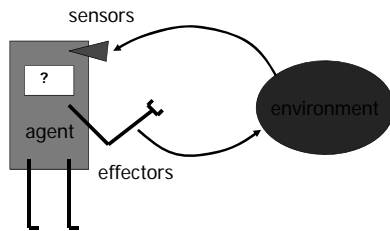


Robotics



Robots have physical sensors and effectors.

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Sensors

- Sensors that tell the robot position/change of joints: odometers, speedometers, etc.
- Force sensing. Enables compliant motion--robot just maintains contact with object.
- Sonar. Send out sound waves and measure how long it takes for it to be reflected back. Good for obstacle avoidance.
- Vision systems

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Effectors

- Converts software commands into physical motion
- Typically electrical motors or hydraulic/pneumatic cylinders
- Two main types of effectors:
 - locomotion
 - manipulation

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Locomotion

- Legs
 - traditional (human-like)
 - Other types
 - Statically stable locomotion: can pause at any stage during its gait without falling
 - Dynamically stable locomotion: stable only as long as it keeps moving (e.g., jumping)
- Wheeled locomotion is still most practical for typical environments
- Other methods: fish robots, snake-like robots.

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Manipulation

- Manipulation of objects
- Typical manipulators allow for:
 - Prismatic motion (linear movement)
 - Rotary motion (around a fixed hub)
- Robot hands go from complex anthropomorphic models to simpler ones that are just graspers

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Robots for Surgery

Q: Why use robots?

A: Robots have several surgical advantages over people!

High geometric accuracy
Stable and untiring
Wide range of scales
May be sterilized
Resistant to radiation and infection
Can use diverse sensors (chemical, force, acoustic, etc.)

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Robots for Surgery

Q: Why use people?

A: People have several surgical advantages over robots.

Flexible and adaptable
 Able to use qualitative information
 Good judgment
 Can integrate extensive and diverse information
 Easy to instruct and debrief
 Better hand-eye coordination
 More dexterous (at human scale)

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Minimally Invasive Procedures

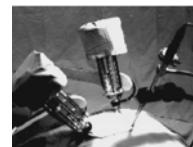
Several advantages over traditional, open surgery:

Less pain
 Faster recovery
 Less scarring
 Reduced hospitalization costs



Several problems:

Restricted vision
 Difficult handling of instruments
 Difficult hand-eye coordination
 No tactile perception



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Image-Based Procedures

Recent advances in 2-D and 3-D imaging techniques have served as a catalyst for robotic surgery.

Three central problems:

Planning – how to specify incision point and instrument path.

Registration – finding correspondence between preoperative image data and physical patient.

Navigation – human or robot “navigates” to the pathological tissue.

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Interaction Modes

Three levels of robotic autonomy:

No autonomy – surgeon controls robot motion from a console (e.g. minimally invasive surgery).

Shared control – robot provides “active constraints” to increase safety and accuracy (e.g. knee joint replacement).

Complete autonomy – robot carries out a preoperative plan without human intervention (e.g., hip joint replacement).

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Robot Movies

Robot Fish
<http://www.youtube.com/watch?v=eO9oseiCTdk>
 Robot Snake
<http://www.youtube.com/watch?v=LZjsSbsLOU>
 Boston Dynamics “Big Dog”
<http://www.youtube.com/watch?v=W1czBcnX1Ww>
 Swarm Robotics
<http://www.youtube.com/watch?v=SkvpEFAPXn4>
 Honda “Asimo” Robot
<http://www.youtube.com/watch?v=sv35itWLBk>
 Robot Violinist
<http://www.youtube.com/watch?v=EzjkBwZtxp4>
 Humanoid Female Robot
<http://www.youtube.com/watch?v=OXs81d8ulaE>
 Robot with Emotions
<http://www.youtube.com/watch?v=3Gki374ZkM4>

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