



ENME 489L: Biologically Inspired Robotics

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University of Maryland



Course Introduction



Logistics

- Class Time: Tuesday and Thursday 2PM to 3:15PM
- Class Location: JMP
- Office Hours: Tuesday and Thursday 3:30PM to 5:00PM
- Course Instructor: Dr. Satyandra K. Gupta
 - Email: skgupta@umd.edu
 - Phone: 301-405-5306,
 - Office: Room 2135 EGR
- Course Co-Instructor: Arvind Ananthanarayanan
 - Email: arvinda@umd.edu
 - Phone: 301-405-0436
 - Office: Room 0124 EGR



Main Topics

- Fundamentals of Traditional Robots
- Fundamentals of Biologically Inspired Robots
- Design and Fabrication of Biologically Inspired Robots



Textbook and References

- **Textbook**

- J.J. Craig. *Introduction to Robotics: Mechanics and Control*. Prentice Hall; 3rd edition, 2003.

- **Additional References**

- G. A. Bekey. *Autonomous Robots*. MIT Press, 2005.
- Karl Williams. *Amphibionics: Build Your Own Biologically Inspired Reptilian Robot*. McGraw-Hill/TAB Electronics, 2003.
- David Cook. *Robot Building for Beginners*. Apress, 2002.



Homework, Exam, and Project

- 8 Homeworks (done individually) (20% of the overall grade)
- Projects (done in groups of 3) (40% of the overall grade)
- 1 Final Exam (40 % of the overall Grade)



Project



Goal

- Design a 4 legged bio-inspired robot (no wheels) that can perform the following function
 - Travel on a straight line 25 times its body's largest dimension in two minutes or less
- Other information
 - Main emphasis is on mechanical design to reproduce kinematics of a gait
 - Use FDM to make structures
 - Some programming is needed
 - Use off-the-shelf motors



Robot Testing

- You will need to demonstrate your robot on two different surfaces
 - Parking lot
 - Carpeted floor
- The slop of the surface will be less than 5 degrees and the test will be done on the dry surface



Final Demonstrations

- The final project submission will consist of a written report describing the robot design, performance test results, manufacturing process description, and engineering drawings
- You will also need to submit Pro/Engineer models of your design



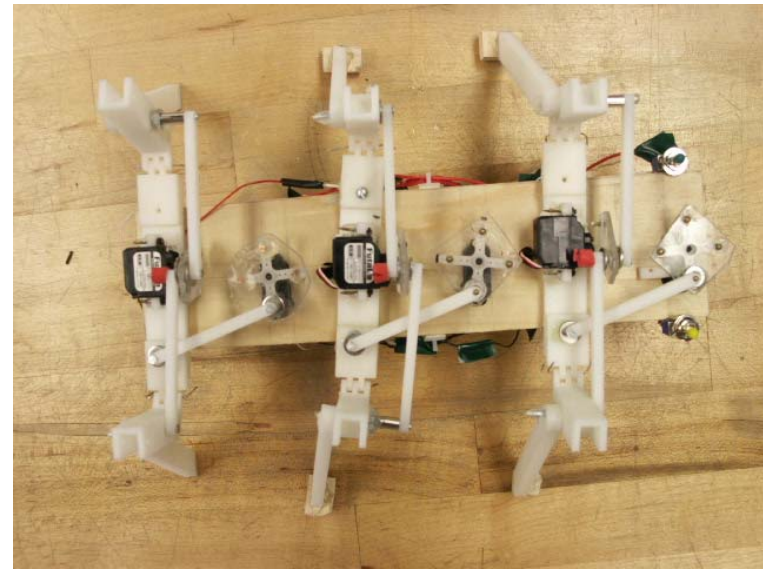
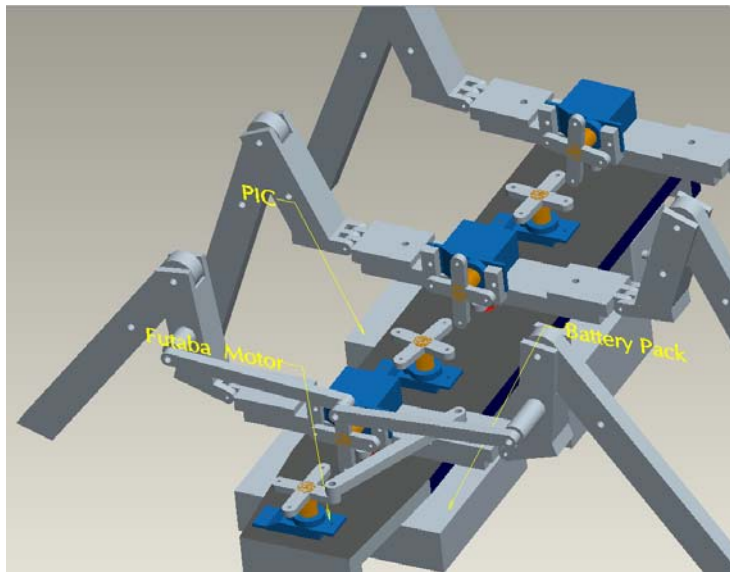
Main components

- Mechanical structure (created using FDM)
- Controller board (~ \$25)
- Batteries (~ \$20 to \$30)
- Motors (~ \$15 per motor)
- Department budget is \$150 per robot

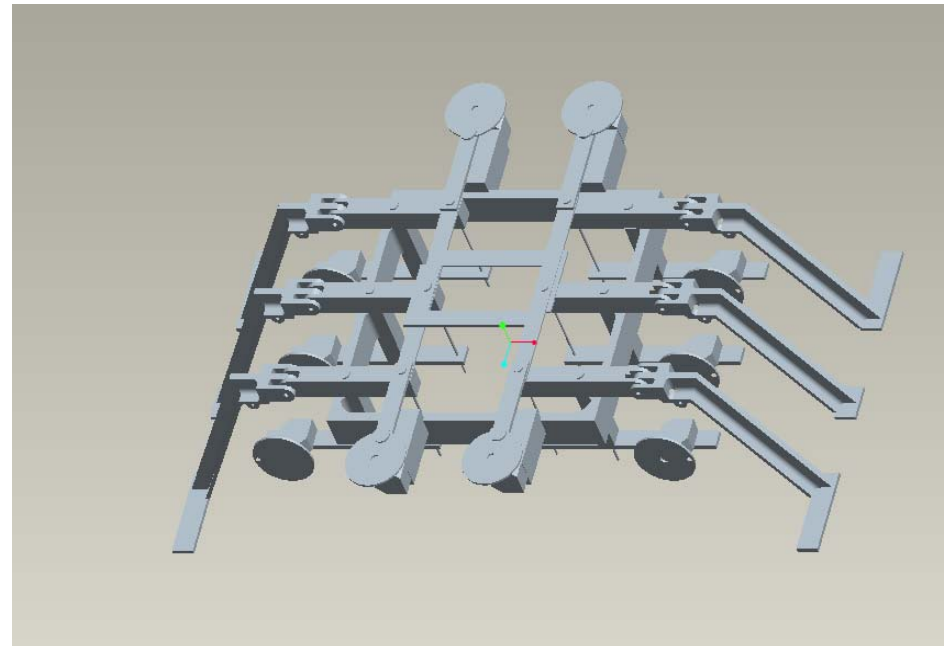
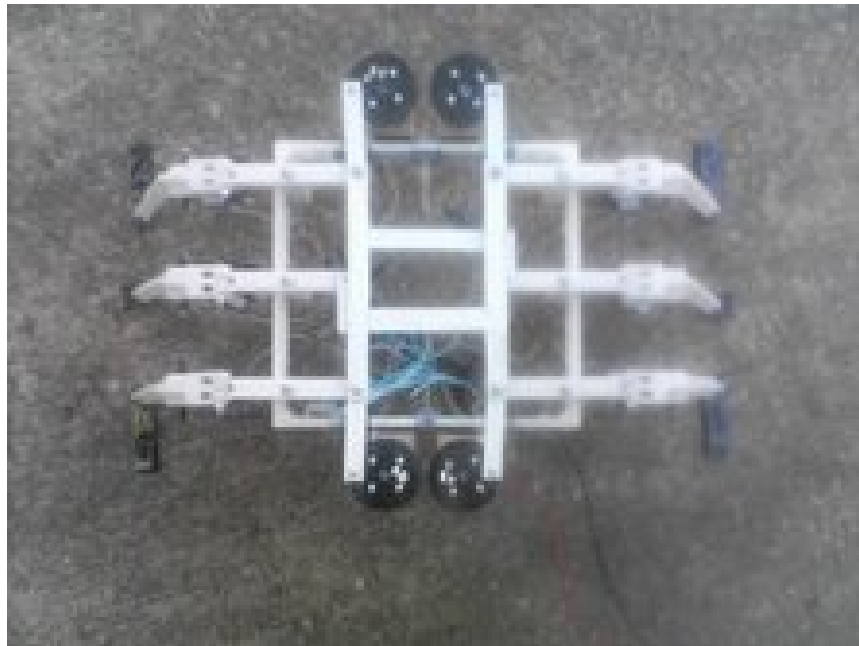


Samples of Robots Built in Spring 2007

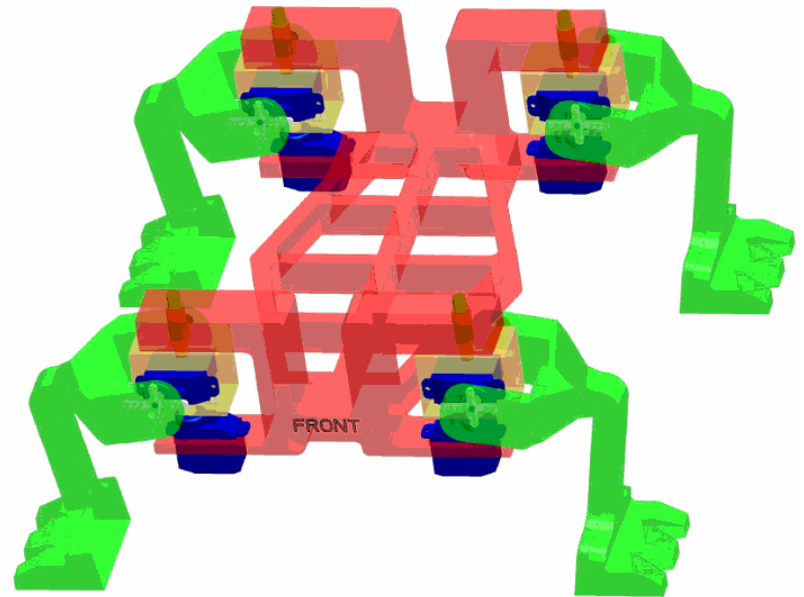
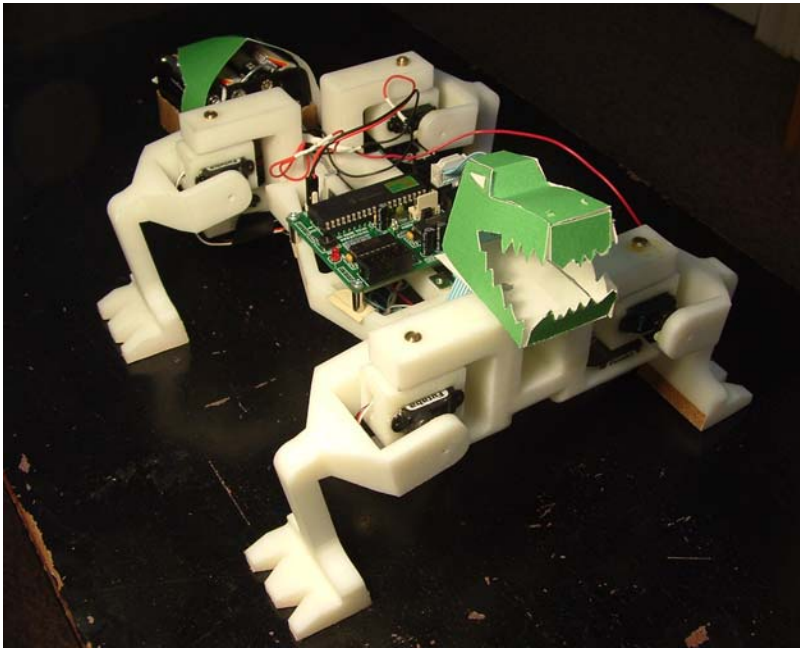
Ant Robot



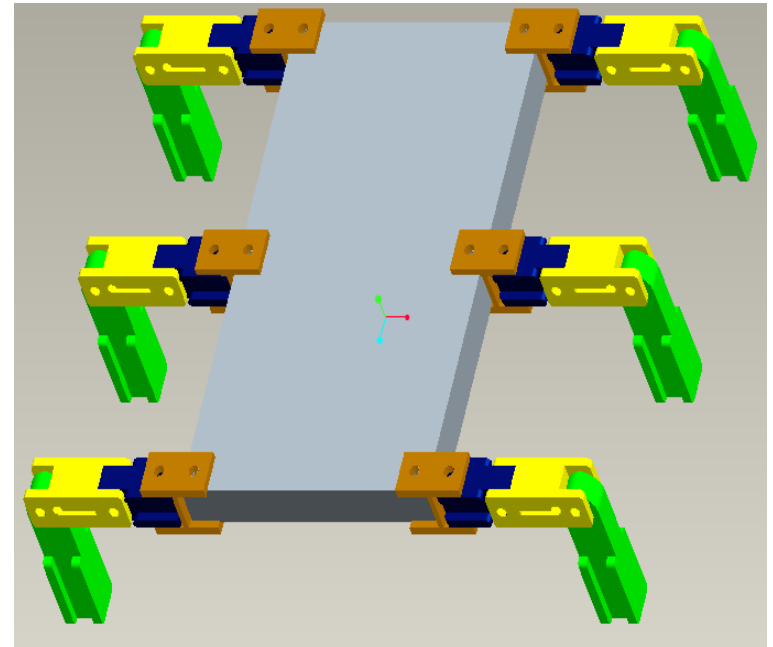
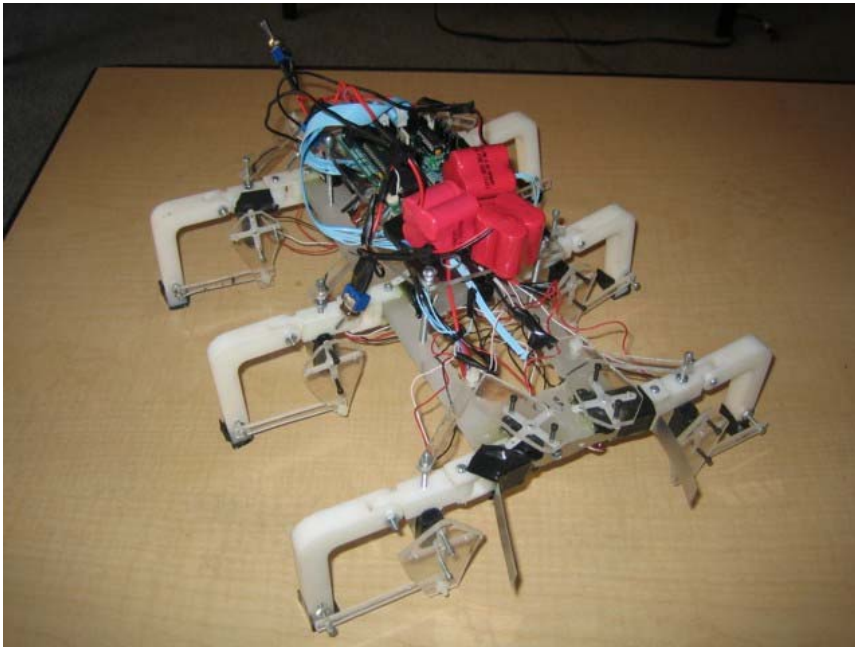
Beetle Robot



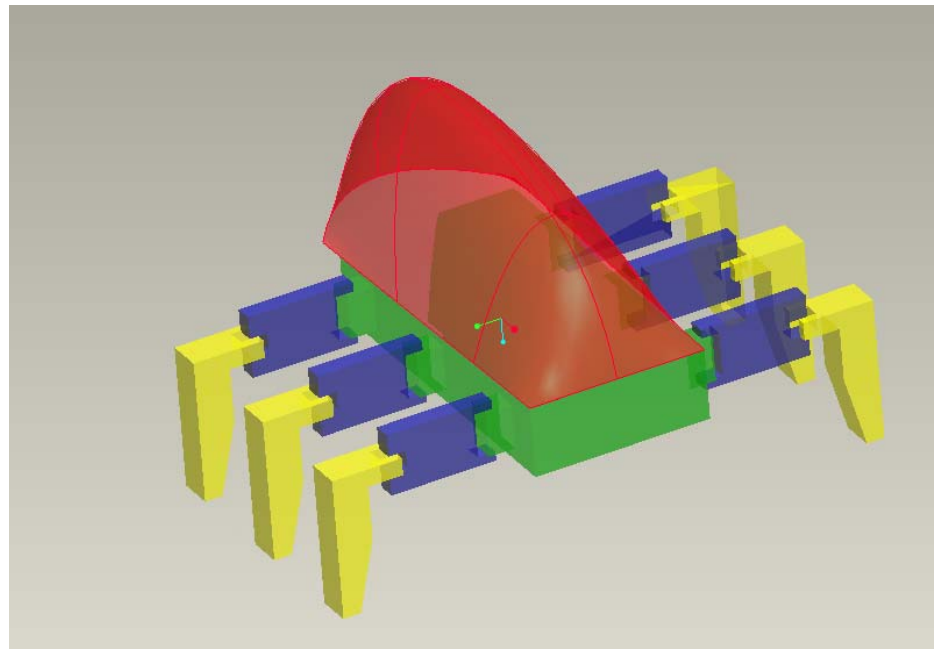
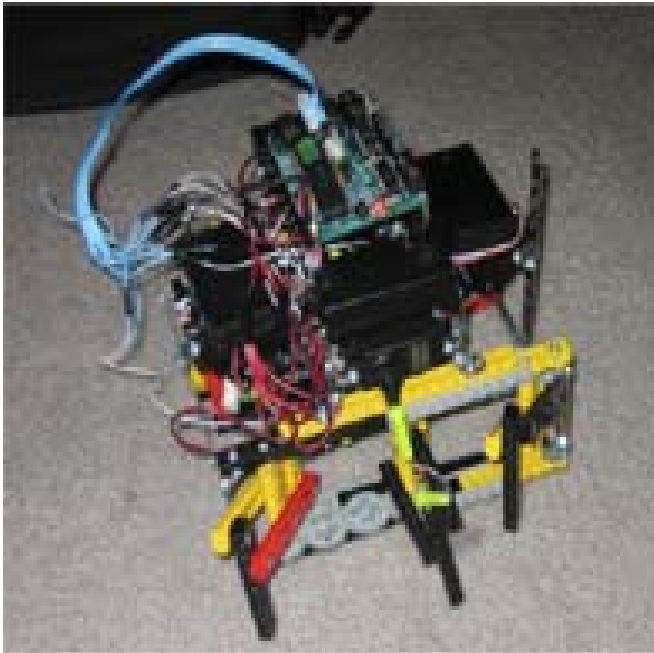
Crocobot



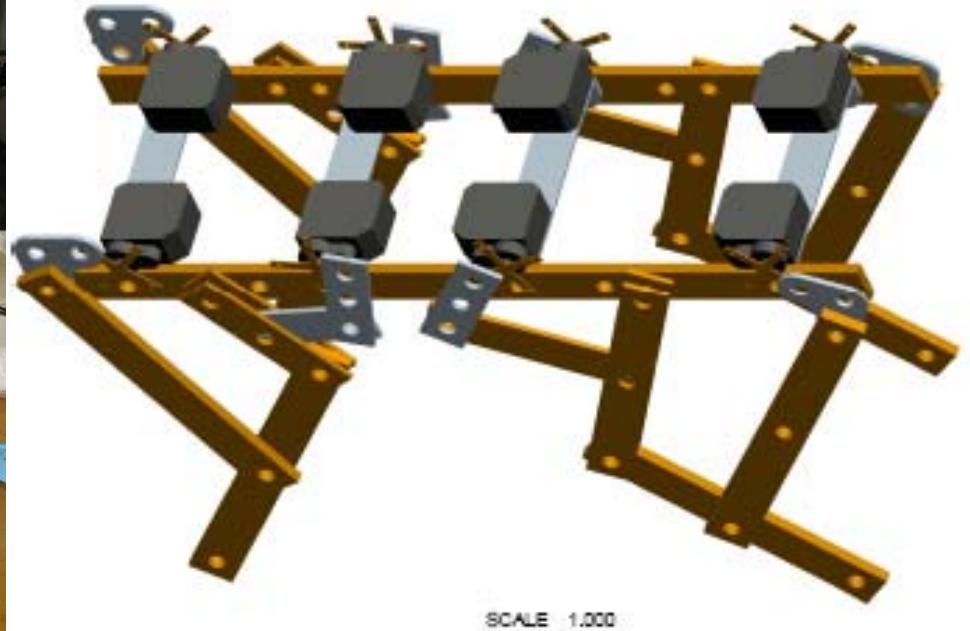
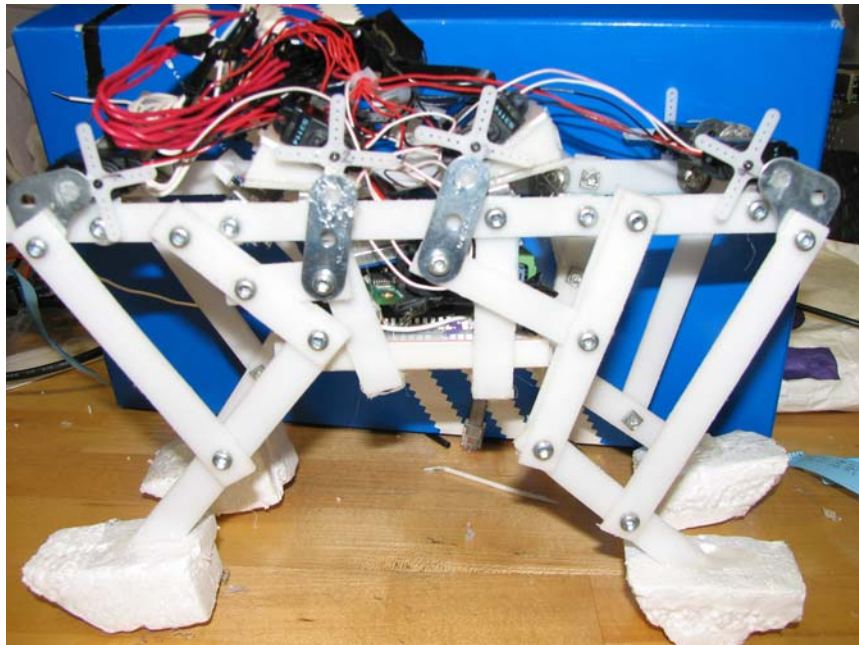
Fire Ant Robot



Ladybug Robot



Tiggerbot





Project Teams

- Team consisting of three students
- Team member names should be sent to skgupta@umd.edu by 6PM on Sunday February 3rd



Robotics Preliminaries



What is a robot?

Origin: Karel Capek's play *R.U.R.* (1921)

Czech: *robot* – servitude, forced labor

“A **machine** (sometimes resembling a human being in appearance) designed to function **in place of a living agent**, esp. one which carries out a variety of tasks automatically or with a **minimum of external impulse.**”

- *Oxford English Dictionary*

“A reprogrammable, multifunctional manipulator designed to move materials, parts, tools, or specialized devices through various programmed motions for the performance of a variety of tasks.”

- The Robot Institute of America



Sony Qrio





Why Use Robots?

Why Use Robots?

For tasks that are . . .

- Hazardous



LAPD Bomb Squad

- Repetitious



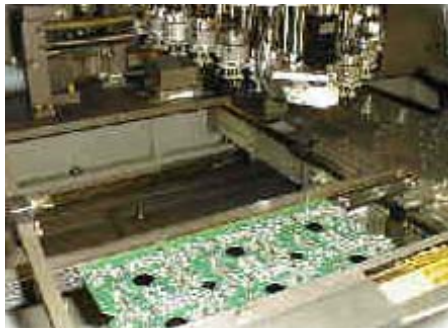
Automated car painting

- Dexterous



Automotive welding

- Precise



Circuit board manufacturing

- Inaccessible



DaVinci robot for cardiothoracic surgery



Where Are Robots Being Used?



Robot Applications

- Assembly
- Automotive Welding
- Automotive Painting
- Space Applications
- Explosive Disposal
- Medical
- Entertainment
- Measurement and Inspection
- Machining
- Survey
- Reconnaissance

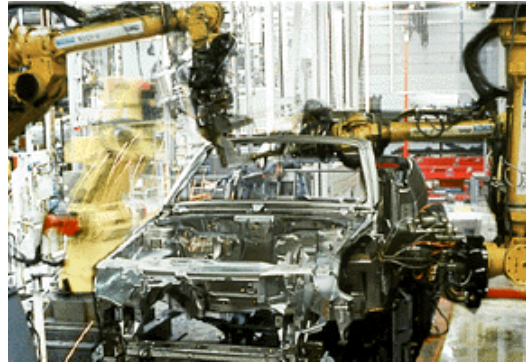


Robot Descriptors

- Stationary vs. mobile
- Manual vs. programmable vs. autonomous
- Remote operated vs. wired
- Payload size
- Speed of task or motion
- Work volume
- Number of degrees of freedom (DOF)
- Power consumption
- Lifetime

Stationary Robots

- Functions
 - Gripping/translating
 - Inspecting/measuring
 - Operating/manipulating
- Applications
 - Manufacturing
 - Machining
 - Assembling
 - Medical devices
 - Spacecraft



Automobile manufacturing



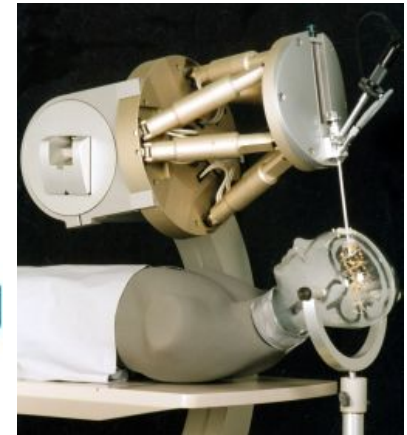
ISS and Endeavor handoff



CMM



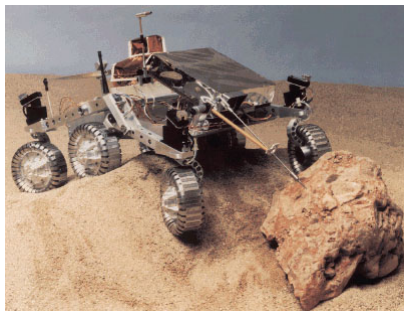
CNC Mill



M-850 Hexapod

Mobile Robots

- Mobile platforms, with other robots attached
- Primary function: locomotion
- Applications
 - Transportation platform
 - Exploration
 - Reconnaissance
 - Surveillance



NASA Mars rover



Maridan 600 UUV

- Applications (continued)
 - Consumer products



Roomba vacuum



Robomower

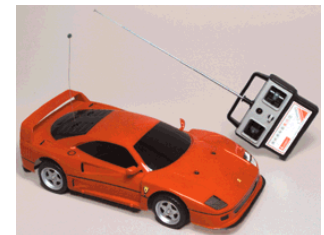


Honda Asimo

- Toys



Sony Aibo



Remote controlled car



Examples of Bio-Inspired Robots