CS123 - Introduction

Programming Your Personal Robot

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Course Description

An introduction to the programming of a sensor-rich personal robot. This course extends programming from the virtual environment into the physical world, which presents unique challenges. Focus is on three areas of intellectual discourse that are fundamental to the programming of physical devices: communication with the devices; programming of event driven behaviors; and reasoning with uncertainty. The concepts introduced will be put into practical use through a series of class projects centered around programming your personal robot. This course also serves as a good introduction to Experimental Robotics by exposing students to basic concepts and techniques that are relevant for real world robot programming.

Is This Class For Me?

What It Is Not

- It's not about programming a "humanoid" robot
- It's not about low level robot control (i.e. dynamics and kinematics)
- It's not about AI

(e.g. motion planning)

Darpa Robotics Challenge 2015: Programming humanoid robot with dynamics/kinematics control with AI. (TEAM SNU)

What It Is

- An introductory class for students who have no (or very limited) experience of programming robots(physical devices) but are interested in learning more.
- A “sampler” (overview): we will cover a range of fundamental topics of robot programming, but we will not be able to go into any specific topic in depth.
  - Communication, Behavior, Uncertainty, Extension, Team
- It’s a good preparatory class for “Experimental Robotics”
- A very hands-on class (learning by doing)

Why Physical Device Programming

- Traditional computer (i.e. workstations, desktops, laptops) have very limited I/O (e.g. keyboards/monitors) and are constrained physically (offices/home)
- Smart Phones have “liberated” computer - can be taken almost everywhere and have more sensors (camera, GPS, G-sensors, and etc.)
- “Smart Device” is “the next big thing”– rich with I/O and connecting to the internet or other computing devices (phone and computer), these smart devices reach further into our life

What Are Smart Devices?

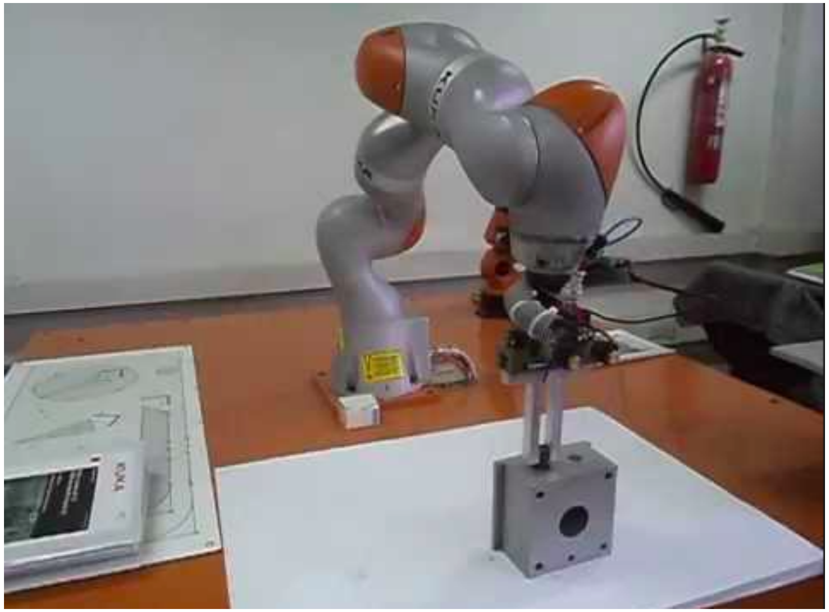
Robots Are Also Smart Devices (That Can Move)

What are Robots Essentially?

- Computers with
  - More sensing - Get more (information) from the environment
  - More actuation - Interact more with the environment

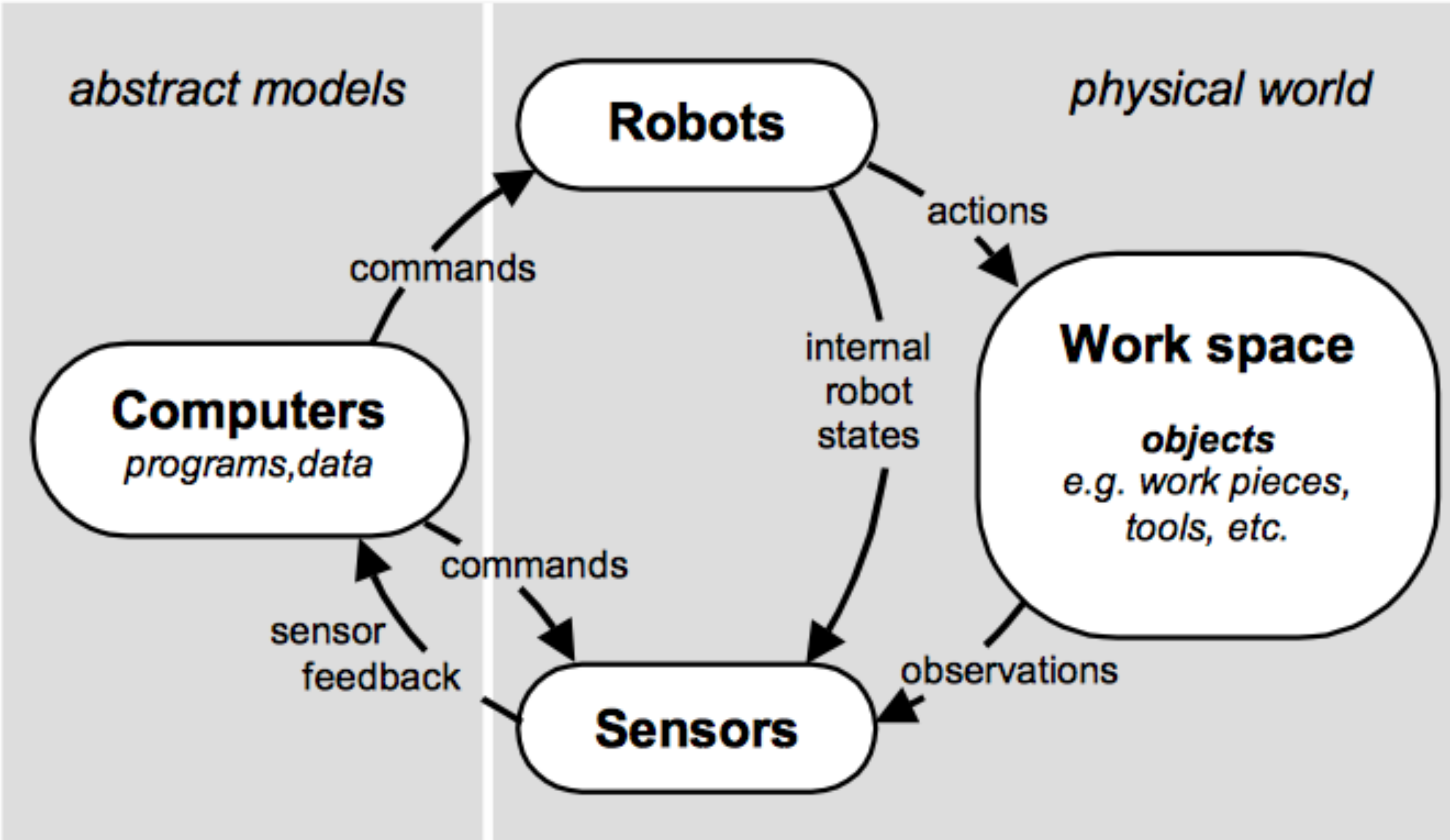
Unique Challenges

- Communication has limits
- Sensing is imperfect
- Control is inaccurate
- Knowledge of the world incomplete
  - Not available
  - Impractical
- In fact, human has the same limitation



The World is “Messy”

A Simplified Paradigm

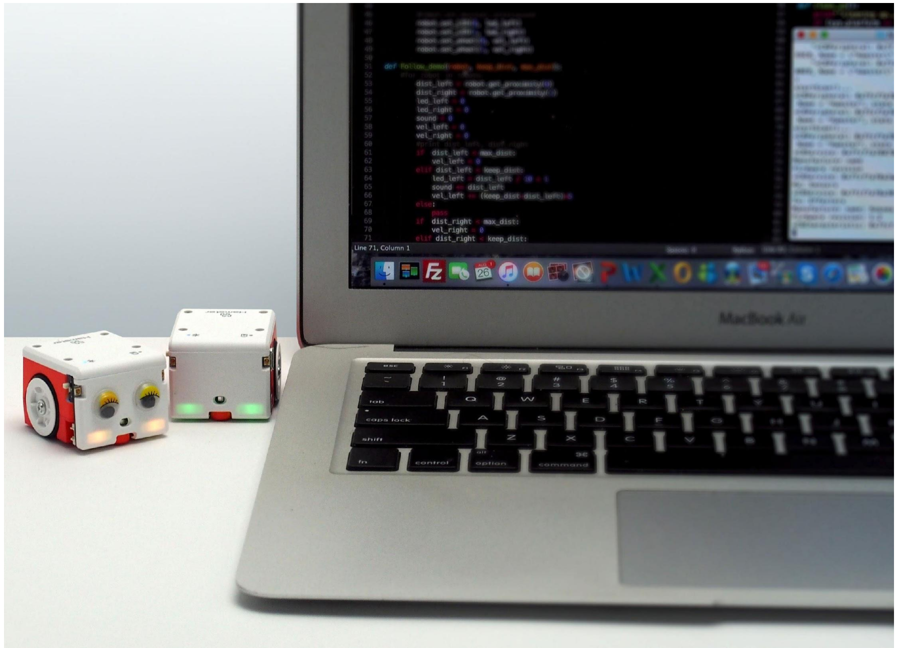


Virtual World

Real (Physical) World

Introducing Hamster

“Karel” Comes Into the Physical World



Karel (Virtual Robot):

- Perfect communication
- Perfect knowledge
- Perfect sensing
- Perfect (accurate) control
- High-level abstraction

Hamster (Real Robot):

- Limited communication
- Incomplete knowledge
- Uncertainty in sensing
- Imperfect control
- Low-level access

What You Should Know

- CS106
  - OOP
- CS107 a plus
- Python
  - Basic understanding
- Enjoy programming in general
  - Very hands-on

Syllabus

- Part 1 - Communicating with robot (2 weeks)
  - BLE communication and robot API
- Part 2 - Event Driven Behavior (2 weeks)
  - Finite State Machine (Behavior Tree)
- Part 3 - Reasoning with Uncertainty (2 weeks)
  - Dealing with noisy data, uncertainty in sensing and control
- Part 4 - Extending the robot (1 weeks)
  - I/O extensions: digital, analog, servo, pwm, etc
- Part 5 – Putting it together (including UI/UX) (3 weeks)
  - Design and implement of final (group) project
  - Encourage you to go “above and beyond”

Course Structure

- Lectures
  - Cover basic concepts
- Readings
  - Provide background and deeper knowledge on relevant topics
- Projects
  - Hands-on experience, learning by doing
- “Freestyle”
  - Going beyond class material on your own. Hamster is an open platform

Grading

- This class will be project base only
  - No exam ☺
- There will be 4 individual projects and 1 team (final) project
  - Project #1 (Communication) – 20%
  - 2 weeks
  - Project #2 (Finite State Machine) - 20%
    - 2 weeks
  - Project #3 (Uncertainty) - 20%
    - 2 weeks
  - Project #4 (Robot Extension) - 10%
    - 1 week
  - Project #5 (Final, Group project) - 30%
    - 3 weeks
    - Design your (team) project (need to get approval)

About US

- Instructors
  - Dr. Kyong-Sok “KC” Chang
  - Dr. David Zhu
- TA
  - Jocelyn Neff
  - Kornel Niedziela

Dr. Kyong-Sok "KC" Chang

- CS Ph.D. 2000 Stanford (Robotics)
- Professional Interest
    - Software framework for efficient modeling, simulation, and control of robotic systems
    - SimLab: Robotics Company (Korea)
        - Quadruped
        - Robotic Hand
        - Mobile base
        - Humanoid: DRC

Dr. David Zhu

- CS Ph.D. ’91: Stanford (Robotics)
- Professional Interest
  - Games
  - Toys to Life
  - Robots For Education
  - China

Artificial intelligence put to practical use

Computer science class applies robots to everyday tasks

By Carrie Chang

No, they aren’t walking garbage cans.

But these 3-foot cylindrical creatures might someday be the ones to take out your trash. Or lug your groceries to the front door. Or maybe even fry up a tasty omelette and deliver it to your bed in the morning.

Meet Karel the Robot in 3-D. Unlike its on-screen counterpart, however, these machines can do a lot more than pick up beepers and run through mazes. These “agents,” the subjects of a computer science course being offered this quarter, come equipped with sensors that allow them to assess their environments and alter their operations accordingly.

“Artificial intelligence for the past few decades has been concerned primarily with very brainy

Please see ROBOTS, page 2

Mimi Kuo — Daily

Robotics entrepreneur David Zhu, left, and Computer Science Prof. Mike Genesereth pose with Nomad and Vagabond, two robots to be used in an innovative class offered this fall.

Jocelyn Neff

- BS CS 2015, MS MS&E 2016
- Professional Interests
  - Autonomous Cars
  - Smart Home
  - Wearables
  - Geo
  - Knowledge Graph

Kornel Niedziela

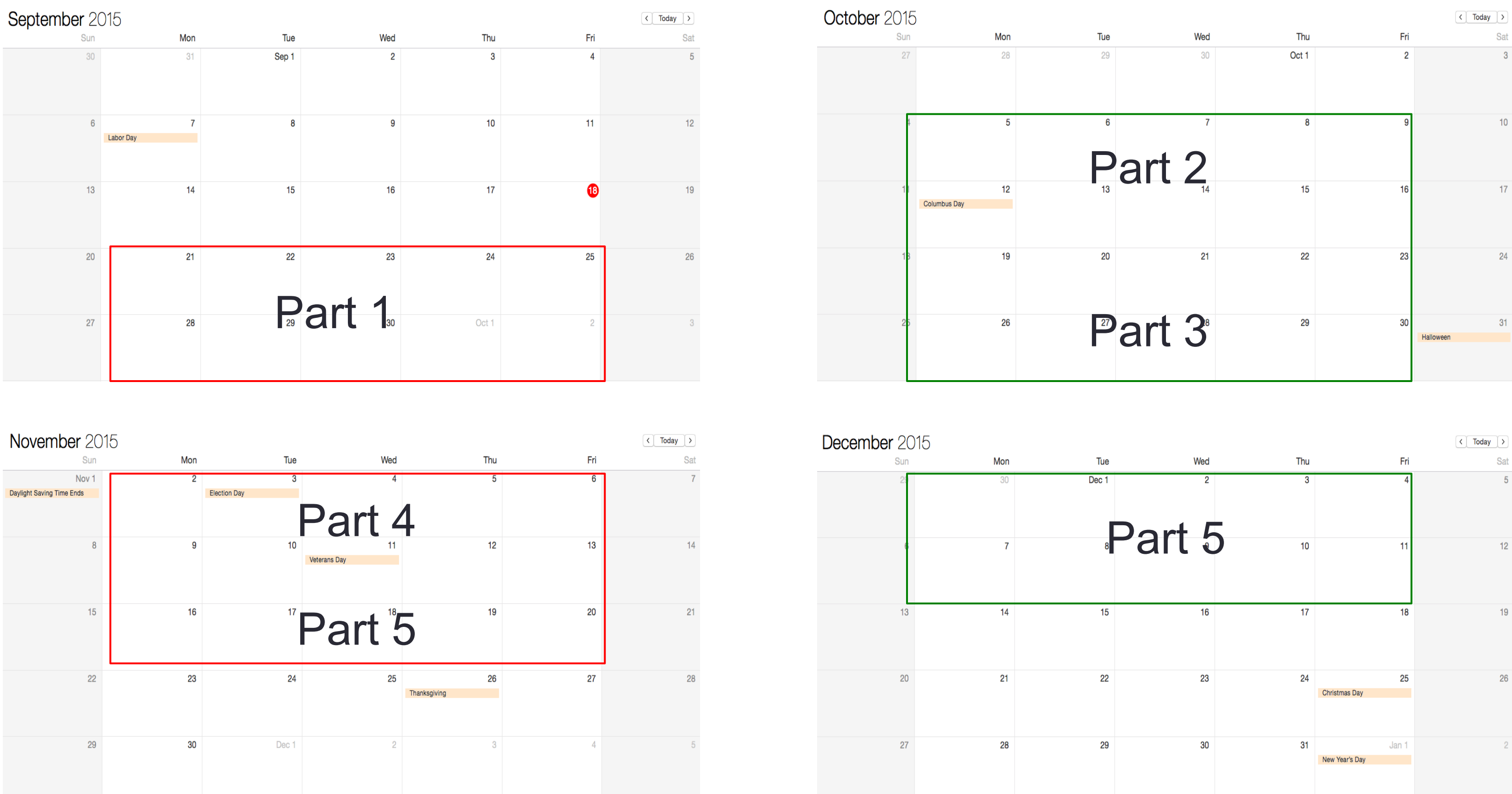
- B.ASc in Mechatronics Eng., U of Waterloo
- MSME, Stanford – Design Methodology focus
- Interested in:
  - Robotics
  - Product Design
  - Automotive

Logistics

- Getting your own Hamster
  - Sign-up sheet
- Programming environment
  - Mac
  - PC
- Website for the class
- TA sessions (office hours)
  - Location
  - Time
- Emails

Feedbacks Are Appreciated

Calendar



KC
Teaching

David
Teaching

BLE: Hamster

<u>Generic Apps: connecting to Hamster</u>

-- iPhone, iPad, Mac: LightBlue

-- Android: nRF Master Control Panel

<u>Sensors: (UUID: 0x00009001...)</u>

-- Read data (20 bytes) from Hamster.

(in hex)

1st byte: version/topology

2nd byte: network ID

3rd byte: command/security

4th byte: Signal Strength (-128~0)

5th byte: Left Proximity (0~255)

6th byte: Right Proximity (0~255)

7th byte: Left Floor (0~255)

8th byte: Right Floor (0~255)

<u>Effectors: (UUID: 0x0000A0000...)</u>

-- Write 11 bytes to Hamster.

<0000103232020300000040>

(in hex)

0x00: version/topology

0x00: network ID

0x10: command/security

0x32: left wheel speed (50: -100~100)

0x32: right wheel speed (50: -100~100)

0x02: left LED color (green: 0~7)

0x03: right LED color (blue: 0~7)

0x00: buzzer high

0x00: buzzer middle

0x00: buzzer low

0x40: musical note (C4: middle C: 0-88)

BLE: Reading

This week's(and future) reading for BLE.

“Getting started with Bluetooth Low Energy” by Townsend, Davidson & Akiba, O’Reilly

https://www.safaribooksonline.com/library/view/getting-started-with/9781491900550/cover.html