Robotics and the National Robotics Initiative

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Overview

• Self-introduction
• President’s vision
• National Robotics Initiative
• State of the art
• Three specific applications: nuclear, military bases, logistics

• ... and lots of cool videos
My Own Background

• Carnegie Mellon Robotics Institute, 1979 – present: PhD student, post-doc, faculty, Director 2000 - 2004
... and a few robots
State of the Art

- Over 6 million robots in use.
- Over 5 million:
- Around 10,000:
1,000,000 Assembly Robots
Robot safety, 1961 - 2011
Robots vs Humans

- Robots
  - Fast
  - Precise
  - Tireless
  - Huge memory
  - Disposable

- Humans
  - Reasoning
  - Perception
  - Adaptable

So why is there a fence between them?
A Roadmap for US Robotics
From Internet to Robotics

Organized by:

Georgia Institute of Technology
University of Southern California
Johns Hopkins University
University of Pennsylvania
University of California, Berkeley
Rensselaer Polytechnic Institute
University of Massachusetts, Amherst
University of Utah
Carnegie Mellon University
Tech Collaborative

Sponsored by:

[Logos for CCC and CRA]
POTUS and Robots
Presidential Priorities for Robots
The President’s Mission

• “You might not know this, but one of my responsibilities as Commander-in-Chief is to keep an eye on robots. (Laughter.) And I’m pleased to report that the robots you manufacture here seem peaceful -- (laughter) - - at least for now.”
Robotics Vision: Machines Who Think

- Building smart machines
  - “Disappearing robots”
  - “Co-workers of the future”
- Building embodied intelligence
  - “Where AI meets the real world”
  - “Why computer science matters”
- Building smart people
  - STEM education
  - K – PhD
- Building smart industry
  - Making the robot revolution happen in the US
  - Moving technology out of the labs and into society
National Robotics Initiative (NRI)

The realization of co-robots acting in direct support of individuals and groups

- manufacturing; exploration; discovery; agriculture; security; .....
The NRI

- Multi-agency SBIR
- DURIP
- Prizes and Competitions
  - RoboBowl, AFRL, ...
- New applications
- Multi-agency RFP: Co-Robots
  - 680 LOIs for small projects / 445 proposals
  - 67 LOIs for large projects / 261 proposals
A visual visit to Mars

A Mars exploration rover is indicated by an arrow next to the Santa Maria crater on Mars. Information gathered at the crater indicates hydrated sulfate.
NRI Research Areas

Fundamental research in robotics science and technology
Controls and dynamical systems
Computational models of human cognition
Application-inspired topics
Platform specific topics
  micro- and nano-robotics,
  neuro-robotics,
  humanoid robotics, and
  networked multi-robot team
Understanding of the long term social, behavioral and economic implications of co-robots across all areas of human activity
Use of co-robots for STEM learning K-16
NRI: The Application Space

Co-Defender
- Security
- Monitoring Inspection
- Intelligent Transportation
- Unmanned Vehicles

Co-Inhabitant
- Services
- Logistics
- Manufacture & Automation Macro
- Manufacture & Automation Micro/Nano

Co-Explorer
- Robust Intelligent Robot
- HR Interface
- Medical Surgery
- Rehab Orthotics Prosthetics

Co-Worker
- Intelligent Transportation
- Unmanned Vehicles
- NRI: The Application Space
Co-Robots: Task Cooperation
Co-robots: Safety through Control

Three Laws of Robotics

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.

2. A robot must obey orders given it by human beings except where such orders would conflict with the First Law.

3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

Isaac Asimov - The Caves Of Steel, p. 177-179, 1942
Co-Robots: Go where people can’t
Co-robots: carry the load
The Evolution of Dogs
Robot Learning

![Graph showing the number of goals per 500 test shots vs. the number of training examples (log scale).]
Tangent: Robots and Proteins
Co-robots: Robot-Ready House; House-Ready Robot
... and Really Really cute design: RoboBowl

- 5-part competition
- Business plans
- Round 1, Health Care Robotics
- Winner: Interbots
## How International is Robotics?

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Ultimate in Human-Friendly Robots
Application 1: Nuclear Disasters
Quince
Qinetiq Bobcat
French and German Rad-Nuke Robots

INTRA: Group of Robotics INTervention on Accidents (INTRA)
Robots for Nuclear Disaster Response

• Who’s in charge?
• Who has the capability?

  • DNDO
  • NNSA
  • NE
  • FEMA
  • DOJ / FBI
  • AMCOM
  • DTRA
  • iRobot
  • Qinetiq
  • Sandia
  • INL
  • SPAWAR
Nuclear Response Robots

• Rad-harden some camera sleds
• Generate roadmap for disaster response
  – Mobility
  – Communications
  – Manipulation
  – User interfaces
  – Air, land, underwater
  – Commonality across CBRN, IED, civil platforms and interfaces
• Solve the robotics problem
Robots on Military Bases

- Let’s get robots running on military bases
- LtG Lynch
- What can robots do today?
Carry Stuff
... Lots of stuff
Operate your warehouse – Kiva version
Seegrid Version
Collect your garbage
DustCart Robot in Peccioli
Our robots get to work once your students and educators go home for the day.

**Education**

Prevent cost savings and consistent cleaning that meet the demands of cleaning schools and universities. Educational environment operating software

The robots' long-range sensors offer a perfect solution for cleaning gymnasiums and cafeterias. Reporting and accountability allow school districts and educational facilities to maintain the highest sanitation standards.

The IntelBot takes care of your floor cleaning needs every night, freeing up your labor staff to concentrate on high-maintenance zones like restrooms and cafeterias.

Our current clients include:
- Mesa Public Schools, Mesa, AZ
- Upper Merion School District, Upper Merion, PA
- Westmoreland County School District, Lamont, PA
- United States Military Academy, Westpoint, NY
- University of California, Long Beach, CA
- Osceola County School District, Orlando, FL

SEND ME MORE INFO
Patrol your perimeter
... affordably

Darpa Urban Challenge
Lead Software Developer for Finalist Team VictorTango
Transitioning autonomous vehicle technologies.

Read More
Application 3

• Robotics and logistics
  – Lots already happening
  – Lots left to do
  – <your ideas go here>
Research Areas

- Touch sensors
- Advanced power sources
- Soft actuation
- Safety skins
- Object recognition
- Intention inference
- Multi-robot cooperation

- Multi-level human interfaces
- Advanced architectures
- House of the future
- Internet interfaces for robotics
- Underwater, surface, air, space, ...
So where are we?

• Lots of open problems:
  – Object recognition
  – Human intention inference
  – Mobility and power and comms and ....

• Lots of successes:
  – Ready for deployment

• The Robot Revolution is underway

• ... and they’re peaceful: Co-robots