

NuTech-R4

Nagaoka Univ. of Tech. / Nagaoka TEKKO-SEIKEN (Joint Team)
http://sessyu.nagaokaut.ac.jp/~kimuralab/
Tetsuya KIMURA, kimura@mech.nagaokaut.ac.jp





Manufacturer's Specs:

- Width: 16.93" (43 cm)
- Length: 24.41 (62 cm) 35.43 (90 cm with flipper extension)
- Height: 17.72" (45 cm)
- Weight: 77 lbs (35 kg)
- Locomotion: crawler with sub-crawler (flippers)
- Steering: skid
- Turning Diam: 29.53 (75 cm)
- Max Speed: 0.3 mps
- Power Source: battery
- Endurance: 30 min
- Tether: communication (optional)
- Control: remote tele-operation
- Sensors: thermal, sound, arm camera
- Payload: 3 kg (body), 300 g (manipulator)
- Manipulator: 5 DOFs, reach 39.37" (100 cm)

Radio TX: 802.11 a /g/n
Radio RX: 802.11 a /g/n

NuTech-R4

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

NuTech-R4

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

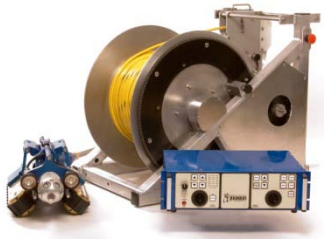
Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Versatrax 150

SeaTrepid
www.inuktun.com
Bob Christ



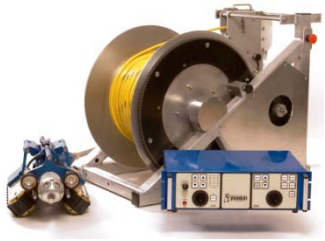
Manufacturer's Specs:

- Width: Inline: 4.5" (11.43 cm)
- Parallel: 11.5" (29.21cm) and larger
- Length: Inline: 64" (162.5 cm)
- Parallel: 24" (61cm)
- Height: Inline: 8.57" (21.8 cm) and larger
- Weight: 88 lbs (40 kg)
- Locomotion: Tracked
- Steering: Skid steering
- Turning Diam: Various; depending on pipe diameters
- Max Speed: 30 fpm (9 mpm)
- Power Source: 88-264 VAC 50/60Hz
- Endurance: Continuous
- Tether: Power and comms
- Control: Remote teleop
- Sensors: Sonar, sonde
- Payload: N/A
- Manipulator: N/A

Radio TX:
Radio RX:

Versatrax 150

SeaTrepid
www.inuktun.com
Bob Christ



Manufacturer's Specs:

- Width: Inline: 4.5" (11.43 cm)
- Parallel: 11.5" (29.21cm) and larger
- Length: Inline: 64" (162.5 cm)
- Parallel: 24" (61cm)
- Height: Inline: 8.57" (21.8 cm) and larger
- Weight: 88 lbs (40 kg)
- Locomotion: Tracked
- Steering: Skid steering
- Turning Diam: Various; depending on pipe diameters
- Max Speed: 30 fpm (9 mpm)
- Power Source: 88-264 VAC 50/60Hz
- Endurance: Continuous
- Tether: Power and comms
- Control: Remote teleop
- Sensors: Sonar, sonde
- Payload: N/A
- Manipulator: N/A

Radio TX:
Radio RX:

Versatrax 150

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Versatrax 150

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

167

Chaos

Autonomous Solutions.
www.autonomoussolutions.com
Omar Salas

Manufacturer's Specs:

- Width: 28" (70 cm)
- Length: 28" (71 cm)
- Height: 8" (20 cm)
- Weight: 120 lbs (55 kg)
- Turning Dia: 39" (100)
- Max Speed: TBD
- Power Source: Lithium battery
- Endurance: 240 min
- Tether: None
- Control: remote teleop
- Sensors: 2 Cams
- Payload: TBD
- Manipulator: None

Radio TX: 2400 MHz/1000 mW (Video) 900 MHZ/1000 mW (data)
Radio RX: 2400 MHz/1000 mW (Video) 900 MHZ/1000 mW (data)

Chaos

Autonomous Solutions.
www.autonomoussolutions.com
Omar Salas

Manufacturer's Specs:

- Width: 28" (70 cm)
- Length: 28" (71 cm)
- Height: 8" (20 cm)
- Weight: 120 lbs (55 kg)
- Turning Dia: 39" (100)
- Max Speed: TBD
- Power Source: Lithium battery
- Endurance: 240 min
- Tether: None
- Control: remote teleop
- Sensors: 2 Cams
- Payload: TBD
- Manipulator: None

Radio TX: 2400 MHz/1000 mW (Video) 900 MHZ/1000 mW (data)
Radio RX: 2400 MHz/1000 mW (Video) 900 MHZ/1000 mW (data)

Chaos

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Chaos

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

169

ATRV mini

Idaho National Lab
www.inl.gov/adaptiverobotics
208-526-8659 /Curtis Nielsen

Manufacturer's Specs:

- Width: 22" (55.8 cm)
- Length: 27" (68.6 cm)
- Height: 25" (63.5 cm)
- Weight: 125 lbs (56.7 kg)
- Turning Diam: 0 (turns on center off robot)
- Max Speed: 6.5 fps (2 mps)
- Power Source: battery
- Endurance: 30-45 min
- Tether: none
- Control: eyes-on, remote teleop, waypoints, go to landmarks, drive intent
- Sensors: color video, laser range scanner, ultrasonic sonar sensor.
- Payload: 35 lb (15.9 kg)
- Manipulator: none

Radio TX: 900 MHz (500 mW), 2400 MHz (500 mW)
Radio RX: 900 MHz (500 mW), 2400 MHz

ATRV mini

Idaho National Lab
www.inl.gov/adaptiverobotics
208-526-8659 /Curtis Nielsen

Manufacturer's Specs:

- Width: 22" (55.8 cm)
- Length: 27" (68.6 cm)
- Height: 25" (63.5 cm)
- Weight: 125 lbs (56.7 kg)
- Turning Diam: 0 (turns on center off robot)
- Max Speed: 6.5 fps (2 mps)
- Power Source: battery
- Endurance: 30-45 min
- Tether: none
- Control: eyes-on, remote teleop, waypoints, go to landmarks, drive intent
- Sensors: color video, laser range scanner, ultrasonic sonar sensor.
- Payload: 35 lb (15.9 kg)
- Manipulator: none

Radio TX: 900 MHz (500 mW), 2400 MHz (500 mW)
Radio RX: 900 MHz (500 mW), 2400 MHz

ATRV mini

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

ATRV mini

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

171

Modular Logistics Platform

Segway, Inc.
www.segway.com
Will Pong/603-222-6000

Manufacturer's Specs:

- Width: 33" (84 cm)
- Length: 26.5" (67 cm)
- Height: xxx" (xxx cm)
- Weight: 120 lbs (55 kg)
- Turning Dia: 42" (107 cm)
- Max Speed: 12.5 mph (20 km/h) Power Source: Two lithium-ion battery packs
- Endurance: 12 miles (19 km) off pavement
- Tether: None
- Control: dynamically stabilized, ride onboard, remote teleoperative or autonomous
- Sensors: gyros, wheel encoders, camera
- Payload: 260 lb (118 kg)
- Manipulator: None

Radio TX: 2400 MHz/XXXmW (Video) 2400 MHZ/xxx mW (data)

Modular Logistics Platform

Segway, Inc.
www.segway.com
Will Pong/603-222-6000

Manufacturer's Specs:

- Width: 33" (84 cm)
- Length: 26.5" (67 cm)
- Height: xxx" (xxx cm)
- Weight: 120 lbs (55 kg)
- Turning Dia: 42" (107 cm)
- Max Speed: 12.5 mph (20 km/h) Power Source: Two lithium-ion battery packs
- Endurance: 12 miles (19 km) off pavement
- Tether: None
- Control: dynamically stabilized, ride onboard, remote teleoperative or autonomous
- Sensors: gyros, wheel encoders, camera
- Payload: 260 lb (118 kg)
- Manipulator: None

Radio TX: 2400 MHz/XXXmW (Video) 2400 MHZ/xxx mW (data)

Modular Logistics Platform

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Modular Logistics Platform

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

173

Talon Gen IV

Foster-Miller/Qinetiq North America
www.foster-miller.com/lemming.htm
781-684-3960/Joanne Armstrong

Manufacturer's Specs:

- Width: 22" (56.88 cm)
- Length: 34" (86.36 cm)
- Height: 11"-52" (27.9 c m - 132 cm)
- Weight: 115 to 140 lb (52kg to 64 kg)
- Turning Dia: turns in place
- Max Speed: 0 to 5.2 mph (0-8.3 km/hr
- Power Source: Single Lithium-ion Battery or Dual Lead-Acid Battery Pack
- Endurance: 4.5 hr (7.2 km/hr)
- Tether: Optional 300 or 500 m buffered fiber optic cable
- Control: digital/analog, 500-800 m LOS High Gain antenna range to 1200m LOS
- Sensors: Chemsentry 150 C, ADP 2000, RAE System MultiRAE, Canberra AN-UDR-14, RayTek temp. probe, targeting laser
- Payload: 100 lb (45 kg)
- Manipulator: 30 in-lb of gripping strength, 6 in wide opening, manual 340 degree wrist, OCU controllable 360 degree rotating wrist (optional)

Radio TX: Data 2400MHz / Video 1700-1800MHz
Radio RX: Data 2400MHz / Video 1700-1800MHz

Talon Gen IV

Foster-Miller/Qinetiq North America
www.foster-miller.com/lemming.htm
781-684-3960/Joanne Armstrong

Manufacturer's Specs:

- Width: 22" (56.88 cm)
- Length: 34" (86.36 cm)
- Height: 11"-52" (27.9 c m - 132 cm)
- Weight: 115 to 140 lb (52kg to 64 kg)
- Turning Dia: turns in place
- Max Speed: 0 to 5.2 mph (0-8.3 km/hr
- Power Source: Single Lithium-ion Battery or Dual Lead-Acid Battery Pack
- Endurance: 4.5 hr (7.2 km/hr)
- Tether: Optional 300 or 500 m buffered fiber optic cable
- Control: digital/analog, 500-800 m LOS High Gain antenna range to 1200m LOS
- Sensors: Chemsentry 150 C, ADP 2000, RAE System MultiRAE, Canberra AN-UDR-14, RayTek temp. probe, targeting laser
- Payload: 100 lb (45 kg)
- Manipulator: 30 in-lb of gripping strength, 6 in wide opening, manual 340 degree wrist, OCU controllable 360 degree rotating wrist (optional)

Radio TX: Data 2400MHz / Video 1700-1800MHz
Radio RX: Data 2400MHz / Video 1700-1800MHz

Talon Gen IV

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Talon Gen IV

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

175

Talon-Hazmat

Foster-Miller/Qinetiq North America
www.foster-miller.com/lemming.htm
781-684-3960/Joanne Armstrong

Manufacturer's Specs:

- Width: 22.5 in (57.2 cm)
- Length: 34 in (86.4 cm)
- Height: 11 in (27.9 cm)
- Weight: 115 to 140 lb (52kg to 64 kg)
- Turning Dia: On axis
- Max Speed: 7.6 fps (1.8mps)
- Power Source: Battery Pack
- Endurance: 4.5 hr (7.2 km/hr)
- Tether: Fiber Optics (option)
- Control: remote teleop
- Sensors: chemical warfare agents (blood, nerve, blister), TIC, radiation
  Payload: 100 lb (45 kg)
- Manipulator: reach 52 in (1.3 m)

Radio TX: 1650-1900 MHz / 2000 mW (video), 148-174 MHz/ 600 mW (audio), 2.3-2.4 MHz / 5-500 mW (commands)

Talon-Hazmat

Foster-Miller/Qinetiq North America
www.foster-miller.com/lemming.htm
781-684-3960/Joanne Armstrong

Manufacturer's Specs:

- Width: 22.5 in (57.2 cm)
- Length: 34 in (86.4 cm)
- Height: 11 in (27.9 cm)
- Weight: 115 to 140 lb (52kg to 64 kg)
- Turning Dia: On axis
- Max Speed: 7.6 fps (1.8mps)
- Power Source: Battery Pack
- Endurance: 4.5 hr (7.2 km/hr)
- Tether: Fiber Optics (option)
- Control: remote teleop
- Sensors: chemical warfare agents (blood, nerve, blister), TIC, radiation
  Payload: 100 lb (45 kg)
- Manipulator: reach 52 in (1.3 m)

Radio TX: 1650-1900 MHz / 2000 mW (video), 148-174 MHz/ 600 mW (audio), 2.3-2.4 MHz / 5-500 mW (commands)

Talon-Hazmat

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Talon-Hazmat

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

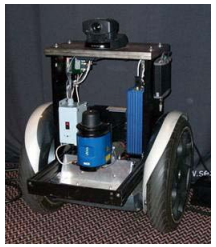
177

Robotic Mobility Platform

(RMP 200/INL)

Segway, Inc.

www.segway.com/Will Pong/603-222-6000



Manufacturer's Specs:

- Width: 29.5" (75 cm)
- Length: 25" 64 cm)
- Height: 24" (61 cm)
- Weight: 140 lbs (64 kg)
- Turning Dia: 39" (99 cm)
- Max Speed: 10 mph (16 km/h)
- Power Source: Two lithium-ion battery packs
- Endurance: 15 miles (24 km)
- Tether: None
- Control: dynamically stabilized, remote teleoperative or autonomous
- Sensors: gyros, wheel encoders, camera, laser scanner for mapping
- Payload: 200 lb (91 kg)
- Manipulator: Barrett Technology WAM

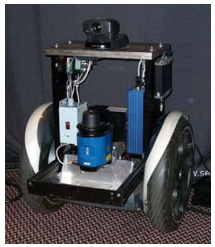
Radio TX: 2400 MHz/XXXmW (Video) 900 MHZ/xxx mW (data)

Robotic Mobility Platform

(RMP 200/INL)

Segway, Inc.

www.segway.com/Will Pong/603-222-6000



Manufacturer's Specs:

- Width: 29.5" (75 cm)
- Length: 25" 64 cm)
- Height: 24" (61 cm)
- Weight: 140 lbs (64 kg)
- Turning Dia: 39" (99 cm)
- Max Speed: 10 mph (16 km/h)
- Power Source: Two lithium-ion battery packs
- Endurance: 15 miles (24 km)
- Tether: None
- Control: dynamically stabilized, remote teleoperative or autonomous
- Sensors: gyros, wheel encoders, camera, laser scanner for mapping
- Payload: 200 lb (91 kg)
- Manipulator: Barrett Technology WAM

Radio TX: 2400 MHz/XXXmW (Video) 900 MHZ/xxx mW (data)

178

Robotic Mobility Platform
(RMP 200/INL)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Robotic Mobility Platform
(RMP 200/INL)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

179

teleMAX

tele*rob* GmbH

www.telerob.de

Manufacturer's Specs:

- Width: 15.75" (40 cm)
- Length: 31.5" - 63“ (80 cm – 160 cm)
- Height: 29.53" (75 cm) (stowed)
- Weight: 175 lbs (79.4 kg)
- Turning Dia: 39.37” (100cm)
- Max Speed: tracks 2.16 mph (3.5 kmh), wheels 2.92 mph (4.7 kmh) Power Source: NiMh, 24V DC
- Endurance: 2 hours
- Tether: none, fiber with video and comms
- Control: eyes-on, remote teleop
- Sensors: optional chemical, radiation, gas, GPS
- Payload: 22 lbs (10kg)
- Manipulator: 7 DOFs, reach 92,52 in to 102,36” (235 cm to 260 cm)

Radio TX: Data 433-435MHz/500mW, Video 2300 MHz/3W
Radio RX:

teleMAX

tele*rob* GmbH

www.telerob.de

Manufacturer's Specs:

- Width: 15.75" (40 cm)
- Length: 31.5" - 63“ (80 cm – 160 cm)
- Height: 29.53" (75 cm) (stowed)
- Weight: 175 lbs (79.4 kg)
- Turning Dia: 39.37” (100cm)
- Max Speed: tracks 2.16 mph (3.5 kmh), wheels 2.92 mph (4.7 kmh) Power Source: NiMh, 24V DC
- Endurance: 2 hours
- Tether: none, fiber with video and comms
- Control: eyes-on, remote teleop
- Sensors: optional chemical, radiation, gas, GPS
- Payload: 22 lbs (10kg)
- Manipulator: 7 DOFs, reach 92,52 in to 102,36” (235 cm to 260 cm)

Radio TX: Data 433-435MHz/500mW, Video 2300 MHz/3W
Radio RX:

180

teleMAX

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

teleMAX

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

181

HD-1J

REMOTEC, Inc.
www.remotec-andros.com
865-483-0228/Jim Daniels

Manufacturer's Specs:

• Width:	26" (66 cm)
• Length:	47.5" (120.65 cm)
• Height:	30" (76cm) with antenna 70"(177.8)
• Weight:	200 lbs (90.72 kg)
• Turning Dia:	
• Max Speed:	4.3mph
• Power Source:	Lithium Polymer Battery
• Endurance:	3-6 hr
• Tether:	Fiber-Optic Cable
• Control:	tethered/Radio Control
• Sensors:	Color Camera/LED lighting/
• Payload:	TBD
• Manipulator:	72" (182.88 cm)Max. Gripper Height 6" (15.2 cm) Gripper with 360 degree rotation, weapons with gripper capable

Radio TX RX: Control 464.5 Mhz/Video 2.4Mhz/Audio 151.9Mhz

HD-1J

REMOTEC, Inc.
www.remotec-andros.com
865-483-0228/Jim Daniels

Manufacturer's Specs:

• Width:	26" (66 cm)
• Length:	47.5" (120.65 cm)
• Height:	30" (76cm) with antenna 70"(177.8)
• Weight:	200 lbs (90.72 kg)
• Turning Dia:	
• Max Speed:	4.3mph
• Power Source:	Lithium Polymer Battery
• Endurance:	3-6 hr
• Tether:	Fiber-Optic Cable
• Control:	tethered/Radio Control
• Sensors:	Color Camera/LED lighting/
• Payload:	TBD
• Manipulator:	72" (182.88 cm)Max. Gripper Height 6" (15.2 cm) Gripper with 360 degree rotation, weapons with gripper capable

Radio TX RX: Control 464.5 Mhz/Video 2.4Mhz/Audio 151.9Mhz

HD-1J

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

HD-1J

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

183

Mini-Andros II

REMOTEC, Inc.
www.remotec-andros.com
865-483-0228/Jim Daniels

Manufacturer's Specs:

- Width: 24.5" (62 cm)
- Length: 53" (134c m)
- Height: 27" (68 cm)
- Weight: 225 lbs (102.6 kg)
- Turning Dia: length of vehicle
- Max Speed: 1.1 mph(1.7 km/hr)
- Power Source: 24VDC - gel cell battery pack Battery
- Endurance: 3-6 hr
- Tether: Fiber-Optic Cable or hard tether cable
- Control: tethered,Radio Control
- Sensors: Color Camera
- Payload: 15 lbs (6.8 kg)
- Manipulator: 78" (2 m) telescoping arm with four degrees of freedom

Radio TX: tethered or RF
Radio RX: tethered or RF

Mini-Andros II

REMOTEC, Inc.
www.remotec-andros.com
865-483-0228/Jim Daniels

Manufacturer's Specs:

- Width: 24.5" (62 cm)
- Length: 53" (134 cm)
- Height: 27" (68 cm)
- Weight: 225 lbs (102.6 kg)
- Turning Dia: length of vehicle
- Max Speed: 1.1 mph(1.7 km/hr)
- Power Source: 24VDC - gel cell battery pack Battery
- Endurance: 3-6 hr
- Tether: Fiber-Optic Cable or hard tether cable
- Control: tethered,Radio Control
- Sensors: Color Camera
- Payload: 15 lbs (6.8 kg)
- Manipulator: 78" (2 m) telescoping arm with four degrees of freedom

Radio TX: tethered or RF
Radio RX: tethered or RF

Mini-Andros II

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Mini-Andros II

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

185

Robotic Mobility Platform

(RMP 400/INL)

Segway, Inc.

www.segway.com/Will Pong/603-222-6000

Manufacturer's Specs:

- Width: 30" (76 cm)
- Length: 44" (112 cm)
- Height: 24" (61 cm)
- Weight: 240 lbs (109 kg)
- Turning Dia: 53" (135 cm)
- Max Speed: 18 mph (29 km/h)
- Power Source: Four lithium-ion battery packs
- Endurance: 15 miles (24 km)
- Tether: None
- Control: Statically stabilized, remote teleoperative or autonomous
- Sensors: gyros, wheel encoders,
- Payload: 400 lb (180 kg)
- Manipulator: Barrett Technology WAM

Radio TX: 75 MHz/XXXmW (Video) 2400 MHZ/xxx mW (data)

Robotic Mobility Platform

(RMP 400/INL)

Segway, Inc.

www.segway.com/Will Pong/603-222-6000

Manufacturer's Specs:

- Width: 30" (76 cm)
- Length: 44" (112 cm)
- Height: 24" (61 cm)
- Weight: 240 lbs (109 kg)
- Turning Dia: 53" (135 cm)
- Max Speed: 18 mph (29 km/h)
- Power Source: Four lithium-ion battery packs
- Endurance: 15 miles (24 km)
- Tether: None
- Control: Statically stabilized, remote teleoperative or autonomous
- Sensors: gyros, wheel encoders,
- Payload: 400 lb (180 kg)
- Manipulator: Barrett Technology WAM

Radio TX: 75 MHz/XXXmW (Video) 2400 MHZ/xxx mW (data)

Robotic Mobility Platform
(RMP 400/INL)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Robotic Mobility Platform
(RMP 400/INL)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Andros F6A

REMOTEC, Inc.
www.remotec-andros.com
865-483-0228/Jim Daniels

Manufacturer's Specs:

- Width: 29" (73 cm
- Length: 52" (132 cm)
- Height: 56.5" (140 cm)
- Weight: 485 lb (219.99kg)
- Turning Dia: within the length of vehicle
- Max Speed: 3.5 mph (5.6 km/hr)
- Power Source: 24VDC 35 amp-hr gel-cell battery pack
- Endurance: 3-6 hr
- Tether: Interchangeable Fiber Optic Cable reel, RF system, or Hard-line cable reel system
- Control: tethered or RF
- Sensors: Color camera with low-light
- Payload: 45 lbs (20.4 kg)
- Manipulator: Arm -Vertical reach 109" (2.76 m) with tracks down and arm fully extended, Horizontal reach 56" (1.42 m) from front of vehicle

Radio TX: tethered or RF
Radio RX: tethered or RF

Andros F6A

REMOTEC, Inc.
www.remotec-andros.com
865-483-0228/Jim Daniels

Manufacturer's Specs:

- Width: 29" (73 cm
- Length: 52" (132 cm)
- Height: 56.5" (140 cm)
- Weight: 485 lb (219.99kg)
- Turning Dia: within the length of vehicle
- Max Speed: 3.5 mph (5.6 km/hr)
- Power Source: 24VDC 35 amp-hr gel-cell battery pack
- Endurance: 3-6 hr
- Tether: Interchangeable Fiber Optic Cable reel, RF system, or Hard-line cable reel system
- Control: tethered or RF
- Sensors: Color camera with low-light
- Payload: 45 lbs (20.4 kg)
- Manipulator: Arm -Vertical reach 109" (2.76 m) with tracks down and arm fully extended, Horizontal reach 56" (1.42 m) from front of vehicle

Radio TX: tethered or RF
Radio RX: tethered or RF

Andros F6A

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

Andros F6A

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

189

BOZ I

BOZ Robotics
www.bozrobot.com
847-574-0168/Jamie Alvarez

Manufacturer's Specs:

- Width: 26.4 in (67 cm)
- Length: 67.3 in (171 cm)
- Height: 53.2 in (135 cm)
- Weight: 1,300 lbs (600 kg)
- Turning Dia: 360 degrees
- Max Speed: 6.7 km/h
- Power Source: battery
- Endurance: 3 - 4 hrs to continuous w/generator
- Tether: 100 meter; 1 km remote los
- Control: computer w/case and joystick
- Sensors: ultra sound distance sensors (to the cm) 5 cameras; 3 infrared
- Payload: 265 lb (120 kg) lifting capacity w/arm straight; 441 lbs (200 kg) arm bent
- Manipulator: Hydraulic gripper w/12,717 lbs (5,770 kg) of opening force, reach 11.5 ft (350 cm) and four joints independently operated to tear off car doors, trunks, & dexterity to pour a soda bottle in a glass

Radio TX: 2400 MHz
Radio RX: 2400 MHz

BOZ I

BOZ Robotics
www.bozrobot.com
847-574-0168/Jamie Alvarez

Manufacturer's Specs:

- Width: 26.4 in (67 cm)
- Length: 67.3 in (171 cm)
- Height: 53.2 in (135 cm)
- Weight: 1,300 lbs (600 kg)
- Turning Dia: 360 degrees
- Max Speed: 6.7 km/h
- Power Source: battery
- Endurance: 3 - 4 hrs to continuous w/generator
- Tether: 100 meter; 1 km remote los
- Control: computer w/case and joystick
- Sensors: ultra sound distance sensors (to the cm) 5 cameras; 3 infrared
- Payload: 265 lb (120 kg) lifting capacity w/arm straight; 441 lbs (200 kg) arm bent
- Manipulator: Hydraulic gripper w/12,717 lbs (5,770 kg) of opening force, reach 11.5 ft (350 cm) and four joints independently operated to tear off car doors, trunks, & dexterity to pour a soda bottle in a glass

Radio TX: 2400 MHz
Radio RX: 2400 MHz

BOZ I

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

BOZ I

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____ Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Confined Space

Minimum Height: _____ Time: _____
Pallets

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Ground Robots

Grasping Dexterity (shelves with objects):

	Top (Near)			Top (Mid)			Top (Far)			Time	Contacts
	Over	Under	Open	Over	Under	Open	Over	Under	Open		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:

Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Mobility/Endurance (single charge):

Terrain (flat): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (ramps): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)
Terrain (stepfields): # pallets, time (x hrs.), MTBF: (x hrs.), Field maint. (x min.)

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Random Maze:

Coverage: (x%), Time: (x min), Targets: (x of x)

Stairs:

Max. Degrees: 30 / 45 / 60: Time (Ascend: x min., Descend (Time: x min.)

Visual Acuity:

Ambient (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Dark (x lumens): Near: normal (x.x); zoom (x.x), Far: normal (x.x); zoom (x.x)
Var. illumination: (yes/no); Field of View (x deg); Pan (x deg); Tilt (x deg)

191

192

Wall Climbers

Wall Climbers

Wall Climbers

193

VMRP

Vortex HC LLC.
www.vortexhc.com
919-462-8828

Manufacturer's Specs:

- Width: 8.5" (21.5 cm)
- Length: 6.5" (16.5 cm)
- Height: 4" (10 cm)
- Weight: 1.87 lbs (.84kg)
- Turning Dia: TBD
- Max Speed: 6"/sec. (.154m/sec)
- Power Source: battery
- Endurance: 20- 40 minutes
- Tether: none
- Control: teleoped
- Sensors: 2 color camera (boom pan drive camera)
- Payload: 1 lbs (.45kg) (scalable)
- Manipulator: n/a

Radio TX: 2400 MHz (Bluetooth) video 1200 MHz
Radio RX: 2400 MHz (Bluetooth)

VMRP

Vortex HC LLC.
www.vortexhc.com
919-462-8828

Manufacturer's Specs:

- Width: 8.5" (21.5 cm)
- Length: 6.5" (16.5 cm)
- Height: 4" (10 cm)
- Weight: 1.87 lbs (.84kg)
- Turning Dia: TBD
- Max Speed: 6"/sec. (.154m/sec)
- Power Source: battery
- Endurance: 20- 40 minutes
- Tether: none
- Control: teleoped
- Sensors: 2 color camera (boom pan drive camera)
- Payload: 1 lbs (.45kg) (scalable)
- Manipulator: n/a

Radio TX: 2400 MHz (Bluetooth) video 1200 MHz
Radio RX: 2400 MHz (Bluetooth)

VMRP

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:
Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Radio Communications:
LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:
Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Wall Climbers

VMRP

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:
Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Radio Communications:
LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:
Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Wall Climbers

NanoMag

Inuktun
www.inuktun.com/
1-877-468-5886

Manufacturer's Specs:

- Width: 17 " (43.1cm)
- Length: 12" (30.4 cm)
- Height: 3.5" (8.8 cm)
- Weight: 5 lbs (2.26kg)
- Turning Dia: TBD
- Max Speed: 0-5 ft/min (0-1.5 m/min)
- Power Source: TBD
- Endurance: TBD
- Tether: 100ft (30m)
- Control: teleoped
- Sensors: TBD
- Payload: TBD
- Manipulator: n/a

Radio Tx: (tether only)
Radio Rx: (tether only)

NanoMag

Inuktun
www.inuktun.com/
1-877-468-5886

Manufacturer's Specs:

- Width: 17 " (43.1cm)
- Length: 12" (30.4 cm)
- Height: 3.5" (8.8 cm)
- Weight: 5 lbs (2.26kg)
- Turning Dia: TBD
- Max Speed: 0-5 ft/min (0-1.5 m/min)
- Power Source: TBD
- Endurance: TBD
- Tether: 100ft (30m)
- Control: teleoped
- Sensors: TBD
- Payload: TBD
- Manipulator: n/a

Radio Tx: (tether only)
Radio Rx: (tether only)

NanoMag

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:
Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Radio Communications:
LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:
Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Wall Climbers

NanoMag

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Incline Plane:
Max. Operating Angle: Grnd. (20, 30, 40, 50, 60, 70, 80), Wall: (90), Inverted: (100, 135, 180)

Radio Communications:
LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:
Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Wall Climbers

198

Aerial Robots

Aerial Robots

Aerial Robots

199

Micro-Drone 200

BCB International, Ltd.
www.taccsc4i.com/www.bcbin.com
Barry Davies/Edward J. Schmitt

Manufacturer's Specs:

- Width: 36” (95 cm)
- Weight: 1.5 lbs (680 gm)
- Range: 1.5 mi (3 km) Radius of Operation
- Avg Speed: 15 mph (35kmph)
- Launch: VTOL
- Recovery: deep stall vertical
- Propulsion: electric motors
- Altitude: 0-1500 ft (30-500 m)
- Orbit Direction: Left
- Orbit Diameter: @200ft AGL= <3 ft, @400ft AGL= <3 ft
- Endurance: 20 min
- Sensors: fwd/side color, zoom, Night Vision, Thermal Imaging, chem
- Payload: .44 lbs (200g)
- Other Features: waypoint following, Autonomous flight. Hi-Res Photo cameras, Infrared Camera, Thermal Camera, Laser rangefinder, GSM Jammer, IED detection, CBRN detection, Communication (repeater), RFID Long Range detectionPayload: small camera

* Has not attended any exercises to date

Radio TX: 2.3-2.5 GHz / 10 mW (video), 2.3-2.5GHz / 10 mW (audio), 2.3-2.5 GHz / 200 mW (commands), 2.4 GHz / xxx mW (other),

Micro-Drone 200

BCB International, Ltd.
www.taccsc4i.com/www.bcbin.com
Barry Davies/Edward J. Schmitt

Manufacturer's Specs:

- Width: 36” (95 cm)
- Weight: 1.5 lbs (680 gm)
- Range: 1.5 mi (3 km) Radius of Operation
- Avg Speed: 15 mph (35kmph)
- Launch: VTOL
- Recovery: deep stall vertical
- Propulsion: electric motors
- Altitude: 0-1500 ft (30-500 m)
- Orbit Direction: Left
- Orbit Diameter: @200ft AGL= <3 ft, @400ft AGL= <3 ft
- Endurance: 20 min
- Sensors: fwd/side color, zoom, Night Vision, Thermal Imaging, chem
- Payload: .44 lbs (200g)
- Other Features: waypoint following, Autonomous flight. Hi-Res Photo cameras, Infrared Camera, Thermal Camera, Laser rangefinder, GSM Jammer, IED detection, CBRN detection, Communication (repeater), RFID Long Range detectionPayload: small camera

* Has not attended any exercises to date

Radio TX: 2.3-2.5 GHz / 10 mW (video), 2.3-2.5GHz / 10 mW (audio), 2.3-2.5 GHz / 200 mW (commands), 2.4 GHz / xxx mW (other),

200

Micro-Drone 200

Aerial Station Keeping (single charge):

Targets: (flush: x of x), (recessed: x of x), Total: (y of y), Time: (x min.)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____Pallets _____

Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)

Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Aerial Robots

Micro-Drone 200

Aerial Station Keeping (single charge):

Targets: (flush: x of x), (recessed: x of x), Total: (y of y), Time: (x min.)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____Pallets _____

Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)

Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Aerial Robots

201

AirRobot

AirRobot GmbH
www.AirRobot.com
49 2932 54 77 40/info@airrobot.de

Manufacturer's Specs:

- Rotor span: 36” (91.4 cm)
- Length: 36” (91.4 cm) diameter
- Weight: less than 2.2 lbs (less than 1 kg)
- Range: up to 1640 ft (up to 500 m)
- Speed: approximate 25 mph
- Launch: vertical
- Recovery: vertical
- Propulsion: electric, LiPo Battery 14.8 V, 2.05 Ah
- Altitude: up to 492 ft (150m)
- Endurance: 20-25 min
- Control: video glasses or Tablet PC
- Payload: 0.44 lb (0.2 kg)

Radio TX: 35 MHz (200 mW)
Radio RX: 35 MHz Video 1420 MHz

AirRobot

AirRobot GmbH
www.AirRobot.com
49 2932 54 77 40/info@airrobot.de

Manufacturer's Specs:

- Rotor span: 36” (91.4 cm)
- Length: 36” (91.4 cm) diameter
- Weight: less than 2.2 lbs (less than 1 kg)
- Range: up to 1640 ft (up to 500 m)
- Speed: approximate 25 mph
- Launch: vertical
- Recovery: vertical
- Propulsion: electric, LiPo Battery 14.8 V, 2.05 Ah
- Altitude: up to 492 ft (150m)
- Endurance: 20-25 min
- Control: video glasses or Tablet PC
- Payload: 0.44 lb (0.2 kg)

Radio TX: 35 MHz (200 mW)
Radio RX: 35 MHz

AirRobot

Aerial Station Keeping (single charge):

Targets: (flush: x of x), (recessed: x of x), Total: (y of y), Time: (x min.)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____Pallets _____

Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)

Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Aerial Robots

AirRobot

Aerial Station Keeping (single charge):

Targets: (flush: x of x), (recessed: x of x), Total: (y of y), Time: (x min.)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____Pallets _____

Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)

Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Aerial Robots

203

Nighthawk

Applied Research Associates, Inc
www.ara.com
Adam Sloan/asloan@ara.com

Manufacturer's Specs:

- Wingspan: 2.2 ft (0.66 m)
- Length: 1.7 ft (0.51 m)
- Weight: 1.65 lbs (0.750 kg)
- Range: 6.2 miles (10 km)
- Speed: 28 mph (44 kmph)
- Launch: hand
- Recovery: skid land
- Propulsion: electric motor
- Altitude: 100-500 ft (30.48m-152.4m) AGL
- Endurance: 60-90 min
- Control: auto waypoint following
- Payload: color camera, infrared

Radio TX:915-928 MHz / 650 mW/2409-2469 MHz / 600 mW
Radio RX:

Nighthawk

Applied Research Associates, Inc
www.ara.com
Adam Sloan/asloan@ara.com

Manufacturer's Specs:

- Wingspan: 2.2 ft (0.66 m)
- Length: 1.7 ft (0.51 m)
- Weight: 1.65 lbs (0.750 kg)
- Range: 6.2 miles (10 km)
- Speed: 28 mph (44 kmph)
- Launch: hand
- Recovery: skid land
- Propulsion: electric motor
- Altitude: 100-500 ft (30.48m-152.4m) AGL
- Endurance: 60-90 min
- Control: auto waypoint following
- Payload: color camera, infrared

Radio TX:915-928 MHz / 650 mW/2409-2469 MHz / 600 mW
Radio RX:

204

Nighthawk

Aerial Station Keeping (single charge):

Targets: (flush: x of x), (recessed: x of x), Total: (y of y), Time: (x min.)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____Pallets _____

Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)

Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Aerial Robots

Nighthawk

Aerial Station Keeping (single charge):

Targets: (flush: x of x), (recessed: x of x), Total: (y of y), Time: (x min.)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____Pallets _____

Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)

Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Aerial Robots

205

Raven

AeroVironment Inc.
www.avsuav.com
626-357-9983

Manufacturer's Specs:

- Wingspan: 4.5 ft (1.4 m)
- Length: 3 ft (0.9 m)
- Weight: 4.2 lbs (1.9 kg)
- Range: 6.2 miles (10 km)
- Speed: 20-50 mph (32-82 km/hr)
- Launch: hand
- Recovery: deep stall vertical
  Propulsion: electric motor
- Altitude: 100-500 ft (30.48m-152.4m) AGL
- Endurance: 80-110 min
- Control: auto waypoint following
- Payload: color camera, infrared

Radio TX:
Radio RX:

Raven

AeroVironment Inc.
www.avsuav.com
626-357-9983

Manufacturer's Specs:

- Wingspan: 4.5 ft (1.4 m)
- Length: 3 ft (0.9 m)
- Weight: 4.2 lbs (1.9 kg)
- Range: 6.2 miles (10 km)
- Speed: 20-50 mph (32-82 km/hr)
- Launch: hand
- Recovery: deep stall vertical
  Propulsion: electric motor
- Altitude: 100-500 ft (30.48m-152.4m) AGL
- Endurance: 80-110 min
- Control: auto waypoint following
- Payload: color camera, infrared

Radio TX:
Radio RX:

206

Raven

Aerial Station Keeping (single charge):

Targets: (flush: x of x), (recessed: x of x), Total: (y of y), Time: (x min.)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____Pallets _____

Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)

Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Raven

Aerial Station Keeping (single charge):

Targets: (flush: x of x), (recessed: x of x), Total: (y of y), Time: (x min.)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____Pallets _____

Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)

Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Aerial Robots

207

Dragon Eye

AeroVironment Inc.
www.avsuav.com
626-357-9983

Manufacturer's Specs:

- Wingspan: 3 ft (0.9 m)
- Length: 3 ft (0.9 m)
- Weight: 5.9 lbs (2.7kg)
- Range: 3.1 mile (5 km)
- Speed: 21.7 mph (35 km/hr
  Launch: bungee
- Recovery: horizontal landing
- Propulsion: electric motor
- Altitude: 100-500 ft (30.48m-152.4m) AGL
- Endurance: 45-60 min
- Control: auto waypoint following
- Payload: color camera, infrared

Radio TX:
Radio RX:

Dragon Eye

AeroVironment Inc.
www.avsuav.com
626-357-9983

Manufacturer's Specs:

- Wingspan: 3 ft (0.9 m)
- Length: 3 ft (0.9 m)
- Weight: 5.9 lbs (2.7kg)
- Range: 3.1 mile (5 km)
- Speed: 21.7 mph (35 km/hr
  Launch: bungee
- Recovery: horizontal landing
- Propulsion: electric motor
- Altitude: 100-500 ft (30.48m-152.4m) AGL
- Endurance: 45-60 min
- Control: auto waypoint following
- Payload: color camera, infrared

Radio TX:
Radio RX:

Dragon Eye

Aerial Station Keeping (single charge):

Targets: (flush: x of x), (recessed: x of x), Total: (y of y), Time: (x min.)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____Pallets _____

Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)

Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Dragon Eye

Aerial Station Keeping (single charge):

Targets: (flush: x of x), (recessed: x of x), Total: (y of y), Time: (x min.)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____Pallets _____

Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)

Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Aerial Robots

209

Cyberbug

CyberDefense Systems
www.cyberdefensesystems.com/
Billy Robinson/727-577-0878

Manufacturer's Specs:

- Wingspan: 3.5 ft (1.1 m)
- Length: 3.5 ft (1.1 m)
- Weight: 7 lbs (3.2 kg)
- Range: 6.2 miles (10 km)
- Speed: 24.85 mph (40 km/hr)
- Launch: hand
- Recovery: horizontal landing
- Propulsion: electric motor
- Altitude: 100-500 ft (30.48m-152.4m) AGL
- Endurance: 45 min
- Control:
  Payload: auto waypoint following
  color camera, infrared

Radio TX: 900 MHz – 2400 MHz
Radio RX:

Cyberbug

CyberDefense Systems
www.cyberdefensesystems.com/
Billy Robinson/727-577-0878

Manufacturer's Specs:

- Wingspan: 3.5 ft (1.1 m)
- Length: 3.5 ft (1.1 m)
- Weight: 7 lbs (3.2 kg)
- Range: 6.2 miles (10 km)
- Speed: 24.85 mph (40 km/hr)
- Launch: hand
- Recovery: horizontal landing
- Propulsion: electric motor
- Altitude: 100-500 ft (30.48m-152.4m) AGL
- Endurance: 45 min
- Control:
  Payload: auto waypoint following
  color camera, infrared

Radio TX: 900 MHz – 2400 MHz
Radio RX:

CyberBug

Aerial Station Keeping (single charge):

Targets: (flush: x of x), (recessed: x of x), Total: (y of y), Time: (x min.)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____Pallets _____

Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)

Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

CyberBug

Aerial Station Keeping (single charge):

Targets: (flush: x of x), (recessed: x of x), Total: (y of y), Time: (x min.)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____Pallets _____

Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)

Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Aerial Robots

211

Evolution-XTS

BAI Aerosystems
Kirk Jenkins/ 410-820-8500

Manufacturer's Specs:

- Wingspan: 5.4 ft (1.6 m)
- Length: 3.2 ft (1.0 m)
- Weight: 8.2 lbs (3.7 kg)
- Range: 10000 m LOS
- Speed: 30-50mph (48-81 kmph)
- Launch: hand
- Recovery: horizontal landing
- Propulsion: electric motor
- Altitude: 100-500 ft (30.48m-152.4m) AGL
- Endurance: 90 min
- Control: auto waypoint following
- Payload: color camera, infrared bio/chemical

Radio TX: 399.37 MHz / 1500 mW
Radio RX:

Evolution-XTS

BAI Aerosystems
Kirk Jenkins/ 410-820-8500

Manufacturer's Specs:

- Wingspan: 5.4 ft (1.6 m)
- Length: 3.2 ft (1.0 m)
- Weight: 8.2 lbs (3.7 kg)
- Range: 10000 m LOS
- Speed: 30-50mph (48-81 kmph)
- Launch: hand
- Recovery: horizontal landing
- Propulsion: electric motor
- Altitude: 100-500 ft (30.48m-152.4m) AGL
- Endurance: 90 min
- Control: auto waypoint following
- Payload: color camera, infrared bio/chemical

Radio TX: 399.37 MHz / 1500 mW
Radio RX:

212

Evolution-XTS

Aerial Station Keeping (single charge):

Targets: (flush: x of x), (recessed: x of x), Total: (y of y), Time: (x min.)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Aerial Robots

Evolution-XTS

Aerial Station Keeping (single charge):
Targets: (flush: x of x), (recessed: x of x), Total: (y of y), Time: (x min.)

Cache packaging, weight, setup, tools
Packages: Ropacks _____ Pelicans _____ Hardiggs _____Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Radio Communications:
LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:
Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Aerial Robots

213

Flying Bassett

University of Alabama in Huntsville (UAH)
Gary Maddux/gary.maddux@us.army.mil

Manufacturer's Specs:

- Rotor span: 6 ft (1.8 m)
- Length: 7 ft (2.13 m)
- Weight: 45 lbs (20.4 kg)
- Range: 0.5 mi (0.81km) LOS, Further with GCS
- Speed: 5 mph (8.1km/hr)
- Launch: vertical takeoff
- Recovery: vertical landing
- Propulsion: Zenoah 80cc 8 hp Twin ylinder, Gasoline
- Altitude: 500 ft (152 m)
- Endurance: 20 min
- Control: auto waypoint following
- Payload:

Radio TX: 72.230 MHz / 100 mW
Radio RX:

Flying Bassett

University of Alabama in Huntsville (UAH)
Gary Maddux/gary.maddux@us.army.mil

Manufacturer's Specs:

- Rotor span: 6 ft (1.8 m)
- Length: 7 ft (2.13 m)
- Weight: 45 lbs (20.4 kg)
- Range: 0.5 mi (0.81km) LOS, Further with GCS
- Speed: 5 mph (8.1km/hr)
- Launch: vertical takeoff
- Recovery: vertical landing
- Propulsion: Zenoah 80cc 8 hp Twin ylinder, Gasoline
- Altitude: 500 ft (152 m)
- Endurance: 20 min
- Control: auto waypoint following
- Payload:

Radio TX: 72.230 MHz / 100 mW
Radio RX:

Flying Bassett

Aerial Station Keeping (single charge):

Targets: (flush: x of x), (recessed: x of x), Total: (y of y), Time: (x min.)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____Pallets _____

Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)

Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Flying Bassett

Aerial Station Keeping (single charge):

Targets: (flush: x of x), (recessed: x of x), Total: (y of y), Time: (x min.)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____Pallets _____

Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)

Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Aerial Robots

215

Yamaha Helicopter

SkeyesUnlimited Inc.
www.skeyesunlimited.com/index.html
412-661-0292

Manufacturer's Specs:

- Rotor span: 10.2 ft (3.1 m)
- Length: 11.8 ft (3.6 m)
- Weight: 207 lbs (94 kg)
- Range: 492 ft (150 m) LOS
- Speed: TBD
- Launch: vertical takeoff
- Recovery: vertical landing
- Propulsion: 21 hp, 246 cc, 2-stroke, gas/oil mix
- Altitude: TBD
- Endurance: 60 min
- Control: auto waypoint following
- Payload: 3-D laser scanner

Radio TX: TBD
Radio RX: TBD

Yamaha Helicopter

SkeyesUnlimited Inc.
www.skeyesunlimited.com/index.html
412-661-0292

Manufacturer's Specs:

- Rotor span: 10.2 ft (3.1 m)
- Length: 11.8 ft (3.6 m)
- Weight: 207 lbs (94 kg)
- Range: 492 ft (150 m) LOS
- Speed: TBD
- Launch: vertical takeoff
- Recovery: vertical landing
- Propulsion: 21 hp, 246 cc, 2-stroke, gas/oil mix
- Altitude: TBD
- Endurance: 60 min
- Control: auto waypoint following
- Payload: 3-D laser scanner

Radio TX: TBD
Radio RX: TBD

216

Yamaha Helicopter

Aerial Station Keeping (single charge):

Targets: (flush: x of x), (recessed: x of x), Total: (y of y), Time: (x min.)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Yamaha Helicopter

Aerial Station Keeping (single charge):

Targets: (flush: x of x), (recessed: x of x), Total: (y of y), Time: (x min.)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____Pallets _____
Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)
Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Aerial Robots

217

Blimp

ARACAR
www.aracar.org/index.html
985-845-3774

Manufacturer's Specs:

- Length: 10’ -20’ (3 m-6 m)
- Weight: < 0! lbs (< 0! kg)
- Range: 150 ft (50 m) tethered
- Speed: 0 km/hr (or tether vehicle speed)
- Launch: vertical pay out of tether
- Recovery: vertical retrieval of tether
- Propulsion: none
- Altitude: 150 ft (50 m)
- Endurance: TBD
- Control: none
- Payload: small camera

Radio TX:
Radio RX:

Blimp

ARACAR
www.aracar.org/index.html
985-845-3774

Manufacturer's Specs:

- Length: 10’ -20’ (3 m-6 m)
- Weight: < 0! lbs (< 0! kg)
- Range: 150 ft (50 m) tethered
- Speed: 0 km/hr (or tether vehicle speed)
- Launch: vertical pay out of tether
- Recovery: vertical retrieval of tether
- Propulsion: none
- Altitude: 150 ft (50 m)
- Endurance: TBD
- Control: none
- Payload: small camera

Radio TX:
Radio RX:

218

Blimp

Aerial Station Keeping (single charge):

Targets: (flush: x of x), (recessed: x of x), Total: (y of y), Time: (x min.)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____Pallets _____

Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)

Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Blimp

Aerial Station Keeping (single charge):

Targets: (flush: x of x), (recessed: x of x), Total: (y of y), Time: (x min.)

Cache packaging, weight, setup, tools

Packages: Ropacks _____ Pelicans _____ Hardiggs _____Pallets _____

Weights: Shipping _____ Deployed _____ Setup Time: X min. Tools: standard

Directed Perception (boxes with holes):

	Face			Top (Near)			Top (Far)			Time	Contacts
	Left	C	Right	Left	C	Right	Left	C	Right		
Level 4:	x	x	x	x	x	x	x	x	x	x min.	#
Level 3:	x	x	x	x	x	x	x	x	x	x min.	#
Level 2:	x	x	x	x	x	x	x	x	x	x min.	#
Level 1:	x	x	x	x	x	x	x	x	x	x min.	#

Radio Communications:

LOS: (x m, time, near field acuity), BLOS: (x m, time, near field acuity)

Visual Acuity:

Ambient (x lumens): near field (x.x), far field (x.x), zoom (x.x)

Dark (x lumens): near field (x.x), far field (x.x), zoom (x.x) – var. illumination: (yes/no)

Aerial Robots

219

220

Aquatic Robots

Aquatic Robots

Aquatic Robots

Aquatic Robots

221

VideoRay Pro 3

VideoRay
www.videoray.com/index.htm

Manufacturer's Specs:

- Width: 9" (22.5 cm)
- Length: 12" (30.5 cm)
- Height: 8.5" (21 cm)
- Weight: Submersible: 8.4 lbs (3.8 kg), Total System: 90 lbs
- Depth Rating 500 ft (152 m)
- Max Speed: 2.6 knots
- Power Source: Battery Pack
- Endurance: xx
- Tether: power, comms, 250 ft (75 m)
- Control: remote teleop
- Sensors: front/rear camera, scanning sonar (seasprite)
- Payload: xxx
- Manipulator: 10" (25 cm) gripper accessory

VideoRay Pro 3

VideoRay
www.videoray.com/index.htm

Manufacturer's Specs:

- Width: 9" (22.5 cm)
- Length: 12" (30.5 cm)
- Height: 8.5" (21 cm)
- Weight: Submersible: 8.4 lbs (3.8 kg), Total System: 90 lbs
- Depth Rating 500 ft (152 m)
- Max Speed: 2.6 knots
- Power Source: Battery Pack
- Endurance: xx
- Tether: power, comms, 250 ft (75 m)
- Control: remote teleop
- Sensors: front/rear camera, scanning sonar (seasprite)
- Payload: xxx
- Manipulator: 10" (25 cm) gripper accessory

LBV200L2

SeaBotix Inc.
www.SeaBotix.com
Sean Newsome

Manufacturer's Specs:

- Width: 9.65 in (245 cm)
- Length: 21 in (530 cm)
- Height: 10 in (254 cm)
- Weight: 26.5 lbs (12 kg)
- Locomotion: 4 Brushless Thrusters (1 vertical, 1 lateral & 2 forward/reverse)
- Steering: Combined Thrust
- Turning Diam: 21 in (530 cm)
- Max Speed: 5 fps (1.54 mps)
- Power Source: 110V/220V
- Tether: Power, Data & Communication
- Control: Integrated Control Console with Handheld Controller
- Sensors: Standard: Color and Black/White Cameras, Depth, Heading, Water Temperature Optional: Grabber Attachment, Multi-beam Sonar, Scanning Sonar, Navigation System (USBL), Zoom Camera, High-Definition (HD) Camera, Scaling Lasers, Radiation Detector, Thickness Gauge, Altimeter, LYYN Video Enhancement
- Payload in water: 1 lb (0.45 kg), (additional floats can accommodate more weight)
- Manipulator: parallel: Grabber (3 jaw, interlocking, & cutting), reach 10 in (25.4 cm)

LBV200L2

SeaBotix Inc.
www.SeaBotix.com
Sean Newsome

Manufacturer's Specs:

- Width: 9.65 in (245 cm)
- Length: 21 in (530 cm)
- Height: 10 in (254 cm)
- Weight: 26.5 lbs (12 kg)
- Locomotion: 4 Brushless Thrusters (1 vertical, 1 lateral & 2 forward/reverse)
- Steering: Combined Thrust
- Turning Diam: 21 in (530 cm)
- Max Speed: 5 fps (1.54 mps)
- Power Source: 110V/220V
- Tether: Power, Data & Communication
- Control: Integrated Control Console with Handheld Controller
- Sensors: Standard: Color and Black/White Cameras, Depth, Heading, Water Temperature Optional: Grabber Attachment, Multi-beam Sonar, Scanning Sonar, Navigation System (USBL), Zoom Camera, High-Definition (HD) Camera, Scaling Lasers, Radiation Detector, Thickness Gauge, Altimeter, LYYN Video Enhancement
- Payload in water: 1 lb (0.45 kg), (additional floats can accommodate more weight)
- Manipulator: parallel: Grabber (3 jaw, interlocking, & cutting), reach 10 in (25.4 cm)

Aquatic Robots

223

LBV150SE-5

SeaBotix Inc.
www.SeaBotix.com
Sean Newsome

Manufacturer's Specs:

	LBV w/CSA	LBV only
• Width:	19.7 in (50 cm)	19.7 in (50 cm)
• Length:	20.5 in (52 cm)	20.5 in (52 cm)
• Height:	15.75 in (40 cm)	8.7 in (22 cm)
• Weight:	61.7 lbs (28 kg)	28.6 lbs (13 kg)
• Locomotion:	Standard 4-axis in-water flight without CSA Attached or combo of wheeled drive with Vortex attach. 5-axis in-water flight in Crawler mode	
• Steering: Turning Diam:	Joystick/var. knob control/Skid ~20 in (51 cm)	
• Max Speed: mps)	Water: 3 knots/crawler:1.64 fps(0.5	
• Power Source:	AC power via shore power, generator, inverter w/true sign wave.	
• Endurance:	Indefinitely with power applied.	
• Tether:	Yes	
• Sensors: Optional:	Video, sonar, depth, temp, heading. Grabber Attachment, Multi-beam Sonar, Scanning Sonar, Navigation System (USBL), Zoom Camera, Scaling Lasers, Rad.Detector, Thickness Gauge, Altimeter, LYYN Video Enhancement	
• Payload:	3.3 lb (1.5 kg) in water.	
• Manipulator:	Single function 3-jaw standard (open/close) w/ optional attachments for cutting, parallel, and interlocking.	

LBV150SE-5

SeaBotix Inc.
www.SeaBotix.com
Sean Newsome

Manufacturer's Specs:

	LBV w/CSA	LBV only
• Width:	19.7 in (50 cm)	19.7 in (50 cm)
• Length:	20.5 in (52 cm)	20.5 in (52 cm)
• Height:	15.75 in (40 cm)	8.7 in (22 cm)
• Weight:	61.7 lbs (28 kg)	28.6 lbs (13 kg)
• Locomotion:	Standard 4-axis in-water flight without CSA Attached or combo of wheeled drive with Vortex attach. 5-axis in-water flight in Crawler mode	
• Steering: Turning Diam:	Joystick/var. knob control/Skid ~20 in (51 cm)	
• Max Speed: mps)	Water: 3 knots/crawler:1.64 fps(0.5	
• Power Source:	AC power via shore power, generator, inverter w/true sign wave.	
• Endurance:	Indefinitely with power applied.	
• Tether:	Yes	
• Sensors: Optional:	Video, sonar, depth, temp, heading. Grabber Attachment, Multi-beam Sonar, Scanning Sonar, Navigation System (USBL), Zoom Camera, Scaling Lasers, Rad.Detector, Thickness Gauge, Altimeter, LYYN Video Enhancement	
• Payload:	3.3 lb (1.5 kg) in water.	
• Manipulator:	Single function 3-jaw standard (open/close) w/ optional attachments for cutting, parallel, and interlocking.	

Sensors

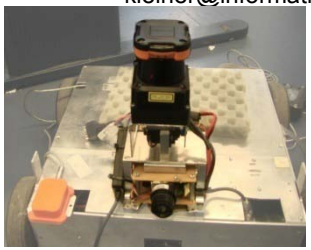
Sensors

225

Sensors

dcMap

University of Freiburg
www.informatik.uni-freiburg.de/~kleiner
kleiner@informatik.uni-freiburg.de



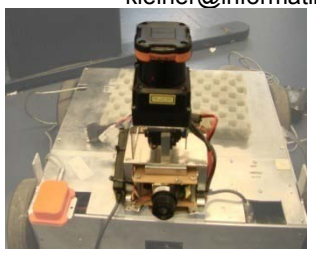
Manufacturer's Specs:

•Width:	3.92" (10 cm)
•Length:	4.3" (11 cm)
•Height:	9.06" (23 cm)
•Weight:	1.76lbs (0.8 kg)
•Power Source:	Lith.Polymer battery,
•Endurance:	120 min
•Control:	remote teleop
•Sensors:	Hokuyo UTM30 Laser Range Finder, ThermalEye thermo cam, Xsens IMU

•The sensor head can be mounted on any robot system without requiring data from the robot, such as wheel odometry data.

dcMap

University of Freiburg
www.informatik.uni-freiburg.de/~kleiner
kleiner@informatik.uni-freiburg.de



Manufacturer's Specs:

•Width:	3.92" (10 cm)
•Length:	4.3" (11 cm)
•Height:	9.06" (23 cm)
•Weight:	1.76lbs (0.8 kg)
•Power Source:	Lith.Polymer battery,
•Endurance:	120 min
•Control:	remote teleop
•Sensors:	Hokuyo UTM30 Laser Range Finder, ThermalEye thermo cam, Xsens IMU

•The sensor head can be mounted on any robot system without requiring data from the robot, such as wheel odometry data.

GammaRAE II Responder

RAE Systems, Inc
www.raesystems.com

Manufacturer's Specs:

- Width: 2.7 "(6.8 cm)
- Length: 4.9 " (12.5 cm)
- Height: 1.4 "(3.5 cm)
- Weight: 0.625 lbs (0.24 kg)
- Sensitivity: (Cs-137, Co-60, Am-241)
- Energy range: 60 keV to 3.0 MeV
- Exposure rate range: 1 µR/h to 10 R/h
- Response with angle if incidence: ±20% from 0° for -45° to 45° (Cs-137)
- Type of detector: CsI(Tl)+photodiode & energy-compensated PIN diode
- Data transmission type: Bluetooth
- Battery type and lifetime: 2xAA alkaline, 500hr
- Display type: Backlit LCD
- Alarm type: Audible, Visual LEDs, Built-in vibration
- Control: Manual
- Radio frequency immunity:
- Radiated emission: omplies with FCC Part 15
- Shock resistance: from 59" Passes drop tests (1.5 m)

GammaRAE II Responder

RAE Systems, Inc
www.raesystems.com

Manufacturer's Specs:

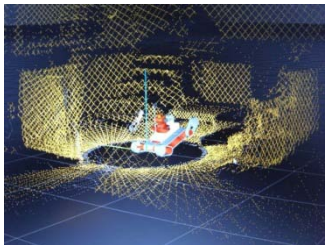
- Width: 2.7 "(6.8 cm)
- Length: 4.9 " (12.5 cm)
- Height: 1.4 "(3.5 cm)
- Weight: 0.625 lbs (0.24 kg)
- Sensitivity: (Cs-137, Co-60, Am-241)
- Energy range: 60 keV to 3.0 MeV
- Exposure rate range: 1 µR/h to 10 R/h
- Response with angle if incidence: ±20% from 0° for -45° to 45° (Cs-137)
- Type of detector: CsI(Tl)+photodiode & energy-compensated PIN diode
- Data transmission type: Bluetooth
- Battery type and lifetime: 2xAA alkaline, 500hr
- Display type: Backlit LCD
- Alarm type: Audible, Visual LEDs, Built-in vibration
- Control: Manual
- Radio frequency immunity:
- Radiated emission: omplies with FCC Part 15
- Shock resistance: from 59" Passes drop tests (1.5 m)

227

Sensors

High Speed 3D Scanner

School of Information Sciences, Tohoku University / IRS
: Kazunori Ohno/kazunori@rm.is.tohoku.ac.jp

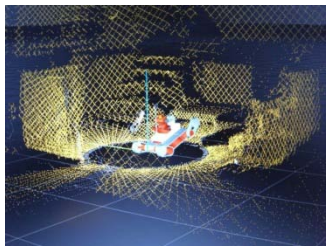


Manufacturer's Specs:

- Width: 5.1 in (13.0 cm)
- Length: 4.1 in (10.5 cm)
- Height: 8.8 in (22.4 cm)
- Weight: 11 lbs (5.0 kg)
- Max Speed: .1fps (Frame Per Second)
- Power Source: battery
- Endurance: N/A
- Tether: LAN
- Control: N/A
- Sensors: 2D LRF + Pan Tilt base
- Payload: N/A
- Manipulator: N/A
- Radio Tx: Tethered
- Radio Rx: Tethered

High Speed 3D Scanner

School of Information Sciences, Tohoku University / IRS
: Kazunori Ohno/kazunori@rm.is.tohoku.ac.jp



Manufacturer's Specs:

- Width: 5.1 in (13.0 cm)
- Length: 4.1 in (10.5 cm)
- Height: 8.8 in (22.4 cm)
- Weight: 11 lbs (5.0 kg)
- Max Speed: .1fps (Frame Per Second)
- Power Source: battery
- Endurance: N/A
- Tether: LAN
- Control: N/A
- Sensors: 2D LRF + Pan Tilt base
- Payload: N/A
- Manipulator: N/A
- Radio Tx: Tethered
- Radio Rx: Tethered

228

ICS-4000 Radionuclide Identifier

XRF Corporation
www.xrfcorp.com / www.laurussystems.com
410-465-5558

Manufacturer's Specs:

- Width: 3.4"
- Length: 10.2"
- Height: 1.2"
- Weight: 1.75 lbs
- Sensitivity: Cs-137: 90 cps/mR/h, Co-60: 25 cps/mR/h, Am-241: 2900 cps/mR/h
- Energy range: 10 keV – 2 MeV
- Exposure rate range: 50 mR/h – 1 R/h
- Response with angle if incidence: -3.3% 0° for -45° to 45° (Cs-137)
- Type of detector: Solid state CdTe for dose rate & radionuclide ID
- Data transmission type: Bluetooth
- Battery type and lifetime: 24 hours
- Display type: LCD w LED backlight
- Alarm type: Audible & visual
- Control: Remote / manual
- Radio frequency immunity: Class A per standard EN 61326 (1997) + A1 (1998) + A2 (2001)
- Radiated emission: Class B per standard EN 61326 (1997) + A (1998) + A2 (2001)
- Shock resistance: Conditional per ANSI N42.34

ICS-4000 Radionuclide Identifier

XRF Corporation
www.xrfcorp.com / www.laurussystems.com
410-465-5558

Manufacturer's Specs:

- Width: 3.4"
- Length: 10.2"
- Height: 1.2"
- Weight: 1.75 lbs
- Sensitivity: Cs-137: 90 cps/mR/h, Co-60: 25 cps/mR/h, Am-241: 2900 cps/mR/h
- Energy range: 10 keV – 2 MeV
- Exposure rate range: 50 mR/h – 1 R/h
- Response with angle if incidence: -3.3% 0° for -45° to 45° (Cs-137)
- Type of detector: Solid state CdTe for dose rate & radionuclide ID
- Data transmission type: Bluetooth
- Battery type and lifetime: 24 hours
- Display type: LCD w LED backlight
- Alarm type: Audible & visual
- Control: Remote / manual
- Radio frequency immunity: Class A per standard EN 61326 (1997) + A1 (1998) + A2 (2001)
- Radiated emission: Class B per standard EN 61326 (1997) + A (1998) + A2 (2001)
- Shock resistance: Conditional per ANSI N42.34

Inspector-1000

Canberra Industries
www.canberra.com

Manufacturer's Specs:

- Width: 7.5 in (19 cm)
- Length: 6.5 in (16.5 cm)
- Height: 2.5 in (6.4 cm)
- Weight: 2.2 lbs (1.0 kg)
- Sensitivity: (Cs-137, Co-60, Am-241)
- Energy range: 50-3000 keV
- Exposure rate range: 1000 mR/h
- Response with angle if incidence: 95% from 0° for -45° to 45° (Cs-137)
- Type of detector: GM + (either NaI(Tl) or LaBr) with radionuclide ID
- Data transmission type: USB
- Battery type and lifetime: 12, hours
- Display type: color display LCD 320 x 200 Hi-res
- Alarm type: audible, visual
- Control: eyes-on, manual
- Radio frequency immunity: yes
- Radiated emission: yes
- Shock resistance: yes

Inspector-1000

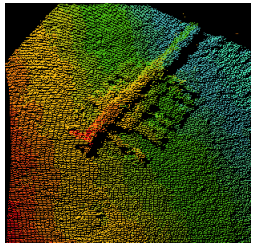
Canberra Industries
www.canberra.com

Manufacturer's Specs:

- Width: 7.5 in (19 cm)
- Length: 6.5 in (16.5 cm)
- Height: 2.5 in (6.4 cm)
- Weight: 2.2 lbs (1.0 kg)
- Sensitivity: (Cs-137, Co-60, Am-241)
- Energy range: 50-3000 keV
- Exposure rate range: 1000 mR/h
- Response with angle if incidence: 95% from 0° for -45° to 45° (Cs-137)
- Type of detector: GM + (either NaI(Tl) or LaBr) with radionuclide ID
- Data transmission type: USB
- Battery type and lifetime: 12, hours
- Display type: color display LCD 320 x 200 Hi-res
- Alarm type: audible, visual
- Control: eyes-on, manual
- Radio frequency immunity: yes
- Radiated emission: yes
- Shock resistance: yes

Multibeam Imaging Sonar

MBI350-45
BlueVeiw Technologies
www.blueveiwtech.com



Manufacturer's Specs:

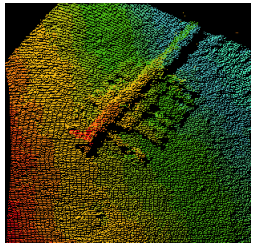
- **Specifications**
  - Field of View: 45˚x 1°
  - Max Range: 90 ft
  - True Beam Width: 1˚x 1˚
  - Number of Beams: 256
  - Beam Spacing: 0.18°
  - Range Resolution: .016"
  - Update Rate: Up to 40 Hz
  - Frequency: 1.35 MHz

- **Mechanical Specifications**
  - Weight in Air: 12.0 lb
  - Weight in Water: 3.2 lb
  - Depth Rating: 1000 ft
  - Size: 10.5" x 9.2" x 5.3"

- **Interface Specifications**
  - Coms: Ethernet
  - Voltage: 12-48 VDC
  - Power: 15 Watts

Multibeam Imaging Sonar

MBI350-45
BlueVeiw Technologies
www.blueveiwtech.com



Manufacturer's Specs:

- **Specifications**
  - Field of View: 45˚x 1°
  - Max Range: 90 ft
  - True Beam Width: 1˚x 1˚
  - Number of Beams: 256
  - Beam Spacing: 0.18°
  - Range Resolution: .016"
  - Update Rate: Up to 40 Hz
  - Frequency: 1.35 MHz

- **Mechanical Specifications**
  - Weight in Air: 12.0 lb
  - Weight in Water: 3.2 lb
  - Depth Rating: 1000 ft
  - Size: 10.5" x 9.2" x 5.3"

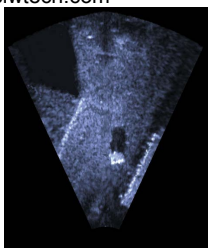
- **Interface Specifications**
  - Coms: Ethernet
  - Voltage: 12-48 VDC
  - Power: 15 Watts

Multibeam Imaging Sonar

P450E-15

BlueVeiw Technologies

www.blueveiwtech.com



Manufacturer's Specs:

- **Specifications**
  - Field of View: 45˚x 15°
  - Max Range: 450 ft
  - True Beam Width: 1˚x 15˚
  - Number of Beams: 256
  - Beam Spacing: 0.18°
  - Range Resolution: 2"
  - Update Rate: Up to 10 Hz
  - Frequency: 450 kHz

- **Mechanical Specifications**
  - Weight in Air: 5.7 lb
  - Weight in Water: 1.4 lb
  - Depth Rating: 1000 ft
  - Size: 9.6" x 6.9" x 4"

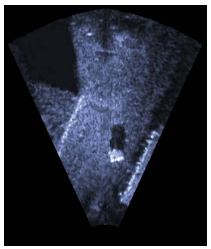
- **Interface Specifications**
  - Coms: Ethernet
  - Voltage: 12-48 VDC
  - Power: 10 Watts

Multibeam Imaging Sonar

P450E-15

BlueVeiw Technologies

www.blueveiwtech.com



Manufacturer's Specs:

- **Specifications**
  - Field of View: 45˚x 15°
  - Max Range: 450 ft
  - True Beam Width: 1˚x 15˚
  - Number of Beams: 256
  - Beam Spacing: 0.18°
  - Range Resolution: 2"
  - Update Rate: Up to 10 Hz
  - Frequency: 450 kHz

- **Mechanical Specifications**
  - Weight in Air: 5.7 lb
  - Weight in Water: 1.4 lb
  - Depth Rating: 1000 ft
  - Size: 9.6" x 6.9" x 4"

- **Interface Specifications**
  - Coms: Ethernet
  - Voltage: 12-48 VDC
  - Power: 10 Watts

232

Multibeam Imaging Sonar

P900E-20
BlueVeiw Technologies
www.blueveiwtech.com
206-545-7260

Manufacturer's Specs:

- **900 kHz Head Specifications**
  - Field of View: 45˚x 20°
  - Max Range: 180 ft
  - True Beam Width: 1˚x 20˚
  - Number of Beams: 256
  - Beam Spacing: 0.18°
  - Range Resolution: 1"
  - Update Rate: Up to 10 Hz
  - Frequency: 900 kHz

- **Mechanical Specifications**
  - Weight in Air: 4.0 lb
  - Weight in Water: 1 lb
  - Depth Rating: 1000 ft
  - Size: 7"x 4" OD

- **Interface Specifications**
  - Coms: Ethernet
  - Voltage: 12-48 VDC
  - Power: 10 Watts

Multibeam Imaging Sonar

P900E-20
BlueVeiw Technologies
www.blueveiwtech.com
206-545-7260

Manufacturer's Specs:

- **900 kHz Head Specifications**
  - Field of View: 45˚x 20°
  - Max Range: 180 ft
  - True Beam Width: 1˚x 20˚
  - Number of Beams: 256
  - Beam Spacing: 0.18°
  - Range Resolution: 1"
  - Update Rate: Up to 10 Hz
  - Frequency: 900 kHz

- **Mechanical Specifications**
  - Weight in Air: 4.0 lb
  - Weight in Water: 1 lb
  - Depth Rating: 1000 ft
  - Size: 7" x 4" OD

- **Interface Specifications**
  - Coms: Ethernet
  - Voltage: 12-48 VDC
  - Power: 10 Watts

233

Sensors

Multibeam Imaging Sonar

BlueVeiw Technologies
www.blueveiwtech.com
206-545-7260

Manufacturer's Specs:

- **900 kHz Head Specifications**
  - Field of View: 45˚x 20°
  - Max Range: 180 ft
  - True Beam Width: 1˚x 20˚
  - Number of Beams: 256
  - Beam Spacing: 0.18°
  - Range Resolution: 1"
  - Update Rate: Up to 10 Hz
  - Frequency: 900 kHz
- **2.25 MHz Head Specifications**
  - Field of View: 45˚x 20°
  - Max Range: 15 ft
  - True Beam Width: 1˚x 20˚
  - Number of Beams: 256
  - Beam Spacing: 0.18°
  - Range Resolution: 0.4"
  - Update Rate: Up to 10 Hz
  - Frequency: 2.25 MHz
- **Mechanical Specifications**
  - Weight in Air: 6.0 lb
  - Weight in Water: 1.5 lb
  - Depth Rating: 1000 ft
  - Size: 8.3" x 5.0" OD
- **Interface Specifications**
  - Coms: Ethernet
  - Voltage: 12-48 VDC
  - Power: 15 Watts

Multibeam Imaging Sonar

BlueVeiw Technologies
www.blueveiwtech.com
206-545-7260

Manufacturer's Specs:

- **900 kHz Head Specifications**
  - Field of View: 45˚x 20°
  - Max Range: 180 ft
  - True Beam Width: 1˚x 20˚
  - Number of Beams: 256
  - Beam Spacing: 0.18°
  - Range Resolution: 1"
  - Update Rate: Up to 10 Hz
  - Frequency: 900 kHz
- **2.25 MHz Head Specifications**
  - Field of View: 45˚x 20°
  - Max Range: 15 ft
  - True Beam Width: 1˚x 20˚
  - Number of Beams: 256
  - Beam Spacing: 0.18°
  - Range Resolution: 0.4"
  - Update Rate: Up to 10 Hz
  - Frequency: 2.25 MHz
- **Mechanical Specifications**
  - Weight in Air: 6.0 lb
  - Weight in Water: 1.5 lb
  - Depth Rating: 1000 ft
  - Size: 8.3 in x 5.0 in OD
- **Interface Specifications**
  - Coms: Ethernet
  - Voltage: 12-48 VDC
  - Power: 15 Watts

234

Radiogem

Canberra Industries
www.canberra.com

Manufacturer's Specs:

- Width: 5.9 in (15.0 cm)
- Length: 3.3 in (8.5 cm)
- Height: 1.8 in (4.5 cm)
- Weight: .66 lbs(0.300 kg)
- Sensitivity: yes (Cs-137, Co-60, Am-241)
- Energy range: 30 - 2000 keV (probe dep.)
- Exposure rate range: 0.03-10,000mR/h
- Response with angle if incidence: 95% from 0° for -45° to 45° (Cs-137)
- Type of detector: GM, or NaI, Plastic
- Data transmission type: RS-232
- Battery type and lifetime: 80 hours
- Display type: LCD display
- Alarm type: audible, visual
- Control: eyes-on, manual
- Radio frequency immunity: yes
- Radiated emission: yes
- Shock resistance: yes

Radiogem

Canberra Industries
www.canberra.com

Manufacturer's Specs:

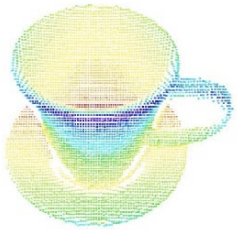
- Width: 5.9 in (15.0 cm)
- Length: 3.3 in (8.5 cm)
- Height: 1.8 in (4.5 cm)
- Weight: .66 lbs(0.300 kg)
- Sensitivity: yes (Cs-137, Co-60, Am-241)
- Energy range: 30 - 2000 keV (probe dep.)
- Exposure rate range: 0.03-10,000mR/h
- Response with angle if incidence: 95% from 0° for -45° to 45° (Cs-137)
- Type of detector: GM, or NaI, Plastic
- Data transmission type: RS-232
- Battery type and lifetime: 80 hours
- Display type: LCD display
- Alarm type: audible, visual
- Control: eyes-on, manual
- Radio frequency immunity: yes
- Radiated emission: yes
- Shock resistance: yes

235

Sensors

Swiss Ranger 4000

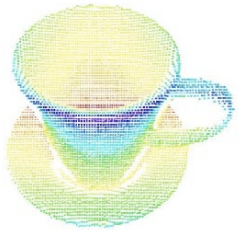
Mesa Imaging AG/Acroname Inc.
www.acroname.com (US) / www.mesa-imaging.ch (Switzerland)
Steve Richards (steve@acroname.com)



Manufacturer's Specs:

- Width: 2.6" (6.5 cm)
- Length: 2.6" (6.8 cm)
- Height: 2.6" (6.5 cm)
- Weight: 1.05 lbs (470 g)
- Locomotion: None
- Steering: None
- Turning Diam: None
- Max Speed: 54 fps
- Power Source: battery (12V)
- Endurance: None
- Tether: USB or Ethernet
- Control: Mac, Linux, Windows Drivers
- Sensors: 3D Depth Imaging (176x144) pixel, 0.3 to 5.0 meter
- Payload: None
- Manipulator: None

Swiss Ranger 4000



Manufacturer's Specs:

- Width: 2.6" (6.5 cm)
- Length: 2.6" (6.8 cm)
- Height: 2.6" (6.5 cm)
- Weight: 1.05 lbs (470 g)
- Locomotion: None
- Steering: None
- Turning Diam: None
- Max Speed: 54 fps
- Power Source: battery (12V)
- Endurance: None
- Tether: USB or Ethernet
- Control: Mac, Linux, Windows Drivers
- Sensors: 3D Depth Imaging (176x144) pixel, 0.3 to 5.0 meter
- Payload: None
- Manipulator: None

UltraRadiac

Canberra Industries
www.canberra.com

Manufacturer's Specs:

- Width: 2.61 in (6.6 cm)
- Length: 3.95 in (10.0 cm)
- Height: 1.14 in (2.9 cm)
- Weight: .6 lbs (0.269 kg)
- Sensitivity: yes (Cs-137, Co-60, Am-241)
- Energy range: 60 - 1300 keV
- Exposure rate range: 0.001 – 500,000 mR/h
- Response with angle if incidence: 45° to 45° (Cs-137) 95% from 0° for -
- Type of detector: GM
- Data transmission type: RS-232
- Battery type and lifetime: 150 hours
- Display type: LCD display
- Alarm type: audible, visual, vibration
- Control: yes-on, manual
- Radio frequency immunity: yes
- Radiated emission: yes
- Shock resistance: yes

UltraRadiac

Canberra Industries
www.canberra.com

Manufacturer's Specs:

- Width: 2.61 in (6.6 cm)
- Length: 3.95 in (10.0 cm)
- Height: 1.14 in (2.9 cm)
- Weight: .6 lbs (0.269 kg)
- Sensitivity: yes (Cs-137, Co-60, Am-241)
- Energy range: 60 - 1300 keV
- Exposure rate range: 0.001 – 500,000 mR/h
- Response with angle if incidence: 45° to 45° (Cs-137) 95% from 0° for -
- Type of detector: GM
- Data transmission type: RS-232
- Battery type and lifetime: 150 hours
- Display type: LCD display
- Alarm type: audible, visual, vibration
- Control: yes-on, manual
- Radio frequency immunity: yes
- Radiated emission: yes
- Shock resistance: yes

237

Sensors

238

General Index

Contact Information 3

Program Overview 4

Events

2008-Disater City 6

College Station, TX

2007-Disater City 20

College Station, TX

2006-MD TF-1 24

Rockville, MD

2006-Disaster City 28

College Station, TX

Safety 35

Test Methods 37

Ground Robots 111

Wall Climbers 193

Aerial Robots 199

Aquatic Robots 221

Sensors 225

General Index

Contact Information 3

Program Overview 4

Events

2008-Disater City 6

College Station, TX

2007-Disater City 20

College Station, TX

2006-MD TF-1 24

Rockville, MD

2006-Disaster City 28

College Station, TX

Safety 35

Test Methods 37

Ground Robots 111

Wall Climbers 193

Aerial Robots 199

Aquatic Robots 221

Sensors 225

Index-Size

Robot Name	Company	
Ground Robots		
Eyeball R1	O.D.F.	112
Recon Scout	ReconRobotics	114
ToughBot	Omnitech Robotics	116
Active Scope Camera	Tohoku University	118
Pointman (LRV)	Applied Research Assoc.	120
VGTV-Exteme	Inuktun	122
Dragon Runner	Foster-Miller/Automatika	124
BomBot	WVHTC	126
Versatrax 100	Inuktun	128
Marv	Mesa Robotics	130
G2Bot	Mesa Robotics	132
Soryu	IRS	134
BomBot 2	WVHTC	136
Soryu V	IRS	138
Jacobs Rugg.Robot	Jacobs University	140
Hero	First Response Robotics	142
Super Kenaf	IRS	144
Kenaf	IRS	146
PackBot EOD	iRobot	148
PackBot Explorer	iRobot	150
Hibiscus	Toin	152
Cphea	Toin	154
Robbie 6	University Koblenz-Landau	156
Shinobi	Univer. Electro Comm.	158
Matilda	Mesa Robotics	160
Matilda II	Mesa Robotics	162
NuTech-R-4	Nagaoka Univ. Tech.	164
Versatrax 150	Inuktun	166
Chaos	Autonomous Solutions, Inc.	168

Index-Size

Robot Name	Company	
Ground Robots		
Eyeball R1	O.D.F.	112
Recon Scout	ReconRobotics	114
ToughBot	Omnitech Robotics	116
Active Scope Camera	Tohoku University	118
Pointman (LRV)	Applied Research Assoc.	120
VGTV-Exteme	Inuktun	122
Dragon Runner	Foster-Miller/Automatika	124
BomBot	WVHTC	126
Versatrax 100	Inuktun	128
Marv	Mesa Robotics	130
G2Bot	Mesa Robotics	132
Soryu	IRS	134
BomBot 2	WVHTC	136
Soryu V	IRS	138
Jacobs Rugg.Robot	Jacobs University	140
Hero	First Response Robotics	142
Super Kenaf	IRS	144
Kenaf	IRS	146
PackBot EOD	iRobot	148
PackBot Explorer	iRobot	150
Hibiscus	Toin	152
Cphea	Toin	154
Robbie 6	University Koblenz-Landau	156
Shinobi	Univer. Electro Comm.	158
Matilda	Mesa Robotics	160
Matilda II	Mesa Robotics	162
NuTech-R-4	Nagaoka Univ. Tech.	164
Versatrax 150	Inuktun	166
Chaos	Autonomous Solutions, Inc.	168

240

Index-Size

Robot Name	Company	
Ground Robots Cont.		
ATRV mini	Idaho National Lab	170
Modular Logistics Platform	Segway	172
Talon Gen IV	Foster-Miller/Qinetiq	174
Talon Hazmat	Foster-Miller/Qinetiq	176
RMP 200	Segway	178
TeleMax	TeleRob	180
HD-1J	Remotec	182
Mini-Andros II	Remotec	184
RMP 400	Segway	186
Andros F6A	Remotec	188
Boz I	BOZ Robotics	190
Wall Climbers		
VMRP	Vortex	194
NanoMag	Inuktun	196
Aerial Robots		
Fixed Wing		
Micro-Drone 200	BCB International, Ltd.	200
Nighthawk	Applied Research Assoc.	204
Raven	AeroVironment Inc.	206
Dragon Eye	AeroVironment, Inc.	208
CyberBug	Cyber Defense Systems, Inc.	210
Evolution-XTS	L-3 BAI Aerosystems, Inc	212
Rotor		
AirRobot	AirRobot	202
Flying Bassett	Univ. of AL – Huntsville	214
Yamaha Helicopter	Skeyes Unlimited	216
Other		
Blimp	ARACAR	218
Aquatic Robots		
VideoRay Pro 3	VideoRay	222
LBV200L2	SeaBotix	223
LBV150SE-5	SeaBotix	224

Index-Size

Robot Name	Company	
Ground Robots Cont.		
ATRV mini	Idaho National Lab	170
Modular Logistics Platform	Segway	172
Talon Gen IV	Foster-Miller/Qinetiq	174
Talon Hazmat	Foster-Miller/Qinetiq	176
RMP 200	Segway	178
TeleMax	TeleRob	180
HD-1J	Remotec	182
Mini-Andros II	Remotec	184
RMP 400	Segway	186
Andros F6A	Remotec	188
Boz I	BOZ Robotics	190
Wall Climbers		
VMRP	Vortex	194
NanoMag	Inuktun	196
Aerial Robots		
Fixed Wing		
Micro-Drone 200	BCB International, Ltd.	200
Nighthawk	Applied Research Assoc.	204
Raven	AeroVironment Inc.	206
Dragon Eye	AeroVironment, Inc.	208
CyberBug	Cyber Defense Systems, Inc.	210
Evolution-XTS	L-3 BAI Aerosystems, Inc	212
Rotor		
AirRobot	AirRobot	202
Flying Bassett	Univ. of AL – Huntsville	214
Yamaha Helicopter	Skeyes Unlimited	216
Other		
Blimp	ARACAR	218
Aquatic Robots		
VideoRay Pro 3	VideoRay	222
LBV200L2	SeaBotix	223
LBV150SE-5	SeaBotix	224

241

Index- Sensors

dcMap 226
GammaRAE II Responder 227
High Speed 3D Scanner 228
ICS-4000 Radionuclide Identifier 229
Inspector-1000 230
Multibeam Imaging Sonar
- MBI350-45 231
- P450E-15 232
- P900E-20 233
- Multibeam Imaging Sonar 234

Radiogem 235
Swiss Ranger 4000 236
UltraRadiac 237

Index- Sensors

dcMap 226
GammaRAE II Responder 227
High Speed 3D Scanner 228
ICS-4000 Radionuclide Identifier 229
Inspector-1000 230
Multibeam Imaging Sonar
- MBI350-45 231
- P450E-15 232
- P900E-20 233
- Multibeam Imaging Sonar 234

Radiogem 235
Swiss Ranger 4000 236
UltraRadiac 237

242

Index-Robot Name

Robot Name	Company	
Ground Robots		
Active Sc. Camera	Tohoku University	118
Andros F6A	Remotec	188
ATRV mini	Idaho National Lab	170
BomBot	WVHTC	126
BomBot 2	WVHTC	136
Boz I	BOZ Robotics	190
Chaos	Autonomous Solutions, Inc.	168
Cphea	Toin	154
Dragon Runner	Foster-Miller/Automatika	124
Eyeball R1	O.D.F.	112
G2Bot	Mesa Robotics	132
HD-1J	Remotec	182
Hero	First Response Robotics	142
Hibiscus	Toin	152
Jacobs Rugged Robot	Jacobs University	140
Kenaf	IRS	146
Marv	Mesa Robotics	130
Matilda	Mesa Robotics	160
Matilda II	Mesa Robotics	162
Mini-Andros II	Remotec	184
Modular Logistics	Segway	172
NuTech-R-4	Nagaoka Univ. Tech.	164
PackBot EOD	iRobot	148
PackBot Explorer	iRobot	150
Pointman (LRV)	Applied Research Assoc.	120
Recon Scout	ReconRobotics	114
RMP 200	Segway	178
RMP 400	Segway	186
Robbie 6	University Koblenz-Landau	156

Index-Robot Name

Robot Name	Company	
Ground Robots		
Active Sc. Camera	Tohoku University	118
Andros F6A	Remotec	188
ATRV mini	Idaho National Lab	170
BomBot	WVHTC	126
BomBot 2	WVHTC	136
Boz I	BOZ Robotics	190
Chaos	Autonomous Solutions, Inc.	168
Cphea	Toin	154
Dragon Runner	Foster-Miller/Automatika	124
Eyeball R1	O.D.F.	112
G2Bot	Mesa Robotics	132
HD-1J	Remotec	182
Hero	First Response Robotics	142
Hibiscus	Toin	152
Jacobs Rugged Robot	Jacobs University	140
Kenaf	IRS	146
Marv	Mesa Robotics	130
Matilda	Mesa Robotics	160
Matilda II	Mesa Robotics	162
Mini-Andros II	Remotec	184
Modular Logistics	Segway	172
NuTech-R-4	Nagaoka Univ. Tech.	164
PackBot EOD	iRobot	148
PackBot Explorer	iRobot	150
Pointman (LRV)	Applied Research Assoc.	120
Recon Scout	ReconRobotics	114
RMP 200	Segway	178
RMP 400	Segway	186
Robbie 6	University Koblenz-Landau	156

243

Index-Name

Robot Name	Company	
Ground Robots Cont.		
Shinobi	Univer. Electro Comm.	158
Soryu	IRS	134
Soryu V	IRS	138
Super Kenaf	IRS	144
TalonGen IV	Foster-Miller/Qinetiq	174
Talon Hazmat	Foster-Miller/Qinetiq	176
TeleMax	TeleRob	180
ToughBot	Omnitech Robotics	116
Versatrax 100	Inuktun	128
Versatrax 150	Inuktun	166
VGTV-Exteme	Inuktun	122
Wall Climbers		
NanoMag	Inuktun	196
VMRP	Vortex	194
Aerial Robots		
AirRobot	AirRobot	202
Blimp	ARACAR	218
CyberBug	Cyber Defense Systems, Inc.	210
Dragon Eye	AeroVironment, Inc.	208
Evolution-XTS	L-3 BAI Aerosystems, Inc	212
Flying Bassett	Univ. of AL - Huntsville	214
Micro-Drone 200	BCB International	200
Nighthawk	Applied Research Assoc.	204
Raven	AeroVironment, Inc.	206
Yamaha Helicopter	Skeyes Unlimited	216
Aquatic Robots		
LBV200L2	SeaBotix	223
LBV150SE-5	SeaBotix	224
VideoRay Pro 3	VideoRay	222

Index-Name

Robot Name	Company	
Ground Robots Cont.		
Shinobi	Univer. Electro Comm.	158
Soryu	IRS	134
Soryu V	IRS	138
Super Kenaf	IRS	144
TalonGen IV	Foster-Miller/Qinetiq	174
Talon Hazmat	Foster-Miller/Qinetiq	176
TeleMax	TeleRob	180
ToughBot	Omnitech Robotics	116
Versatrax 100	Inuktun	128
Versatrax 150	Inuktun	166
VGTV-Exteme	Inuktun	122
Wall Climbers		
NanoMag	Inuktun	196
VMRP	Vortex	194
Aerial Robots		
AirRobot	AirRobot	202
Blimp	ARACAR	218
CyberBug	Cyber Defense Systems, Inc.	210
Dragon Eye	AeroVironment, Inc.	208
Evolution-XTS	L-3 BAI Aerosystems, Inc	212
Flying Bassett	Univ. of AL - Huntsville	214
Micro-Drone 200	BCB International	200
Nighthawk	Applied Research Assoc.	204
Raven	AeroVironment, Inc.	206
Yamaha Helicopter	Skeyes Unlimited	216
Aquatic Robots		
LBV200L2	SeaBotix	223
LBV150SE-5	SeaBotix	224
VideoRay Pro 3	VideoRay	222

Index-Test Methods

Test Methods 37

Logistics Suite

Cache Packaging/Setup/tools 42

Sensing Suite

Acuity/Field of View 44

Directed Search 46

Underpass Search 48

One/Two Way Audio 50

Mapping 52

Mobility Suite

Flat Dash and Tow 54

Slalom: Flat Flooring 56

Slalom: Continuous Ramps 58

Slalom: Crossing Ramps 60

Slalom: Symmetric Stepfields 62

Gap Crossing 64

Pipe Step 66

Stairs 68

Inclined Plane 70

Tow: Hitch Trailer 72

Tow: Hitch Drag 74

Tow: End-Effector Drag 76

Confined Space 78

Terrain Traversability 80

Radio Comms Suite

Line-of-sight 82

Non line-of-sight 84

Structure & Tunnel Penetration 86

Urban Canyon 88

Index-Test Methods

Test Methods 37

Logistics Suite

Cache Packaging/Setup/tools 42

Sensing Suite

Acuity/Field of View 44

Directed Search 46

Underpass Search 48

One/Two Way Audio 50

Mapping 52

Mobility Suite

Flat Dash and Tow 54

Slalom: Flat Flooring 56

Slalom: Continuous Ramps 58

Slalom: Crossing Ramps 60

Slalom: Symmetric Stepfields 62

Gap Crossing 64

Pipe Step 66

Stairs 68

Inclined Plane 70

Tow: Hitch Trailer 72

Tow: Hitch Drag 74

Tow: End-Effector Drag 76

Confined Space 78

Terrain Traversability 80

Radio Comms Suite

Line-of-sight 82

Non line-of-sight 84

Structure & Tunnel Penetration 86

Urban Canyon 88

Index-Test Methods

Mobile Manipulation Suite
- Perception 90
- Grasping 92
- Door Opening 94

Safety/Environment Suite
- Washdown/Decontamination 96

Energy/Power Suite
- Endurance 98

Human-System Interaction (HSI) Suite
- Random Maze Search 100
- Random Maze Navigation 102
- Checklist Items 104

Maneuvering-Aerial Suite
- VTOL Station Keeping 106

Maneuvering-Aquatic Suite
- Underwater Navigation and Search 108

Index-Test Methods

Mobile Manipulation Suite
- Perception 90
- Grasping 92
- Door Opening 94

Safety/Environment Suite
- Washdown/Decontamination 96

Energy/Power Suite
- Endurance 98

Human-System Interaction (HSI) Suite
- Random Maze Search 100
- Random Maze Navigation 102
- Checklist Items 104

Maneuvering-Aerial Suite
- VTOL Station Keeping 106

Maneuvering-Aquatic Suite
- Underwater Navigation and Search 108