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# Introduction to Robotics
# Program Overview


Department of Mechanical Engineering
Massachusetts Institute of Technology

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# Outline

- Topic Overview
  - Mechanical design
  - Electrical components
  - Software design
- Project Overview
  - Mobile robot platform
  - Robotic arm control with ROS
- Software Installation
  - Mechanical design software options
  - Programming related software
- Additional Topics
  - Graduate school application
  - Personal research overview

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# Highlights

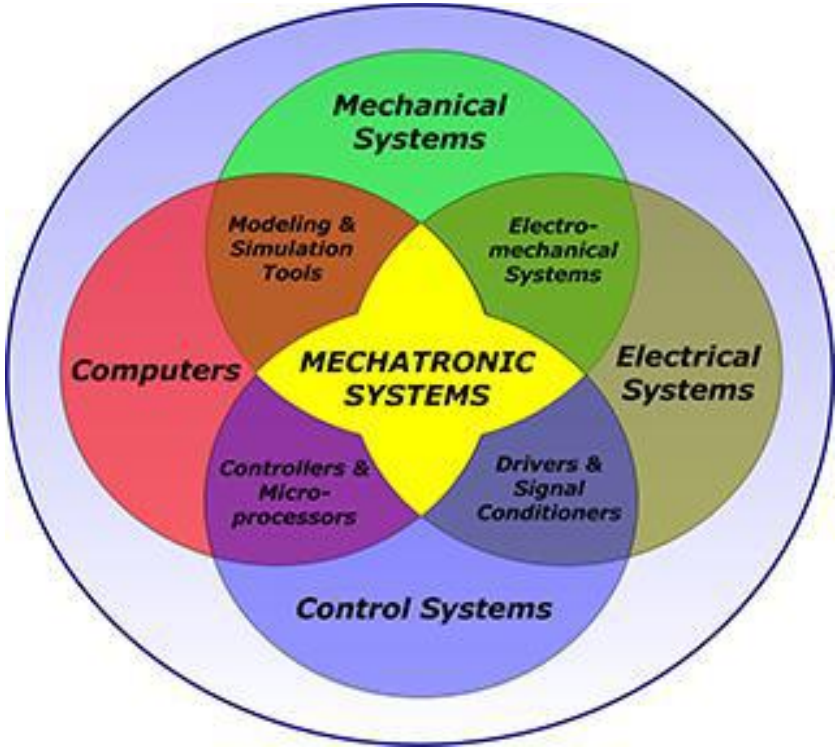
- Gain multidisciplinary insights into the field of robotics
- Obtain hands on experience for PCB design
- Work on the Robot Operating System to control your robots
- Learn LabVIEW: a program SpaceX uses to send rockets into space

ROS.org

NATIONAL INSTRUMENTS LabVIEW

# Mechatronic Systems Overview

- Mechanical Design and Manufacturing
- Electrical Hardware
- Control System
- Computer Program



# Topic Overview

- Computer Aided Design and Manufacturing
  - Mechanical product design procedure
  - Various manufacturing processes
  - Mechanism and transmission design
  - Control theory and application
- Electrical Components
  - Electronics and system identification
  - Arduino sensor overview and PCB layout
  - Embedded system programing
- Software Design
  - Python, C/C++, LabVIEW, Webpage programing
  - Robot operating system and Raspberry PI
  - Computer vision and machine learning

# Additional Topics

- Graduate School Application
  - Overview and timeline
  - GRE, TOEFL & GPA
  - Statement of purpose and CV
  - Letters of recommendation
  - Special notes

- Research Example for Instrumentation
  - Atomic force microscope overview
  - Jumping mode AFM imaging
  - Application of robotics knowledge
  - Discussion on research in graduate school

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# Time Table and Exercise

Day 1

- Session 1: introduction, project overview, manufacturing
- Session 2: electronics overview and basic circuit design
- Session 3: Arduino sensor and robot platform assembly
- Exercise 1: MIT green building modeling in Solidworks/Onshape
- Exercise 2: Prosthetic hand design analysis
- Exercise 3: mobile platform assembly
- Exercise 4: PCB layout for bandpass filter

Day 2

- Session 4: embedded system programing
- Session 5: control theory and application
- Session 6: inverted pendulum demo and vehicle control
- Exercise 5: Python exercise
- Exercise 6: control theory simulation exercise
- Exercise 7: complete vehicle control code

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# Time Table and Exercise

**Day 3**

- Session 7: introduction to mechanism design and robotic arm
- Session 8: research presentation from Peter
- Session 9: robot arm assembly and project practice
- Exercise 8: design of mechanism for 1 DOF index finger
- Exercise 9: finish robot arm assembly
- Session 10: introduction to ROS and Raspberry PI

**Day 4**

- Session 11: ROS robot arm control and personal research
- Session 12: LabVIEW overview and graduate school application workshop
- Exercise 10: walk through ROS publisher and subscriber tutorial
- Exercise 11:complete robotic arm ROS code
- Exercise 12: LabVIEW exercise

**Day 5**

- Session 13: Basic computer vision in robotics and webpage design
- Session 14: Introduction to machine learning
- Session 15: Final project competition
- Exercise 13: Python neural network evaluation of MNIST dataset

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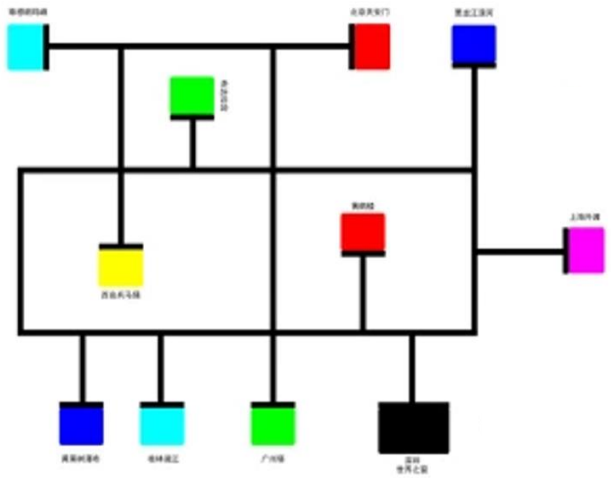
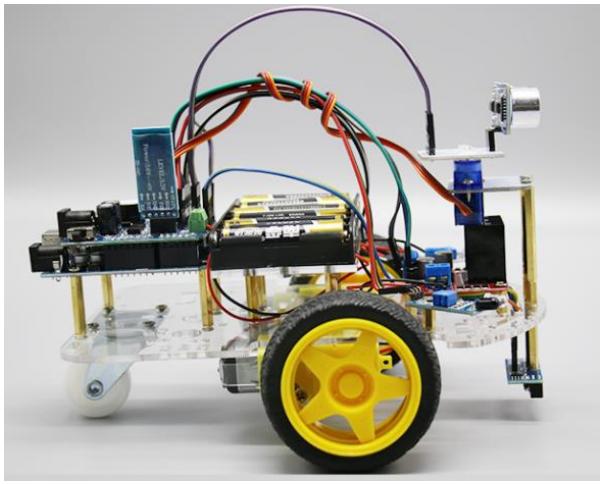
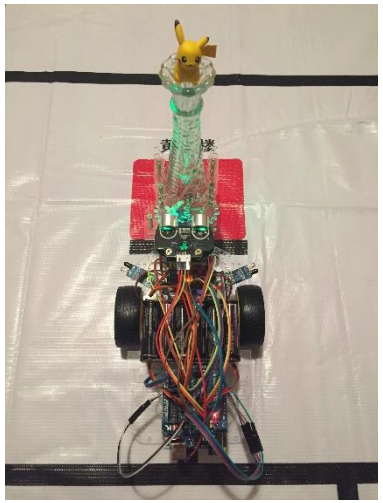
# Project Overview

- Mobile Robot Platform
  - Line following, ultrasonic distance, obstacle avoidance, optical encoder, grey scale sensors
  - Go to stop with same color as start to catch the Pokemon







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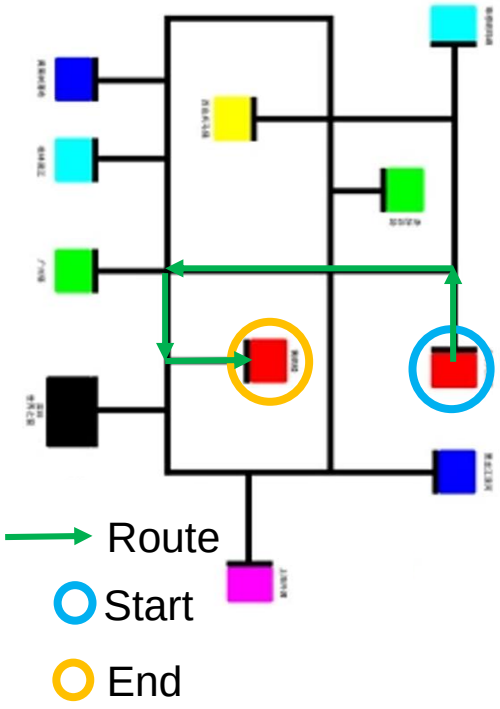
# Project Demo

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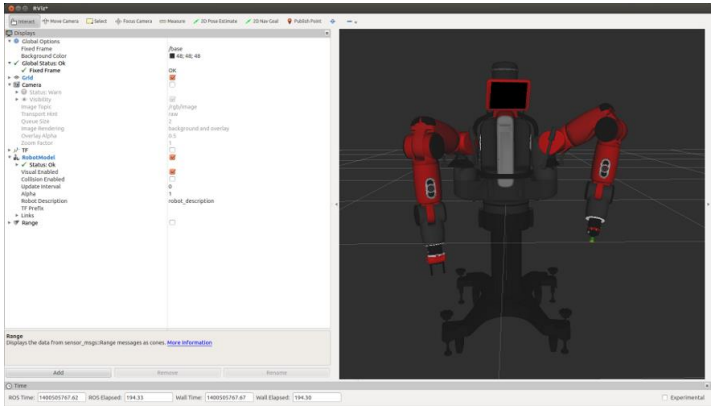
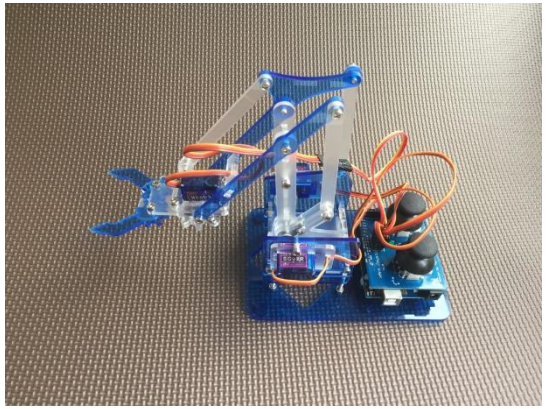
# Project Overview

- Robot Arm Control
  - Joystick control with Arduino
  - Robot operating system on Raspberry PI for visualization and control
  - Fill in the code and move your robot arm





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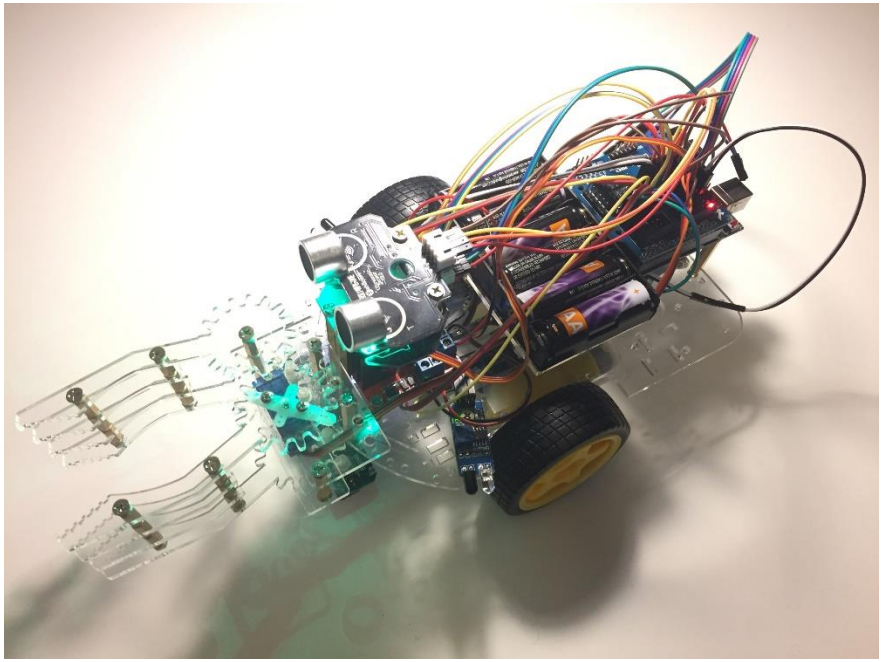
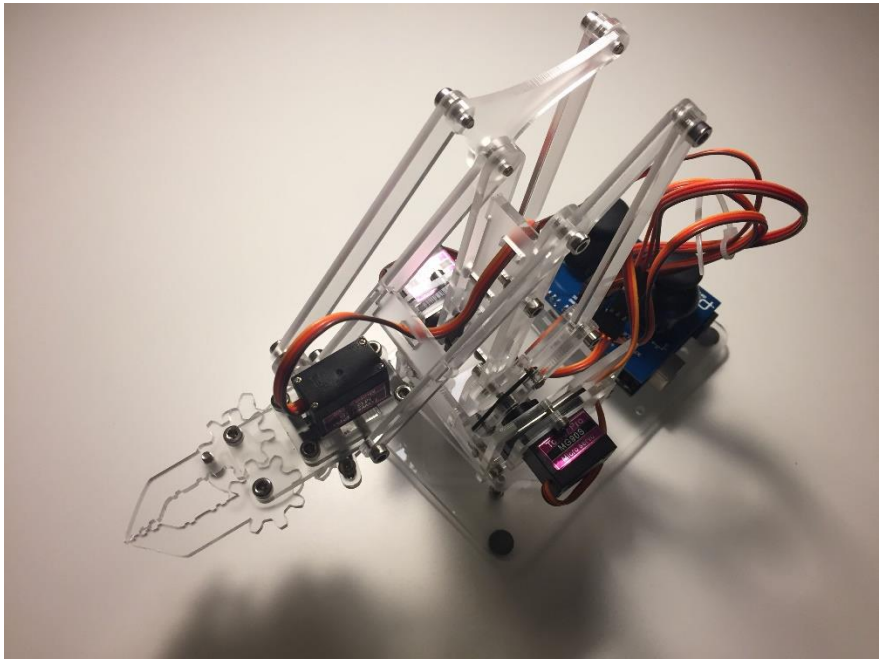
# Assembled Robots



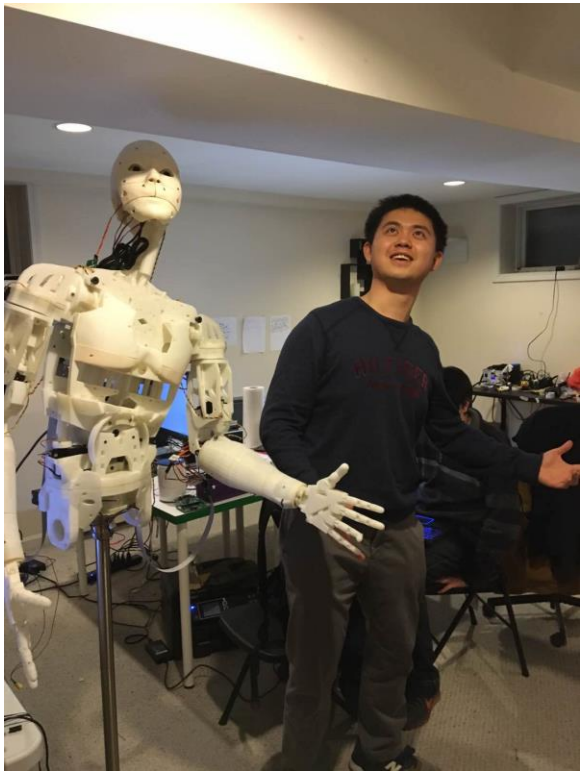


# Software Installation

- Mechanical Design
  - Solidworks (if you have it) or Onshape
- Embedded System
  - Arduino
  - Raspberry PI with ROS image or install on your own with instructions
  - Win32 Disk Imager SD card image burning tool
  - NI Multisim and Ultiboard
- Programming
  - Python 3.5 (or later) install via Anaconda
  - Editor Jupyter (in Anaconda), PyCharm (my favorite), Sublime Text
  - LabVIEW with NI license activator

# Teaching Assistant

- Fangzhou Xia
  - B.S. in ECE from Shanghai Jiao Tong University
  - B.S. in ME from University of Michigan, Ann Arbor
  - M.S. in ME at MIT
  - Ph.D. research assistant in mechatronics research lab
  - Teaching assistant of 2.12 introduction to robotics
  - Specialization: control, robotics and instrumentation




# Thank You!