Rehabilitation Robotics

The Sorcerers Apprentice ?

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Rehabilitation Robotics : The Sorcerers Apprentice

What are Rehabilitation Robots ?

Devices that help--

- Diagnose
- Treat
- Assist functional restoration

Why Do We Need Robots for Neurologic Injury ?

1. Economics of neurologic rehabilitation
2. Demographics- increasing prevalence of stroke
3. Treatment options limited in duration and intensity

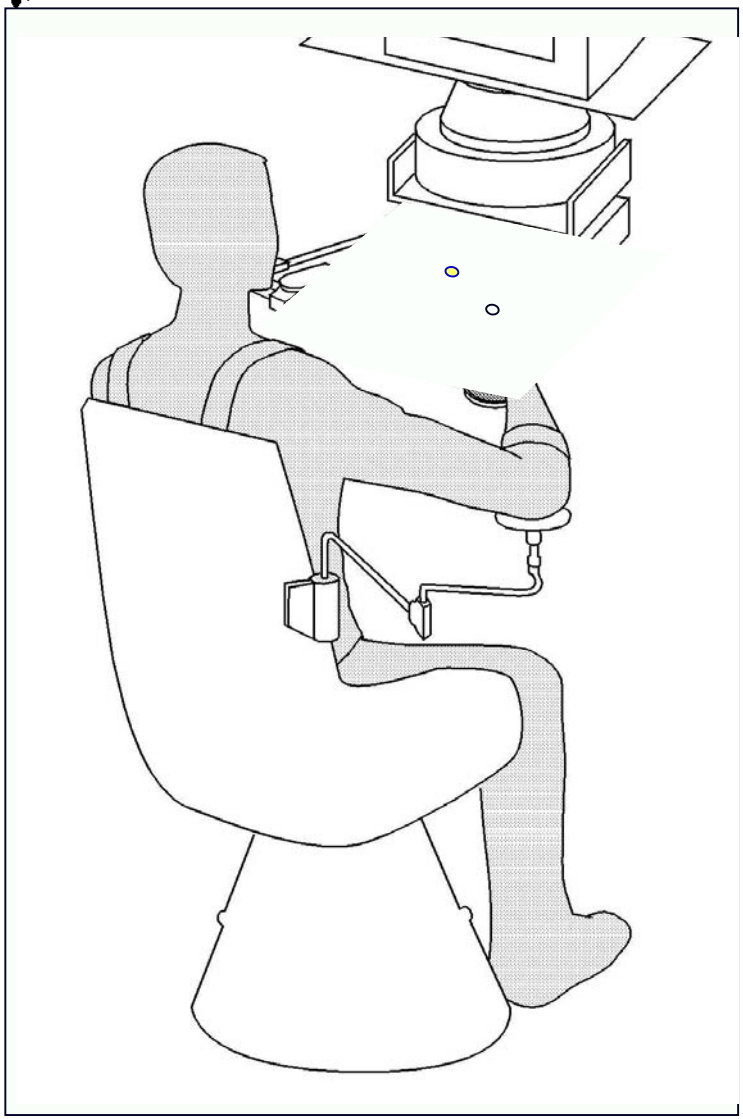
Rehabilitation Robotics : The Sorcerers Apprentice

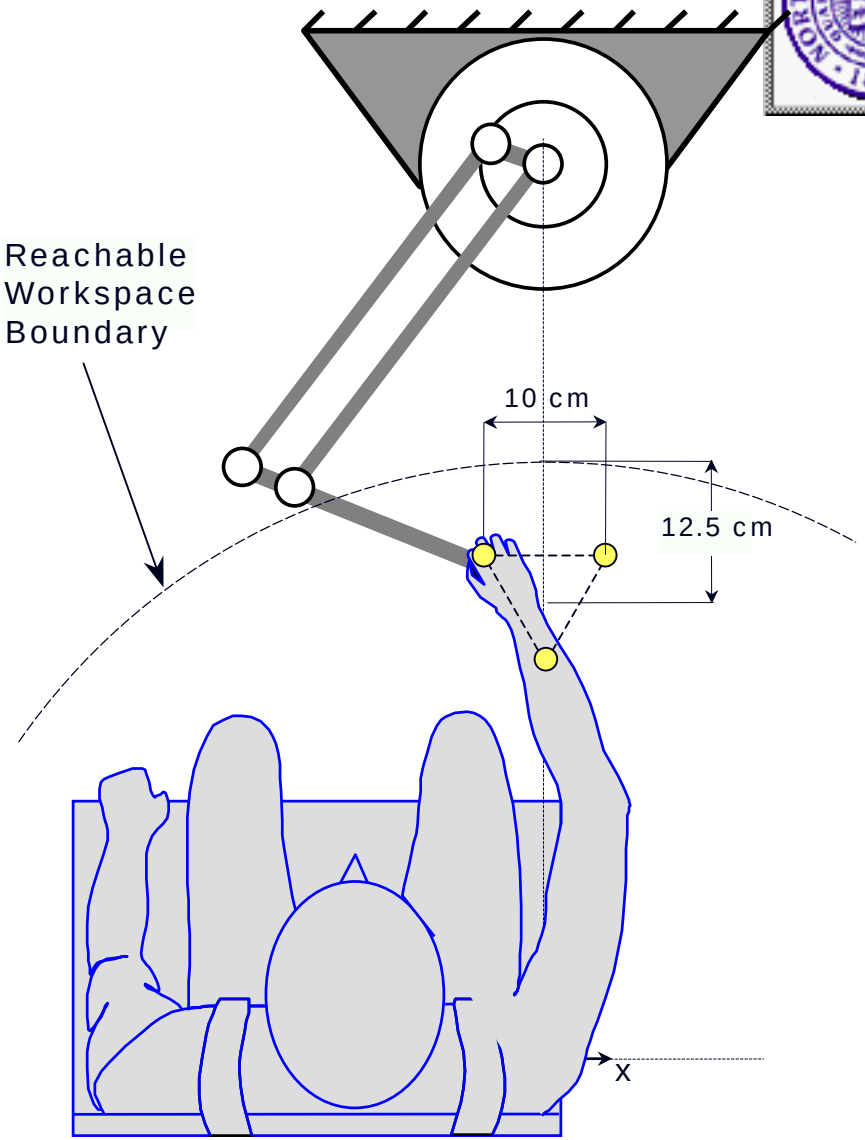
- Planar Robots- MIT manus
- Planar Robots- Reaching Guide
- Whole Arm Manipulator (WAM)
- Lokomat

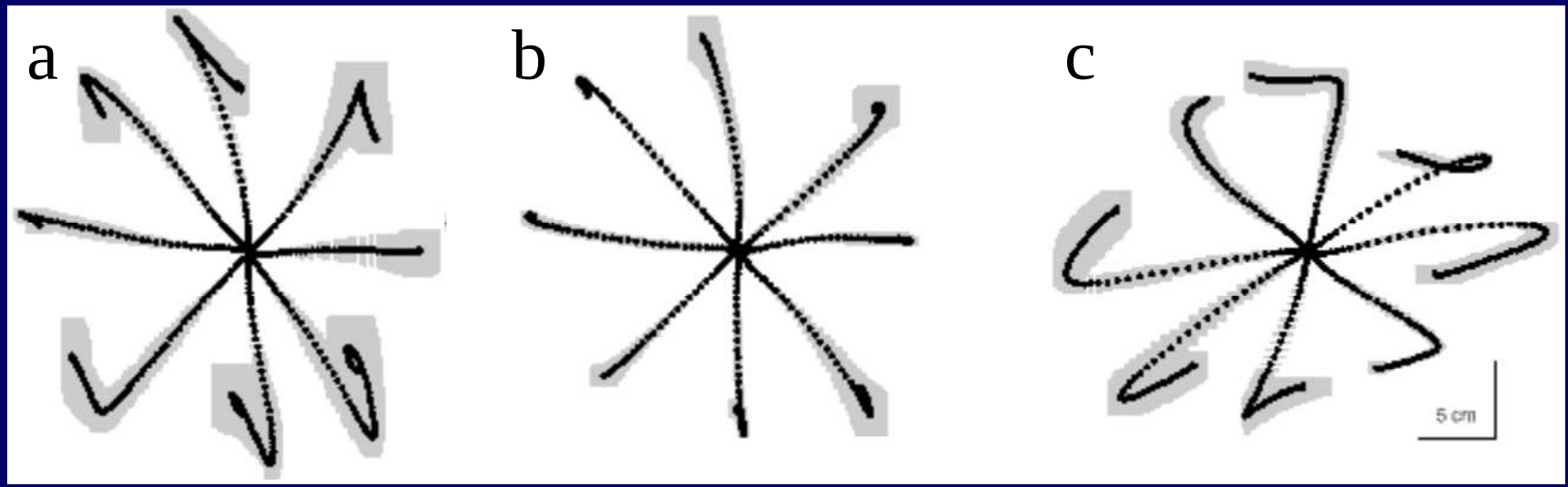
Rehabilitation Robots

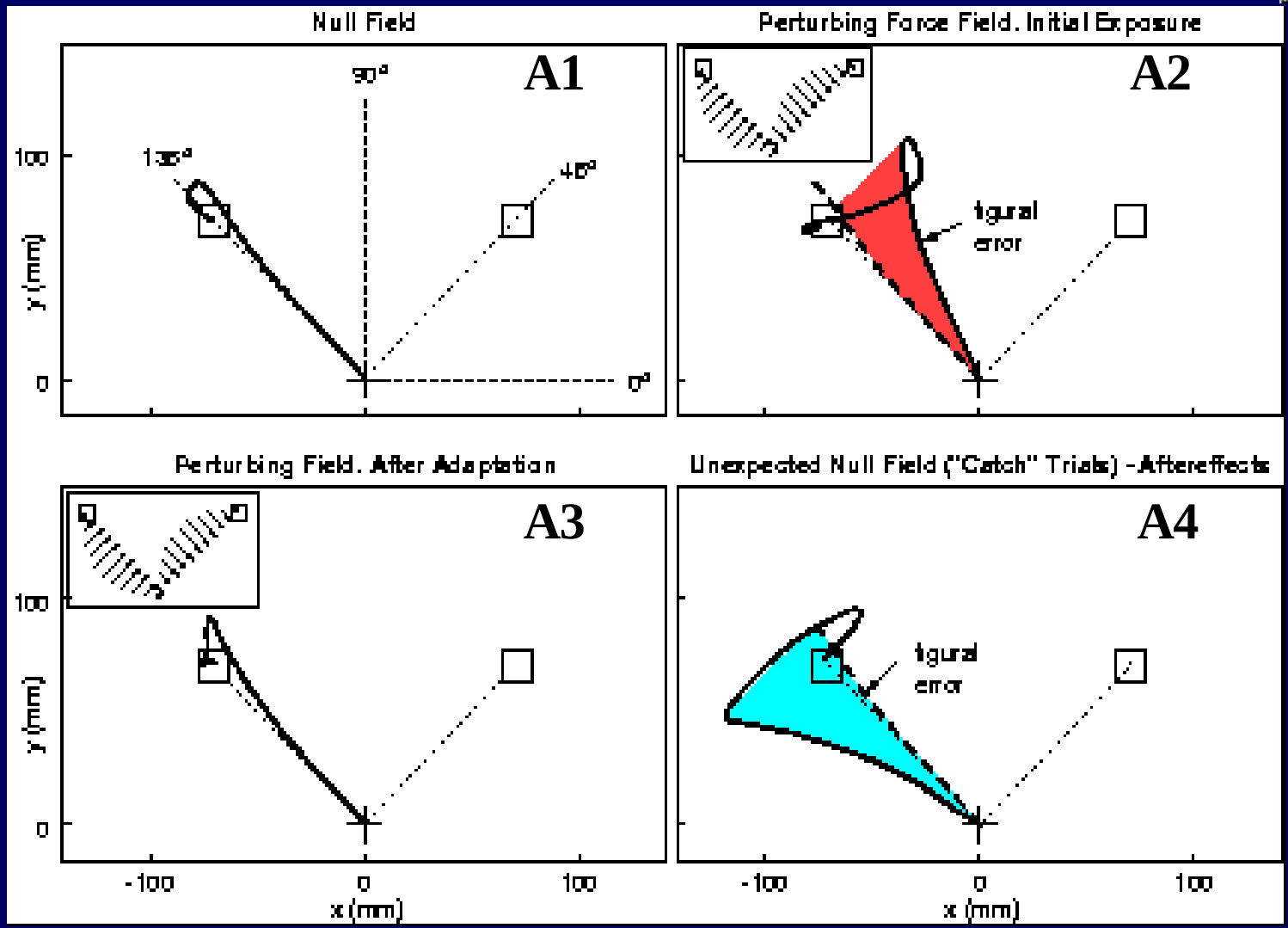
How should they be used ?

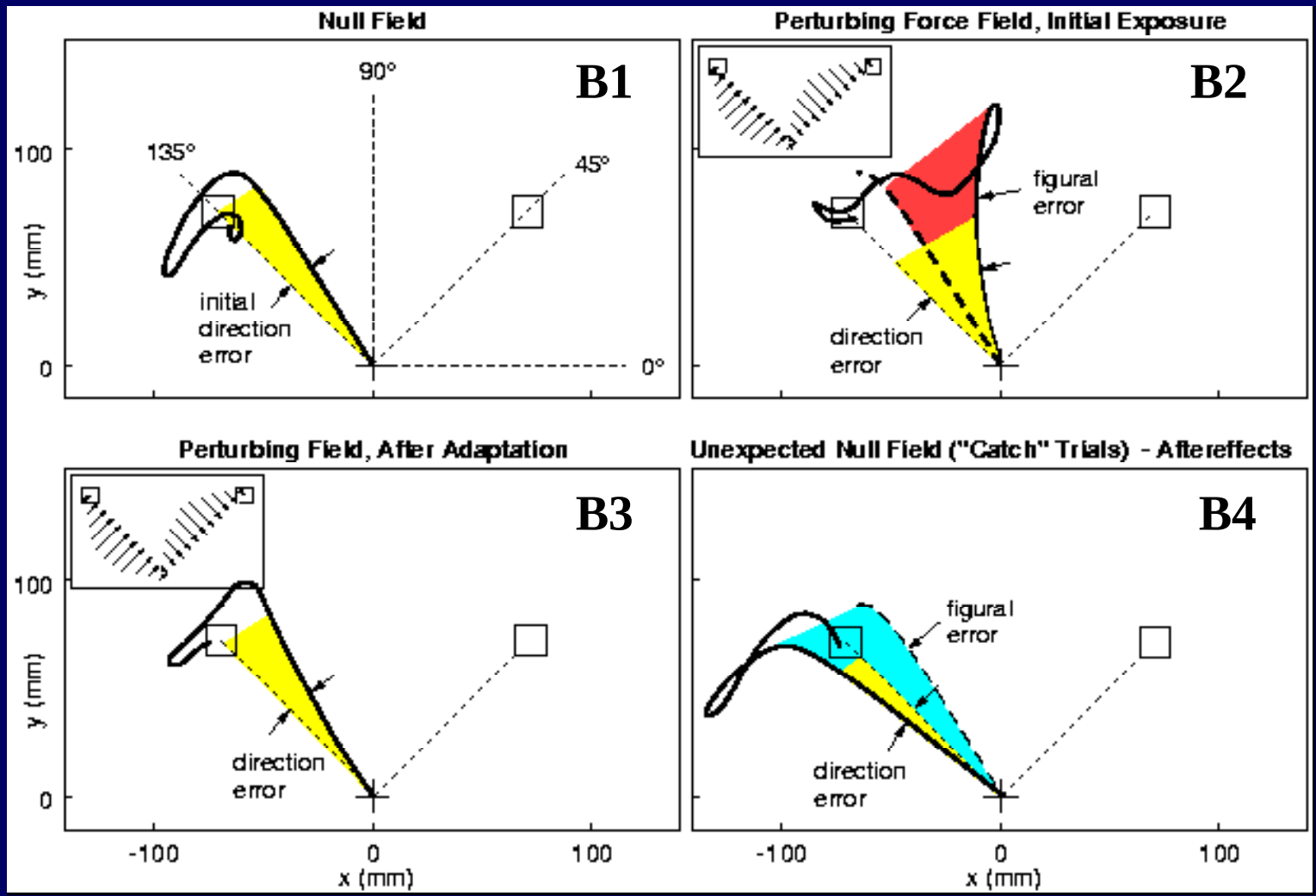
1. Maintain range of motion
2. Error reduction - trajectory training
3. Error magnification - force fields
4. Disrupt synergies by training differing joint torque patterns

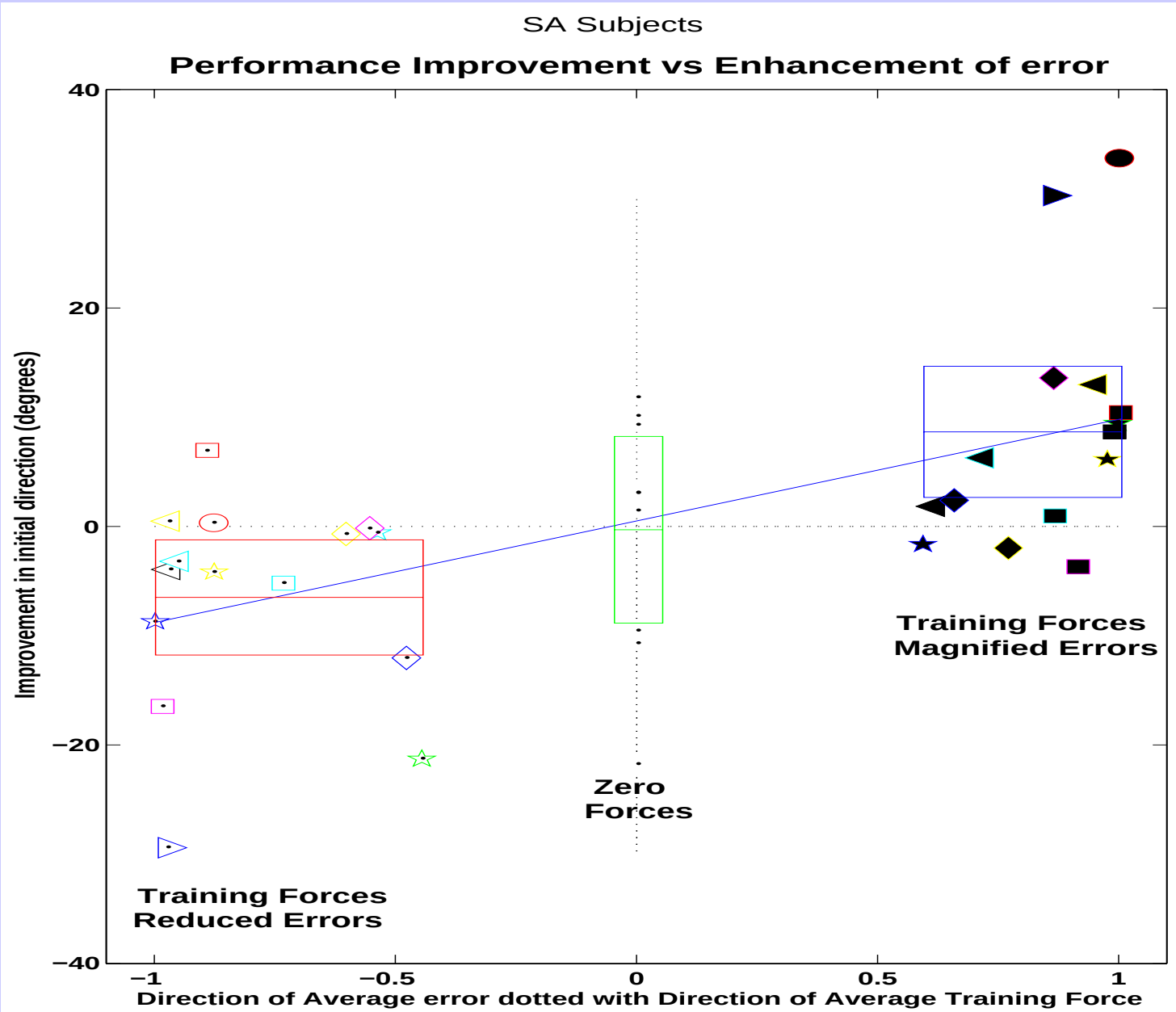



Reachable
Workspace
Boundary
10 cm
12.5 cm
x


a
b
c
5 cm


Null Field
A1
90°
135°
45°
0°
100
0
y (mm)
Perturbing Force Field. Initial Exposure
A2
tigural
error
Perturbing Field. After Adaptation
A3
100
0
y (mm)
-100
0
100
x (mm)
Unexpected Null Field ("Catch" Trials) -Aftereffects
A4
tigural
error
-100
0
100
x (mm)

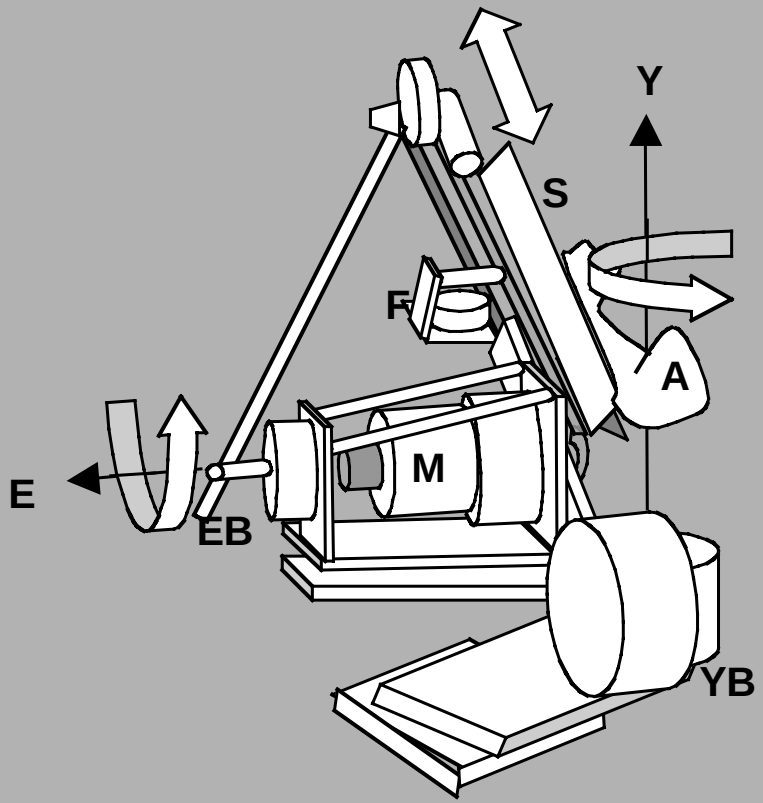

Null Field
B1
90°
135°
45°
0°
initial
direction
error
100
0
y (mm)
Perturbing Force Field, Initial Exposure
B2
figural
error
direction
error
Perturbing Field, After Adaptation
B3
direction
error
-100
0
100
x (mm)
Unexpected Null Field ("Catch" Trials) - Aftereffects
B4
figural
error
direction
error


SA Subjects
Performance Improvement vs Enhancement of error
Improvement in initial direction (degrees)
40
20
0
−20
−40
−1
−0.5
0
0.5
1
Direction of Average error dotted with Direction of Average Training Force
Training Forces
Reduced Errors
Zero
Forces
Training Forces
Magnified Errors

Robot Therapy for Force Training of the Upper Extremity in Chronic Hemiparetic Stroke:

Len Kahn, David Reinkensmeyer

Robotic Therapy for Force Training



WAM/Paris
A Robotic System for Upper extremity With An Augmented Reality Interface

Broad Project Aims

- Prolonged and intensive practice has a dramatic influence on recovery.
- To achieve significant practical applications in rehabilitation, human-interface robots must safely operate in three dimensions with a large workspace and an appropriately designed visual interface.

No current system has all of these features.

Augmented Reality Interface Cont.

- We need instrumentation that allows subjects to receive therapeutic forces while they view synthetic cues and feedback superimposed on the real world.
- A longitudinal study on chronic stroke survivors will test the system's ability to perform against conventional therapy.
- A panel of stroke survivors and clinicians will provide subjective and objective measures of the system's ability to restore function.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Home-Based, Telerehabilitation System for Improving Functional Hand and Arm Movement Recovery Following Stroke: Reinkensmeyer

The Lokomat:

Gait Restoration in Hemiparetic Stroke Patients using Goal-Directed Robot-Assisted Treadmill Training

Joe Hidler Catholic University
George Hornby Rehab Inst of Chicago

Gait Restoration in Hemiparetic Stroke

The specific aim of this study is:

To determine whether robot-assisted gait training with the Lokomat leads to higher functional returns in walking capability when compared to conventional rehabilitation.

Summary

Robotic rehabilitation is a promising approach that offers economic advantages, and can provide long-term intensive treatment.

We do not yet know how best to use these devices, and whether they will be accepted into the hospitals and clinics.