



INTRODUCTION TO ROBOTICS

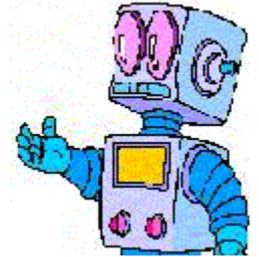
(Kinematics, Dynamics, and Design)

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TEXT BOOK

Introduction to Robotics: Mechanics & Control

By: J. J. Craig, Prentice Hall, 3rd Edition 2005, 2nd/3rd Edition, Translated to Farsi; By A. Meghdari & F. Mirfakhraei, et.al. SUT Press, 1374, 1377, 1384, 1388.

REFERENCE BOOKS

- **Intelligent Robotics Systems; by Mohsen Shahinpoor, ERI Press, 1994.**
- **Fundamentals of Robotics; by R. J. Schilling, Prentice Hall, 1990.**



COURSE OBJECTIVES

At the end of this course, you should be able to:

- Describe and analyze rigid body motion...
- Write down manipulator kinematics/dynamics and operate with the resulting equations...
- Solve inverse kinematics/dynamics problems...
- Design and select robots for performing various robotic tasks...
- Solve trajectory and motion planning problems...
- Program manipulators to perform various motions...



TOPICS

- **Introduction to robotics terminologies & applications**
- **Review of current robotics research (Videos)**
- **Robot arm mechanism's designs & grippers**
- **Mathematical tools: spatial descriptions & transformations**
- **Robot manipulator kinematics**
- **Inverse manipulator kinematics/workspace**
- **Jacobians: velocities & static forces, singularities**
- **Robot manipulator dynamics: Newton-Euler & Lagrangian equations of motion**
- **Robot trajectory and motion planning/generation**
- **Robot Design, and Robot Programming Languages**
- **Laboratory robot's motion programming & task planning**



GRADING POLICY

- **Mid-Term Exam: 30%**
- **Final Exam: 30%**
- **Homework* & Quiz(Weekly): 15%**
- **Lab/Seminar Projects: 25%**

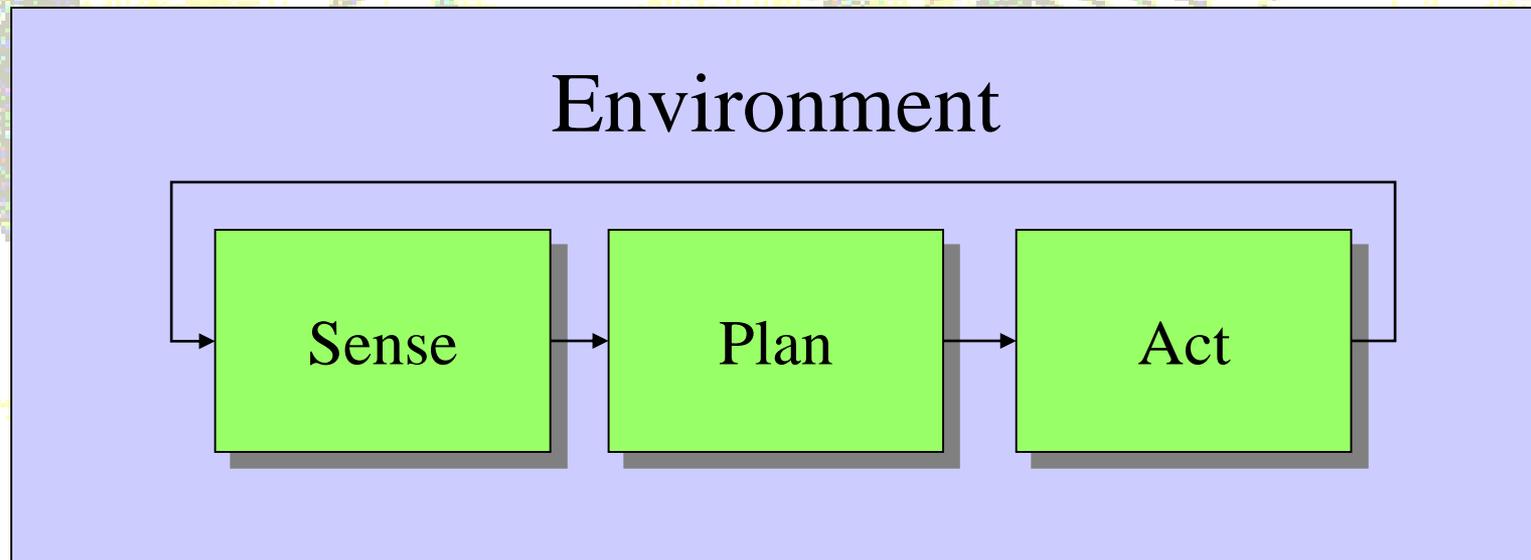
OFFICE HOURS

- **Tuesdays: 3:00 to 4:30 PM**
- **Tel: (021) 6616-5541, 5548**
- **Email: meghdari@sharif.edu**



Basic Issues in Robotics

A Robot is an entity that can sense, think and act!



- *How to SENSE?*
- *How to PLAN?*
- *How to ACT?*



Primitive Robotic Functions

- ***SENSE***
 - The function of acquiring information from the environment (i.e. bump sensors, optical sensors, ...).
- ***PLAN***
 - The function of determining high-level tasks to accomplish Various AI techniques.
- ***ACT***
 - The function of producing low-level actuator commands (i.e. Turn on motor one for a few seconds).



What are Robots Made of?

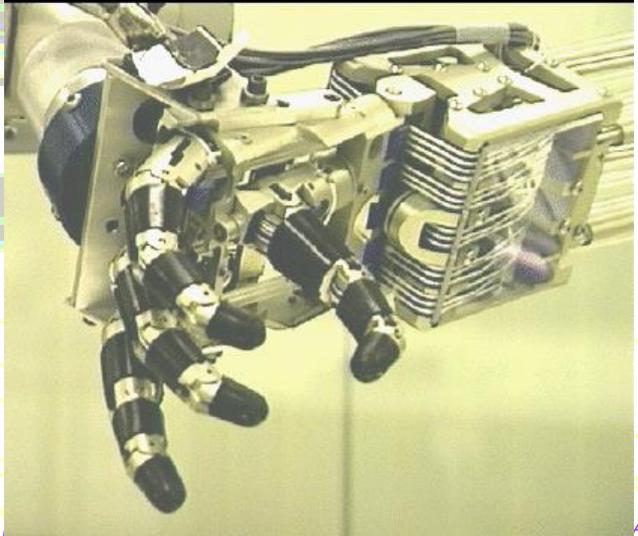
- Sensors
 - cameras
 - ranged finders
 - touch sensors
- Computer
 - embedded controller and microprocessor
- Actuators
 - wheels or legs
 - manipulators (gripper or hand)



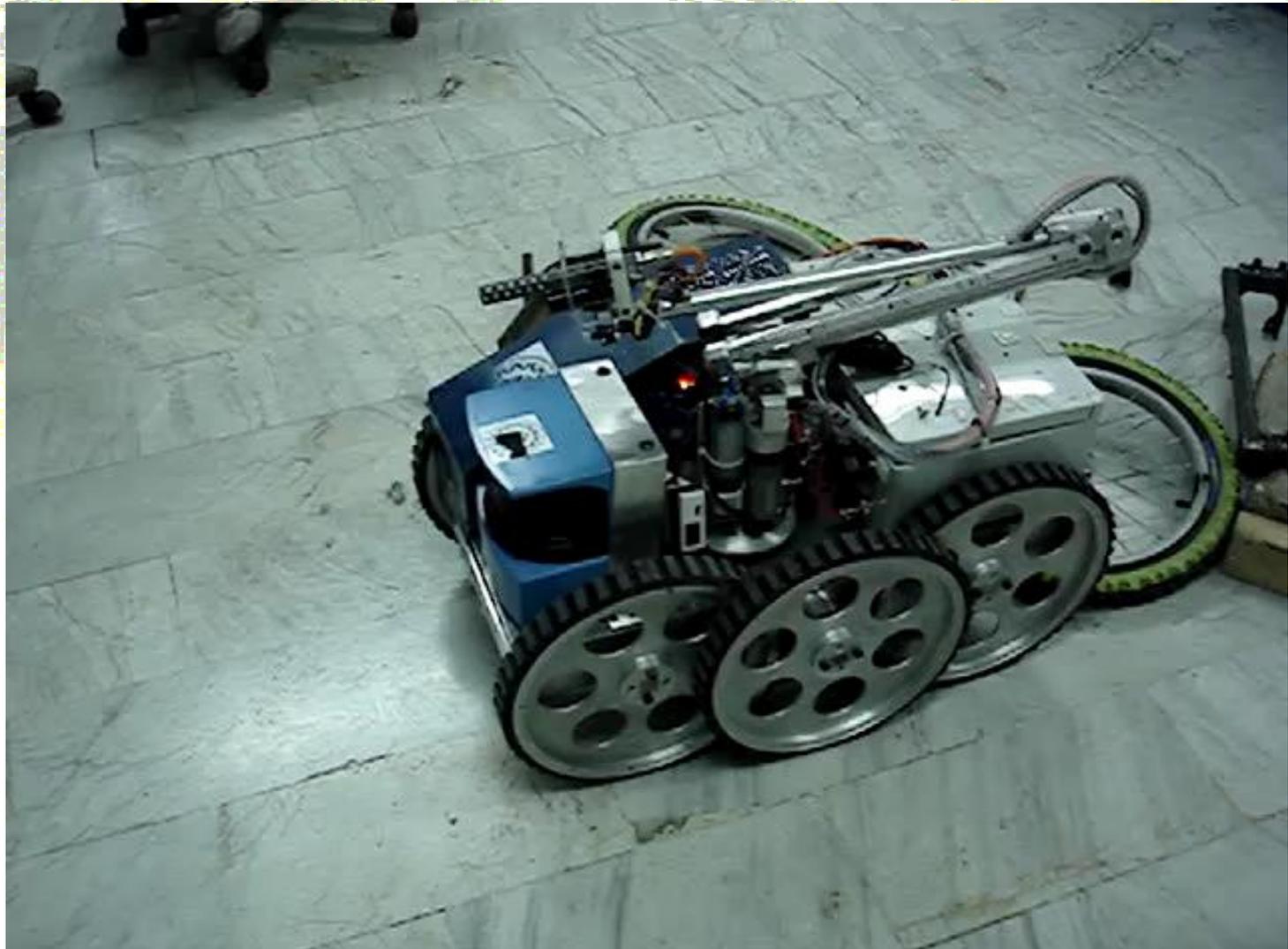
Robot Samples



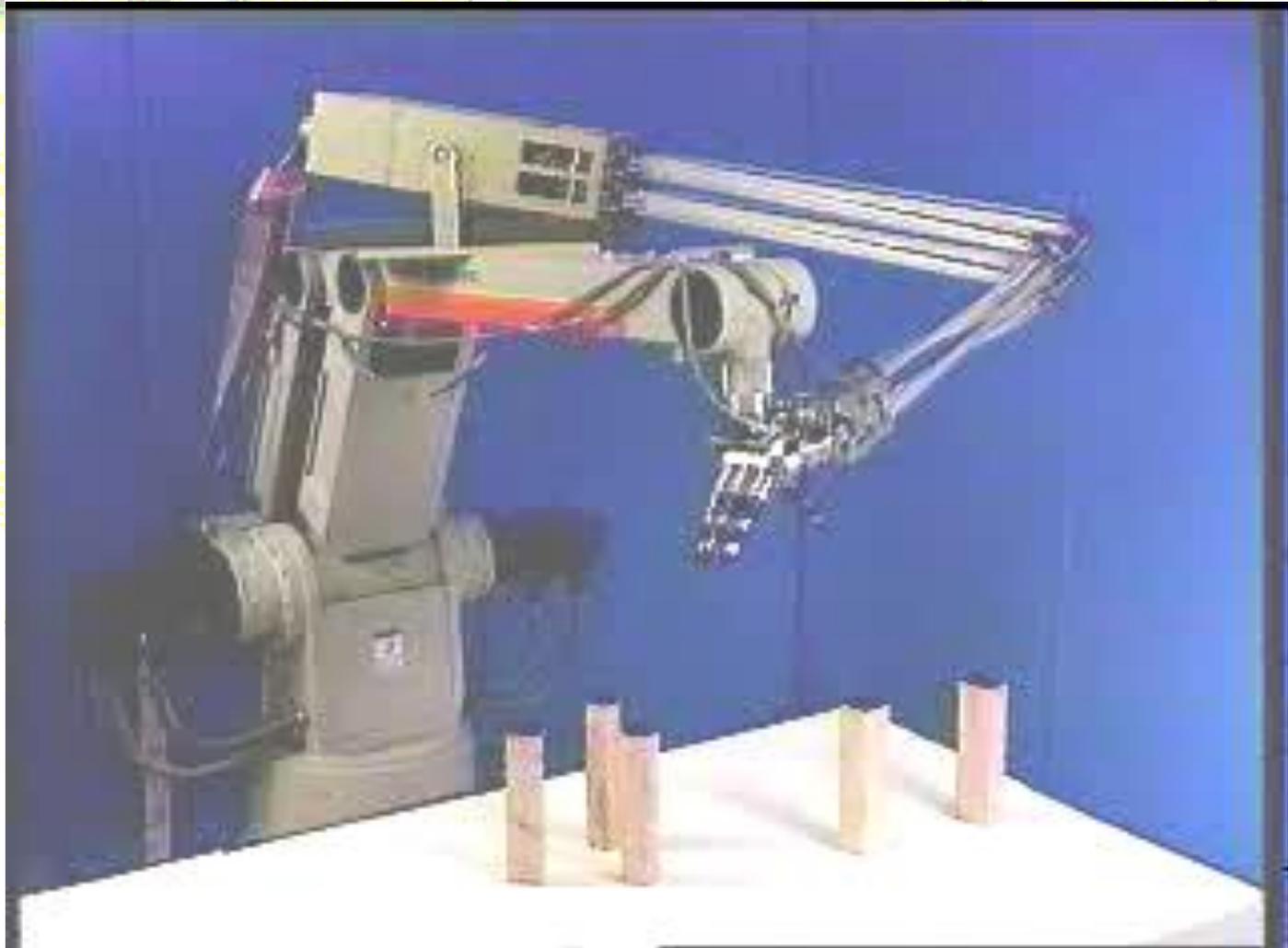
LET YOUR ROBOT DO THE MOWING...



Robot Demos - Rescue



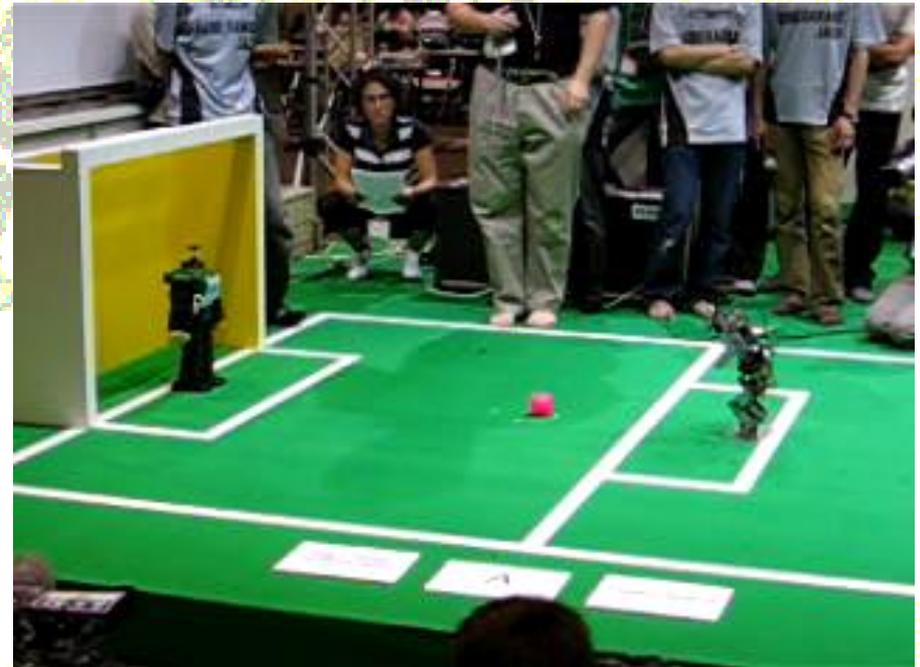
Robot Demos – Pick & Place



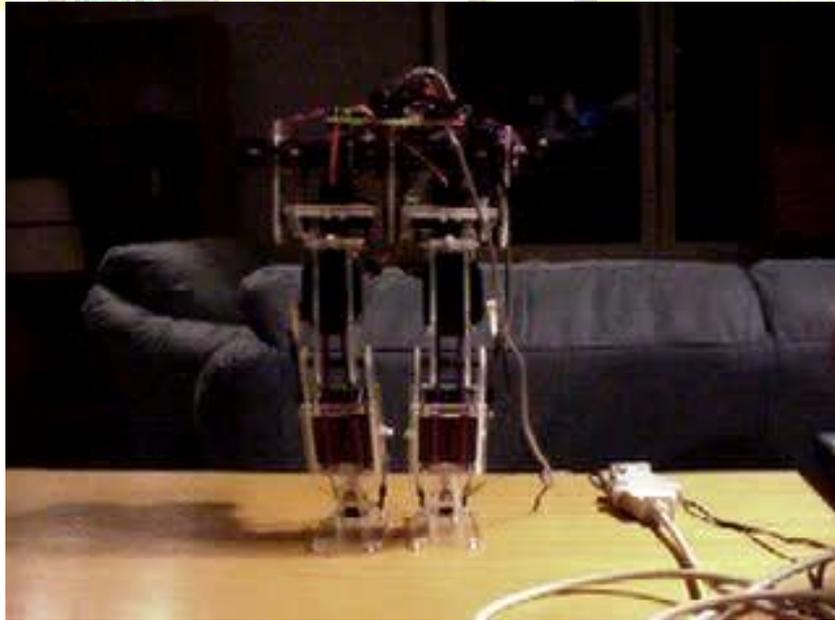
Robot Demos



Robot Demos - Humanoid



Robot Demos



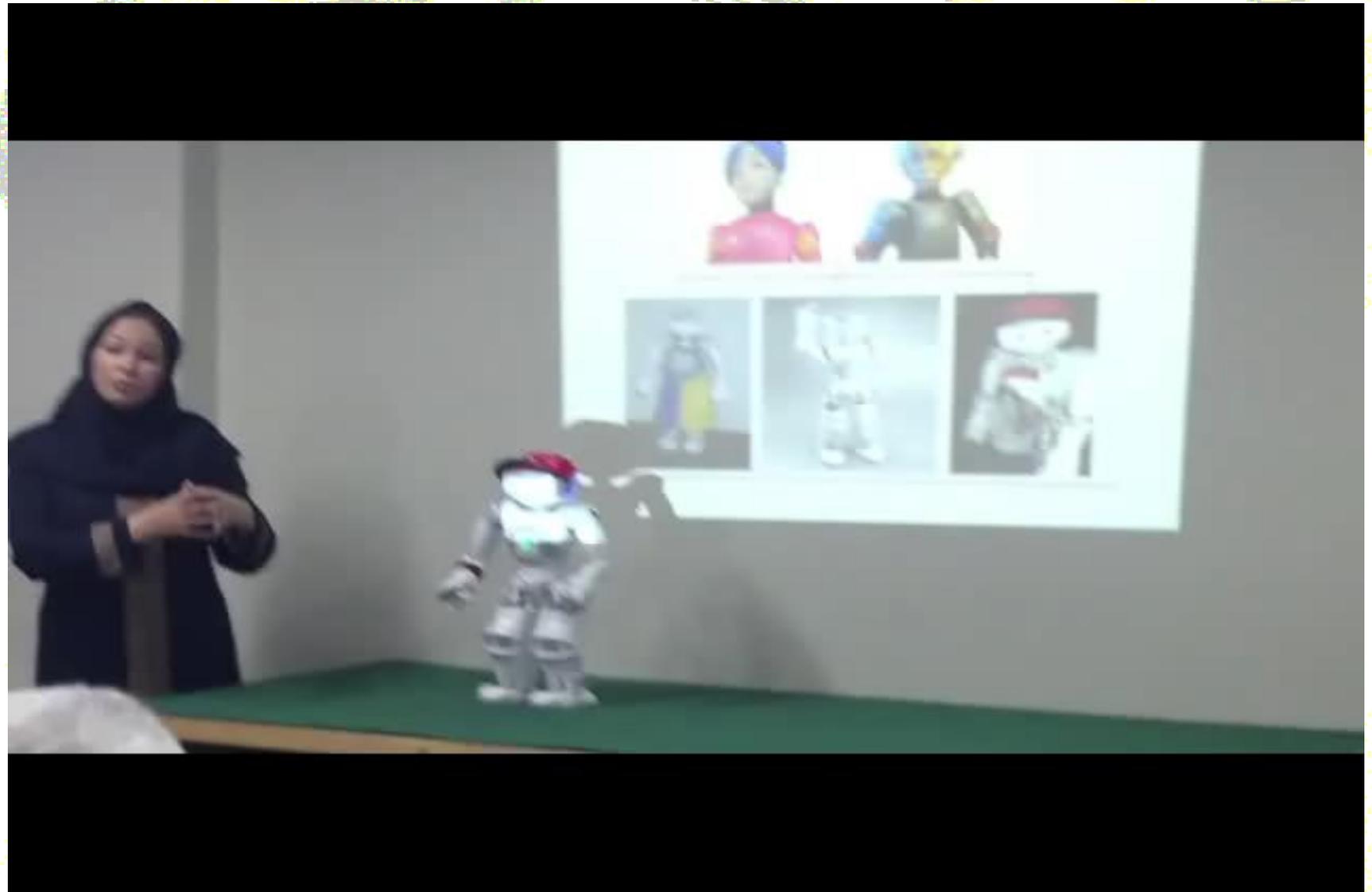
LEAD MCM/PM/JPEG Decoder Eval



Walking.avi



Applying Robots as Teaching Assistants in EFL Classes ...



Passive Robots - Humanoid



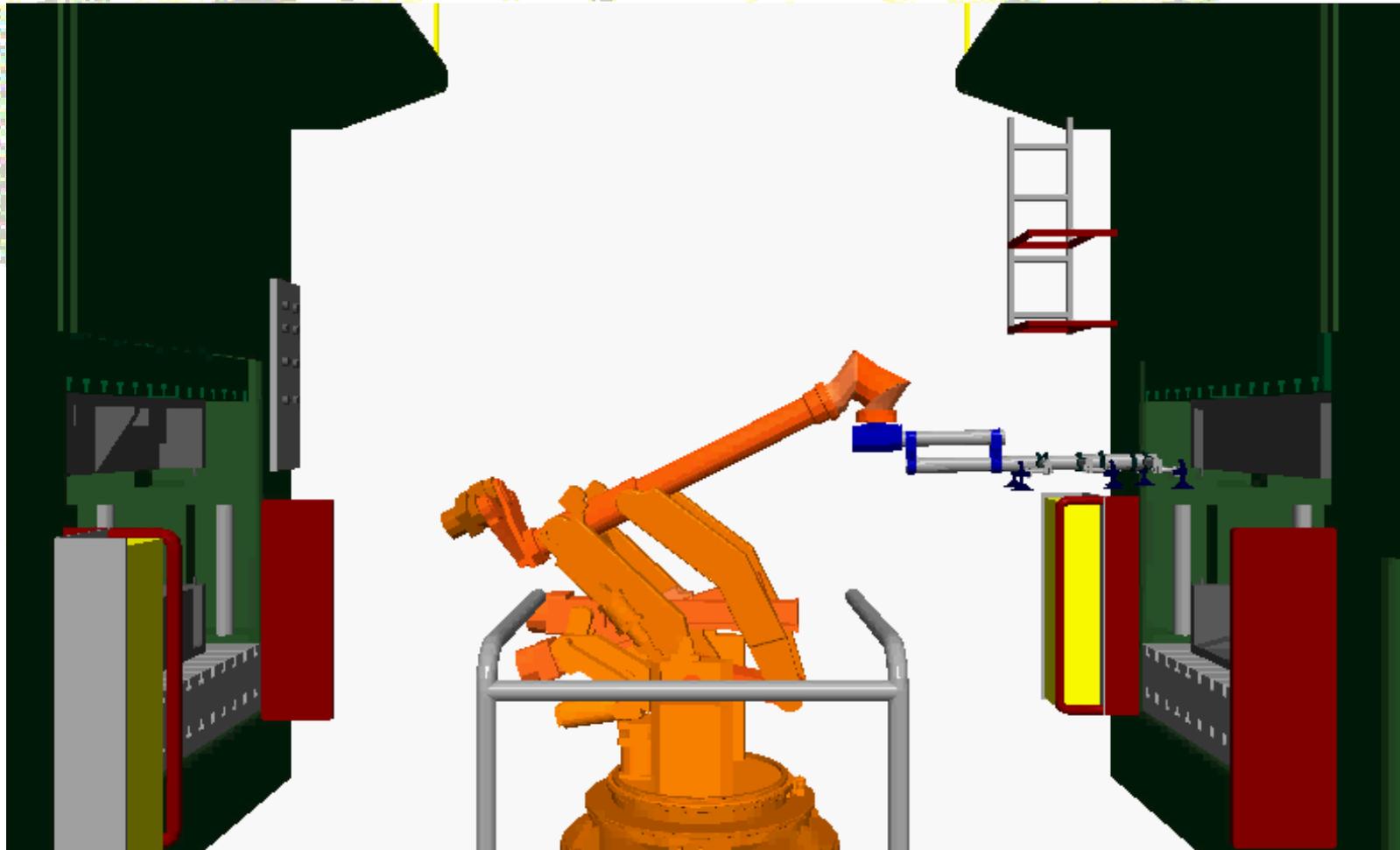
Cornell University
Human Power Lab



Robot Demos



Robot Demos



Robolens: A Clinical Surgery Assistant RobotBird, 1386 (2007), A. Mirbagheri, F. Farahmand, A. Meghdari

Laparoscopic surgery is a specific branch of Minimally Invasive Surgery (MIS) that is performed in the abdominal cavity. In this method "ROBOLENS" helps the surgeon by holding and moving the laparoscopic lens (camera) under his/her supervision during the surgical operation and acquires a stable view from the surgical site. It can be controlled by Voice commands or by a smart foot switch system.

The project is accomplished and the robot has passed technical and clinical tests at the **Imam Khomeini Hospital Complex**, Tehran, Iran.



The slide features logos for SUT, IDRO, and RCSTIM at the top. The main title 'Robolens' is written vertically on the left. The central text describes it as 'A Robotic Assistant for Laparoscopic Surgery' and lists its capabilities. On the right, there are images of the robot and a control panel, along with a list of tested applications. Contact information is provided at the bottom.

Robolens
A Robotic Assistant for Laparoscopic Surgery

- Holding and maneuvering of the laparoscopic lens under direct supervision of the surgeon
- Performing voice commands: up/down, left/right, zooming in/out without any need to training
- Smooth spherical movement with proper velocity in different configurations
- Stable view with no unwanted movement or vibration
- Reduction of the supernumerary staff
- Providing excellent geometrical accuracy
- Improving personal control of the surgeon over the procedure
- Reduced surgery time

Using minimum number of actuators
• Simple action
• High movement safety and automatic stopping in contact with inner viscera
• No contact with other surgery devices and surgeon's hands
• Capability of being operated under either of surgeon's hands
• Less than 30 seconds startup time

Tested Applications

- Laparoscopic General Surgery:
 - Cholecystectomy
 - Appendectomy
 - Splenectomy
 - Hernia repair
- Laparoscopic Urological Surgery:
 - Hand Assisted Laparoscopic Donor Nephrectomy
- Laparoscopic Gynaecological Surgery:
 - Hysterectomy
 - Endoscopic Thoracic Surgery
 - Thymectomy
 - Fetoscopy
 - Laser Treatment

Website: <http://rcstim.tums.ac.ir>
E-mail: mirbagheri@mech.sharif.edu

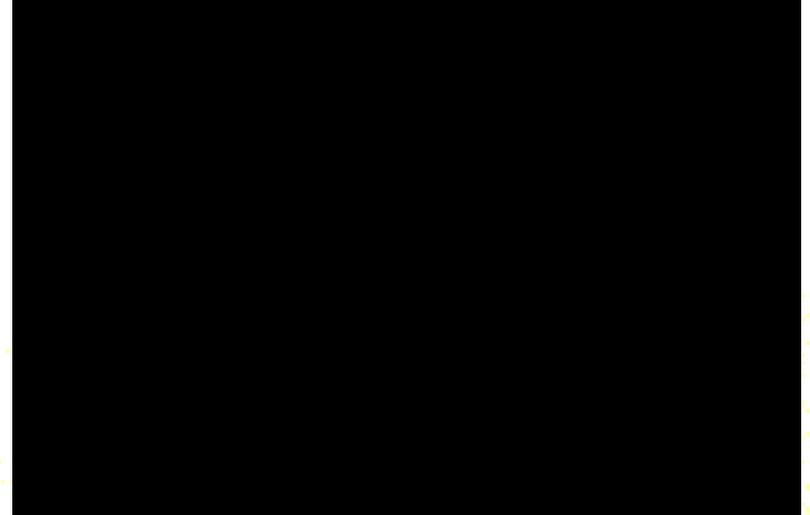
Tel: +98 21 66439831-2 (164-141)
Fax: +98 21 66438630
Imam Khomeini Hospital Complex, Keshavarz Blvd., Tehran, Iran



Animal Like Robots



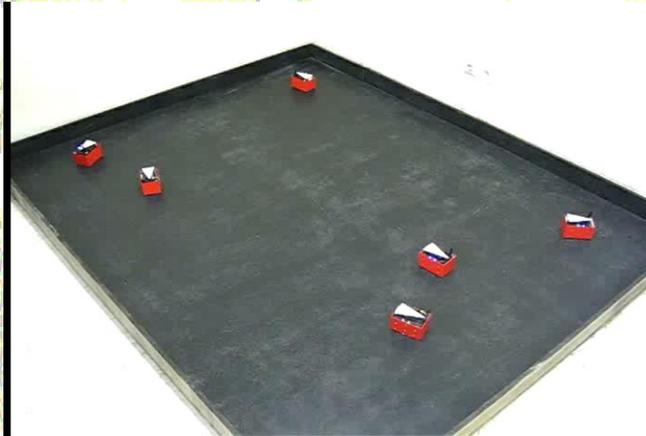
A Flying Insect



Animal Like Robots



Swarm Robots (توده رباتها)



Animal Like Robots



Animal Like Robots

