Mobile Robotics

Near Human Presence

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Introduction

Mobile Robotics

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Vision:

Near Human Presence (NHP) is SNL's effort of creating human-like robotic mobility, manipulation, and vision that is empowered by a cognitive architecture capable of controlling the system in new and dynamic environments through learning and applying previous experiences.

Targeted need:

- Robots that can physically interact in made for human environments.
- Robots that can operate at higher levels of autonomy.

R&D Directions:

- Physical Interaction leveraging Dynamic Balancing
- Brain Emulating Cognition and Control Architecture (BECCA)

Dynamic Balancing

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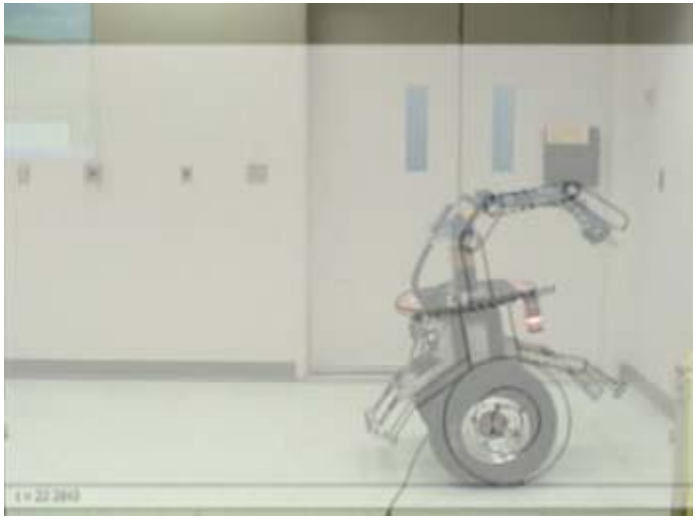
Platform: Segway RMP
Weight: 200 lbs
Height: 6 ft
Width: 2 ft
Arm: 6 DOF PowerCube
Speed: 8 mph
Turning: Zero Degree Radius
Range: 15 mile / charge
Climb: >10 degree
Comm: Wireless 802.11G



Physical Interaction

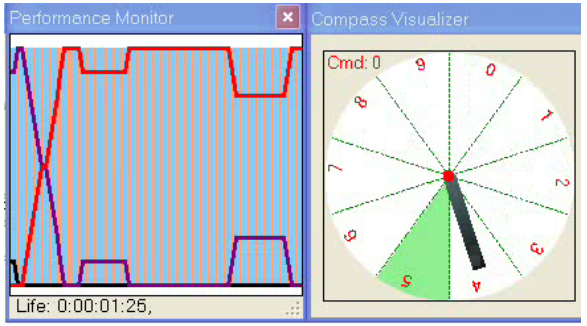
- Most Balancing Work R&D is
  - Mobility, Mapping, Sensing, etc.
- Avoiding Physical Interaction
  - Why? It is a difficult problem.
    - Stability under contact constraints
- What are they missing?
  - Take advantage of balancing platforms unique capabilities to address problems:
    - Opening a door, pushing/pulling object, picking up objects of significant mass, etc.

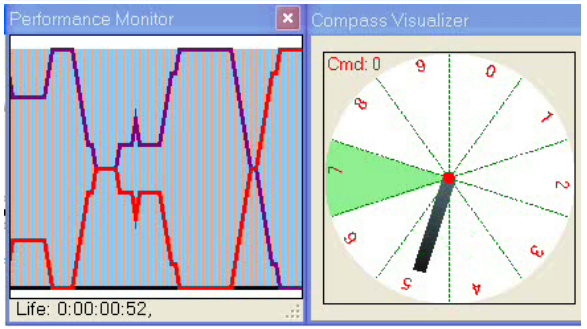
BECCA Overview

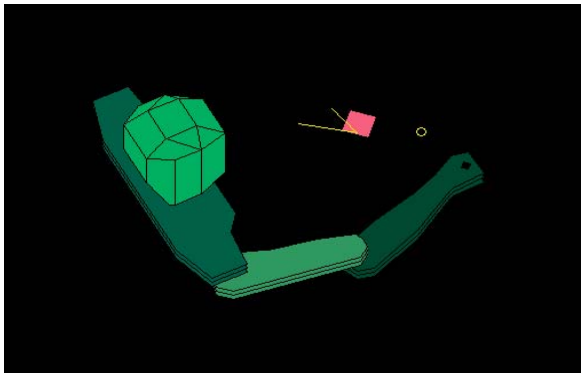
- **BECCA observes** Sequences of Discrete Events
  - As BECCA executes exploratory commands, the updating sensor states are passed to BECCA as discrete “Event Sequences”.
- **BECCA stores** Event Sequences in a Sequence Library
  - Observed event sequences of sensor states are stored in a “Sequence Library” to serve as an growing experience base of actions and their results.
- **BECCA searches** the Sequence Library to Achieve Goals
  - At intervals, BECCA searches through the Sequence Library looking for sequences that begin at (or near) the current state and end in the goal state.
  - When BECCA finds a Event Sequence, it is used as a plan to attempt to reach the goal state.
  - In this manner, previously observed Event Sequences become predictions of what outcome to expect given a course of action(s).

BECCA Learning

- Learning not Training
  - "Learning means better performance through experience."
  - BECCA bootstraps experience through-out it's life-time through experimentation and observation.
- Early Success
  - Compass "Toy Problem"
    - Green bins are goal locations
    - The purple line on the graph is experimentation percent of time
    - The red line on the graph is path planning effort
  - Human Arm Visual Servoing
    - The Red box is a goal location that the hand is trying to reach
    - Yellow lines are previous experiences being used as paths to reach the goal.
- BECCA Challenges?
  - Learning Time
  - Storage Space







Conclusion

Goal: Combine both Dynamic Balancing and BECCA to learn balancing manipulation tasks.

- **Leading R&D** in Dynamic Balancing Interaction Control
  - Taking advantage of balancing platform's strengths over statically stable robots to do Physical Interaction.
- **Leading R&D** in Artificial Intelligence (AI) Autonomy
  - Building on new AI learning techniques, by replacing:
    - Static: "Path Planning in Model state space"
    - Adaptive: "Path Planning in Experience state space"
- Our R&D will be reused in Applications requiring:
  - Robots capable of **Physical Interaction** in our challenging made for human environments.
  - Robots capable of **Higher Levels of Autonomy** through next generation Command and Control (C2) Architecture.

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