February 2, 2012

ENGR110/210
Perspectives in Assistive Technology

David L. Jaffe, MS

Professor Drew Nelson

John Thiemer

Questions?

Projects

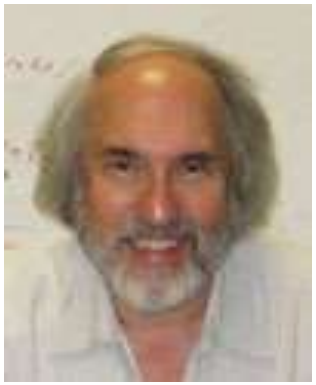
- Cautions
  - How much to bite off?
  - Project goal
  - Moving the process forward
- Think about
  - Mid-term presentation and report (in 2 weeks)
  - Continue to send updates, including photos

Tuesday

Peter W. Axelson, MSME, ATP, RET

Designing Beyond the Norm to Meet the Needs of All People

Today



Allison M. Okamura, PhD and
David L. Jaffe, MS

Rehabilitation Robotics

Assistive Robotics

Dave Jaffe

Agenda

- What is a robot?
- What is an assistive robot?
- What is a medical therapy robot?
- Early assistive robots
- Assistive robots at VA
- Other assistive robots
- Robots in the news
- Summary

- Short break

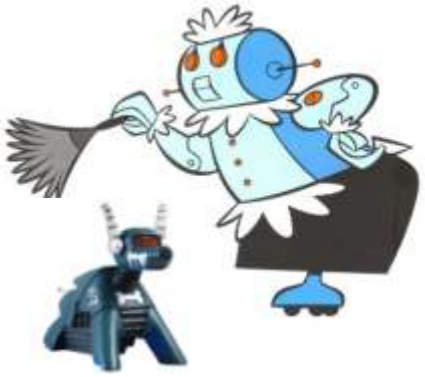
- Movement Therapy Robots – Prof Allison M. Okamura

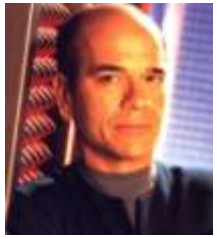
- Final questions

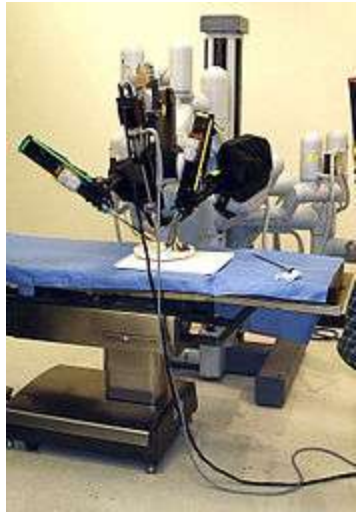
What is a robot?

What image comes to mind when you think of a robot?

Some images of robots







klaatu barada nikto

What defines a robot?

Which of these are required characteristics of a robot?

1. Ability to move – legs, wheels, fly, burrow, swim, orbit
2. Ability to sense – eyes, ears, other inputs
3. Ability to manipulate – arms, hands, fingers
4. Ability to mimic – appearance, human tasks
5. Ability to communicate – expressions, sounds, voice, digital, analog
6. Ability to think – brain, mechanical mechanism, computer, self-awareness
7. Ability to operate – remotely, program control, autonomously
8. Ability to react and respond to different situations
9. Ability to do something useful

Can a software program be considered a robot?
Is Siri a robot?

What defines a robot?

Definition from Wikipedia:

A **robot** is a mechanical or virtual intelligent agent that can perform tasks automatically or with guidance, typically by remote control. In practice a robot is usually an electro-mechanical machine that is guided by computer and electronic programming. Robots can be autonomous, semi-autonomous, or remotely controlled. Robots range from humanoids such as ASIMO and TOPIO to nano robots, swarm robots, industrial robots, military robots, mobile, and servicing robots. By mimicking a lifelike appearance or automating movements, a robot may convey a sense that it has intent or agency of its own.

What is assistive robotics?

VDL's definition: An assistive robot performs a physical task for the well-being of a person with a disability. The task is embedded in the context of normal human activities of daily living (ADLs) and would otherwise have to be performed by an attendant. The person with the disability controls the functioning of the robot. (2005)

Dave's definition: An assistive robot is a device that can sense, process sensory information, and perform actions that benefit people with disabilities and seniors.

What is a movement therapy robot?

Dave's definition: A movement therapy robot is one that is specifically designed to provide a diagnostic (measurement and assessment) or therapeutic (improvement of function) benefit.

Kinds of assistive robotics

Fixed-base robots

Workstation

- vocational, ADL

Bedside

- food, medicine, health

Mobile robots

Autonomous

- fetch & carry
- mobility support

Wheelchair

- autonomous navigation
- manipulator arm

Users of assistive robotics

	Prevalence	Potential users
Spinal cord injury:	90,000	90,000
Cerebral palsy:	500,000	50,000
Rheumatoid arthritis:	2,100,000	20,000
Other:		
Frail elderly		
ALS, MD, MS, stroke, temporary impairment, amputees, etc.		

[Stanger CA (1996) Cawley MF, Demographics of rehabilitation robotics users. *Technology and Disability* 5, pp. 125-137.]

Early assistive robots

Rancho Golden Arm

Early assistive robots

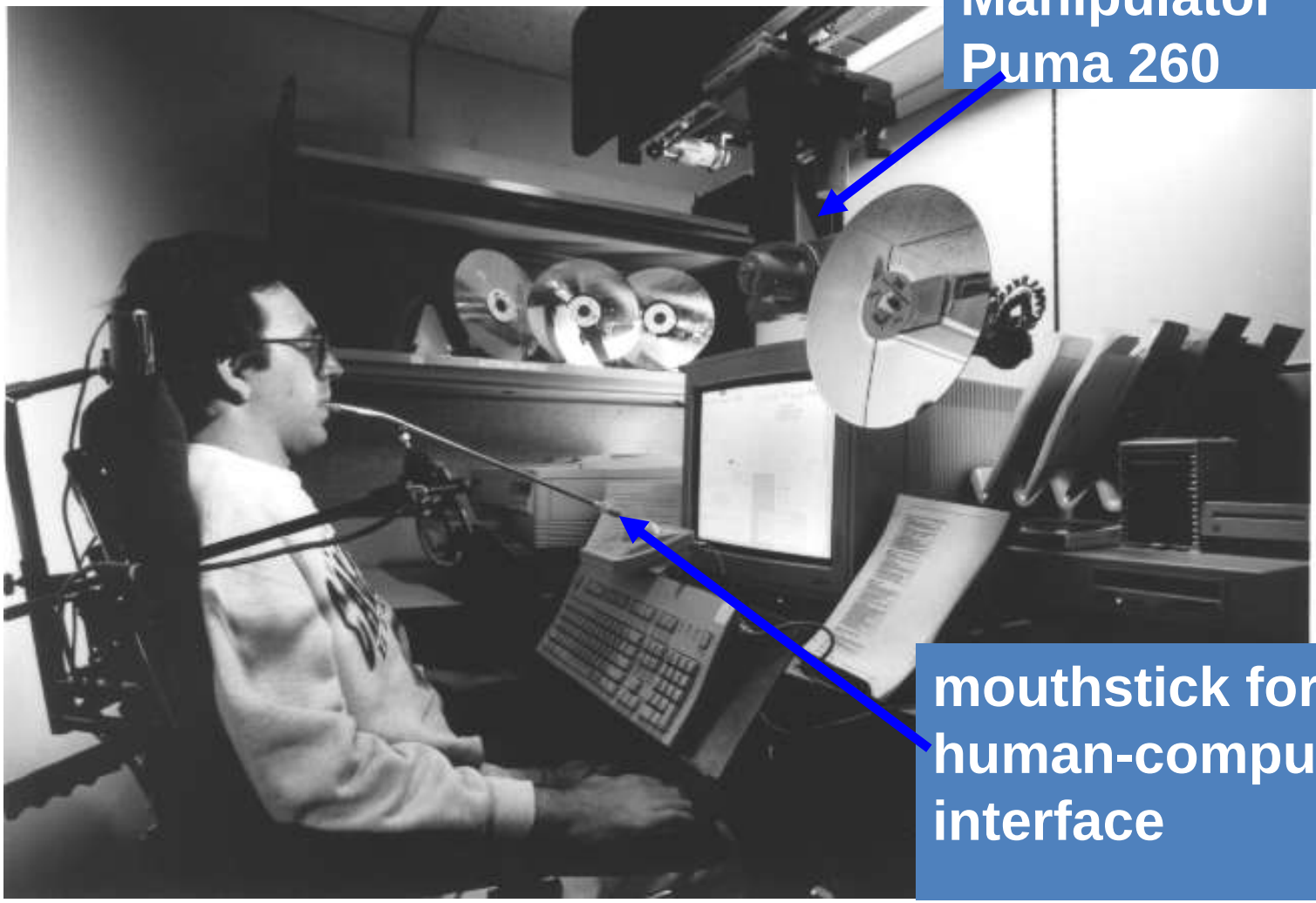
JHU / APL Robotic Workstation

Assistive robotics at VA

VA / Stanford MoVar

DeVAR & ProVAR

Desktop Vocational Assistant Robot



DeVAR & ProVAR

Desktop Vocational Assistant Robot

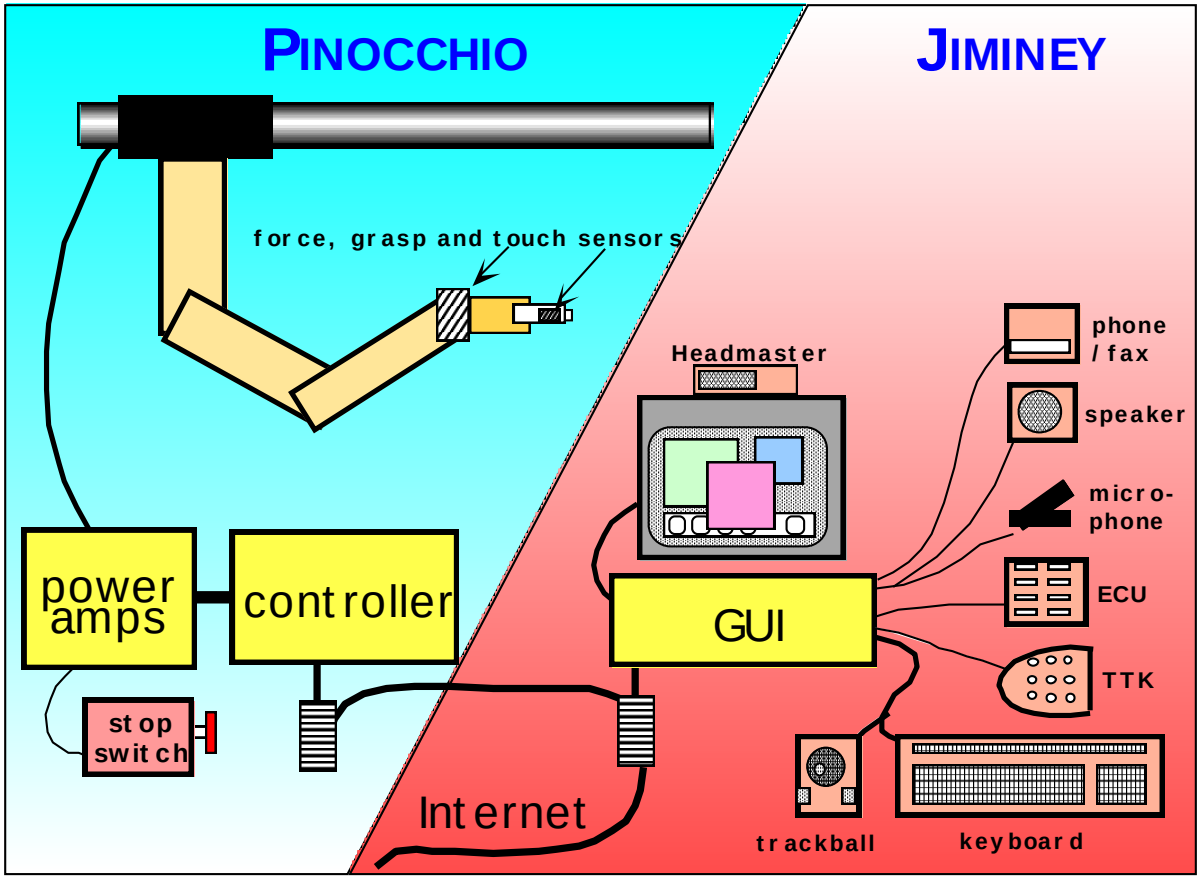
DeVAR & ProVAR

Desktop Vocational Assistant Robot

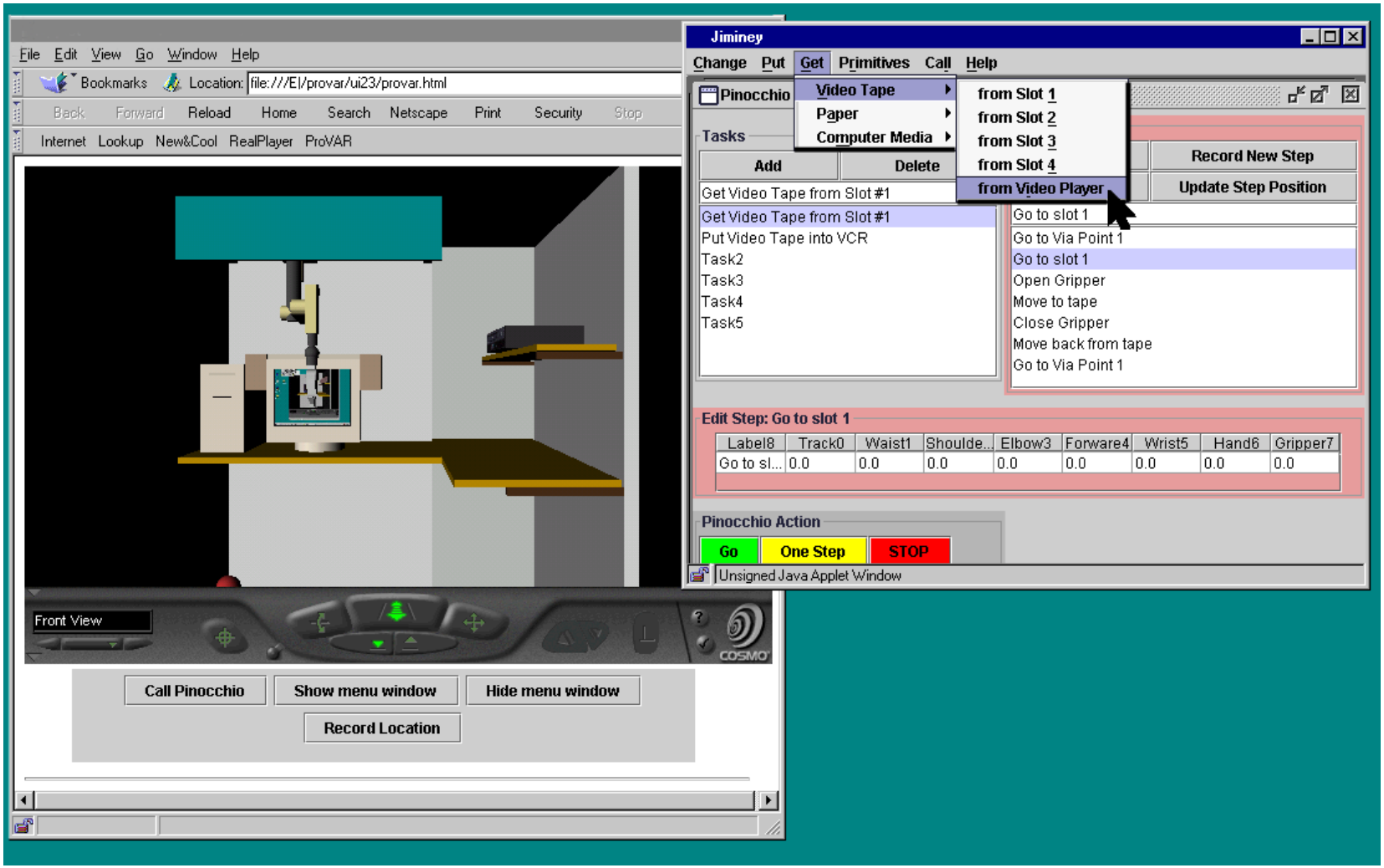
Dual-Character Interface

Joe Wagner, PhD candidate

- Pinocchio: simple-minded robot arm
- Jiminey: helpful consultant / coach



ProVAR Interface



Other assistive robotics

Handy-1

- CP users
- Single-switch input
- Modules for:
  - Feeding
  - Cosmetics
  - Face-hygiene

Link

MANUS Wheelchair Robot

- 5-dof, belt-drives
- Grounded actuators
- Keypad / display input

Link

Raptor Wheelchair Robot

- 4-dof
- Motors in links
- No encoders
- Joystick control
- Over-torque clutches
- Commercialized 2001
- Applied Resources, Corp.

Weston Wheelchair Arm

- R&D at University of Bath, UK
- Inexpensive arm
- Also designed a workstation version

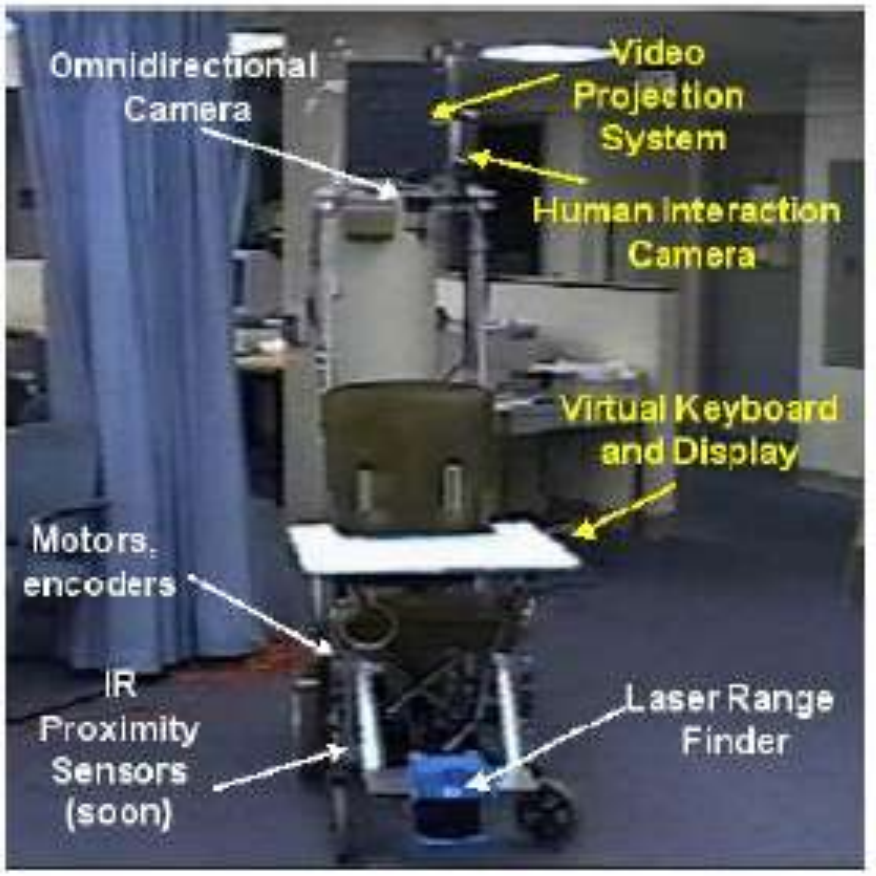
Link

Hephaestus Navigation

- Builds on NavChair, University of Minnesota
- Ultrasonic, IR, and tactile sensors
- Add-on kit for any wheelchair

Link

SmartChair Navigation



Link

Wheelesley

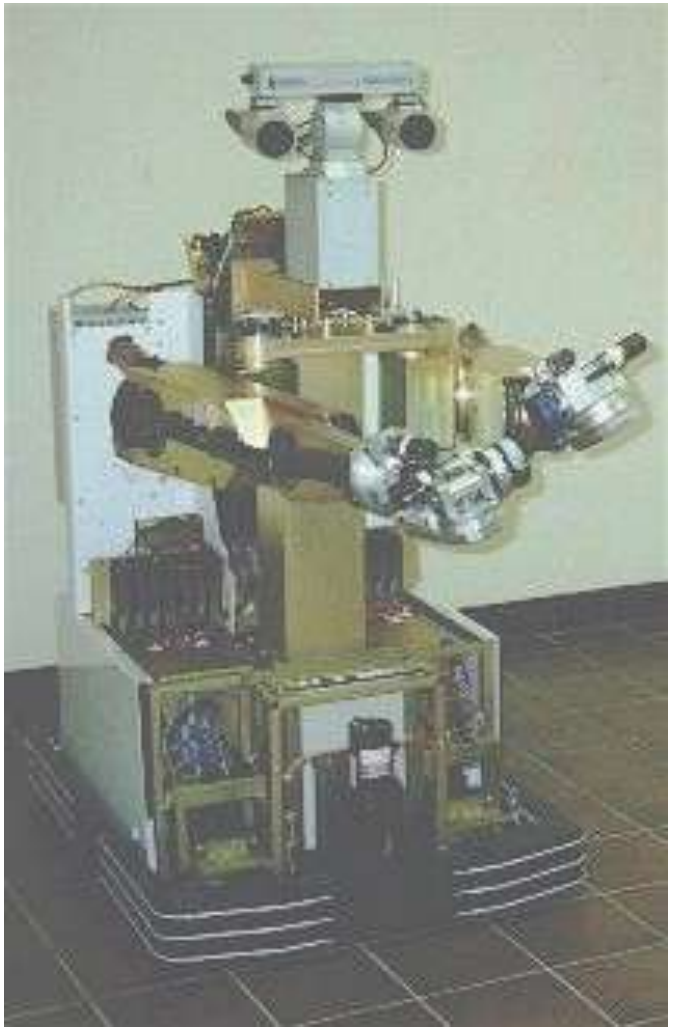
- Eye-tracking (EOG) interface
- Single-switch scanning input
- Vision system navigation
- 12 infrared sensors
- 4 ultrasonic range sensors
- 2 shaft encoders
- Instrumented front bumper

Link

Helpmate - Isaac

Link

- Based on R&D platform “Labmate”
- Voice controlled
- Walking assist for elderly
- Fetch & carry robot in the home



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Walking Assist Robot

- Guido (PamAid)
- Wheels, not motorized
- Steering motorized
- Range sensors in front

Link

Robots in the news

PR2 Can Now Fetch You a Sandwich from Subway

Link

Willow Garage's PR2 robot can fold clothes, set a table, and bake cookies.

Link

eLEGS: Wearable, Artificially Intelligent, Bionic Device

Link

Exoskeleton Technology Helps Paraplegic Student Walk Again

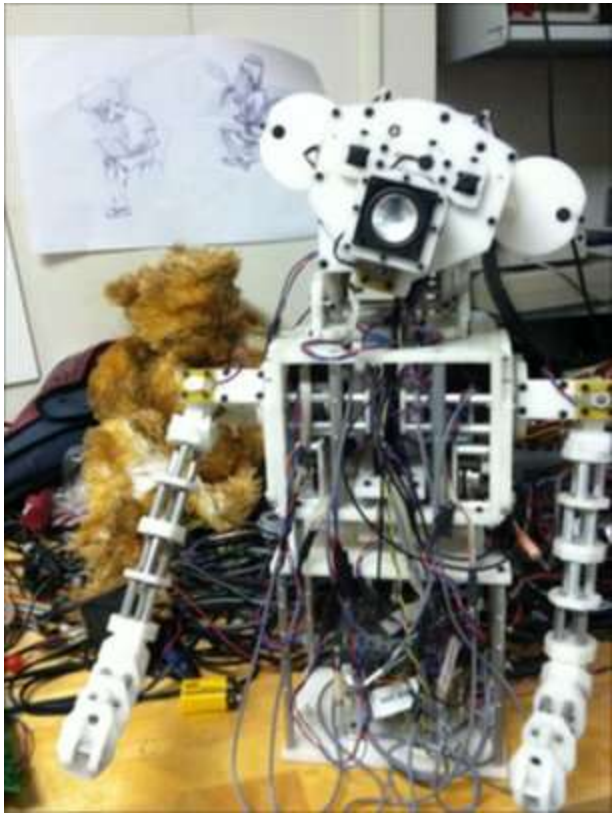
Link

Robosoldier

Link

Glove that Vibrates Fingertip Could Improve One's Sense of Touch

Link



Ready for the robot revolution?

Link

Ready for the robot revolution?

Link

Panasonic's Hospi-Rimo robot tends to patients

Link

Hair-washing robot leaves your locks silky-smooth

Link

Bed Mode

Shown with the back rest up

The wheelchair separated from the bed

Panasonic's Robotic Bed transforms into wheelchair

Link

Development of a Powered Transfemoral Prosthesis

Link

The Revolution Will Be Prosthetized - DARPA

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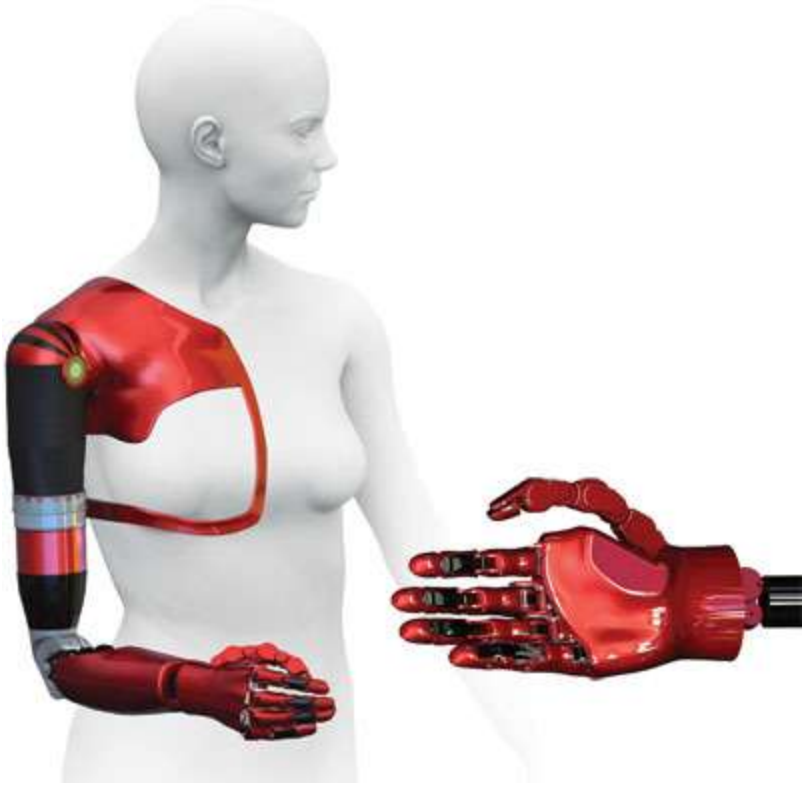

The Revolution Will Be Prosthetized – JHU/APL

Link

Giant teddy bear robot can pick you off the floor

Link

Babyloid: Therapeutic Baby Robot for the Elderly

Link

Robot Helps Quadriplegic Scratch an Itch for the First Time in a Decade

Link

Humanoid Robots: STEM Vehicles Today, Classroom Assistants Tomorrow

Link

Economics of assistive robotics

A $50,000 assistive robot can be amortized over three years if it replaces attendant care at $6 per hour and is used for two 4-hour shifts per day. (2005)

[Hammel J and Symons J (1993) Evaluating reasonable accommodation in the workplace: A team approach. *Work*, 3(4): pp. 12-20.]

The running costs of installation, training, customization, maintenance, and repair will be the dominant factor in determining overall cost, **not the cost of the manipulator** itself.

Robotics Research Issues

- Importance of Multi-Disciplinary Approach
  - Engineering design with only able-bodied subjects can lead to unexpected results and a system not appropriate to the intended user population of persons with a disability.
  - Early integration with medical/rehab team shortens development time.

Robotics Research Issues

- Bring all professionals in at the beginning (actually, before the beginning) to instill sense of ownership
  - PIs from Medical and Engineering domains
  - Therapists as part of staffing of Center
  - Ergonomics experts on-call
  - People with disabilities as an integral part of project
- Ownership = championing of idea
- Conference presentations
- Publication in both clinical & engineering journals

Future of Robots in Health Care

- Economics of care
  - Insistence on ‘best possible care’
  - Consumer-centric healthcare
  - Rehab being pushed into the home setting earlier
- Demographics of disability
  - Aging society
  - Lack of caregivers
  - Better medical care means longer lives and more improvement in function

Future of Robots in Health Care

- Reduction in cost due to mainstreaming of robot technology
- Integration of advanced sensing, actuation, and embedded computer technology in household appliances

Summary

- Robots come in many forms
- Robots can be used in many ways to help people with disabilities
- Lots of research being done, resulting in prototypes
- Few assistive robots in common use today
- High cost and uncertain benefit are major barriers to their widespread adoption

Short Break