Alliance

- General Dynamics Robotic Systems
- Carnegie Mellon University
- Florida A&M University
- University of Central Florida
- University of PA
- Boston Dynamics
- QinetiQ North America
- Cal Tech/Jet Propulsion Lab

- US Army Research Lab

Objectives

Make the research investments that support the Army's robotic system development goals:

- *Perceive and understand dynamic & unknown environments, including creation of a comprehensive model of the surrounding world*

- *Autonomously plan and execute military missions; readily adapt to changing environments and scenarios; learn from prior experience; share common understanding with team members*

- *Seamlessly integrate unmanned systems into military and civilian society*

- *Manipulate objects with near-human dexterity and maneuver through three-dimensional environments*

Technical Areas

- Perception
- Intelligence
- Human-Robot Interaction
- Manipulation & Mobility

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Plan and execute military tasks & missions

- **Intelligence framework**
- **Cognitive reasoning & behavior generation**
- **Learning & Adaptation**
- **Meta-cognition & transparency**
- **Distributed intelligence & scaling**

- **Learn & Adapt**
  - **Deductive reasoning**
  - **Inference**
  - **Generalization/Rules of engagement**
  - **Uncertainty of future conditions**
  - **Probabilistic reasoning**
  - **Spatial & temporal reasoning**
- **Self-awareness/introspection**
  - **Transparency**
  - **Providing non-verbal cues**
  - **Human-robot collaboration**
  - **Fault detection**
- **World model**
  - **Common ground**
  - **Mixed initiative**
- **Scale**
  - **Adapting to resource limitations**
- **Tactically intelligent behavior**
- **Collaboration between homogeneous & heterogeneous systems**

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Perceive & understand a dynamic & unknown environment

- **Sensing**

- **Terrain and object classification, identification & reasoning**

- **Activity detection & Understanding**

- **Distributed & collaborative perception**

- Sensing
  - Greater resolution & range, lower cost
  - Increased fields of view; focus of attention
  - Scale
  - All weather/environments
- Terrain/Object Understanding
  - Broader vocabulary
  - Recognition of cues/saliency of observations
  - Robust & adaptive
  - Reasoning
  - Fusion
- Understanding activity
  - Human activity/intent recognition
  - Saliency of observations/ context & cues
  - Learning
- World model
  - Managed & validated
  - Long-term & short-term memory
  - Collaborative or distributed
  - Common ground (HRI)
  - Navigation (Intelligence, mobility & manipulation)

Seamless integration of robots into military & civilian activity

- **Shared situational awareness**
  - Aware of cultural and behavioral norms.
  - Comprehend commander's intent & act upon it
  - Understand the intent of surrounding humans for consideration in planning
  - Possess common spatial & temporal frames of reference – a "common ground"

- **Trust & Confidence**
  - Transparency of action
  - Cues to activity
  - Tolerance to failure

- **Intuitive Communication**
  - Language – unconstrained dialogue
  - Non-verbal cues, gestures, context, & behavior

- **Operating within society**
  - Adaptable to varying social cues & context

- **Span of control**

- **Understanding human-robot intra-team cognition**
- **Multi-modal communication**
- **Collaborating socially, organizationally & culturally**

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Manipulation of objects with near-human dexterity & unfettered mobility in 3-D

- **Dexterous manipulation**
- **Unique mobility**
- **Next generation actuation**

- **Human-like manipulation**
  - **Range of motion**
  - **Dexterity**
  - **Strength**
- **Control**
- **Efficiency**
- **Automation/Intelligence**
- **Close coupling of perception, planning, & control**
- **Mobility in complex three-dimensional environments**
  - **Urban**
  - **Jungle/Riverine**
  - **Confined spaces**
- **Animal-like adaptability to changing conditions - reconfigurable**
- **Learning from prior experience**

Research to enable future autonomous unmanned systems

Provide technology to enable:
- **Greater level of autonomy for:**
  - **Ground vehicles**
  - **Air systems**
  - **Surface vessels**

Teaming:
- **With soldiers**
  - **Combat multiplier**
  - **Team member**
- **With unmanned systems**
  - **Heterogeneous groups**
  - **Following commander's intent**