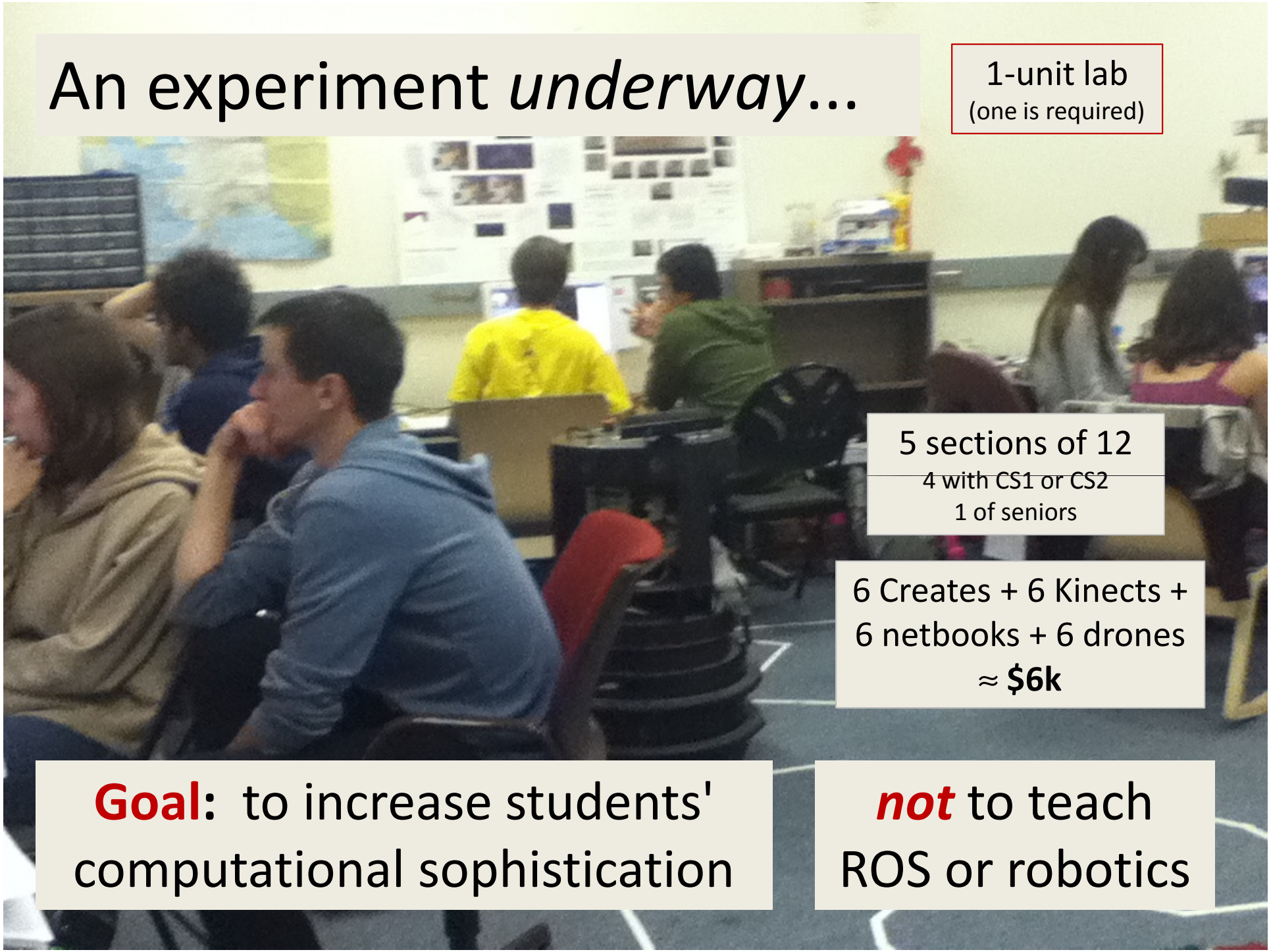
ROS after CS1?

Zach Dodds, Harvey Mudd College 02/29/2012

An experiment *underway*...



1-unit lab
(one is required)

5 sections of 12
4 with CS1 or CS2
1 of seniors

6 Creates + 6 Kinects +
6 netbooks + 6 drones
≈ **$6k**

Goal: to increase students' computational sophistication

not to teach ROS or robotics

N/A?

all situations are different...

The labs

weekly, 2-3 hrs.; 1 hr. for write-up; *no other work*

Week	Lab challenge	New hardware	CS Topics Emphasized
1	Line-following	creates	**command-line & Python**
2	Color segmentation	Kinects: RGB	event-handling
3	Finite-state control	-	finite-state machines
4	Visual servoing	-	understanding vs. implementing
5	Wall-angle estimation	Kinects: Depth	
6	Robot minion!	-	proportional control
7	Wall-following	-	larger-scale integration
9	Gestural control	quadcopters	GUI/visualization
10	Autonomous flight	-	defensive programming
11-14	(Open-ended projects)	all/any	*self-defined* problems

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Singly, in groups, or as a full course – we hope the modules might be of use.

Western State College

from visiting last summer...

Western State College

... to outreach this winter

Western State College

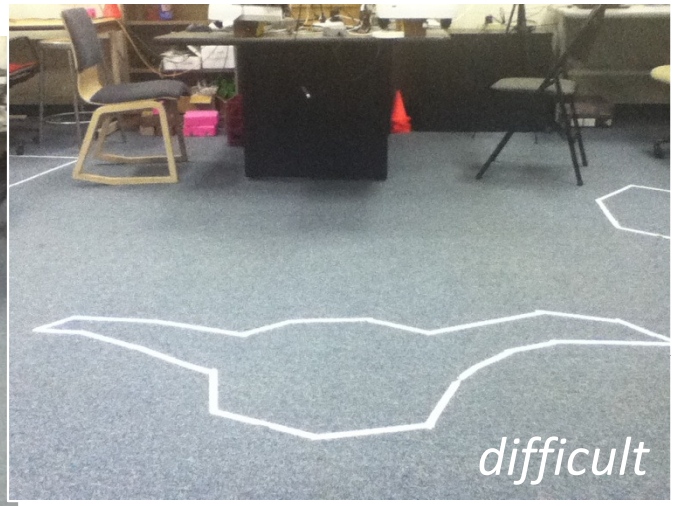
... to outreach this winter

Week 1

Line following

Create

command-line and Python



thanks: Matt Boutell

Week 1

Line following

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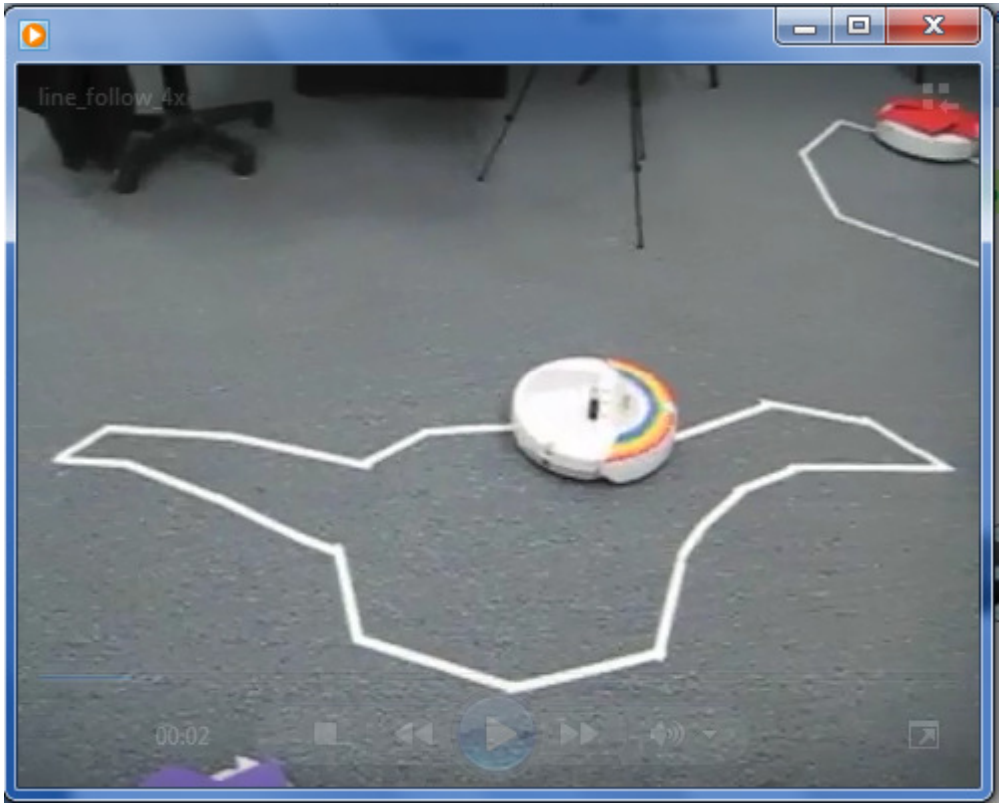
command-line and Python



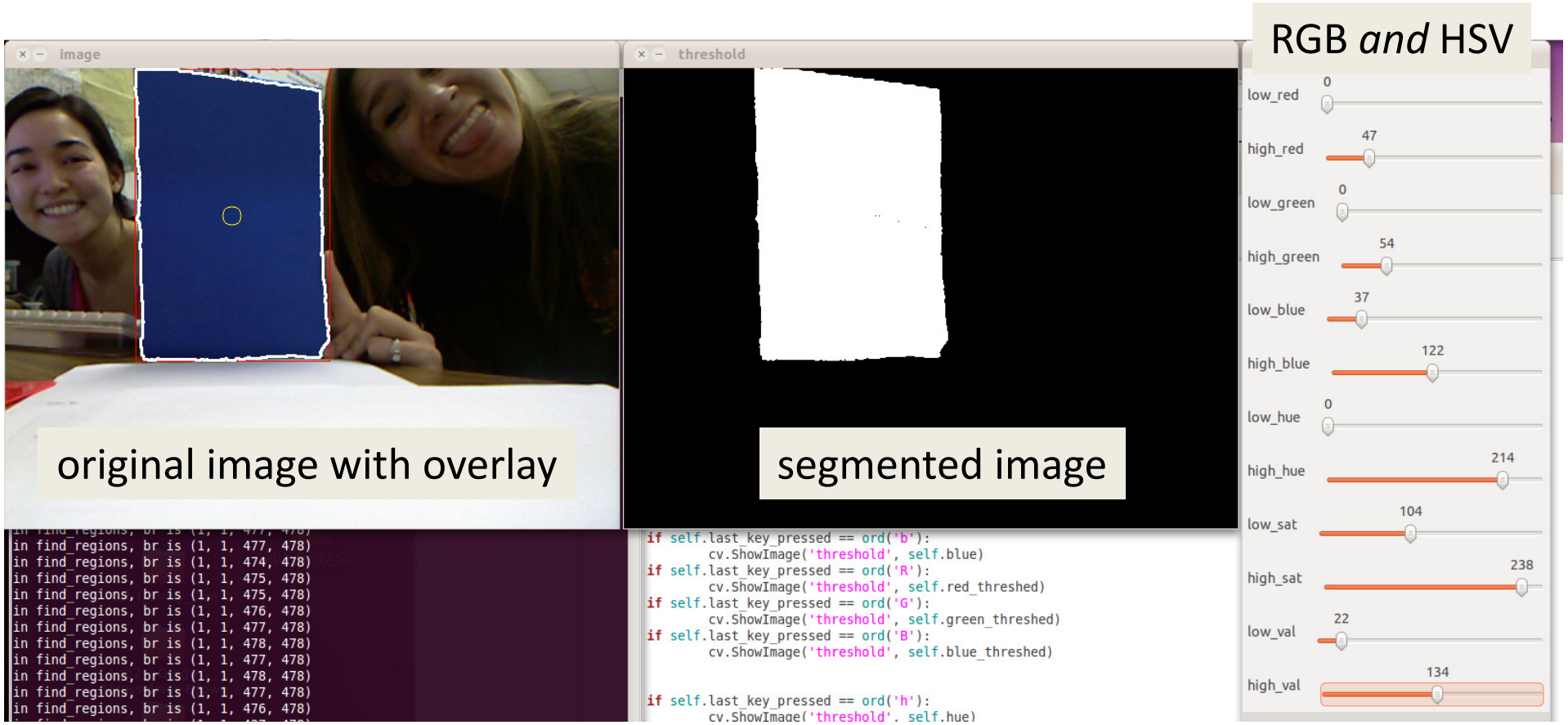
made it! (the video is 4x)

Week 2

Color segmentation

Kinect: RGB

keyboard/mouse events



Week 2

challenging (!) warm-up activity

Identify the six image components: R, G, B, H, S, and V





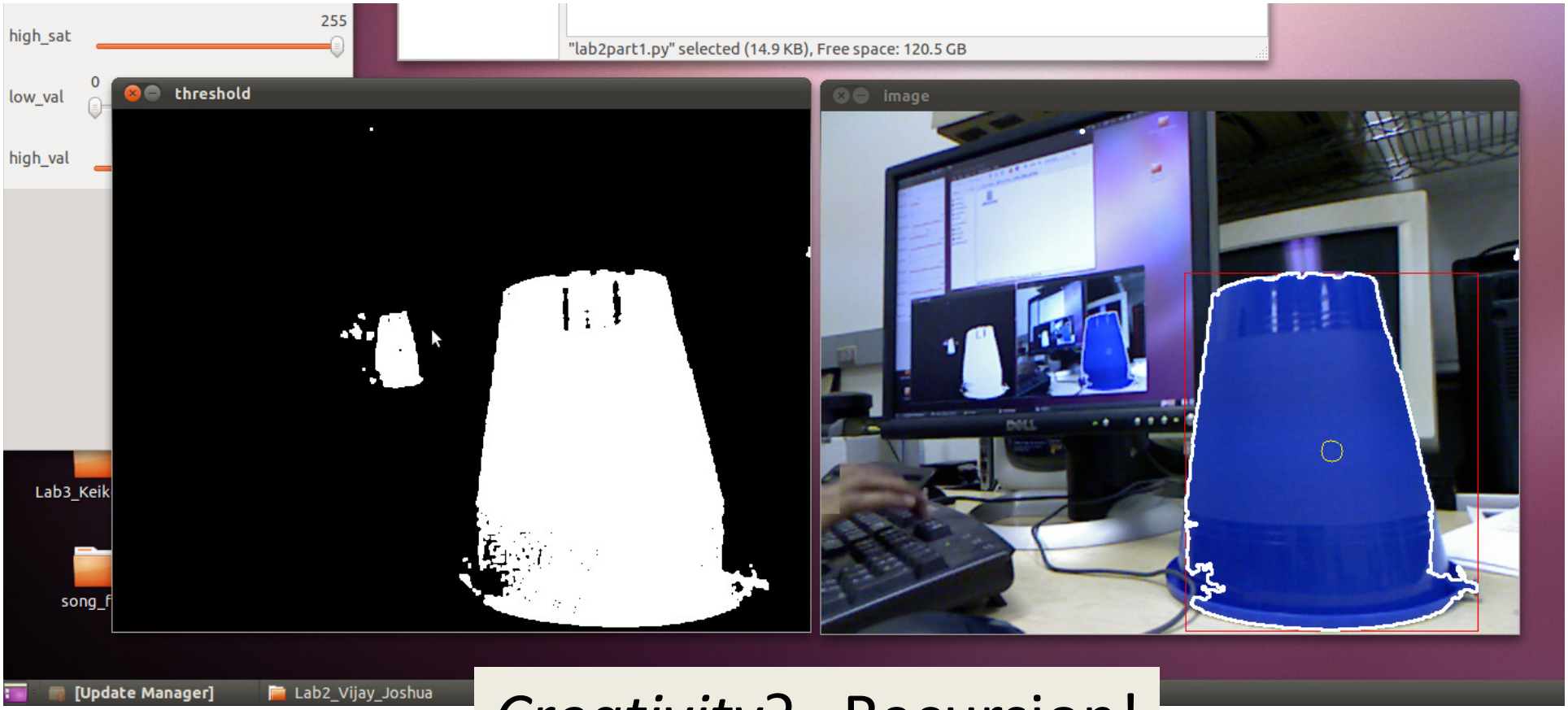

... to identify RGB and HSV components

Week 2

Color segmentation

Kinect: RGB

keyboard/mouse events



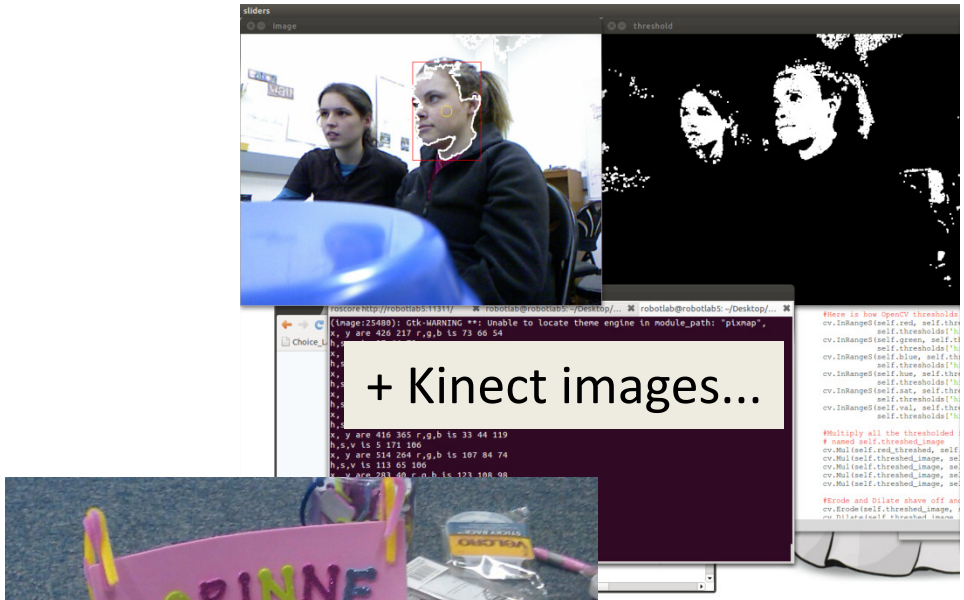
Creativity? Recursion!

Week 3

Finite-state control

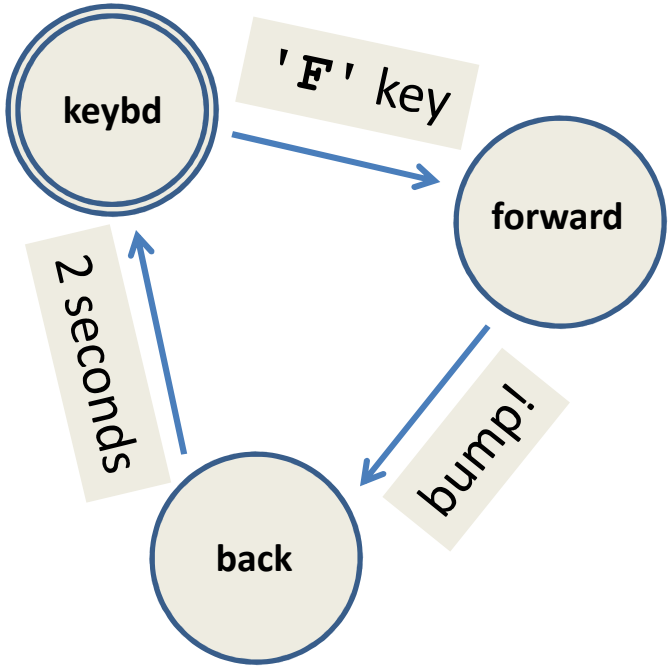
Kinect: RGB

finite-state machines



robot sensors...

+ your own custom state-machine thread

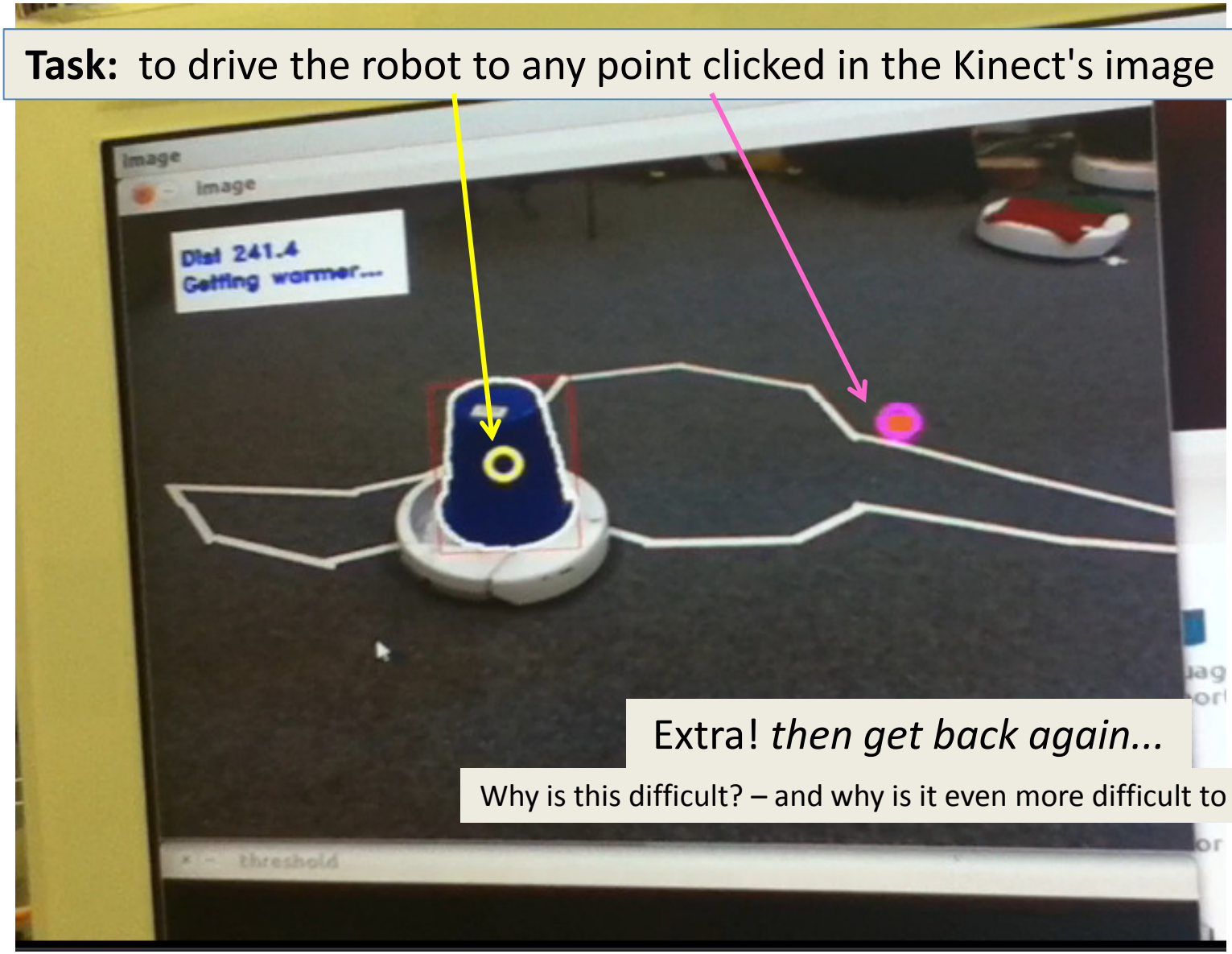


Week 4

Finite-state control

Kinect: RGB

understanding vs. implementation



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Finite-state control

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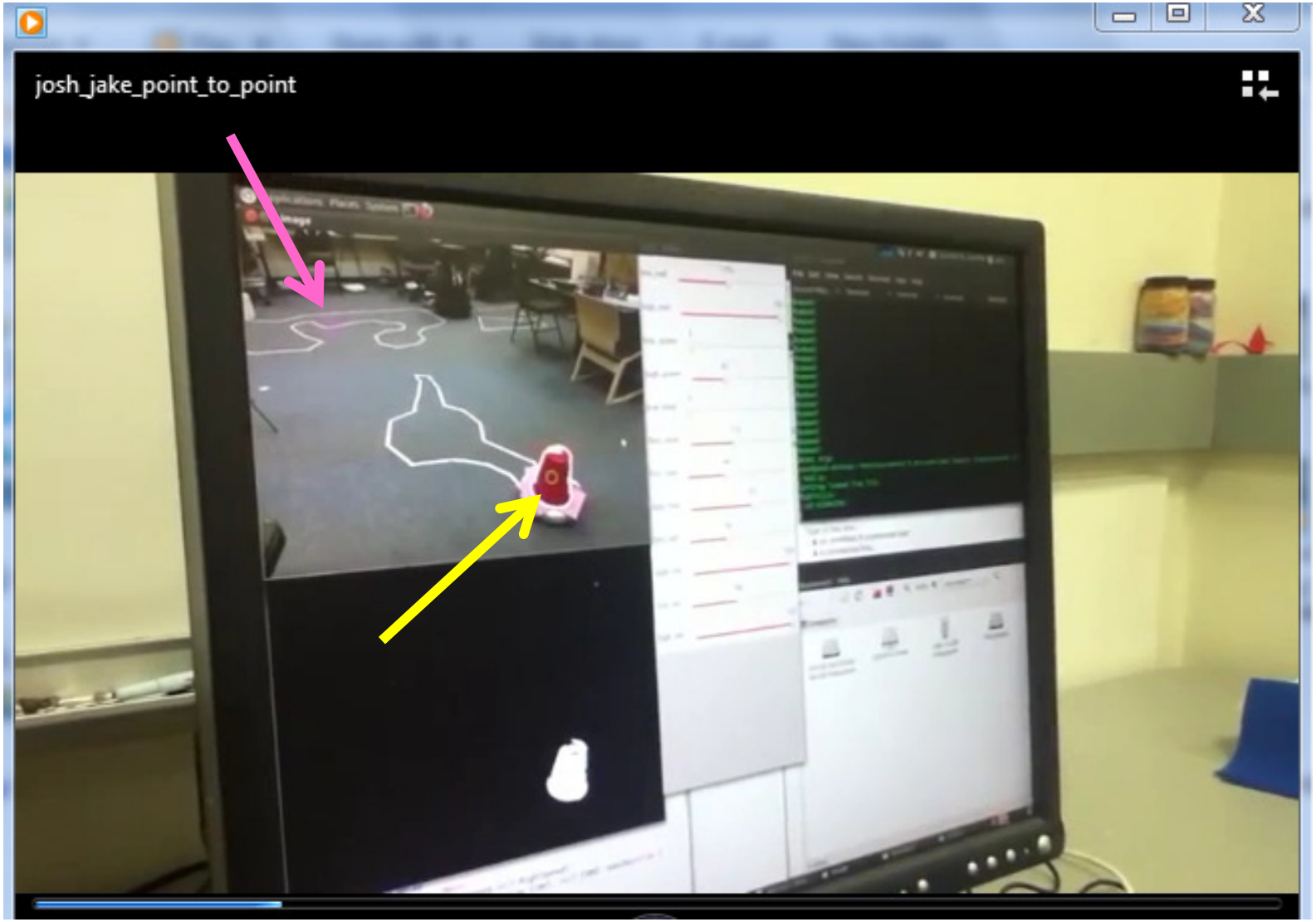
understanding vs. implementation



Week 4

Finite-state control

Kinect: RGB

understanding vs. implementation

Week 4

Finite-state control

Kinect: RGB

understanding vs. implementation

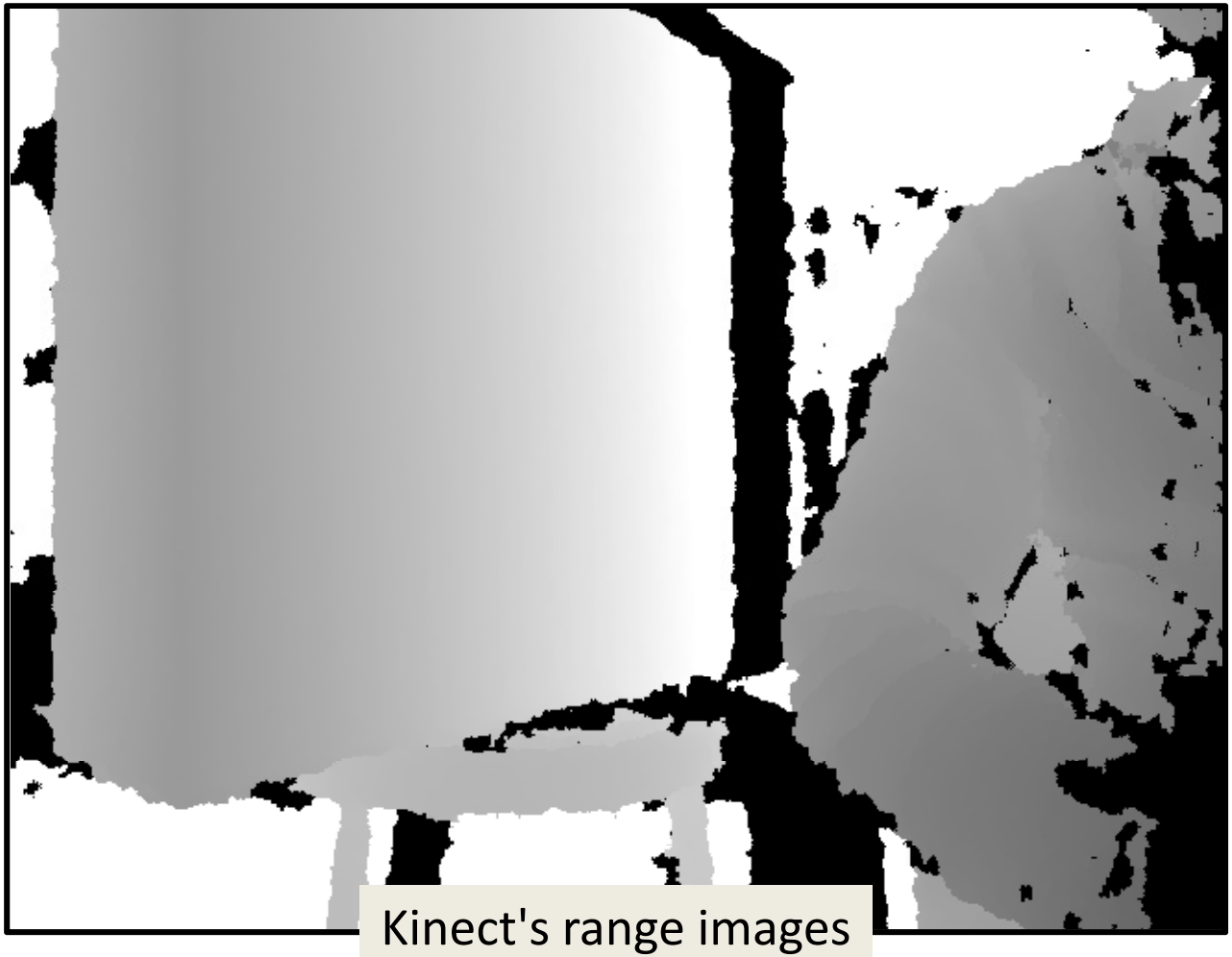
The race: a more polished view...

Week 5

Wall-angle estimation

Kinect: Depth

understanding vs. implementation



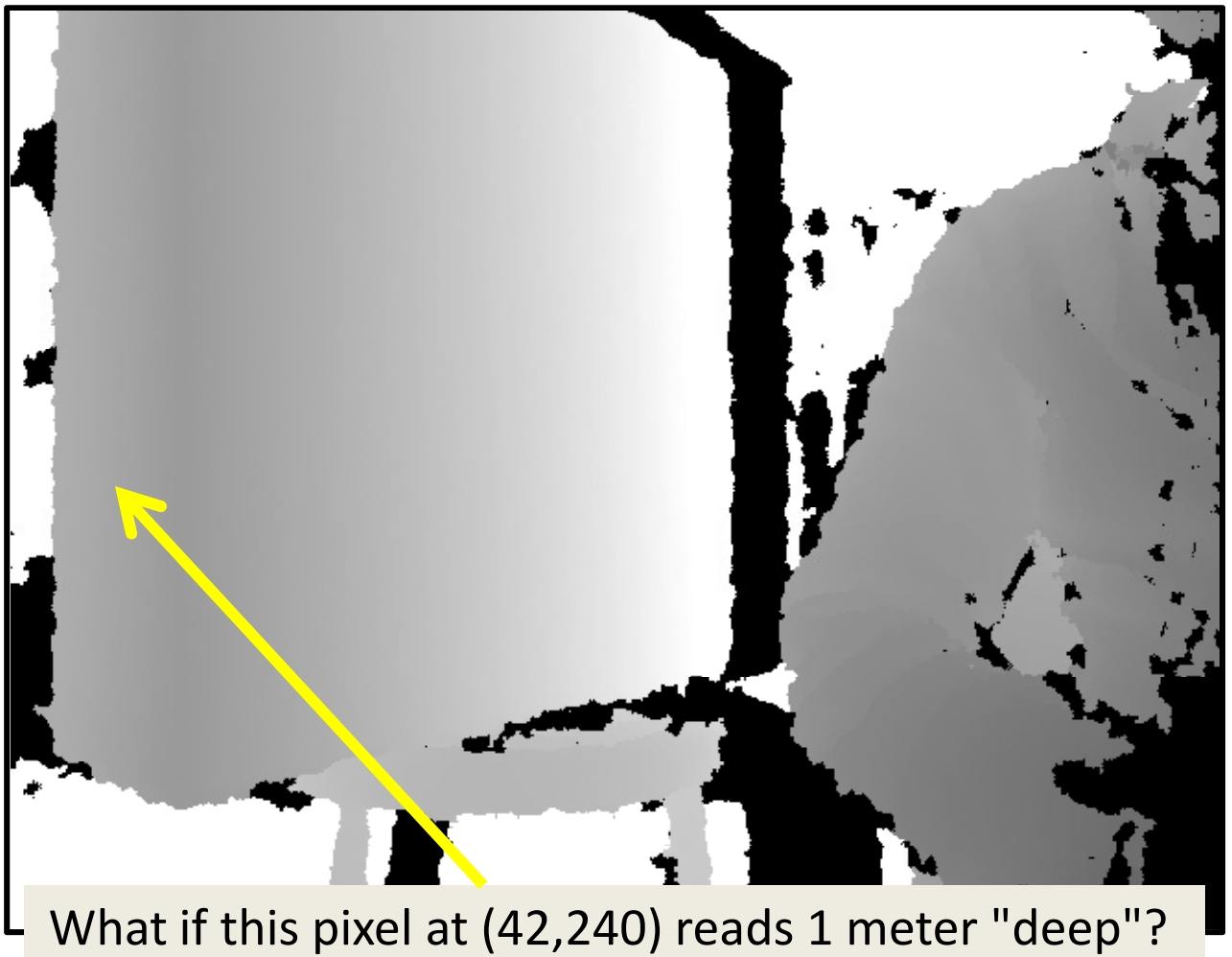
Kinect's range images

Week 5

Wall-angle estimation

Kinect: Depth

understanding vs. implementation



What if this pixel at (42,240) reads 1 meter "deep"?
What are that point's coordinates ***in meters?***

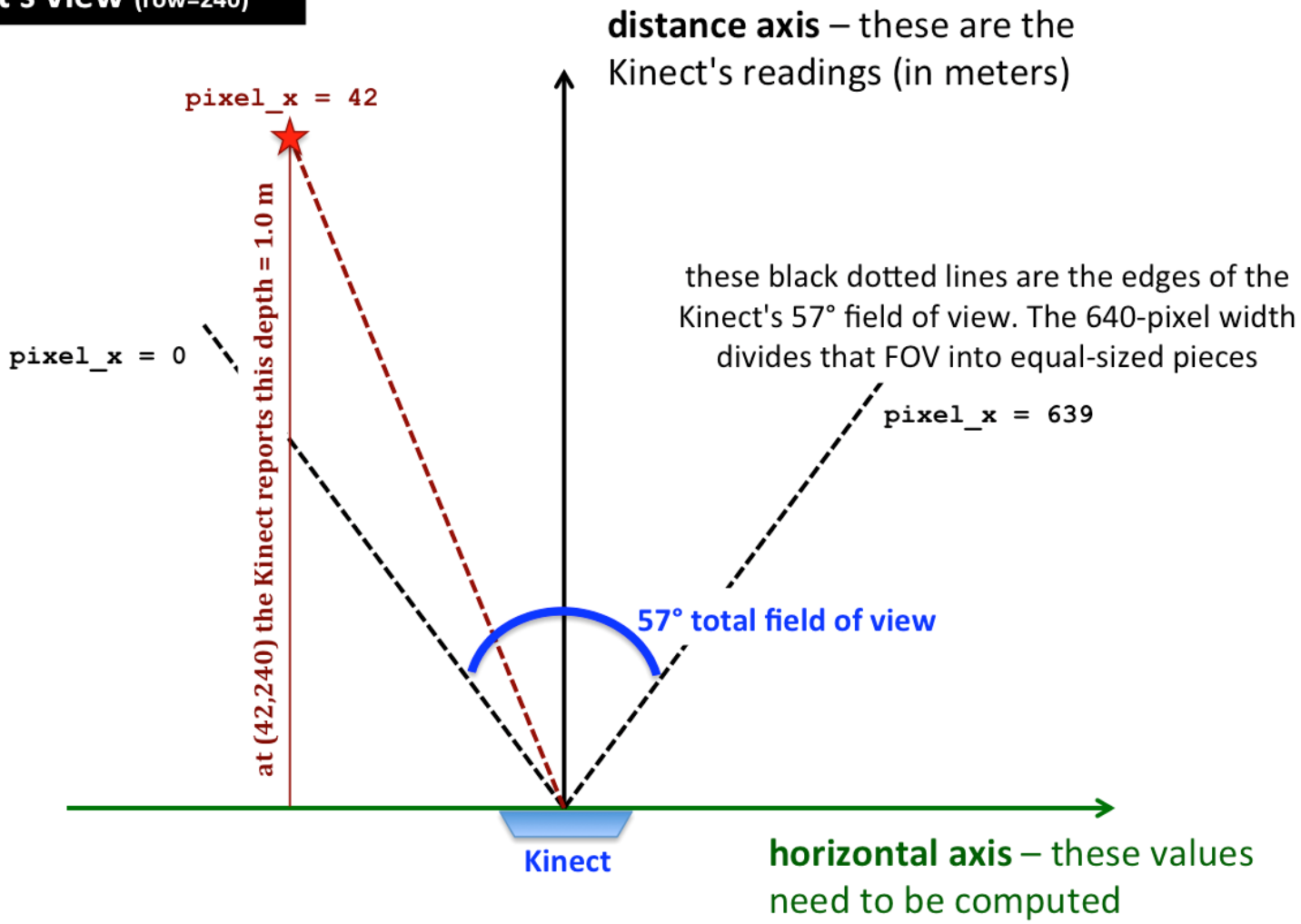
Week 5

Wall-angle estimation

Kinect: Depth

understanding vs. implementation

Top-down look at one slice of the Kinect's view (row=240)

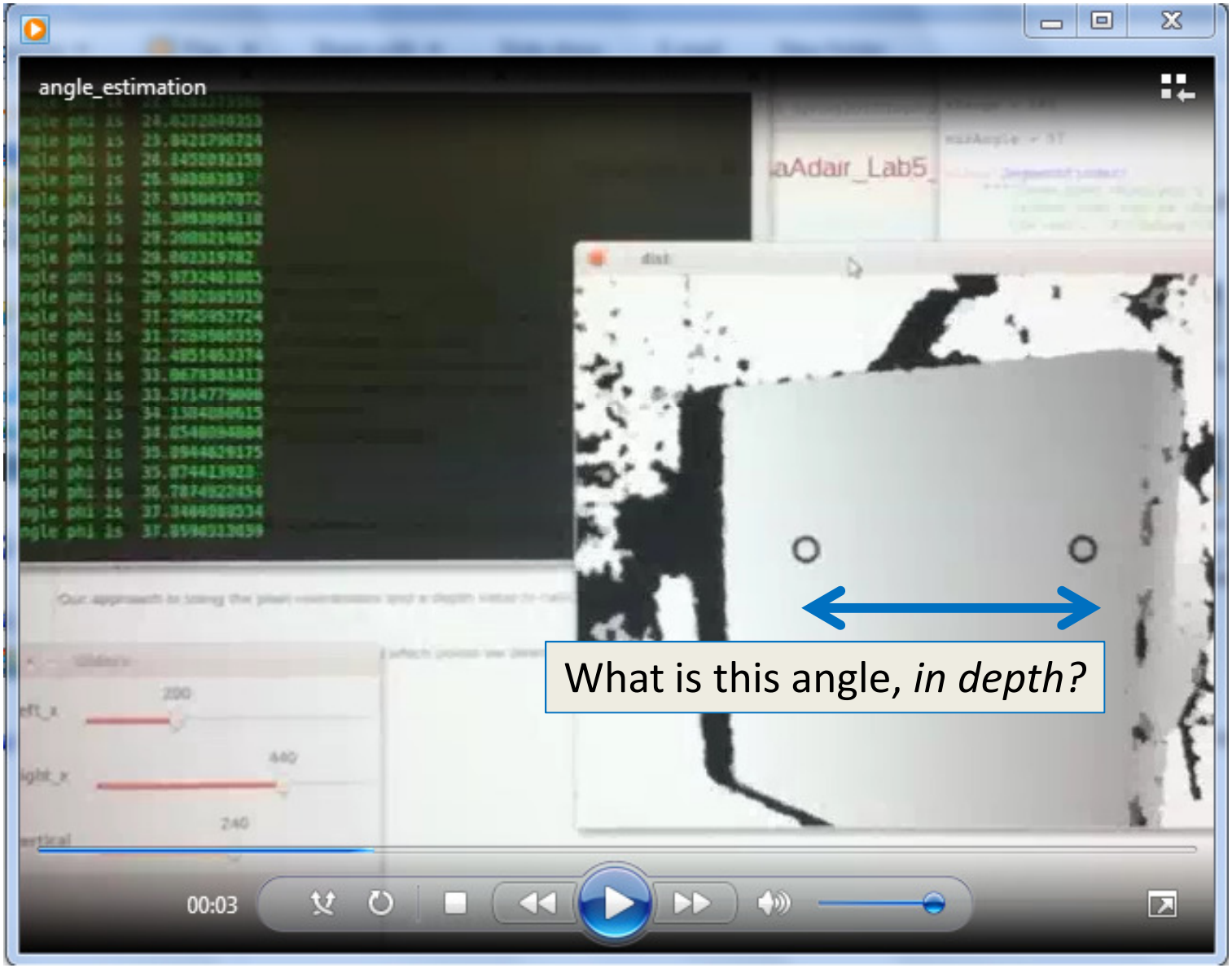


Week 5

Wall-angle estimation

Kinect: Depth

understanding vs. implementation



Feedback on labs 3-5…

understanding vs. implementation

"Our biggest challenge was figuring out the math behind aligning the robot with the target point."

- Sarah and Steve

"We ran into a lot of problems in doing the actual math which should direct the roomba."

- Alexa, Edward, and Spencer

"We focused most of our attention on getting the math correct."

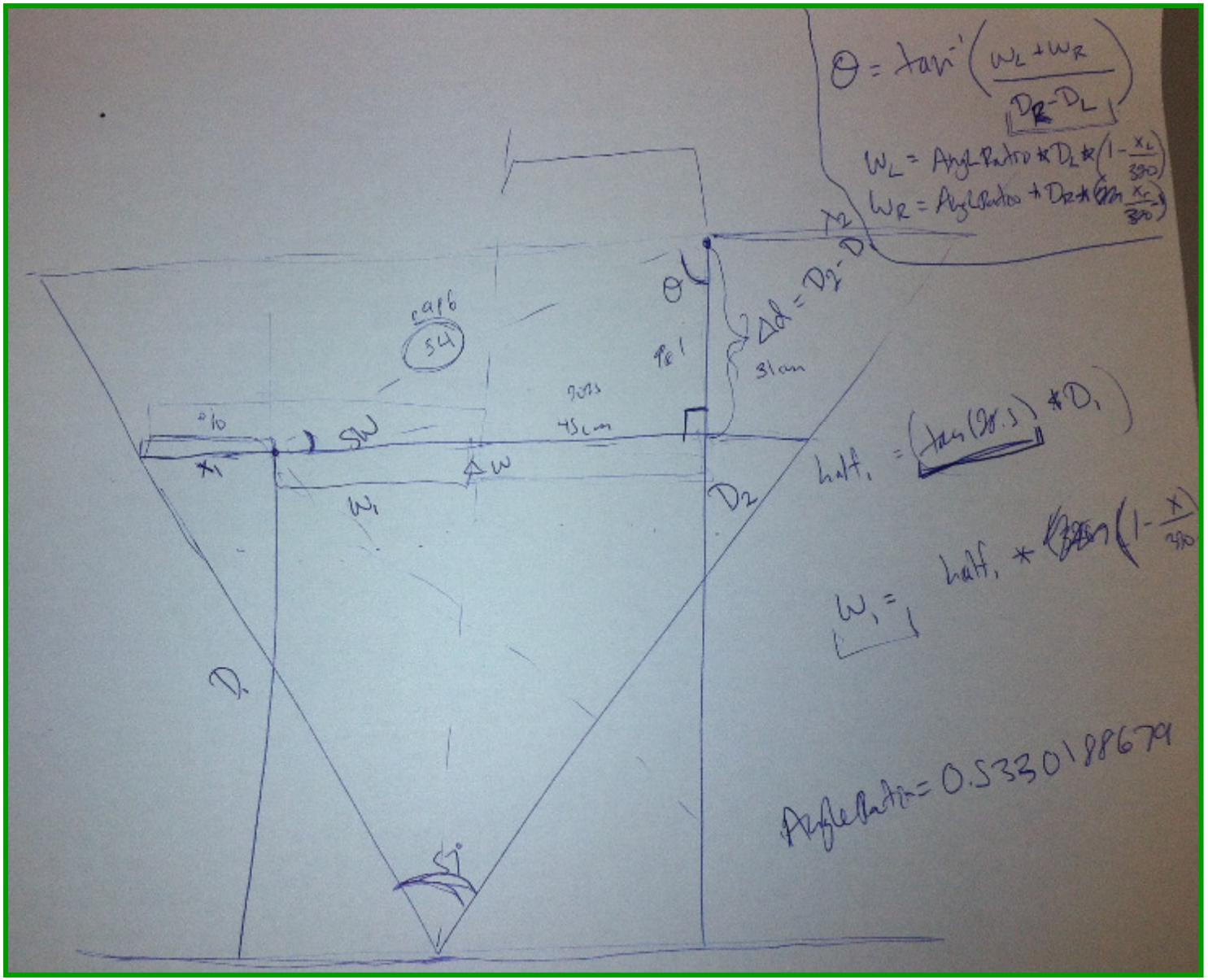
- Eric and Benson

"Math is amazingly hard.."

- Jessi and Haak

Feedback on labs 3-5…

understanding vs. implementation



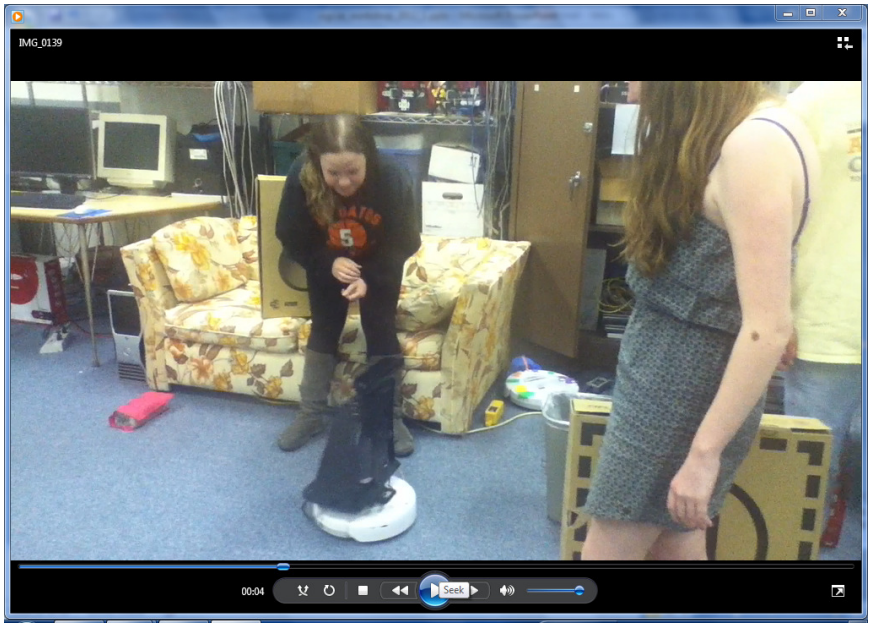
Week 6

Robot follower

Kinect: Depth

proportional control

Challenge: lead your robot out the door, into another room, and back



things can always be worse...?


Weeks 6-7
lots of *floor* time

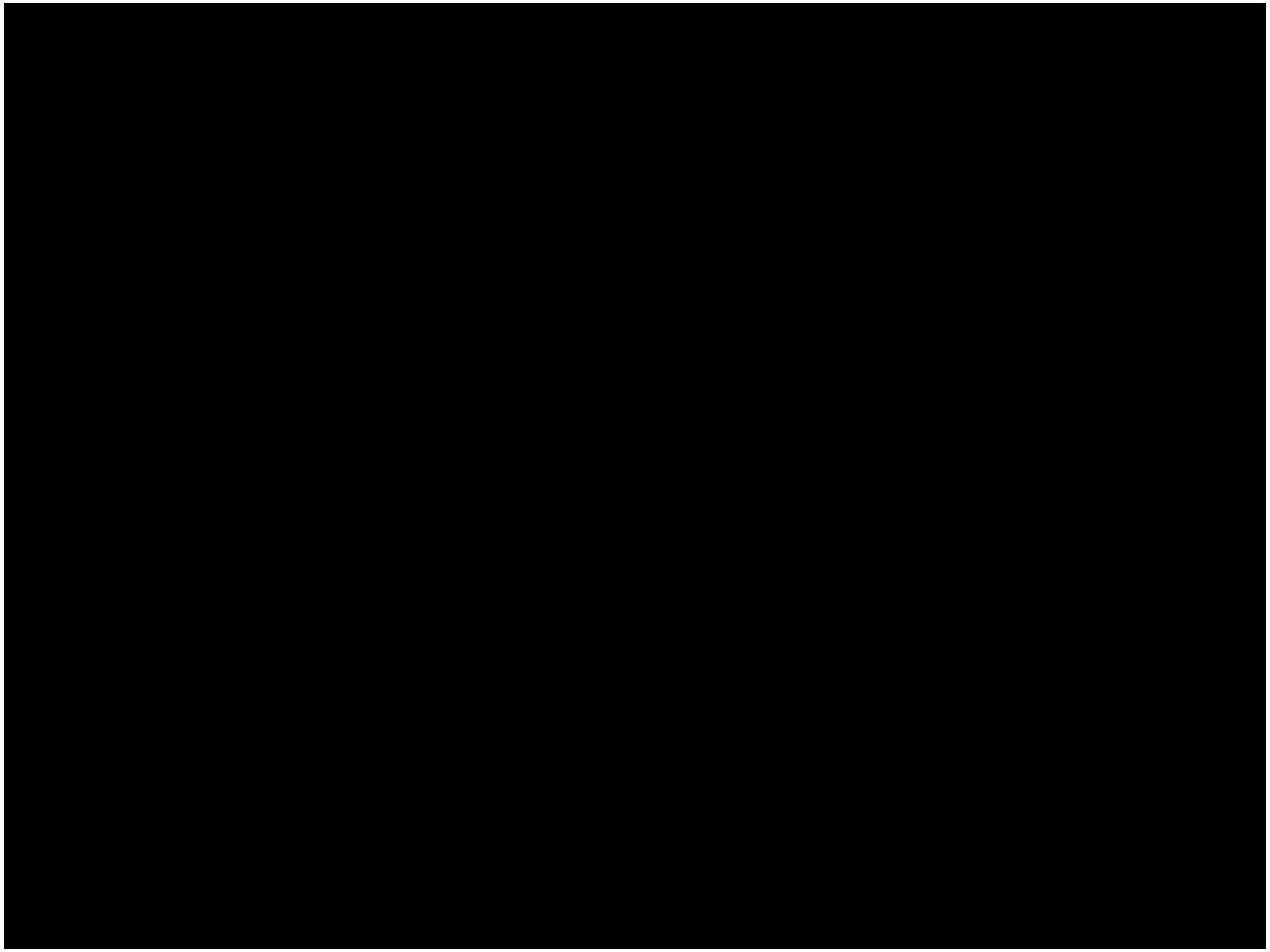

Weeks 6-7
lots of *floor* time
even when it *does* work

Week 6

Robot follower

Kinect: Depth

proportional control



success... (at 2x)

Week 7

Wall follower

Kinect: Depth

integration and debugging

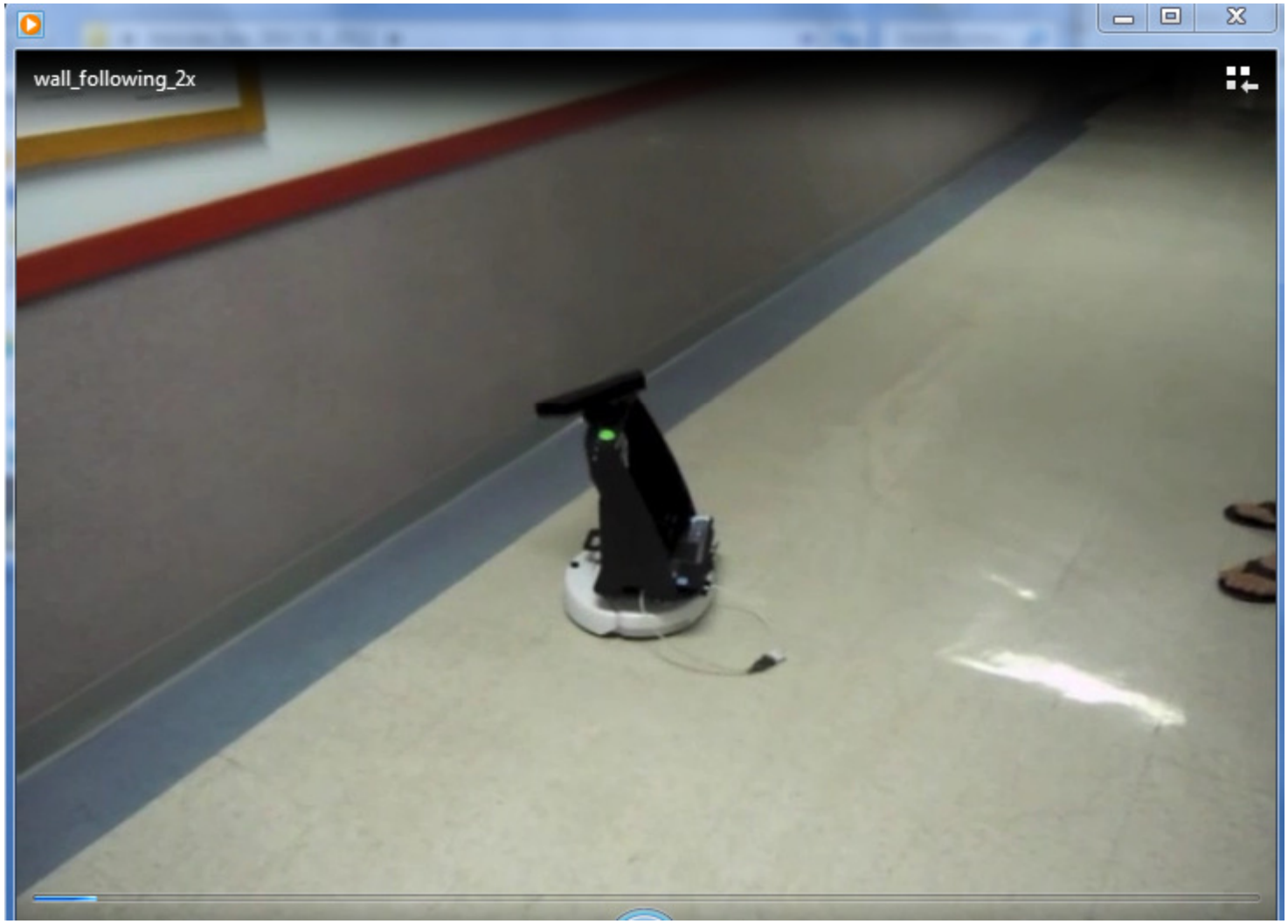
moving-wall following (2x)

Week 7

Wall follower

Kinect: Depth

integration and debugging



down the halls...

Week 9

Gesture control

quadcopters

GUI/visualization

"Supermanning" the drone – *from the drone's point of view.*

Week 10

Autonomous flight

quadcopters

defensive programming

Escape!

Weeks 11-14

open-ended projects

self-defined problems

cat-and-mouse robots (4x)


Summer!

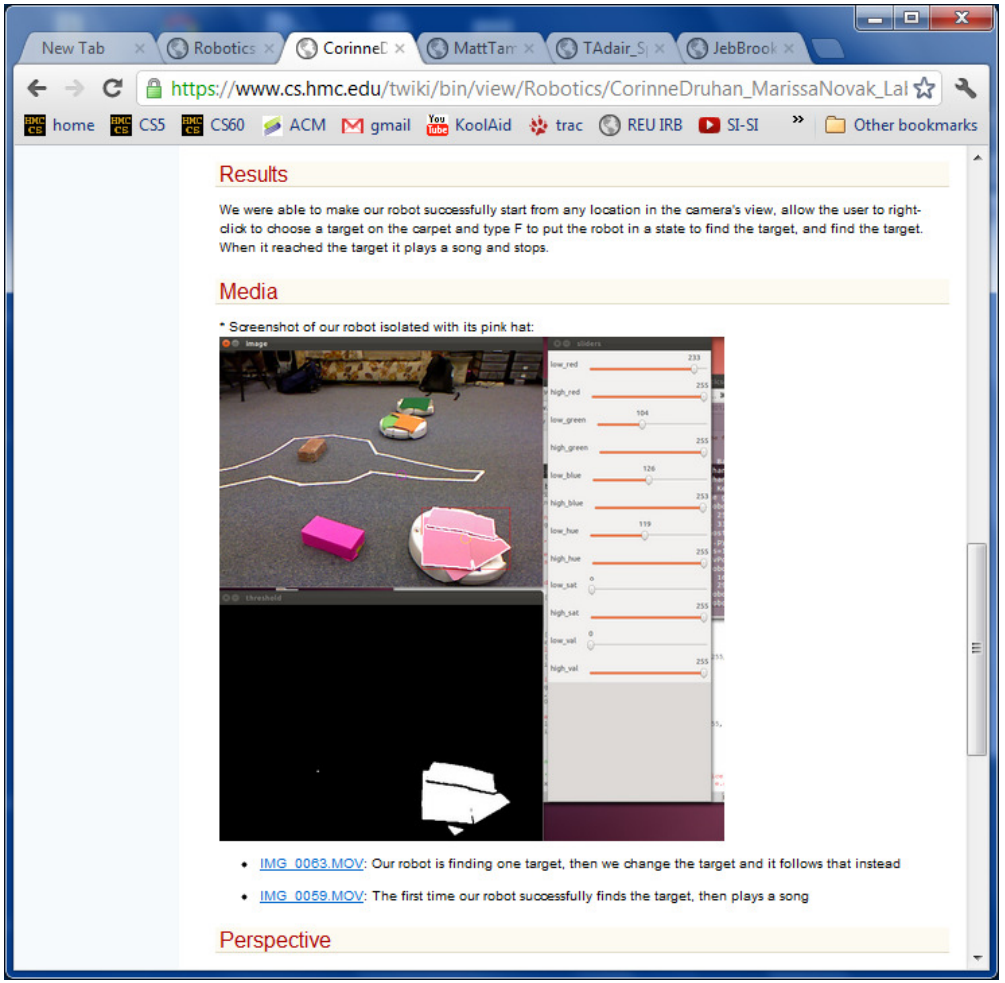

Summer!

In conclusion…

Computational confidence-building right after CS1
command-line
flaky hardware
making state explicit
difficult debugging
compelling applications!

Self-directed portfolio of results (and failures)

Getting beyond ***DWIC***…



10-20 page write-up with screenshots, videos, descriptions, and reflection

Week 2

challenging (!) warm-up activity

... to identify RGB and HSV components