CSE 481C
Robotics Capstone

Imitation Learning in Humanoid Robots

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http://www.cs.washington.edu/cse481c

What's on our plate today?

- Goals of this course
- Logistics & grading
- What is imitation learning?
- Some inspirational and not-so-inspirational examples from the web

Goals of the course

- To program a humanoid robot to imitate and learn new skills from human demonstration using a Kinect RGB+depth camera
- Learn how to solve sub-problems of (1) human motion interpretation from video, (2) control of a humanoid robot, and (3) application of probabilistic and machine learning techniques to imitation.
- Three teams of 4-5 students each.
- Two warm-up projects before you embark on a final course project of your choice.

Projects

1. Lab 0
   - Installation of software for Kinect and NAO, and basic testing [Today and tomorrow]
2. Warm up projects 1 and 2
   - Demo + Report for each
3. Final Project
   - Proposal + Demo + Report

Tentative Teams (semi-random assignment)

- Team 1: Chu, Davis, Goh, Oman, Sackler
- Team 2: Green, Ho, Scheibel, Sloan
- Team 3: Brook, Dodge, Peterson, Wu

- Contact instructor and TA today if you want to switch teams

Grading

10% Class and team meeting participation

30% Warm-up assignments

20% Final project proposal + final report

40% Final project presentation and demo

Prerequisites

Willingness to read, listen, and learn!

Good work ethic, team player, ability to get things done!

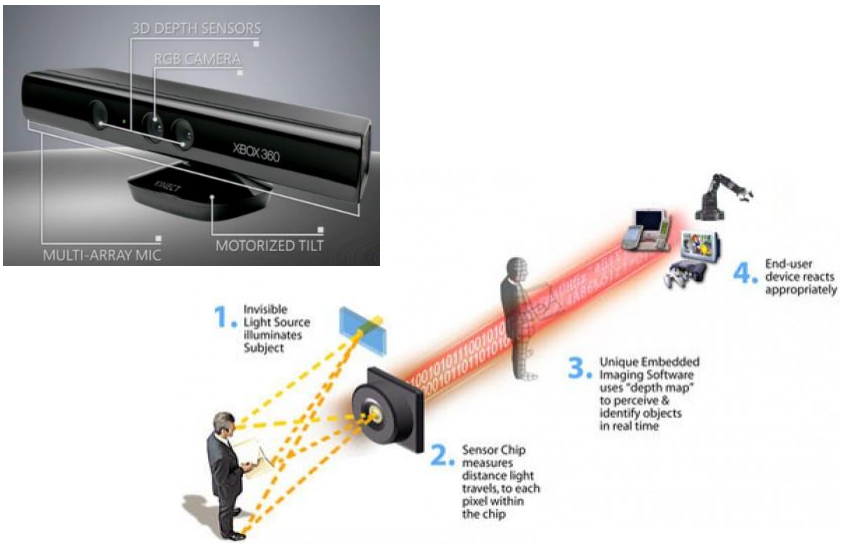
"Sky is the limit"-type can-do attitude!

Useful skills/knowledge:

- C# (easy to learn if you already know Java or C++)
- Linear algebra
- Computer vision or image processing
- Statistical Methods for CS
- AI and machine learning

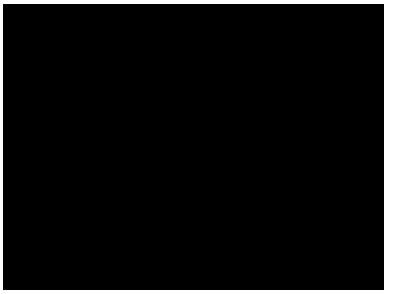
Enuff logistics, let's begin!

Kinect RGB-D camera



RGB + Depth Images

Skeletal Tracking using Kinect



(courtesy of
R. Chalodhorn, K. Lowry)

The NAO humanoid robot

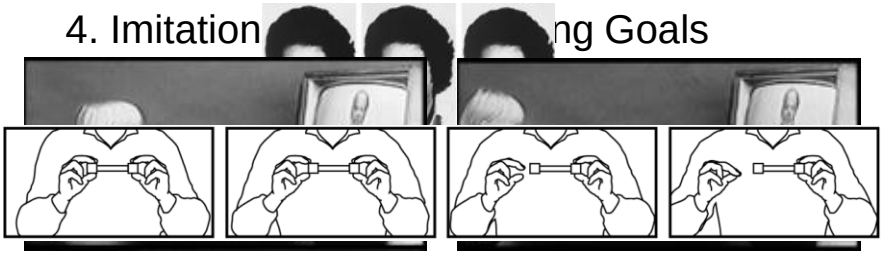
NAO commercial video

What is imitation learning?

Imitation in Humans

A four-stage progression of imitative abilities has been observed in human infants by Meltzoff and colleagues (Meltzoff, 2002):

1. Body Babbling
2. Imitation of Body Movements
3. Imitation of Actions on Objects
4. Imitation ng Goals



What is the state-of-the-art right NAO?

Kinect-Based Control of NAO

Kinect upper body controller for NAO (Eg. 1)

Kinect upper body controller for NAO (Eg. 2)

Kinect gesture-based control of NAO

Kinect-based following & pick-and-place tasks

(Somewhat painful) Banana cutting demo

Stable Full-Body Imitation

Example 1 (using a NAO but not Kinect)

Example 2 (using Kinect and a small humanoid)

Can we do better?

Final Project Ideas

- Stable Full-Body Imitation *Learning* of Human Actions
- Gaze Following and Pointing-Based Knowledge Acquisition from Humans
- Goal-Based Imitation of Human Actions (e.g., on objects) and Sequential Task Learning
- […feel free to fill in]

Today and tomorrow

- Installation of Kinect SDK and NAO SDK on lab computers (in CSE 345)
- Basic testing of Kinect, NAO simulator, and NAO pre-programmed behaviors