CMRoboBits:
Creating Intelligent Robots
Introduction

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TA: Stefan Zickler

15-491, Fall 2007

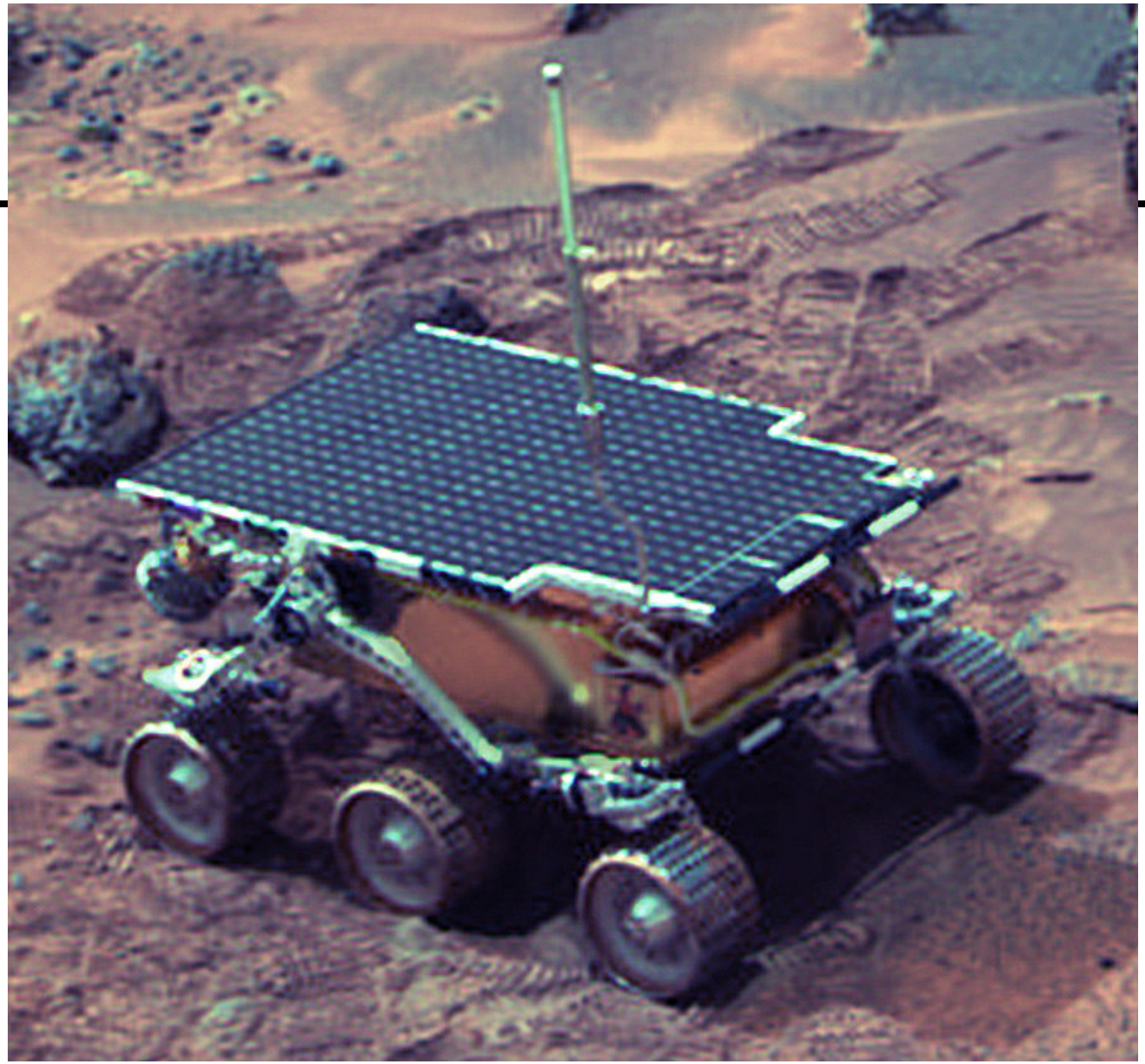
http://www.andrew.cmu.edu/course/15-491

Computer Science Department

Carnegie Mellon

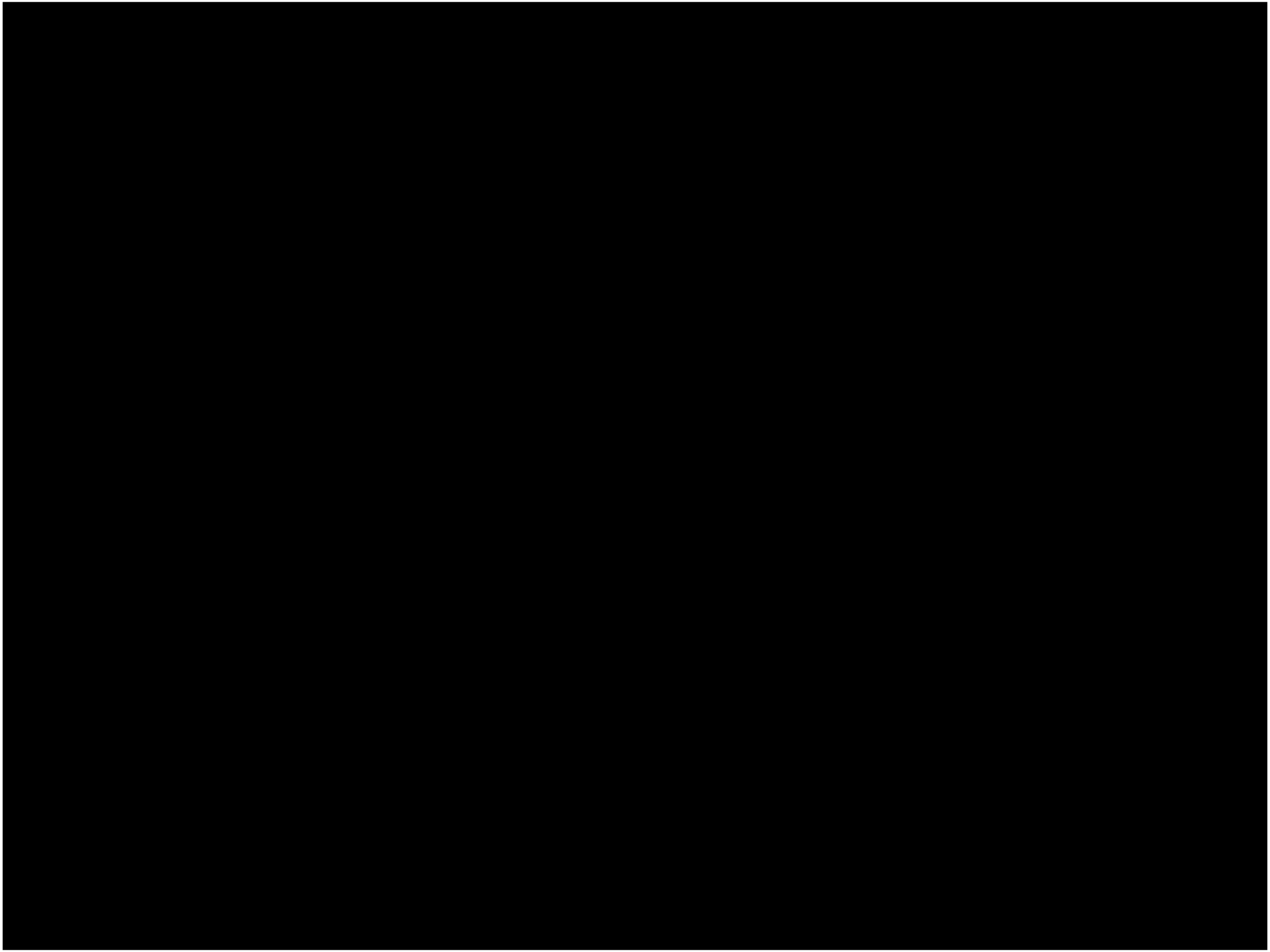
What is a *Robot*?

- Many *robots*…

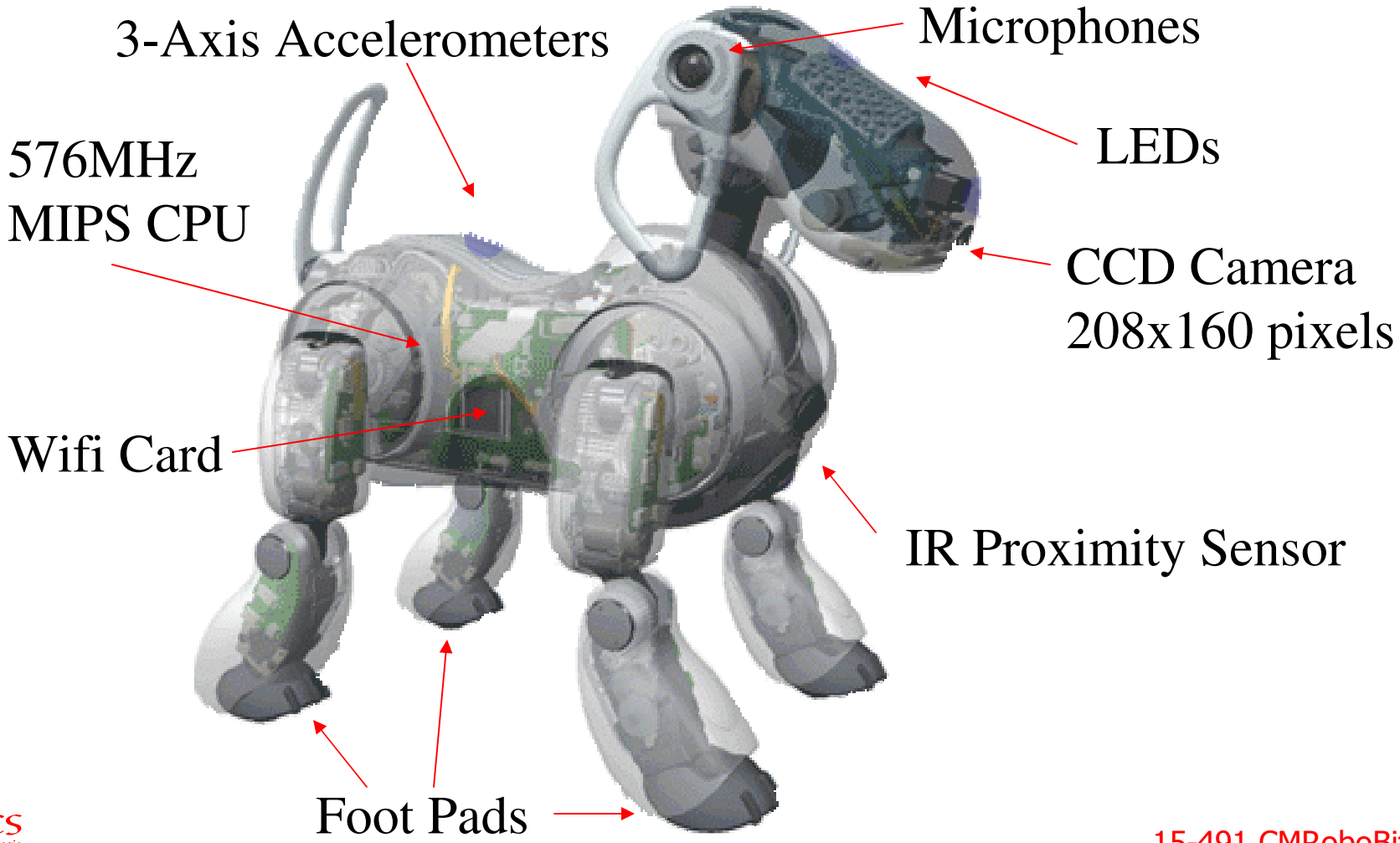


Roboceptionist

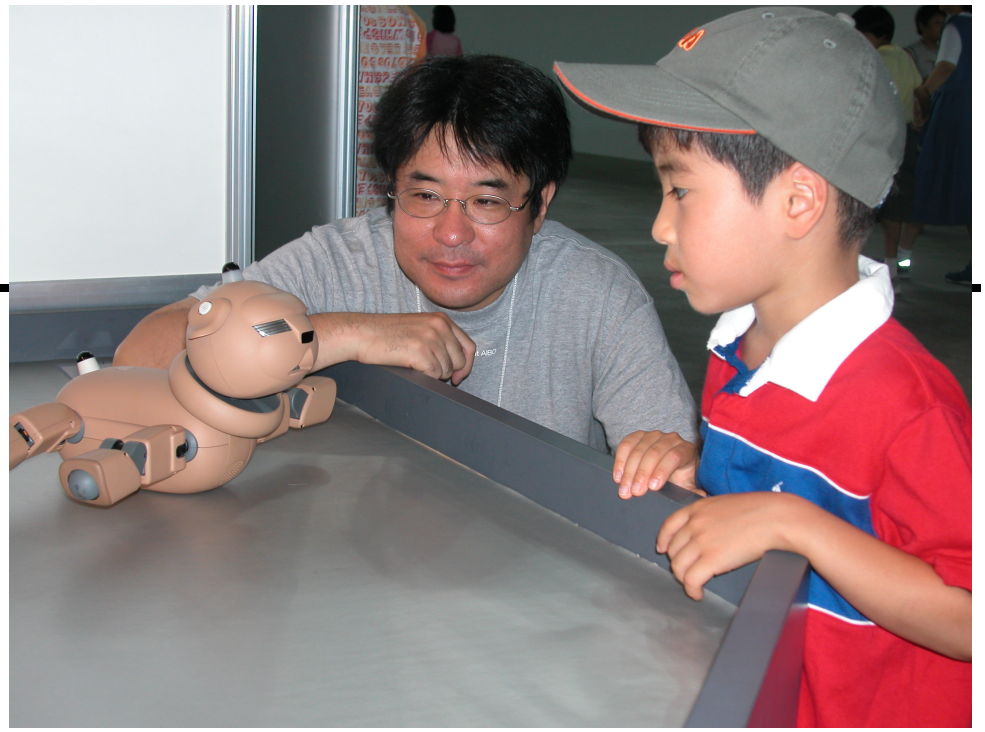
CAT

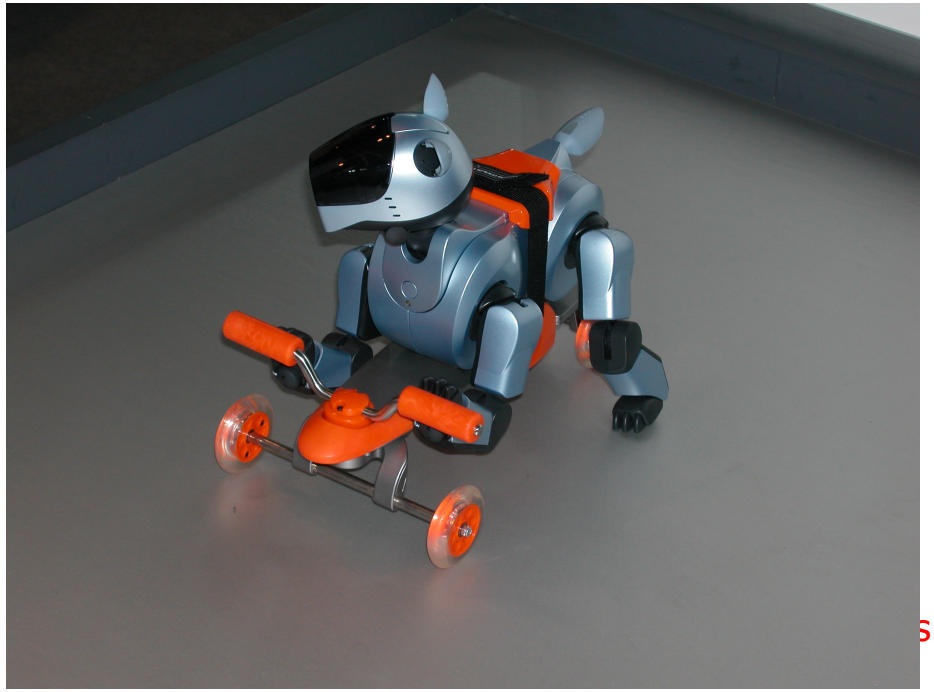


AIBO ERS-7


3-Axis Accelerometers
Microphones
576MHz
MIPS CPU
LEDs
CCD Camera
208x160 pixels
Wifi Card
IR Proximity Sensor
Foot Pads

STAFF



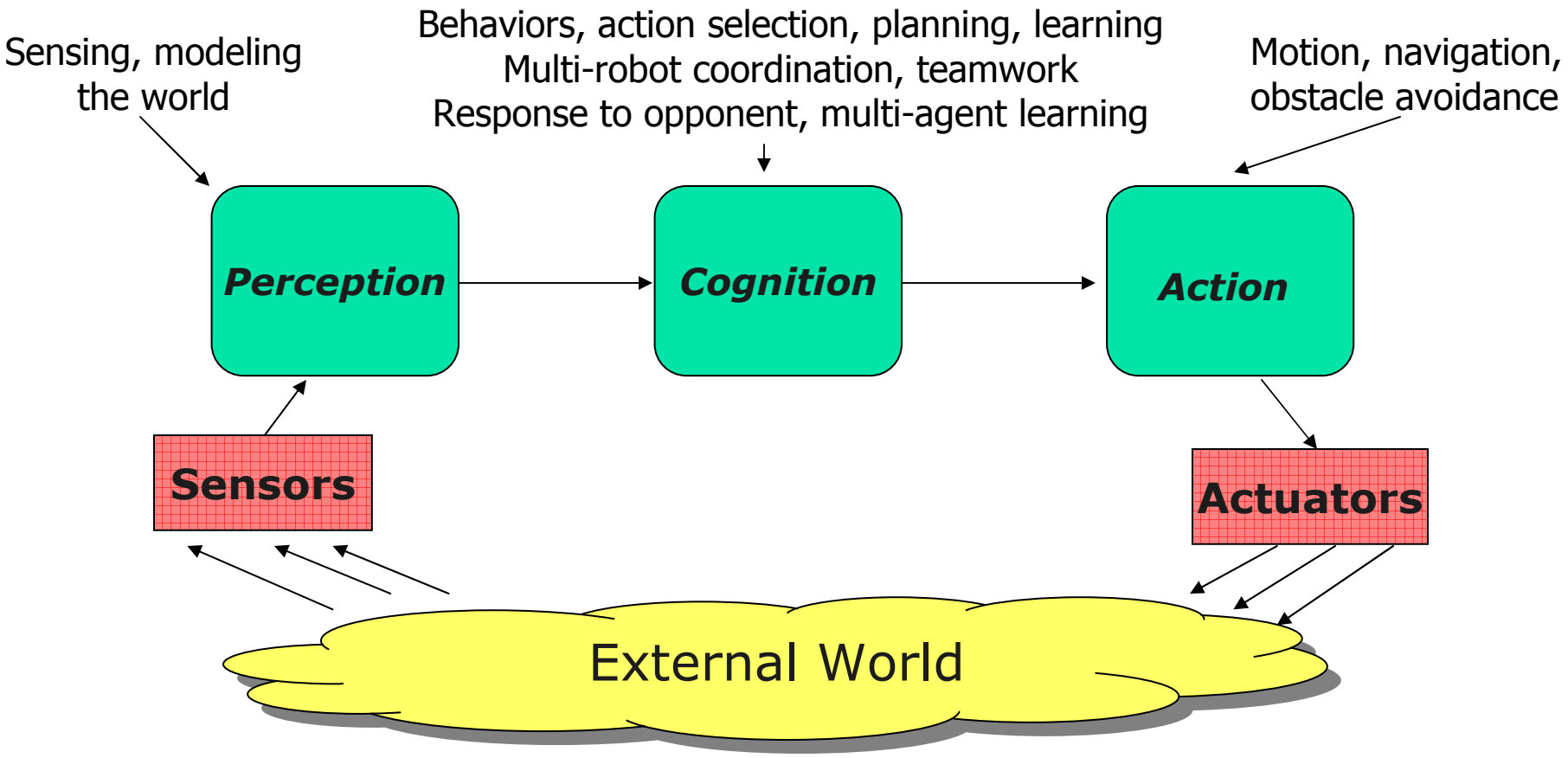


What is a Robot?

競技場

RoboCup
Robotinho
Jupp
Gerd
Paul
Sepp
Bruno
April
Kay

Intelligent Complete Robot



Course Motivations

- Robots are *integrated intelligence:*
  - Sensing & perception
  - Behavior & cognition
  - Learning from the real world
  - Motion & kinematics
  - Multi-robot cooperation & coordination
- Previous courses: AIBO only

RoboCup

"RoboCup is an international research and education initiative. Its goal is to foster artificial intelligence and robotics research by providing a standard problem where a wide range of technologies can be examined and integrated."

- Simulation (since 1996)
- Small-sized (since 1997)
- Mid-sized (since 1997)
- Legged (since 1998)
- Junior : Soccer, Dance, Rescue (since 2000)
- Rescue (since 2000)
- Humanoid (since 2000)

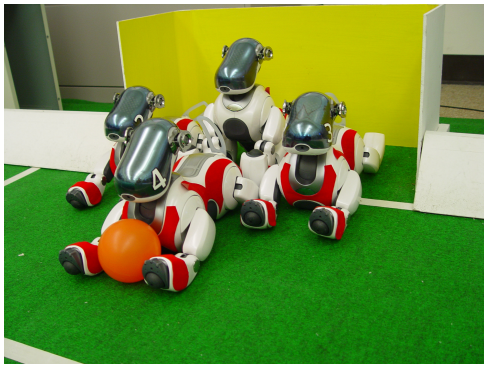
By the year 2050,

develop a team of fully autonomous humanoid robots that can win against the human world soccer champion team.

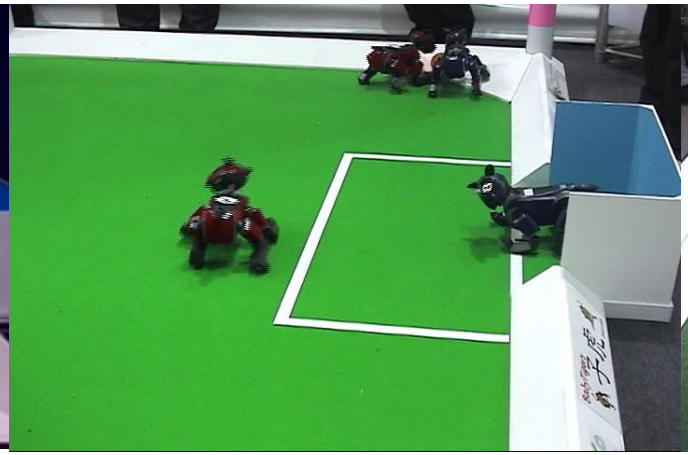
http://www.robocup.org

Legged Robots in RoboCup

- Robust hardware - SONY AIBO robots



1999

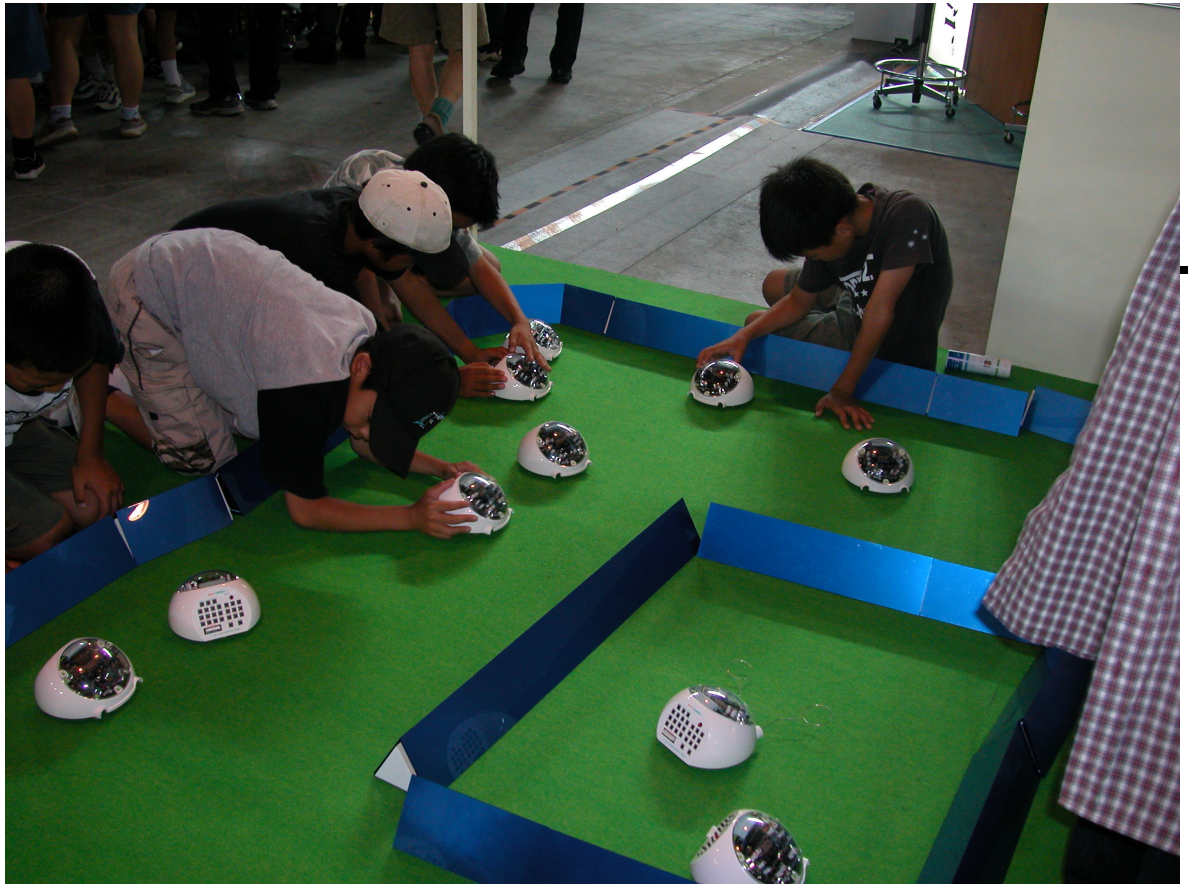


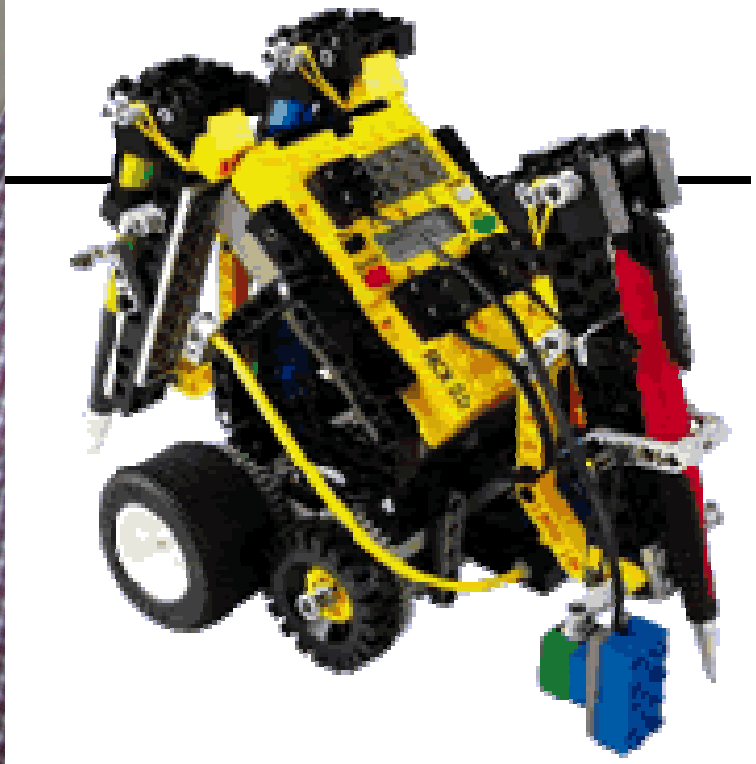
2001

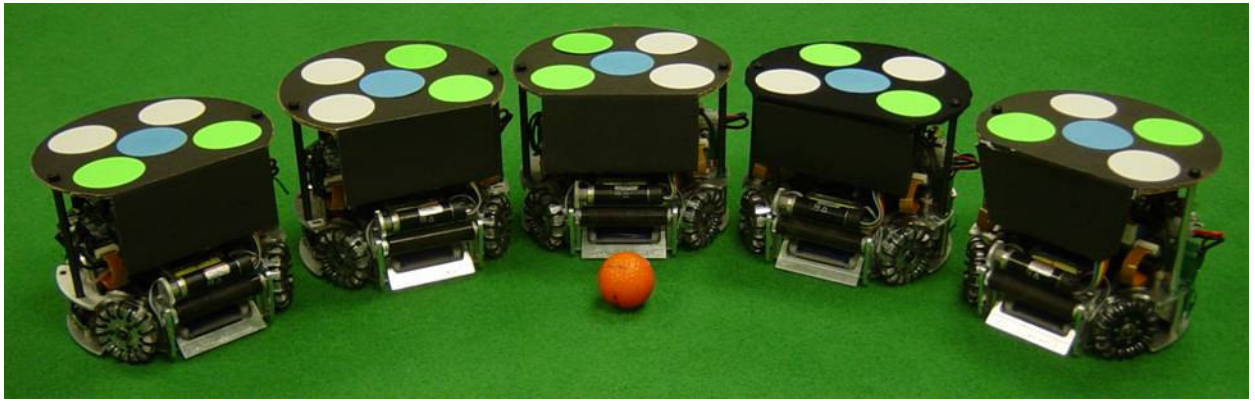
2003

The CMRoboBits Course

- From robot soccer to making AIBOs accessible to all
- How do you solve problems in “real-time”?
- Sensors are inherently noisy. How do you develop behaviors robust to errors?
- How do you coordinate the actions of multiple robots?

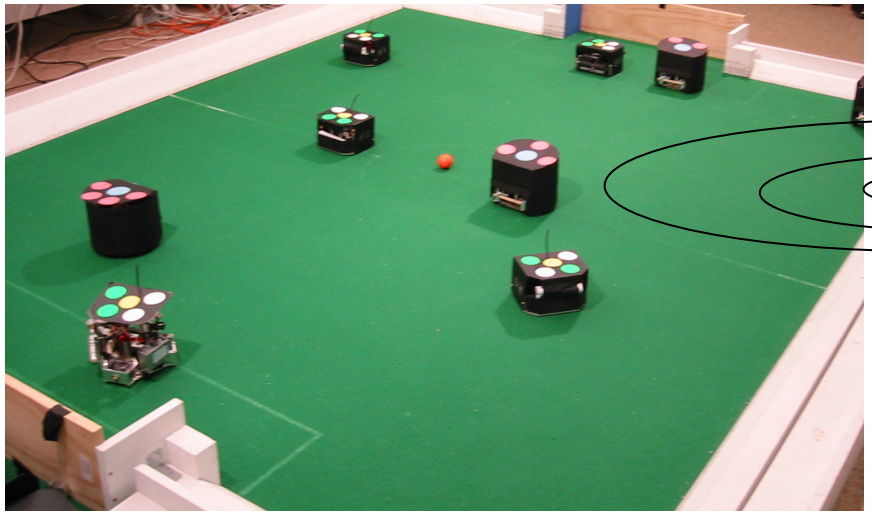


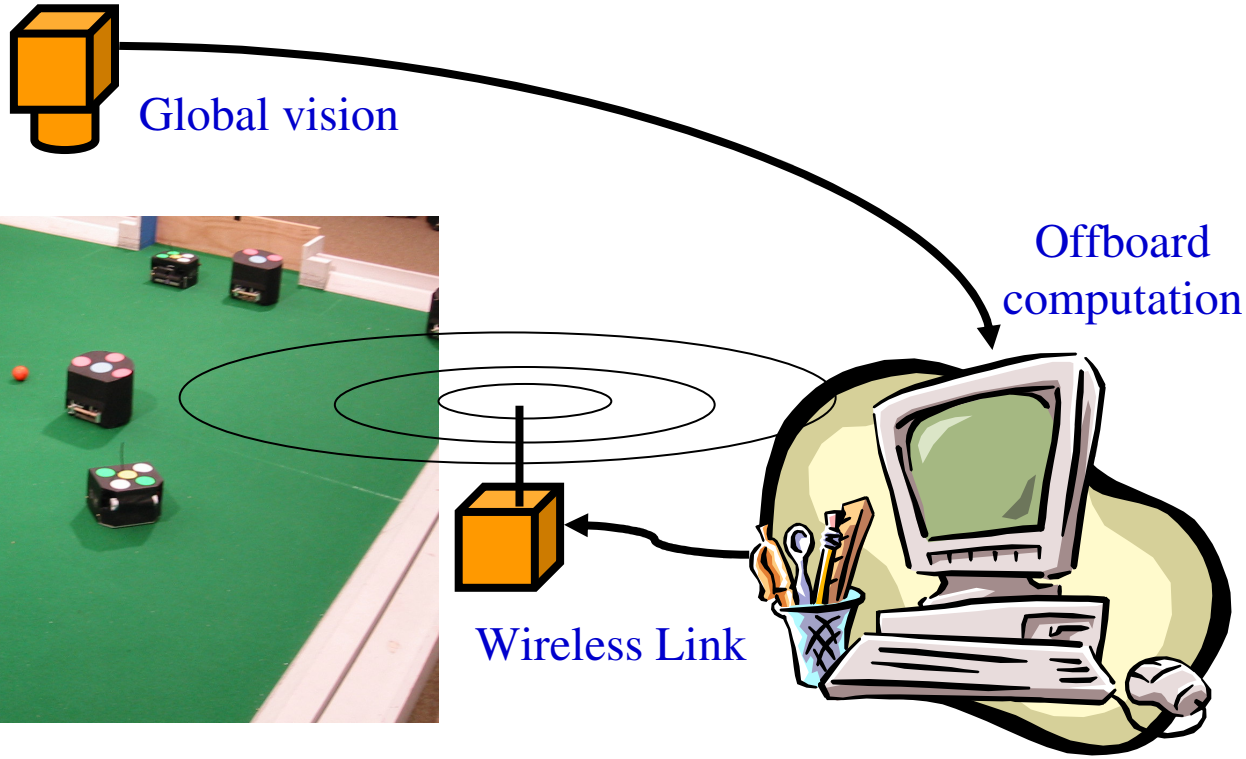




Small-Size Robot Soccer

10 robots + golf ball
5 robots per team
Color markers for ID

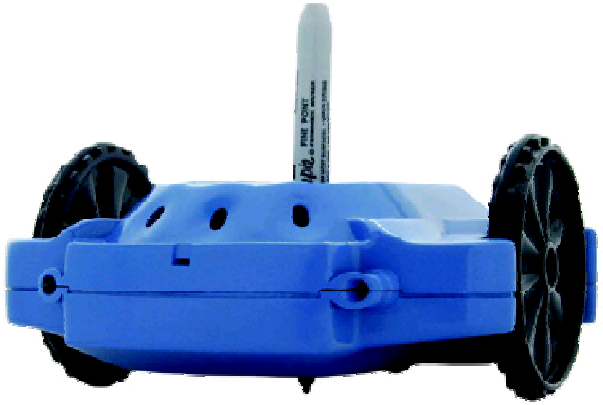




Robot team is autonomous as a *whole*

CMRoboBits Fall 2007

- Multiple robots
- iRobot Create, www.irobot.com
- Scribbler, www.scribblerrobot.com



Scribbler Demo

Simplest Obstacle Avoidance

```
def main():
    while True:
        L,R = getIR()
        L = 1 - L
        R = 1 - R
        if L and R:
            move(0,0.5)
        elif L:
            move(0.6,-0.5)
        elif R:
            move(0.6,0.5)
        else:
            move(0.6,0)
```

CMRoboBits Schedule 07

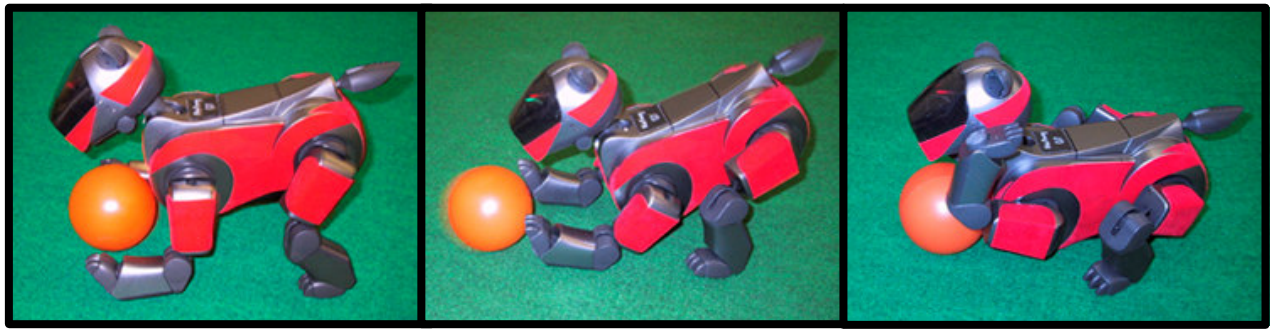
- M, Aug 27 – Introduction
- W, Aug 29 – Lab: Robot setup

- M, Sep 3 – Labor's day – no class
- W, Sep 5 – Lab: Hmw 1 – Scribbler motion modeling

- M, Sep 10 – Robot sensor uncertainty
- W, Sep 12 – Lab: Hmw 2 – MSRS – iRobot

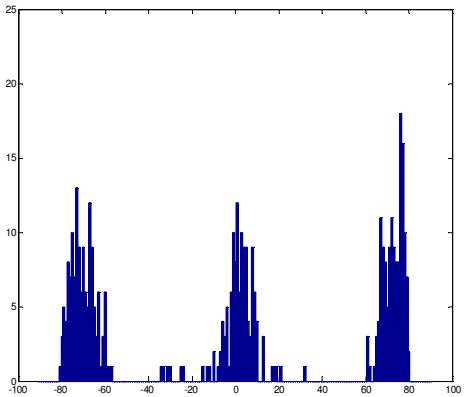
Uncertainty of Robot Actions

- Example: AIBO kicks as planned motions
  - frame-based with kinematic interpolation

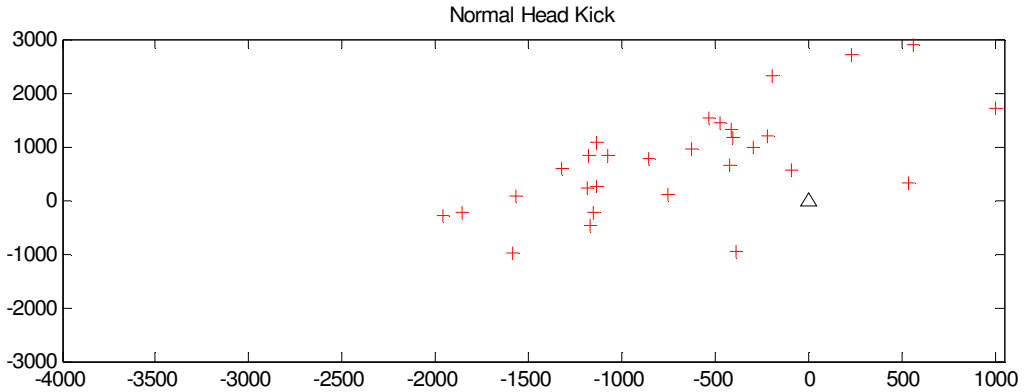


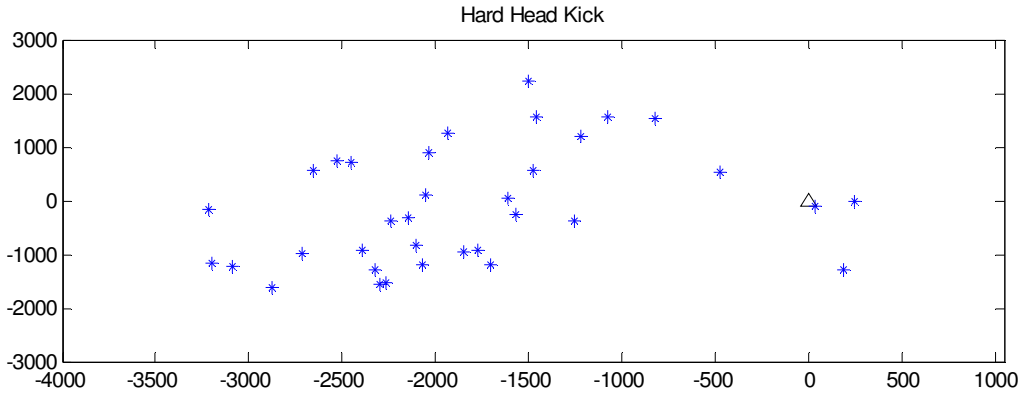
Handling Uncertainty: Model-Based Kick Selection

- Modeling effects of different kicks
  - Angle analysis



  - Strength analysis





SCS Carnegie Mellon

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CMRoboBits Schedule 07

- M, Sep 17 – Robot behaviors
- W, Sep 19 – Lab: Hmw 3 – Motion, line following

- M, Sep 24 – Robot vision I
- W, Sep 26 – Lab: Hmw 4 – Scribbler and iRobot warmups

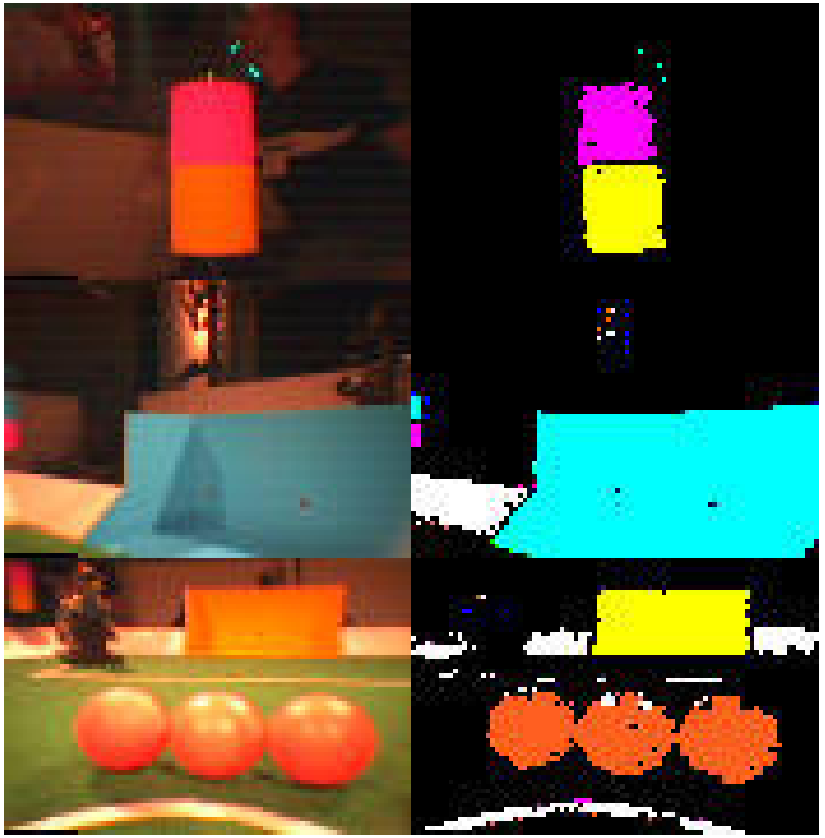
- M, Oct 1 – Path planning
- W, Oct 3 – Lab: Hmw 5 – Stationary obstacles

- M, Oct 8 – Robot Vision II – filtering/prediction
- W, Oct 10 – Lab: Hmw 6 – Moving obstacles

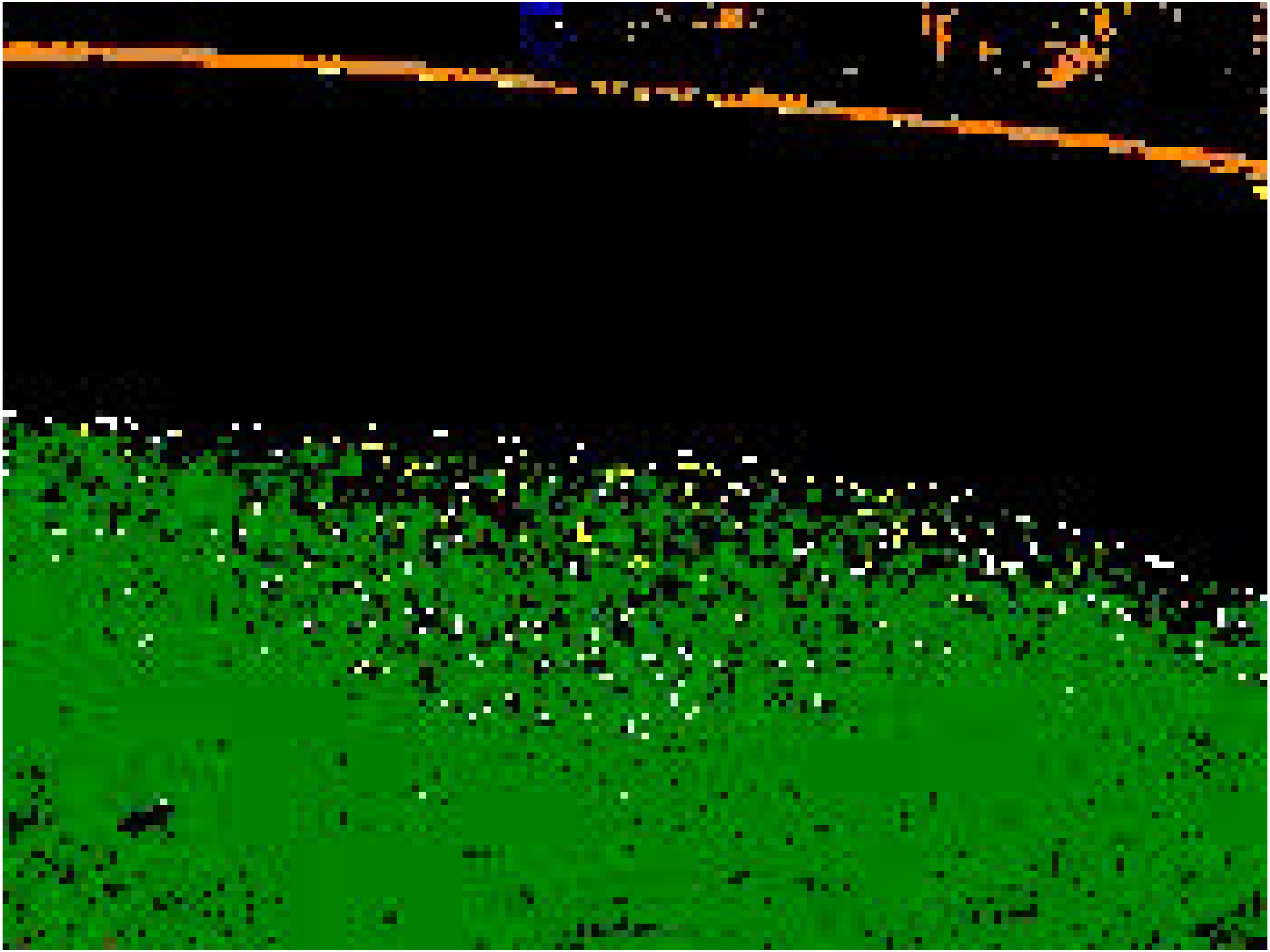
CMRoboBits Robots

- AIBOs and ER1-based robots
- Vision

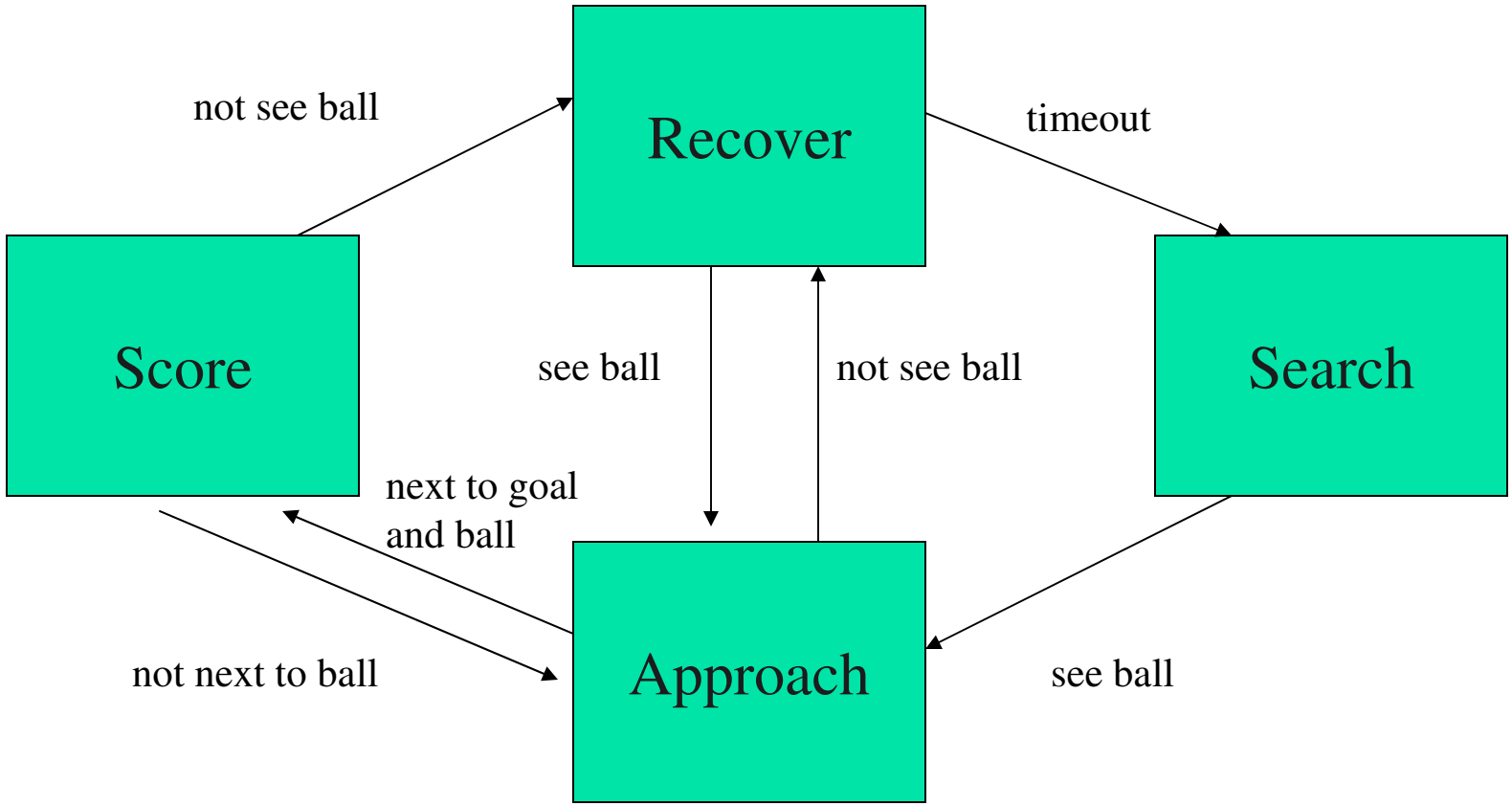
Perception: Vision



- Real-time and robust
- Effective calibration
- Colored blobs identified as objects
- Confidence computed



Cognition: Behaviors



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Path Planning

CMRoboBits Schedule 07

- M, Oct 15 – Multi-robot introduction
- W, Oct 17 – Lab: Hmw 7 – Multi-robot communication

- M, Oct 22 – Multi-robot play coordination and learning
- W, Oct 24 – Lab: Hmw 8 – Plays: definition, switching, and adaptation

- M, Oct 29 – Multi-robot distributed plays
- W, Oct 31 – Lab: Hmw 9 – Maze-based plays

CMRoboBits Schedule 07

- M, Nov 5 – Multi-robot state estimation
- W, Nov 7 – Lab: Hmw 10 – Multi-robot treasure hunt

- M, Nov 12 – Robot Vision III – multi-object detection
- W, Nov 14 – Lab: Hmw 10 – continuation

CMRoboBits Schedule 07

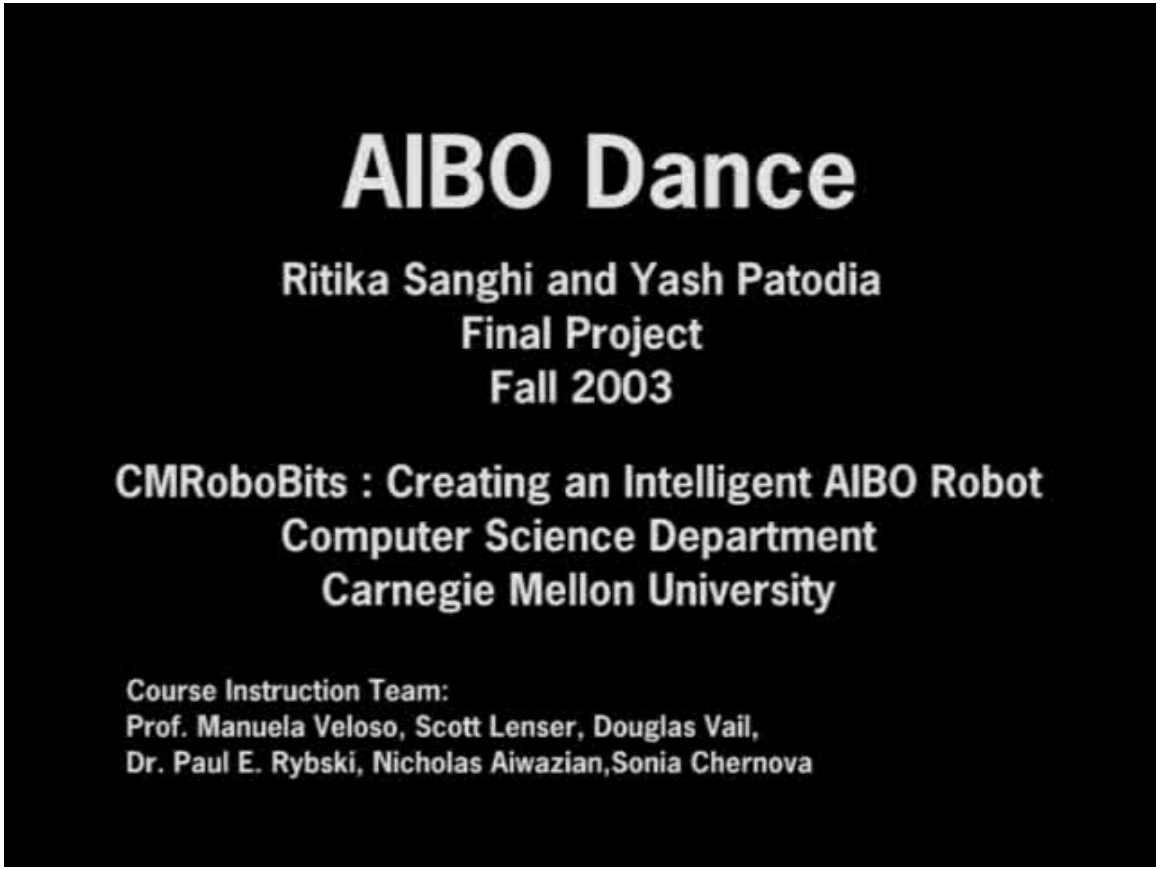
- M, Nov 19 – Multi-robot coordination (Hmw 10 due)
- W, Nov 21 – No class – Thanksgiving – Projects start

- M, Nov 26 – Multi-robot game playing and learning
- W, Nov 28 – Projects

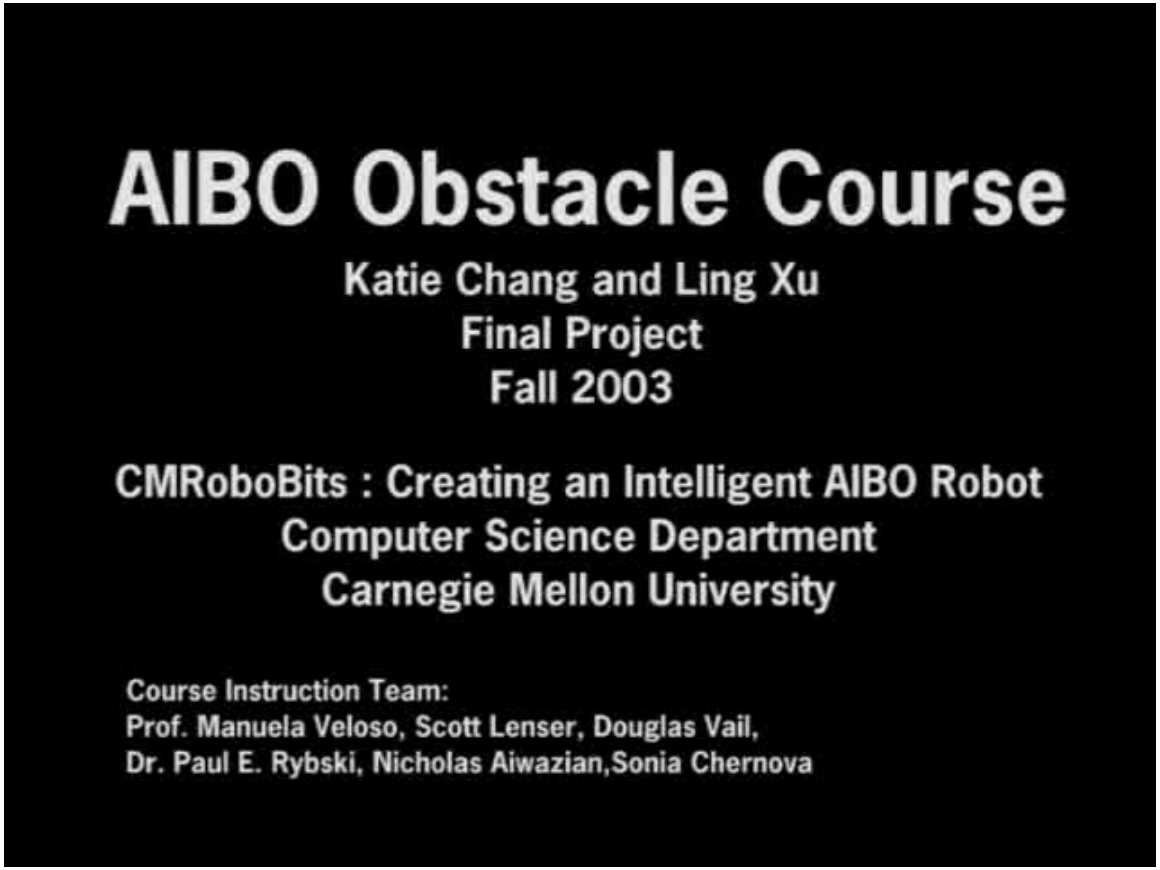
- M, Dec 3 – Course wrap up – project discussion
- W, Dec 5 – Projects

- M, Dec 10 or W, Dec 12 – Final Project Presentation

Action: Motion



Obstacle Course



Many Projects

CMRoboBits Schedule 07

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Conclusion

- Working within the perception, cognition, action loop
- Working with multiple robots
- Microsoft Robotics Studio – MSRS

- An exciting course.

- www.andrew.cmu.edu/course/15-491