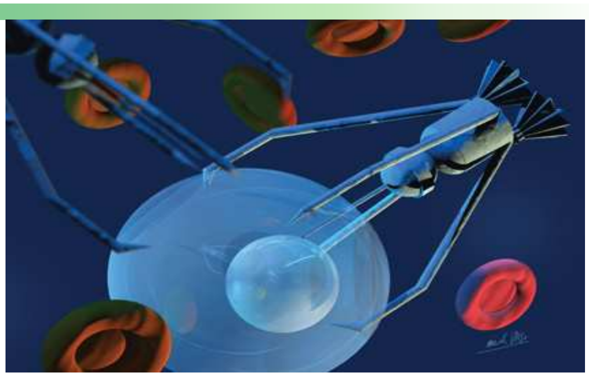
ECGR4161/5196 – Lecture 11 – July 19, 2012

Today:

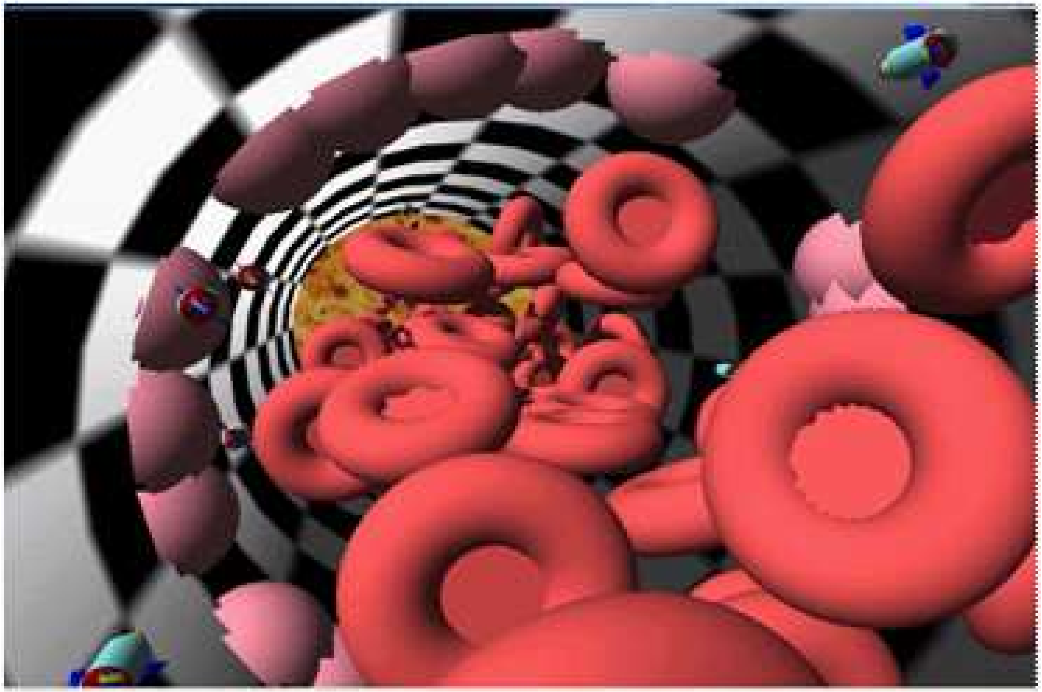
- Discussion - Exam
- Presentations – Future of Robots (recorded in two sessions, with a break in the middle).
- Quiz 9

Future of Medical NanoRobotics

- Possible Uses:
  - Drug Delivery [1]
  - Neural Scans
  - Diagnosis
  - Therapeutic: anti-cancer, anti-viral, and anti-tumor [3]
  - Dentistry
- Implementation:
  - Swarms
  - Injected into System
- Current Limitations:
  - Communication
  - Safe Test Environment



Rendering of Nanobots [1]



Simulation of Nanobots in Blood Vessel [2]

[1] http://www.nanotech-now.com/Art_Gallery/erik-viktor.htm
[2] http://omicsgroup.org/journals/ARA/ARA-1-101.pdf
[3]http://www.futuremedicine.com/doi/full/10.2217/nnm.12.54

AUR Robotic Desk Lamp

- Designed to demonstrate human-robot interaction and nonverbal behavior
- Aimed to evoke a personal relationship with human
- Originally thought up as a research project to study fluency

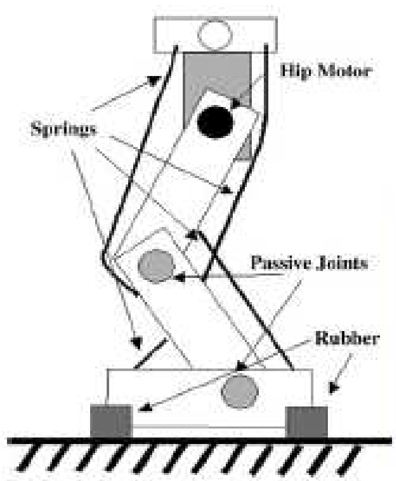
- Tries to simulate the relationship between two humans who are familiar with one another performing a task together
- The robot learns through repetitive practice and learns to "anticipate"

Video: http://www.youtube.com/watch?v=KvyLWvs4DPI&feature=player_embedded

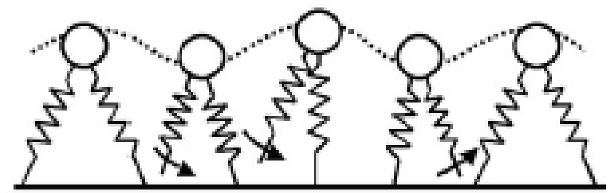
http://robotic.media.mit.edu/projects/robots/aur/overview/overview.html

http://www.sciencephoto.com/image/344517/530wm/T2500545-AUR_robot_desk_lamp,_MIT,_USA-SPL.jpg

Robotics and Autonomous Systems



- While a rigid body stucture is assumed, elastic materials are also essential.
- To understand how to make a human like, robotic leg, examine a human walking.
- Comparable models:
  - Spring-mass



- There's a few major parts to make simple leg motions; four 'muscles,' a motor, passive joints, and rubber.
- Using this knowledge, a test robotic system can be created to analyze.
- Comparing observations of a human leg vs robotic test leg, one can see similarities.
- While this method ignores certain aspects of walking, it shows dynamic behavior well.

Advances in Telesurgery

What is Telesurgery?

-A technique which allows surgeons to robotically operate on a patient while being at a considerable distance from the operating table.

-First successful Telesurgery was a laparoscopic surgery on a woman in France. The surgeon was in New York City thousands of miles away!

How does it work?

-Multiple robotic arms with very accurate and precise sensors are used to interact with the patient. Many cameras at different angles are used.

-All of the information is sent through the internet to the surgeon who then can monitor and control the robotic arms with great precision.

-Today the two most commonly used robots for Telesurgery are the ZEUS and da Vinci.

What is the future of Telesurgery?

-Less delay when transferring data from the operating table to the surgeon. (faster internet speeds)

-More degrees of freedom in the robotic arms to allow for more flexibility.

-Better monitoring systems such as 3D vision and more camera angles.

What are future uses for Telesurgery?

-Surgeries for injured solders on the battlefield

-Surgeon specification in rare operations

http://www.heart-valve-surgery.com/heart-surgery-blog/2010/05/13/robotic-valve-repair-heart-lung-machine-time/

Automated/Self Guided Vehicles (ASG/AGV)

Types of Vehicles - Deck Truck, Fork Lift, Tow Train

- Deck Truck - 4 wheels for greater stability and payload
- Fork Lift/Tow Train - 3 wheels better turn radius

Applications- Container Yards, Assembly Lines, Factories

Energy - Battery Operated, ASG CPU will notify low battery (or when not in use) and send ASG to charging station

Guidance -

- Fixed: Floor wire, Magnetic tape, Reflective tape
- Open: Laser, Inertia (greater path flexibility)
- Semi-Fixed (Magnetic): Magnets embedded in path

Sensors - Encoder; tracks vehicle position using odometry or dead reckoning

Future Advancements – Complete autonomy, longer battery life/solar powered, carry larger payload, more time efficient, more advanced control algorithms

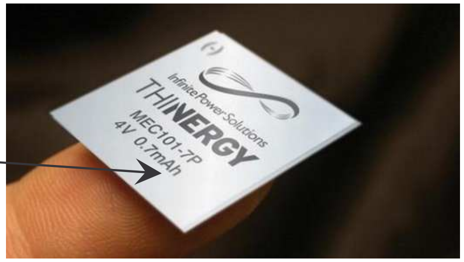
Figure 1: Deck Truck [1]

Figure 2: Tow Train: [1]

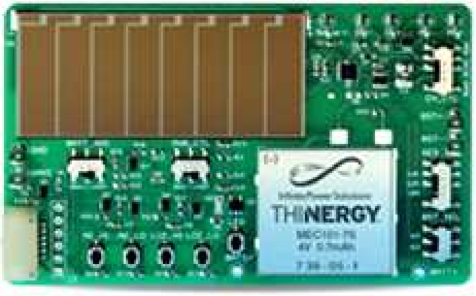
Works Cited:
[1] google images
http://www.journalamme.org/papers_vol31_2/31241.pdf
http://www.werc.org/assets/1/workflow_staging/Publications/430.PDF

THINERGY MEC™

- M.E.C is an acronym for **M**icro-**E**nergy **C**ell
- IPS has developed a thin-film solid-state rechargeable battery that is going to revolutionize the embedded device world!
- What makes these thin-film batteries unique is the acceptance of charge! They can take any amount of current (pulsed or solid)



[1]



[2]

Can be charged with ambient energy sources such as:

- Radio Frequency (RF)
- Kinetic (Vibration)
- Thermal
- Magnetic, Solar…. Etc….

[4]

Q: So what makes THINERGY work so efficiently?

A: The Electrolyte material: Lithium Phosphorus Oxynitride (LiPON)

Imagine a world with no chargers required!

- Advancements in battery technology can always be seen by observing the end user product

THINERGY makes it THIN!!

References:
[1] (2009). *Eco Tech: THINERGY flexible batteries for even slimmer electronics*(2009). [Web Photo]. Retrieved from http://www.ecofriend.com/entry/eco-tech-thinergy-flexible-batteries-for-even-slimmer-electronics/
[2] (2012). *Alpha Micro – Universal energy-harvesting evaluation kit expands wireless portfolio (Alpha Micro - THINERGY MEC201)* (2012). [Web Photo]. Retrieved from http://www.electropages.com/2012/02/alpha-micro-universal-energy-harvesting-evaluation-kit-expands-wireless-portfolio/
[3] (2012). *IPS (Infinite Power Solutions LOGO)*(2012). [Web Photo]. Retrieved from http://www.infinitepowersolutions.com/
[4] (2011). *Action Tracker for April 2011*(2011). [Web Photo]. Retrieved from http://www.engineeringtv.com/latest/2011/4?activity=4&page_key=activity

Neurosurgery For The Future

Current Neuro-robots:

- Assist the surgeon
- Extent or enhance human skills

System Types:

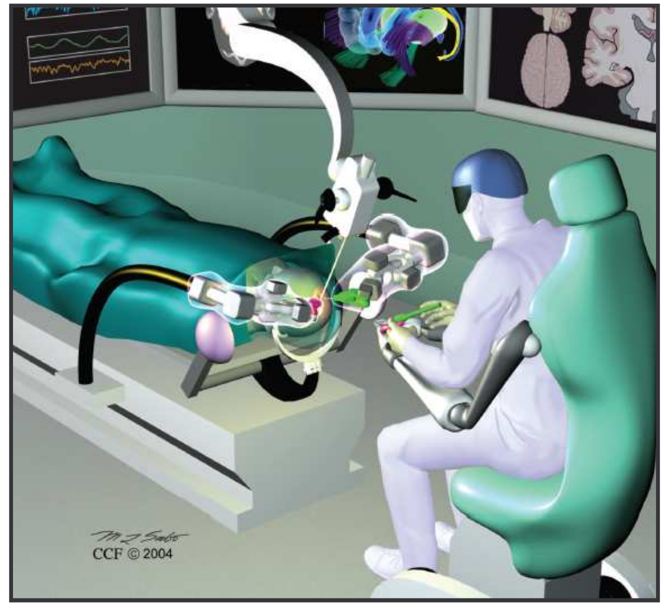
- Supervisory controlled
- Tele-surgical
- Share-control

Future:

- Artificial intelligence
  - Allowed robots to think (make decisions)
  - Program themselves
- More independent and self-reliant

Challenge:

- Convincing surgeons and patients that Neuro-robots are safe



www.neurosurgery-online.com

In touch with robotics: Neurosurgery for the future.

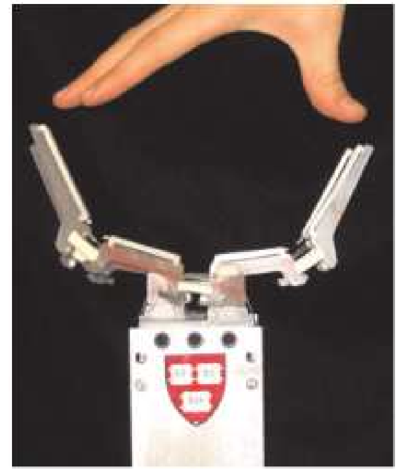
Volume 56: pages 421-433

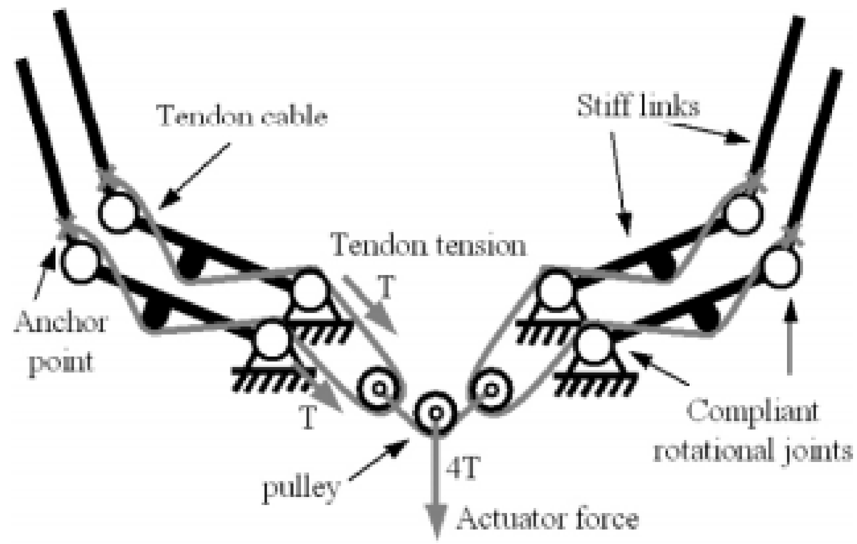
SDM Grasping Hand

- Shape Deposition Manufacturing
- Each finger is one molded piece and is flexible
- Uses 1 actuator
- Simple design
- Embedded force sensor and tendon cable

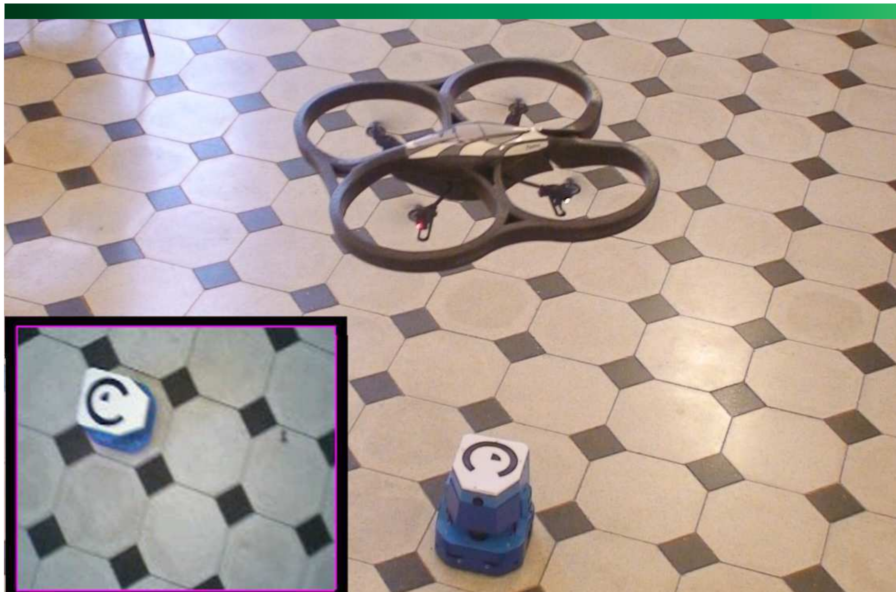
Video:
http://www.youtube.com/watch?v=_4ChbQNVbD4&feature=relmfu

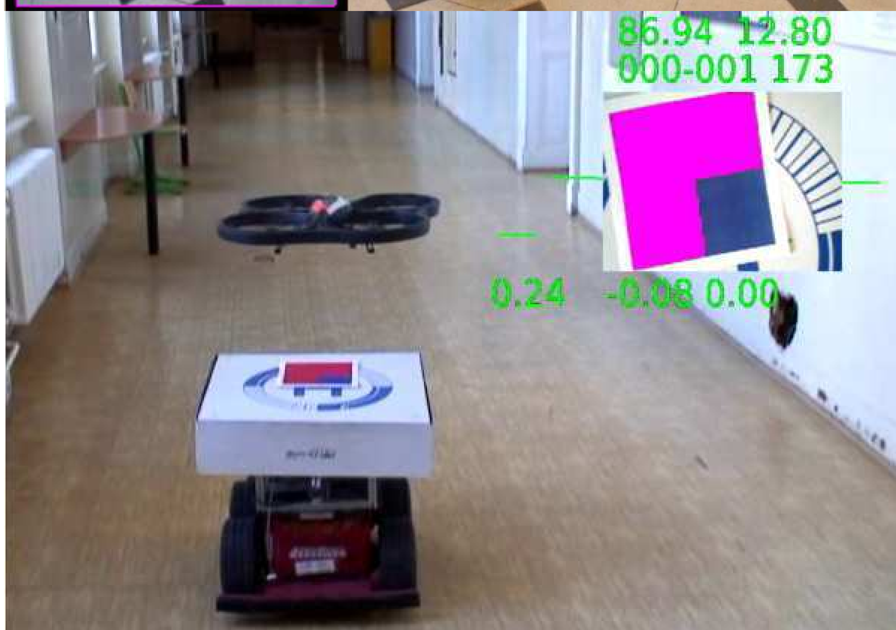
Source:http://biorobotics.harvard.edu/publications.html#tech_report





AR-Drone as a Platform for Robotic Research and Education



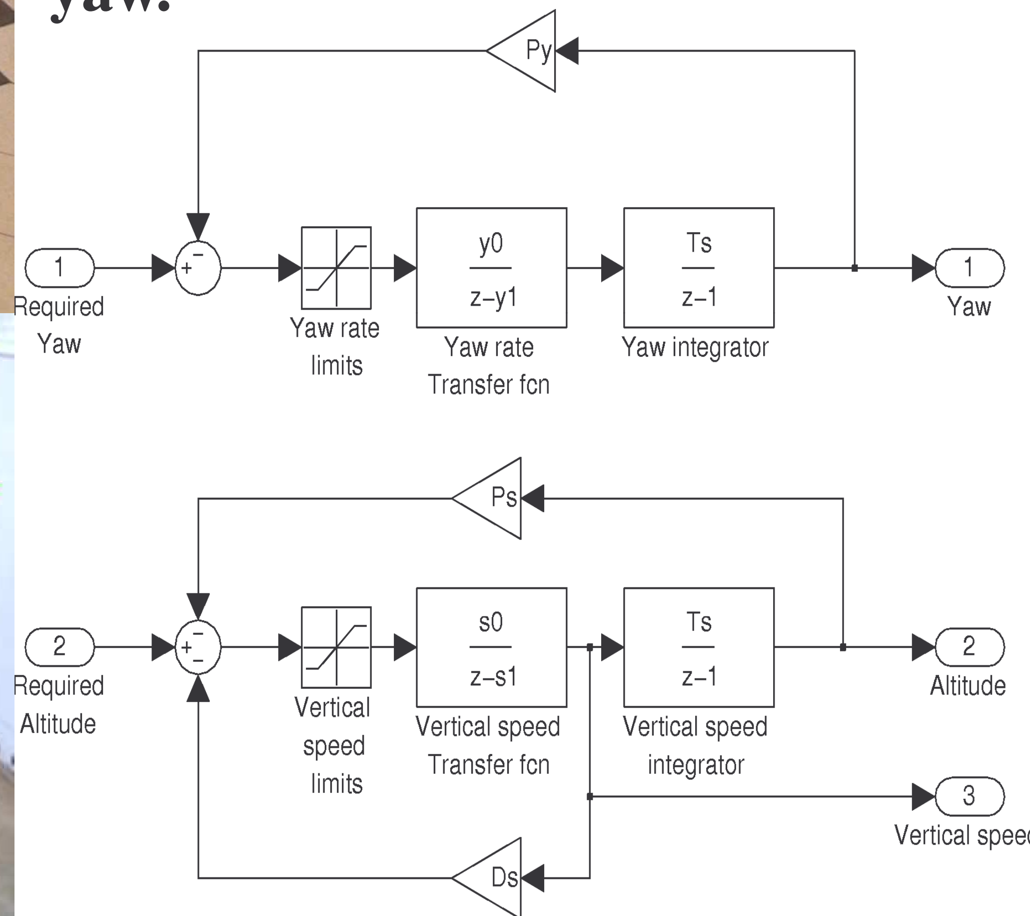


Purpose

To provide a basis for future educational use and implementation of the drone and to gain experience with control systems.

Closed Loop Control Diagrams for vertical velocity, position and yaw.

Open Loop Control Diagrams for position, velocity, pitch, roll, and yaw.



Robotic Mining in Space

- Localization without GPS
  - GPS does not work in mines
  - No positioning satellites around moon
- Small
  - Fit into holes
  - Lightweight
- Autonomous
  - Communication delay
  - No people on the moon

- Transport/Storage
  - Earth
  - ISS
  - Moon
- Profit
  - Transport could outweigh value for ore

Asteroid Mining[1]

[1] http://scitechdaily.com/billionaires-and-futurists-plan-space-missions-to-mine-asteroids-for-metals/

NAMO

Navigation among movable objects

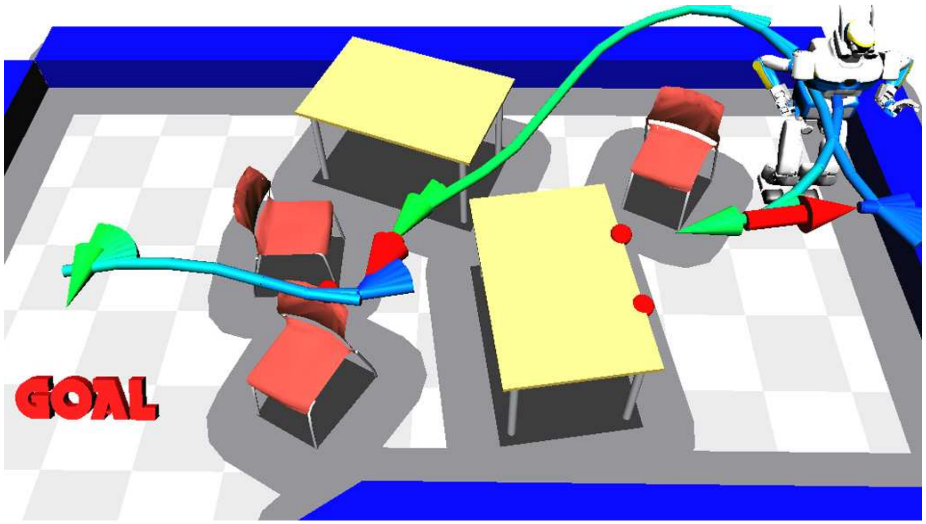
Completing a task with reasoning

Moving objects if needed

External optical tracking

Joint encoders

Four-6 axis force sensors

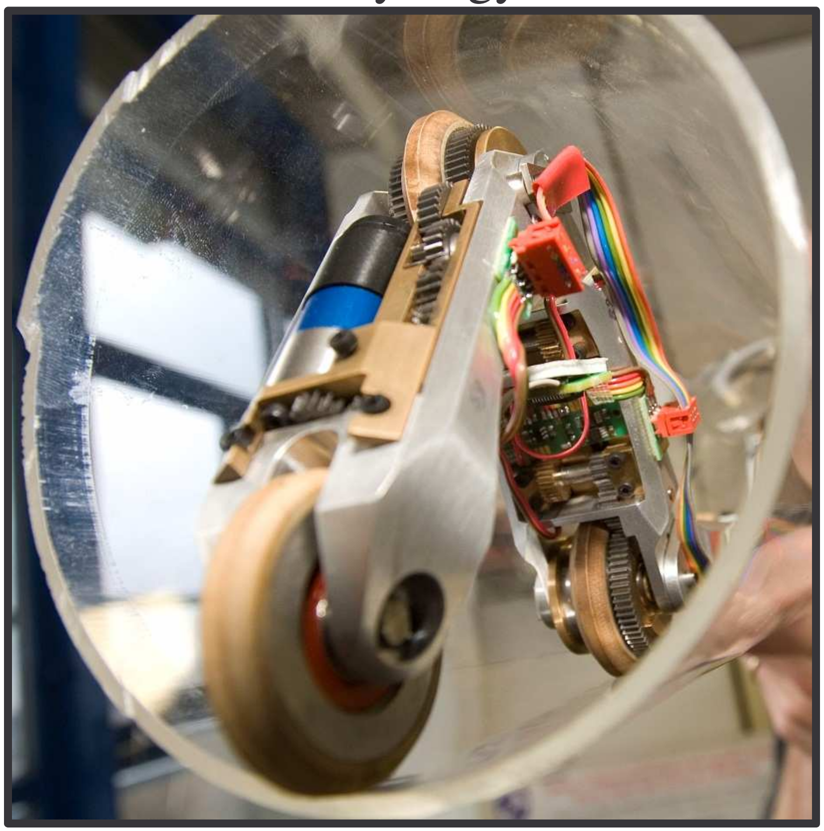


http://www.kuffner.org/james/papers/NAMO_plan_exec_iros2006.pdf

Future Robotics in the Oil and Gas Industry

The Problem: Safety of Humans

- Robots are restricted to static environments and lack of human-robot synergy.



http://www.ce.utwente.nl/e13/pirate/images/pirate.jpg

Key Issues:

- Trust
- Accountability
- Tool or Workmate
  - Interaction Design
  - Autonomy
- Complexity of Environment and Task
- Situational Awareness

Solutions:

- Teleinspection
- Teleoperation
- Complete Autonomy

Robotics In Military Application

- Reconnaissance
- IED Investigation and Elimination
- Fighting
- Weapons and Gear Transfer

http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA534697

Future Applications

- Completely robotic warfare

http://www.youtube.com/watch?v=Kgcl-APRPps

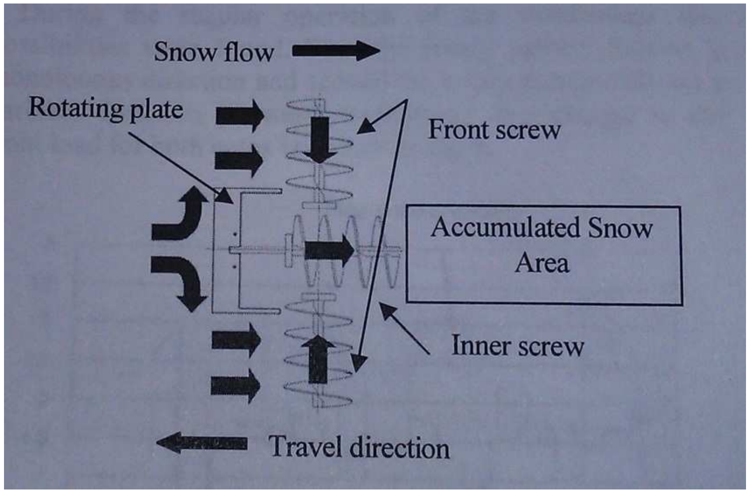
http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA534697

Snow Eater Robot

A snow eater robot was developed in Japan. It is capable of take in the snow from the front tray and compress the snow into an ice brick.

Sensors:

- GPS positioning sensor
- Twin video cameras for obstacle avoidance
- Integral snowblock maker/compressor



IEEE journal "Development of Snow Dragging Mechanism for an Autonomous Snow Eater Robot" http://inventorspot.com/articles/robot_snowplow_japan_shovels_sno_9534

Personal Service Robots (PSR)

J. Scot Collins

- Three sectors: industrial service, personal service and professional service.
- Defined by Robotics Trends as robots or robotic technology purchased by individual buyers (consumers) which educate, entertain or assist in home.
    1. Entertainment, education, home security, medical care, housework routine, etc…
- PSR, will be realized and fully boomed in the next 10-20 years.
    1. PSR development is becoming an intensive knowledge domain in academia and research institutes of global enterprise such as Sony, NEC, Philip, etc…
        - Tiger Electronics – Furby, first robotic pet released in commercial segment in 1998
        - Sony – AIBO, robotic pet in 1999
        - Honda – ASIMO, humanoid robot in 2000
- Robots will/should understand human instruction/desire through use of sensors technology, motion technology and intelligent technology.
- Technologies currently under development include Spatial-temporal cognition, Decision making, Learning, and Interaction and communication.
- According to a Japan Robotics Association study, the personal and professional service robots will triple from $17.1 billion in 2010 to $51.7 billion in 2025.
- Sub-topics/fields of future PSR Technologies
    - system, security, personal assistance, information, interfacing, identification, household, health care, entertainment, education, and communication.

Reference: James K. C. Chen, Algane Jong, Benjamin J. C. Yuan and Julia H. J. Liu. A Study of Personal Service Robot Future Marketing Trend.
www.foresightfordevelopment.org and www.otemerindades.com.

Tactile Gloves for Autonomous Grasping with the NASA Robonaut

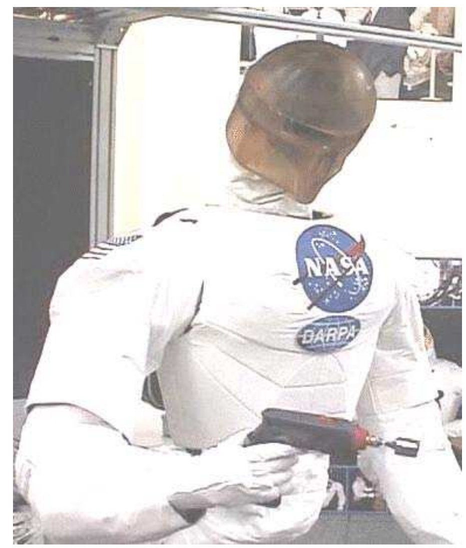
1

http://images.suite101.com/3400684_com_robonaut22.jpg

The Robonaut's hand has 14 DoF, the glove in the hand is rugged and designed to protect the sensors, provide excellent gripping surfaces and take the abuse from wide rage of space and planetary task, also to provide good tactile data.

Both gloves have incorporated the basic construction of an outer glove with a sensor layer. This allows for assembly of the sensors and wiring independent of most of the sewing and to enhance repair or upgrade of the two layers.

The technology in its hands and fingers is considered state of the art and should be capable of allowing R2 to carry out such tasks as changing air filters or manipulating objects using tools.



http://http://www-robotics.cs.umass.edu/Papers/icra04_martin.pdf

2

Teacher Robot

Functions:

- Being able to play multiple roles
- Comprehensive skill-sets for various applications: instructing, problem solving, etc.
- Intelligence for logical behavior and emotional interactions

Features:

- Autonomous
- Simulates the teacher's behavior, intelligence, emotion and functions
- Recognizes the circumstances, interacting freely with students, thereby influencing the students
- Independent and spontaneous
- Decision making ability and free will
- Learns, summarizes and accumulate various teaching experiences

Technology:

- Developed from the teaching software and long-distance education classroom with integrated sensors and actuators

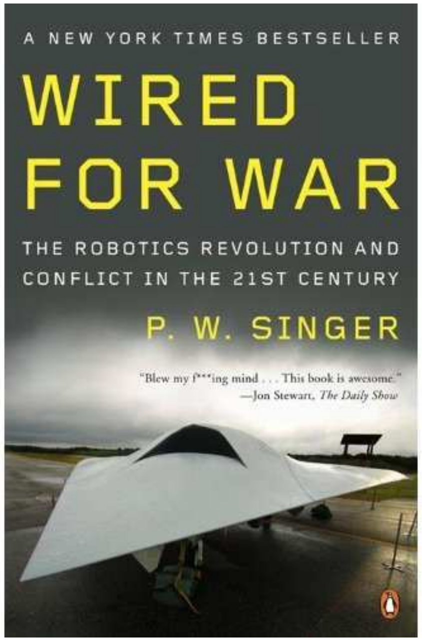
Limiting Factors:

- Interactive technology
- Dynamic decision
- Knowledge database

http://www.popsci.com/technology/article/2010-02/south-korea-gives-go-robot-english-teachers-classrooms

Singularity ("Wired For War" P.W. Singer)

Technological Singularity – The technological singularity is the hypothetical future emergence of greater-than-human super-intelligence through technological means. Since the capabilities of such intelligence would be difficult for an unaided human mind to comprehend, the occurrence of a technological singularity is seen as an intellectual event horizon, beyond which events cannot be predicted or understood.



Citation:

"A singularity in the skies".
Defense Management Journal
Dr. Stephen Prior.
Director of the Autonomous Systems Laboratory
Middlesex University

Singularity – the way they conceptualize it is that every so often you have this meta-change where the rules of the game are rewritten, and there's new questions that have to be asked about not what's possible, but what's proper or not."

EKSO Bionics Powered Exoskeleton

Suit Specs and Features:

•Weighs20 kilograms

•Remote controlled

•4 Servo motors

•Battery pack located on back

•Allows heel-to-toe walk gait

Nerves = Sensors
Motors = Muscles
Computer = Brain

(2)

Future Plans:

•Approval by U.S. food and drug administration

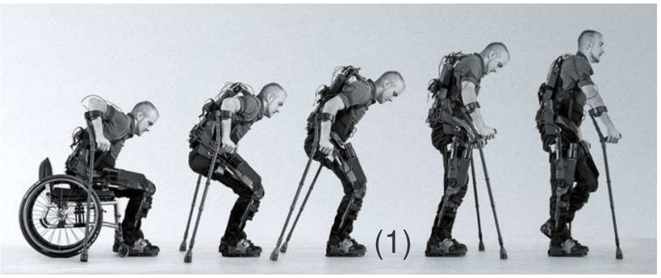
•Motion sensors under walk sticks

•Make it smaller and more lightweight

•Applications for stroke patients

•Better master of balance

•Use in daily living



(1)

References:

1. http://cdn2.digitaltrends.com/wp-content/uploads/2011/10/ekso.jpg
2. http://www.kurzweilai.net/images/Ekso-exoskeleton-profile.png
3. http://www.theengineer.co.uk/sectors/medical-and-healthcare/news/us-researchers-create-suit-that-can-enable-paraplegics-to-walk/1010691.article

Telepresence

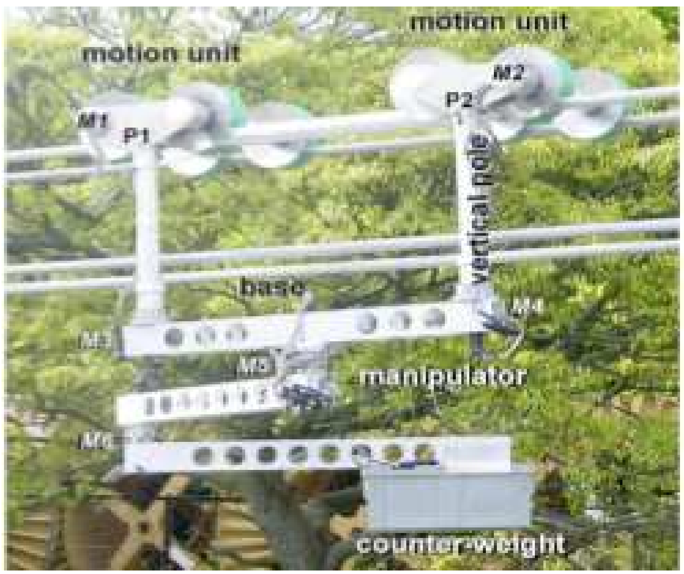
- Use of technology to simulate appearance at distant events.
- Example: MeBot
  - Created by Sigurður Örn Aðalgeirsson at MIT Media Lab.
  - Intended to “convey the non-verbal channels of social communication.” [1]
    - Mobile phone for picture and sound
    - Head movements
    - Hand gestures
- Telepresence vs. Video Conferencing
  - More engaged in interaction.
  - Higher levels of enjoyment.

MeBot Telepresence Robot [1]

1. http://robotic.media.mit.edu/projects/robots/mebot/overview/overview.html
2. Related Paper: http://robotic.media.mit.edu/pdfs/theses/siggi_ms_thesis.pdf

Robotic Applications for Energized Transmission Line

- Transmission line maintenance, assessment/monitoring, and repair
- Remotely controlled: radio controller (transmitter and receiver)
- Visual inspection by Camera
- Application of sensors such: Corrosion detection




Source: IEEE Journal: Overview of Robotic Applications for Energized Transmission Line Work –Technologies, Field Projects and Future Developments. David Elizondo, Thomas Gentile, Hans Candia, Greggory Bell.

Tucson Explorer II

- Designed for autonomous surface and subsurface exploration of Titan lakes

- Sensors
  - Drop Impact Sensor
  - Adapted thermistor or thermocouple
  - Ultrasonic
  - Onboard cameras
  - Onboard Scanning Laser Rangefinder
  - Onboard GPS (Earth based applications)
  - Future onboard sensors for hyperspectral images, monitoring microbes on liquid surfaces

- Hazard Avoidance
- Fuzzy Logic systems

- Youtube Link
- Reference:

Robotic lake lander test bed for autonomous surface and subsurface exploration of Titan lakes, Fink, W.; Tuller, M.; Jacobs, A.; Kulkarni, R.; Tarbell, M.A.; Furfaro, R.; Baker, V.R. Aerospace Conference, 2012 IEEE

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