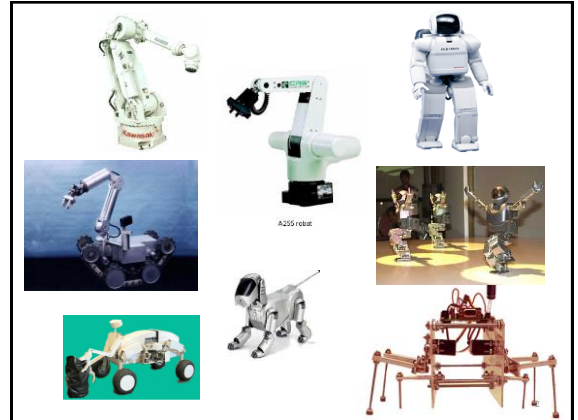


# Robotics

MSE 2400

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## What is a Robot? (1)

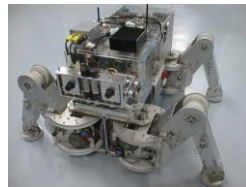
Manipulator



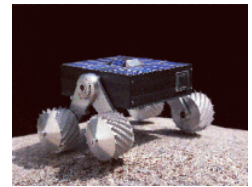
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## What is a Robot? (2)

Legged Robot



Wheeled Robot



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## What is a Robot? (3)

Autonomous Underwater Vehicle



Unmanned Aerial Vehicle



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## What Can Robots Do? (1)



Jobs that are dangerous for humans

**Decontaminating Robot**  
Cleaning the main circulating pump housing in the nuclear power plant

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## What Can Robots Do? (2)



Welding Robot

Repetitive jobs that are boring, stressful, or labor-intensive for humans

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## What Can Robots Do? (3)



The SCRUBMATE Robot

Menial tasks that human don't want to do

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## Definition

- Word robot was coined by a Czech novelist Karel Capek in a 1920 play titled Rossum's Universal Robots (RUR)
- Robota in Czech is a word for worker or servant



Karel Capek

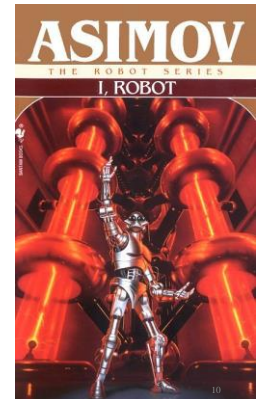
### • Definition of robot:

– A robot is a **reprogrammable, multifunctional** manipulator designed to move material, parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks: Robot Institute of America, 1979

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## Laws of Robots

- Asimov proposed three "Laws of Robotics"
- Law 1: A robot may not injure a human being or through inaction, allow a human being to come to harm
- Law 2: A robot must obey orders given to it by human beings, except where such orders would conflict with a higher order law
- Law 3: A robot must protect its own existence as long as such protection does not conflict with a higher order law



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## History of Robotics (1)

- **The first industrial robot: UNIMATE**
- 1954: The first programmable robot is designed by George Devol, who coins the term Universal Automation. He later shortens this to Unimation, which becomes the name of the first robot company (1962).

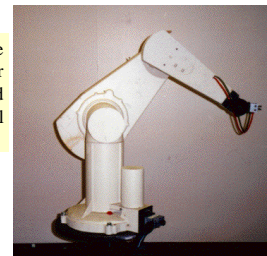


UNIMATE originally automated the manufacture of TV picture tubes

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## History of Robotics (2)

1978: The Puma (Programmable Universal Machine for Assembly) robot is developed by Unimation with a General Motors design support



PUMA 560 Manipulator

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## History of Robotics (3)

1980s: The robot industry enters a phase of rapid growth. Many institutions introduce programs and courses in robotics. Robotics courses are spread across mechanical engineering, electrical engineering, and computer science departments.



Adept's SCARA robots



Cognex In-Sight Robot



Barrett Technology Manipulator

## History of Robotics (4)



1995-present: Emerging applications in small robotics and mobile robots drive a second growth of start-up companies and research

2003: NASA's Mars Exploration Rovers will launch toward Mars in search of answers about the history of water on Mars

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## Knowledgebase for Robotics

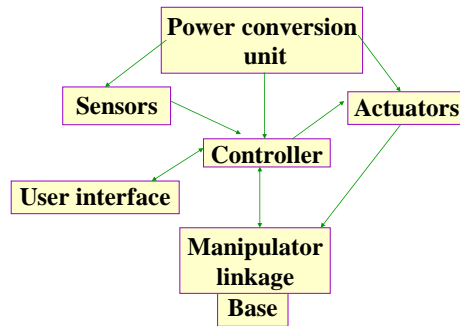
•Typical knowledgebase for the design and operation of robotics systems

- Dynamic system modeling and analysis
- Feedback control
- Sensors and signal conditioning
- Actuators and power electronics
- Hardware/computer interfacing
- Computer programming

Disciplines: mathematics, physics, biology, mechanical engineering, electrical engineering, computer engineering, and computer science

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## Key Components



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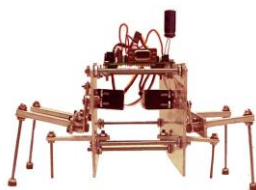
## Robot Base: Fixed v/s Mobile

Robotic manipulators used in manufacturing are examples of fixed robots. They can not move their base away from the work being done.



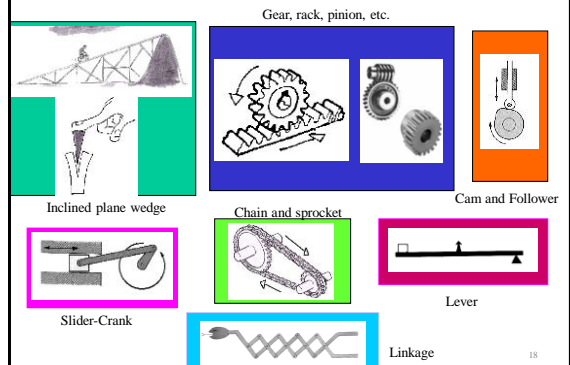
A255 robot

Mobile bases are typically platforms with wheels or tracks attached. Instead of wheels or tracks, some robots employ legs in order to move about.



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## Robot Mechanism: Mechanical Elements



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## Sensors (1)

•Human senses: sight, sound, touch, taste, and smell provide us vital information to function and survive

•Robot sensors: measure robot configuration/condition and its environment and send such information to robot controller as electronic signals (e.g., arm position, presence of toxic gas)

•Robots often need information that is beyond 5 human senses (e.g., ability to: see in the dark, detect tiny amounts of invisible radiation, measure movement that is too small or fast for the human eye to see)



Accelerometer  
Using Piezoelectric Effect



Flexforce Sensor

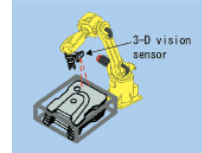
## Sensors (2)

Vision Sensor: e.g., to pick bins, perform inspection, etc.



In-Sight Vision Sensors

Part-Picking: Robot can handle work pieces that are randomly piled by using 3-D vision sensor. Since alignment operation, a special parts feeder, and an alignment pallette are not required, an automatic system can be constructed at low cost.

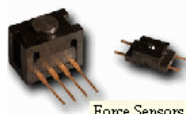


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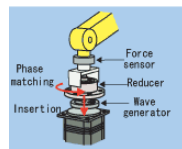
## Sensors (3)

Force Sensor: e.g., parts fitting and insertion, force feedback in robotic surgery

Parts fitting and insertion: Robots can do precise fitting and insertion of machine parts by using force sensor. A robot can insert parts that have the phases after matching their phases in addition to simply inserting them. It can automate high-skill jobs.

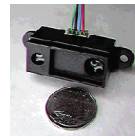


Force Sensors



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## Sensors (4)

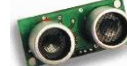


Infrared Ranging Sensor  
Devantech SRF04

Example



KOALA ROBOT



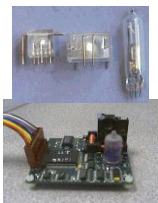
UltraSonic Ranger

- 6 ultrasonic sonar transducers to explore wide, open areas
- Obstacle detection over a wide range from 15cm to 3m
- 16 built-in infrared proximity sensors (range 5-20cm)
- Infrared sensors act as a "virtual bumper" and allow for negotiating tight spaces

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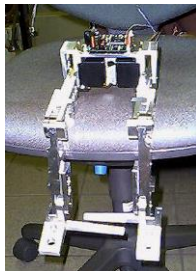
## Sensors (5)

Tilt sensors: e.g., to balance a robot



Tilt Sensor

Example



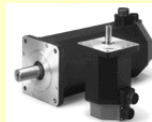
Planar Bipedal Robot

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## Actuators (1)

• Common robotic actuators utilize combinations of different electro-mechanical devices

- Synchronous motor
- Stepper motor
- AC servo motor
- Brushless DC servo motor
- Brushed DC servo motor



<http://www.ab.com/motion/servo/fseries.html>

## Actuators (2)



Hydraulic Motor



Pneumatic Cylinder



Stepper Motor



Pneumatic Motor



DC Motor



Servo Motor

## Controller

- Provide necessary intelligence to control the manipulator/mobile robot
- Process the sensory information and compute the control commands for the actuators to carry out specified tasks

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## Controller Hardware

Storage devices: e.g., memory to store the control program and the state of the robot system obtained from the sensors



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## Industries Using Robotics

- Agriculture
- Automobile
- Construction
- Entertainment
- Health care: hospitals, patient-care, surgery , research, etc.
- Laboratories: science, engineering , etc.
- Law enforcement: surveillance, patrol, etc.
- Manufacturing
- Military: demining, surveillance, attack, etc.
- Mining, excavation, and exploration
- Transportation: air, ground, rail, space, etc.
- Utilities: gas, water, and electric
- Warehouses

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## What Can Robots Do?

### Industrial Robots

- Material handling
- Material transfer
- Machine loading and/or unloading
- Spot welding
- Continuous arc welding
- Spray coating
- Assembly
- Inspection



Material Handling Manipulator



Kawasaki Industrial Robot



Assembly Manipulator

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## Robots In Space



NASA Space Station



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## Robots in Hazardous Environments



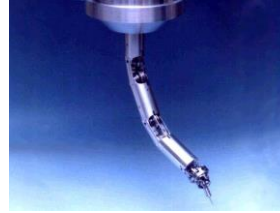
TROV in Antarctica operating under water



HAZBOT operating in atmospheres containing combustible gases

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## Medical Robots



Robotic assistant for micro surgery



the operative system in robotic surgery™

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## Robots at Home



Sony SDR-3X Entertainment Robot



Sony Aibo

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## Future of Robots (1)

### Artificial Intelligence



Cog



Kismet

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## Future of Robots (2)

### Autonomy



Robot Work Crews



Garbage Collection Cart

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## Future of Robots (3)

### Humanoids



HONDA Humanoid Robot