



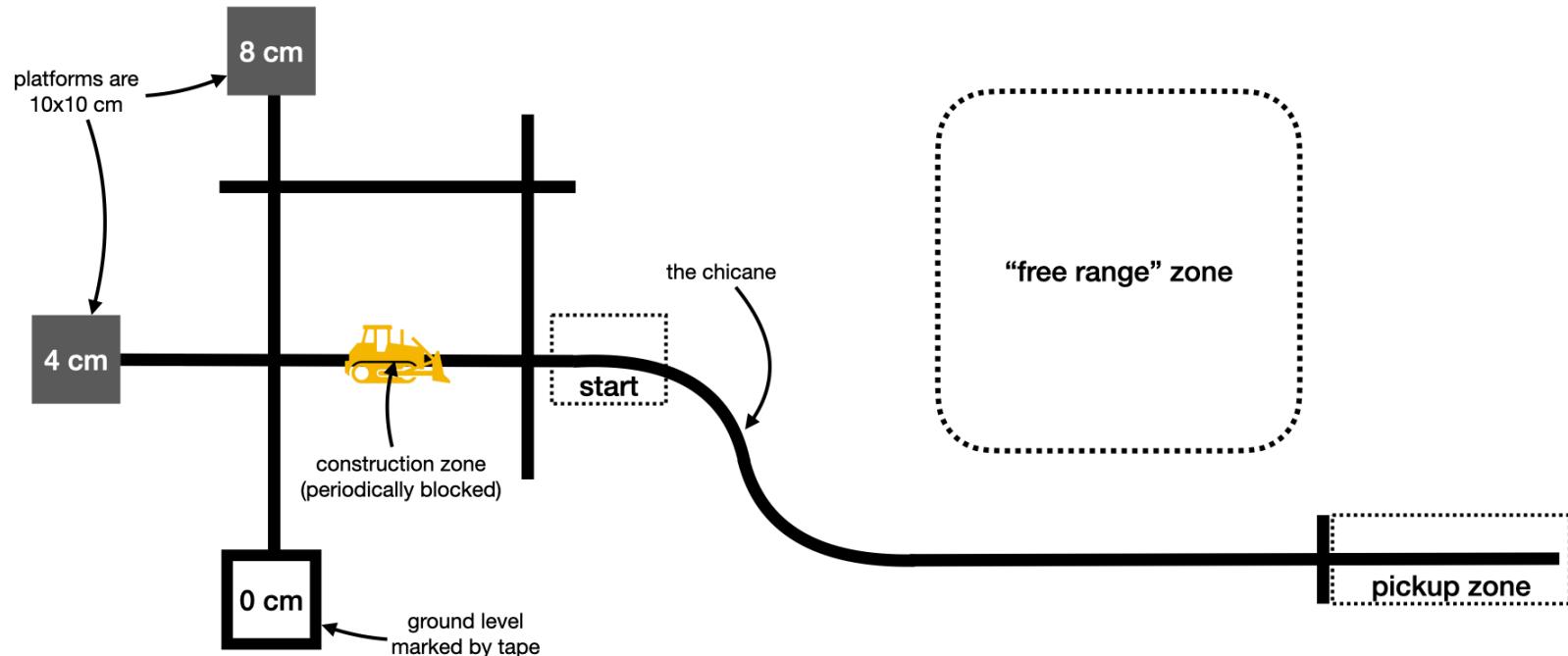
WPI

Delivery Robots

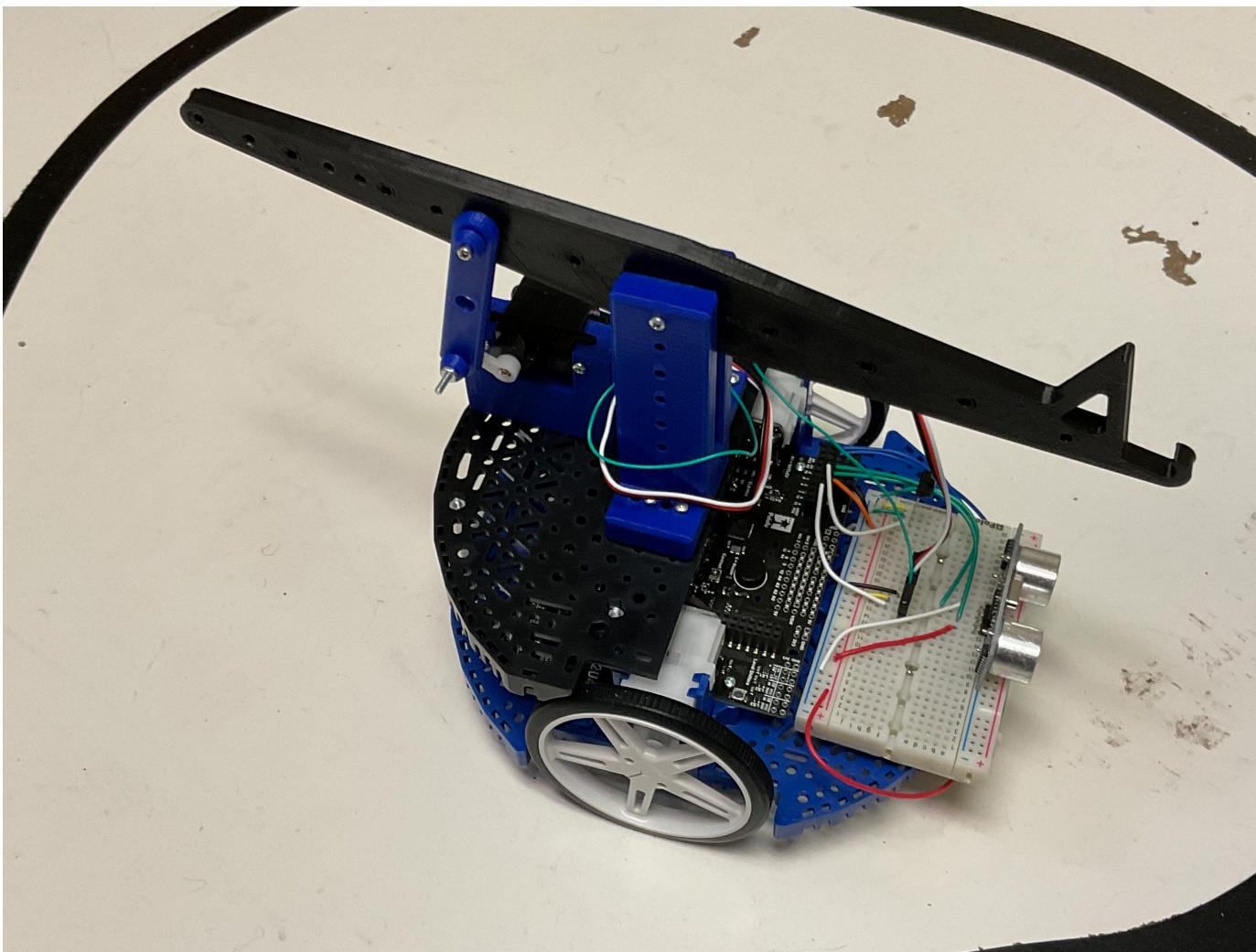
FoMRE NSF Workshop



The Challenge



The Robot

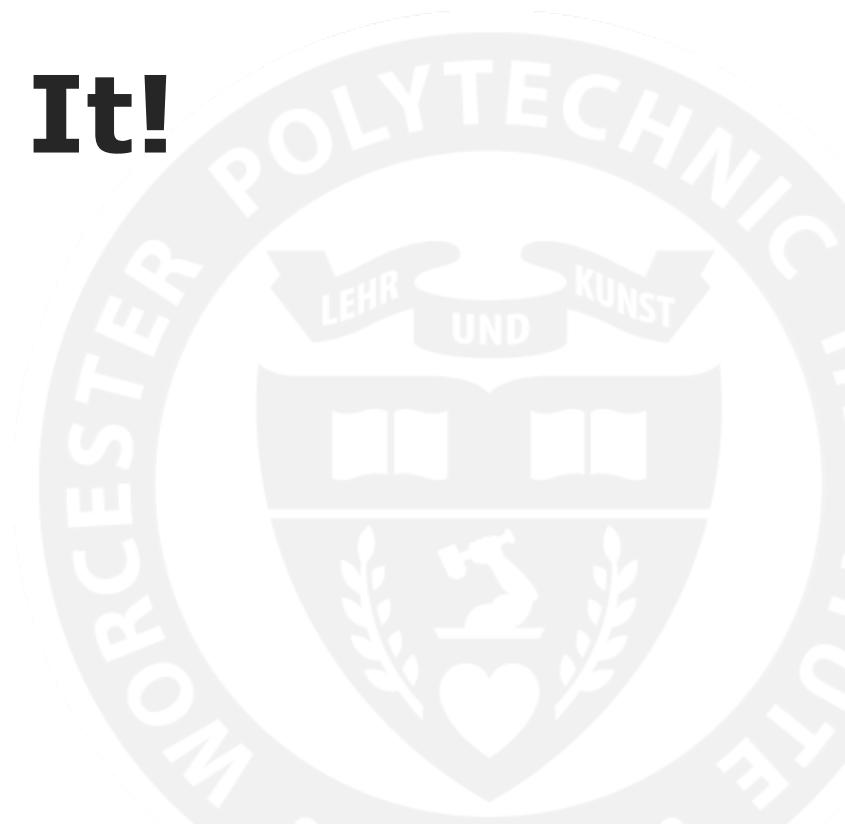


Worcester Polytechnic Institute



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Activity 1: Move It!

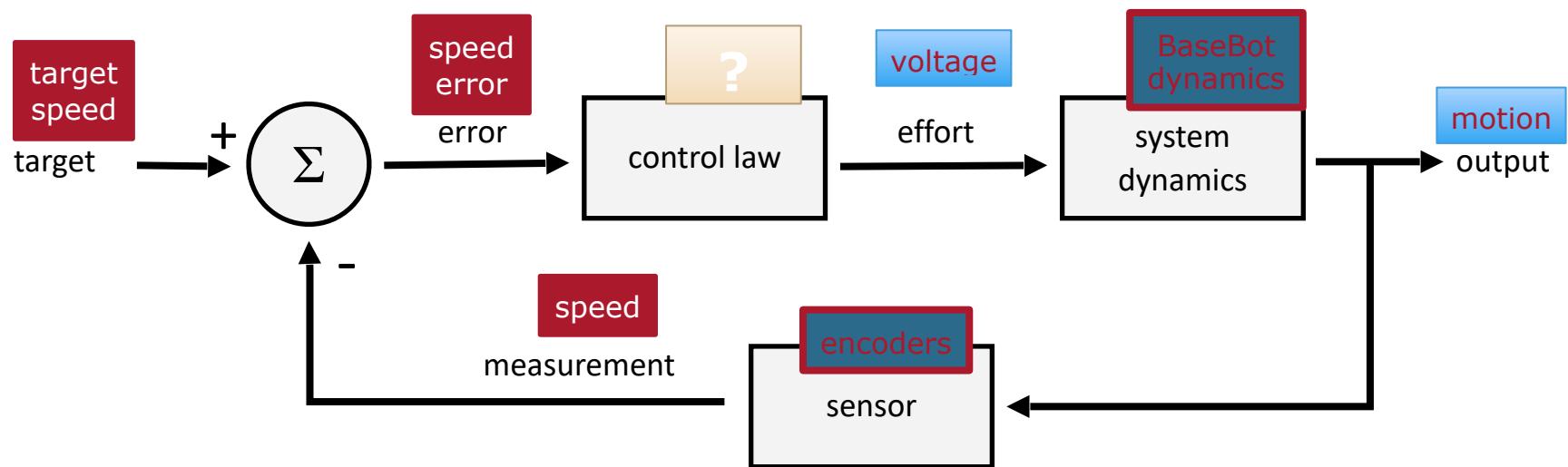


Objectives

- Develop/explore control algorithms
- Explore/calibrate kinematic parameters
- Motivate discussion of *theory vs. experiment*: e.g., you can measure the robot and use values from the datasheet, but calibrating will give you better performance.

Control loops

- PID control is a common control method, and the theory behind it scales well to the students' ability



Task: Perform experiments to calibrate the motion

- Command the robot to drive 50 cm
 - Measure how far it actually went
 - Adjust the parameters until it drives the correct distance
-
- Command the robot to turn 90 degrees
 - Measure how far it actually turned
 - Adjust the parameters until it turns the correct amount



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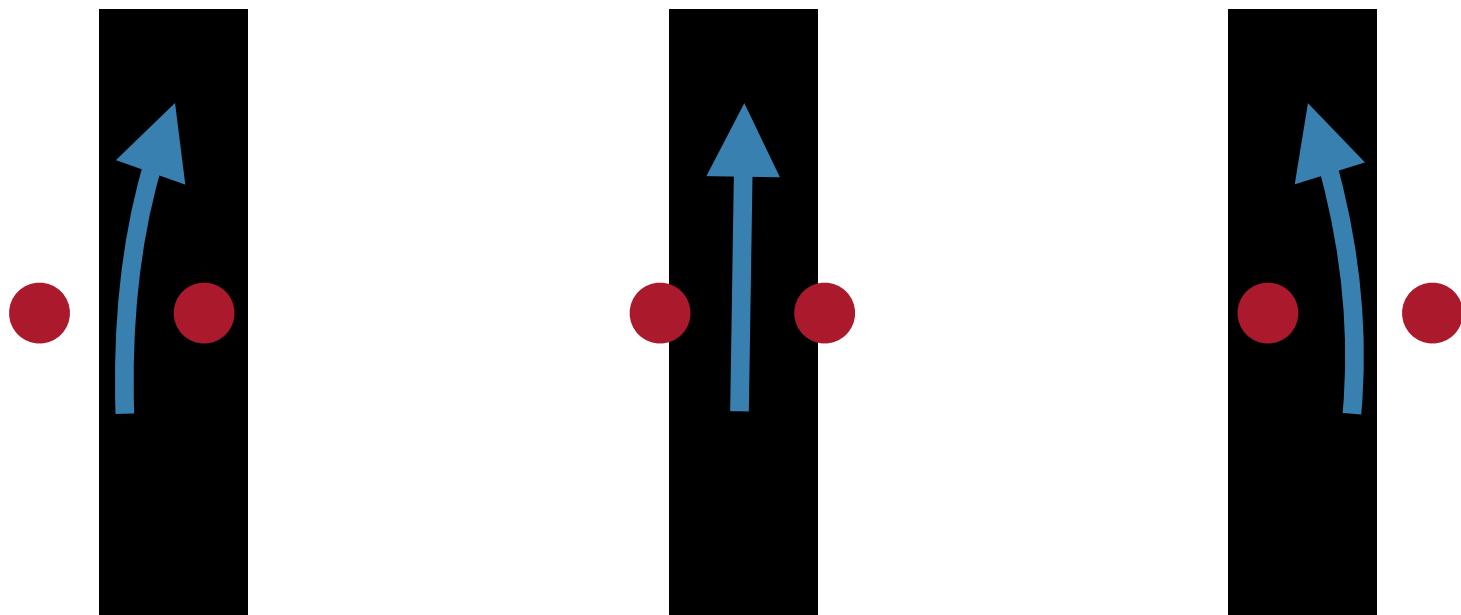
Activity 2: Staying on Track

Objectives

- Implement line following
- Detect intersections as *events*
- Create *state machines* and discuss different kinds of goals for the system

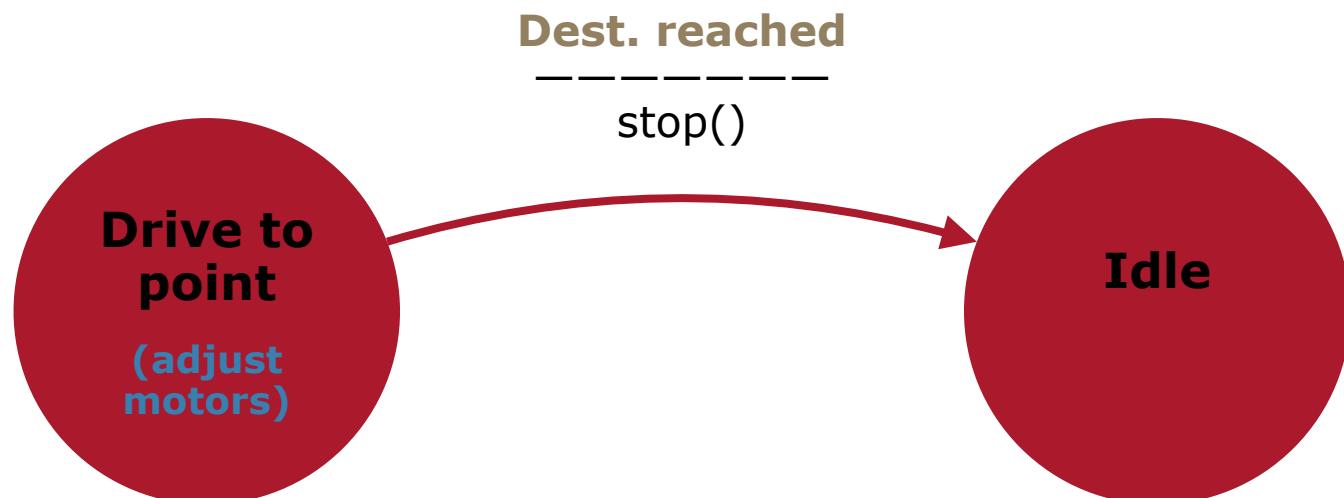
Line following

- Line following is a common method for path following
- Our general strategy will be to read both line sensor elements and compare them



Maintenance and achievement goals

- *Achievement goals* generally correspond to events — when you get something done, it's time to move to a new task
- *Maintenance goals* are associated with ongoing activities and typically associated with a *state*

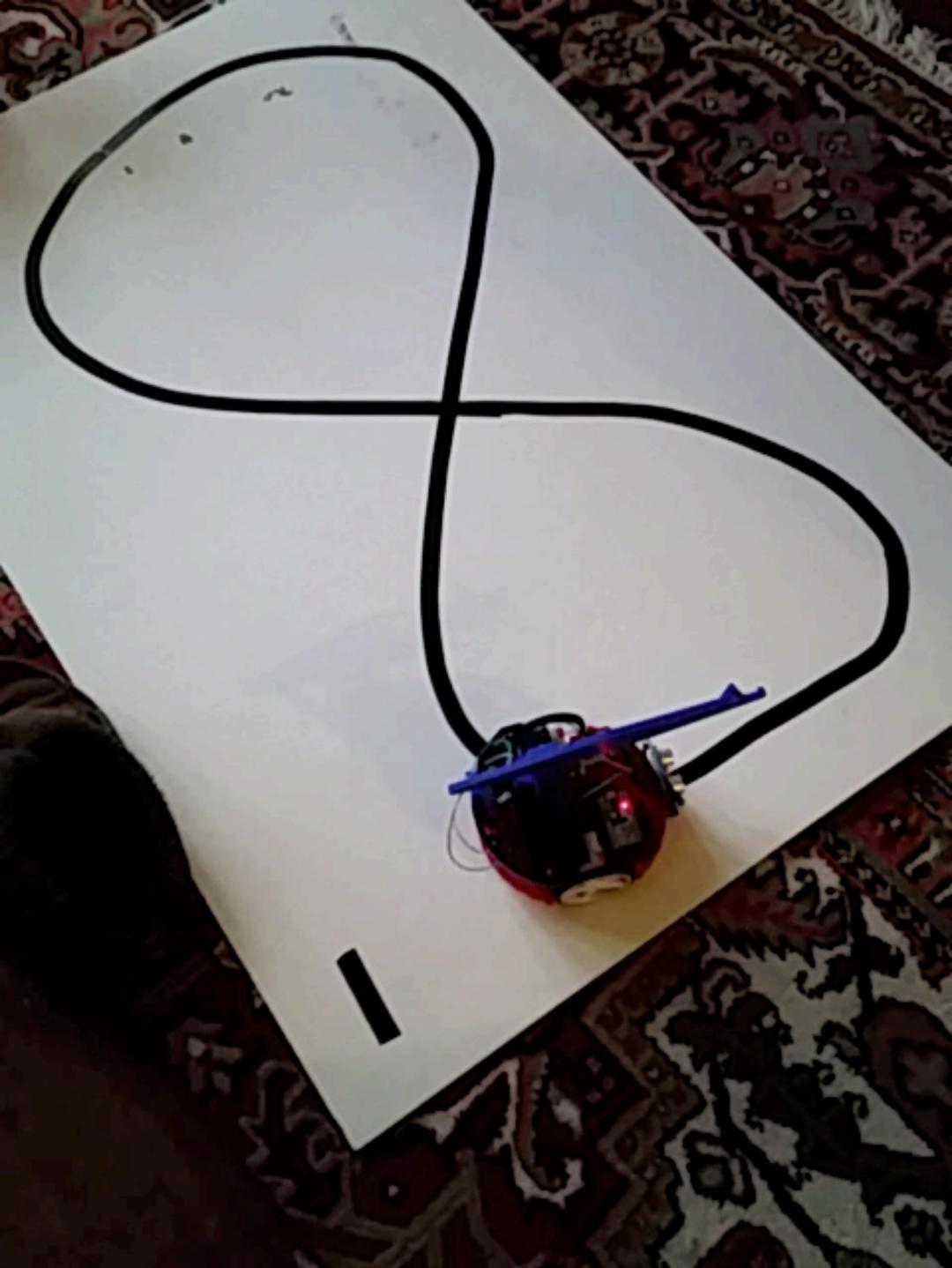


Event detection

- An intersection is denoted by *both* sensors reading a dark surface.
- The *event* of reaching an intersection occurs when the sensors did not previously detect an intersection and now they do

		before	
		no	yes
now	no	F	F
	yes	T	F

Turning





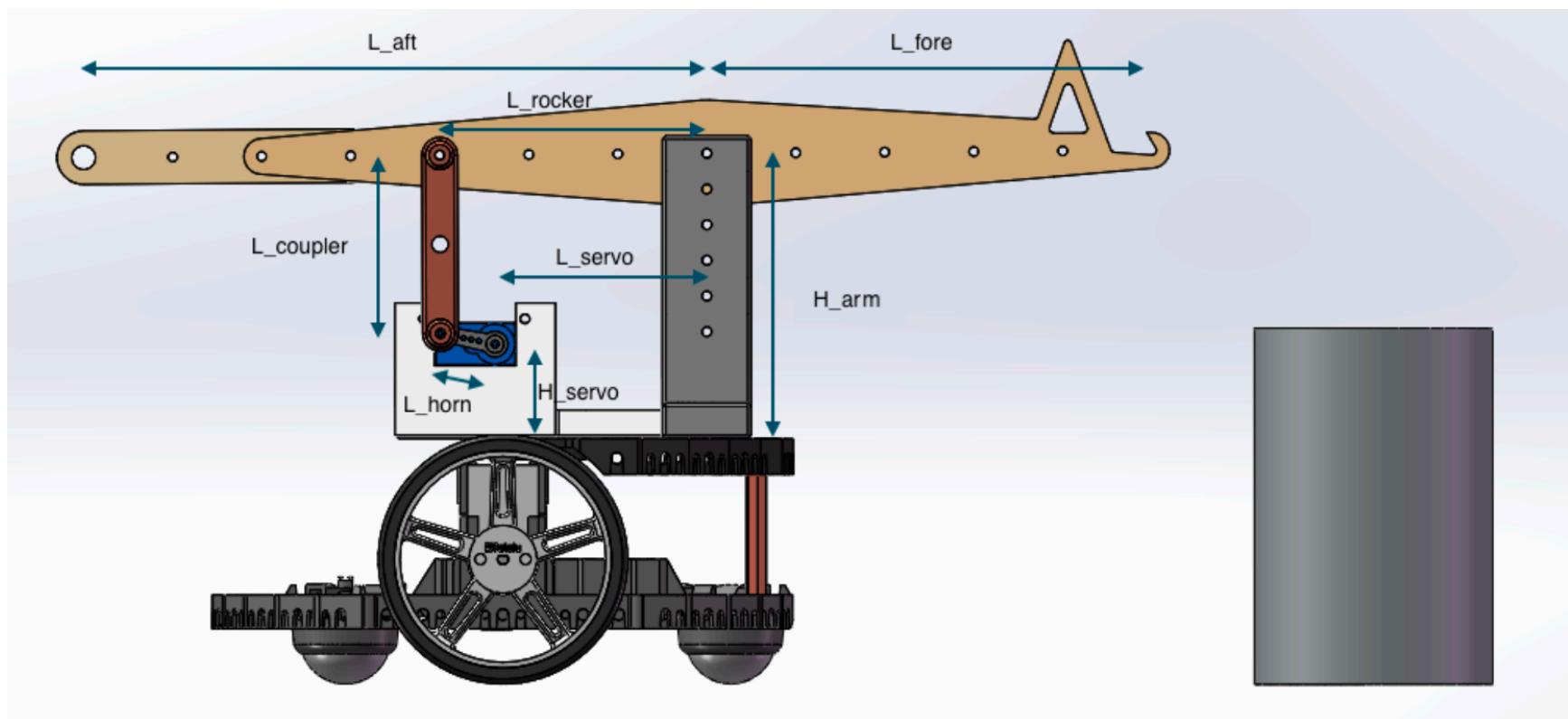
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Activity 3: The Heavy Lifting

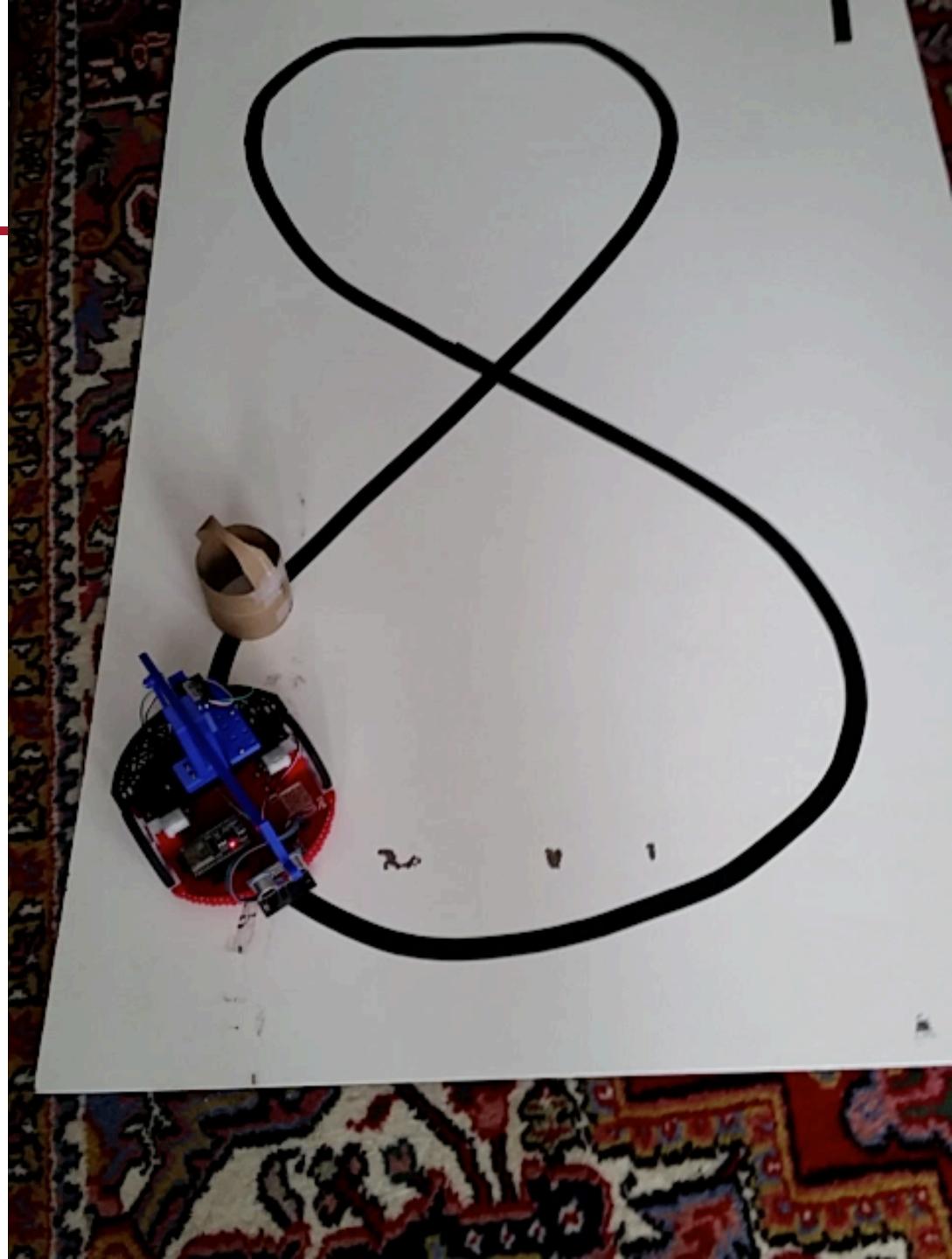
Objectives

- Optimize a system for real constraints
 - Motors provide finite torque/power
 - Platforms are different heights
- Motivates a discussion of trade-offs
- Motivates concept of unintended interactions

Tools



Lifting



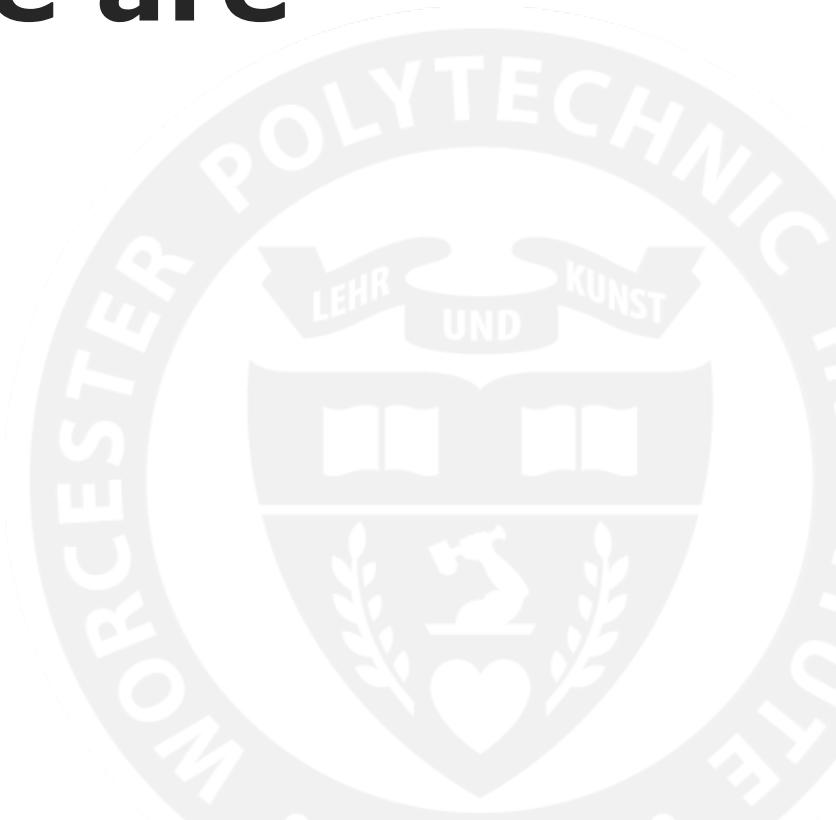
Unanticipated interactions

- Lifting a bag motivates a discussion of unintended interactions
 - The line sensor values may change when the robot is carrying a heavy load
 - Heading corrections and turning typically become more “jerky”
 - Depending on the arm configuration, the bag may interfere with the ultrasonic rangefinder



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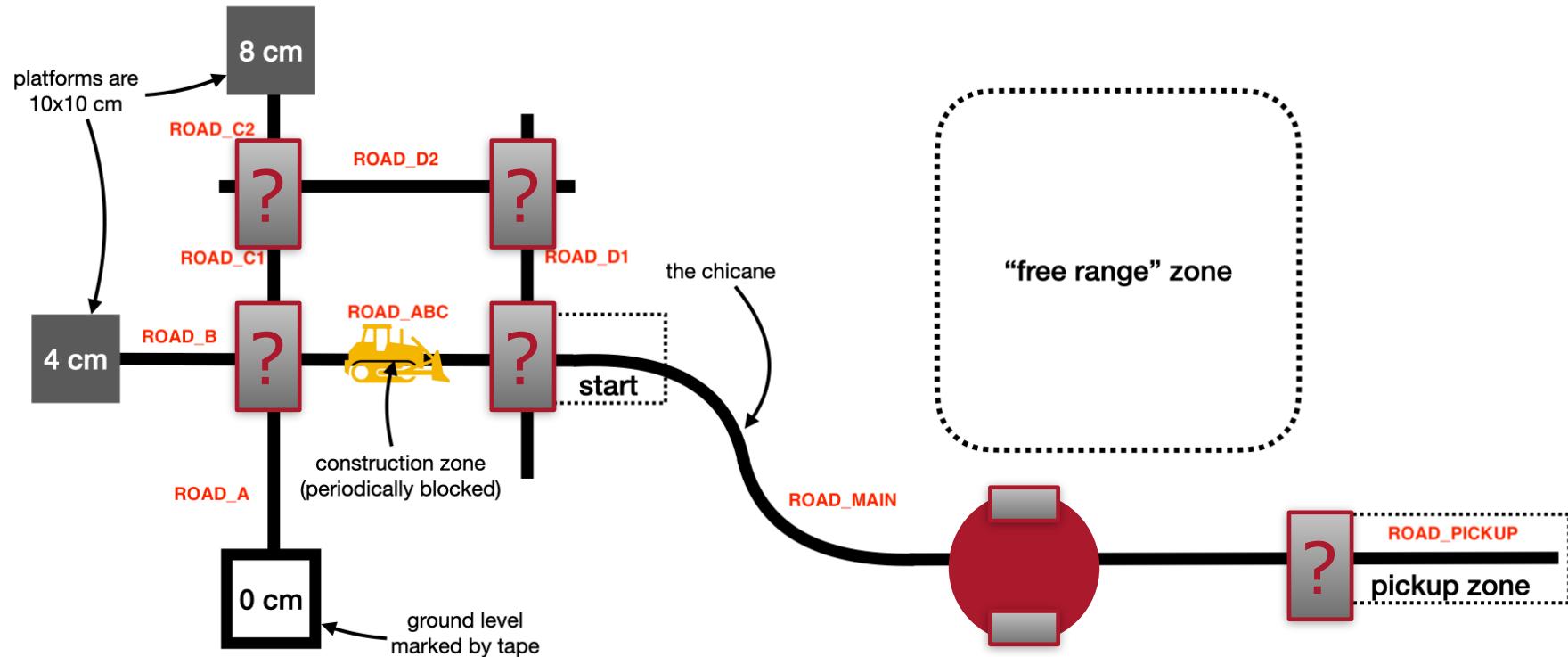
Activity 4: Where are we?



Objectives

- Implement navigation

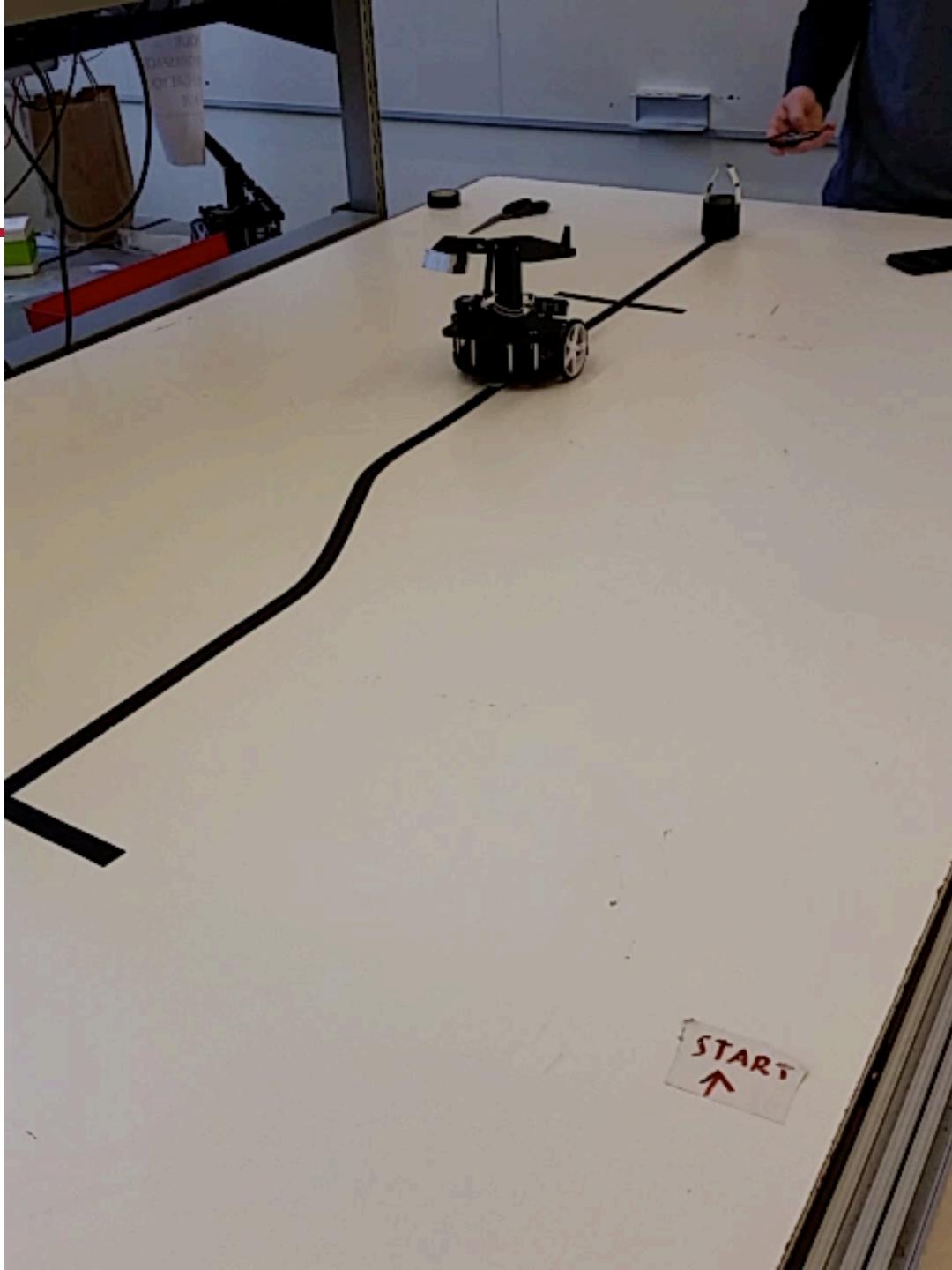
Decisions are made at intersections



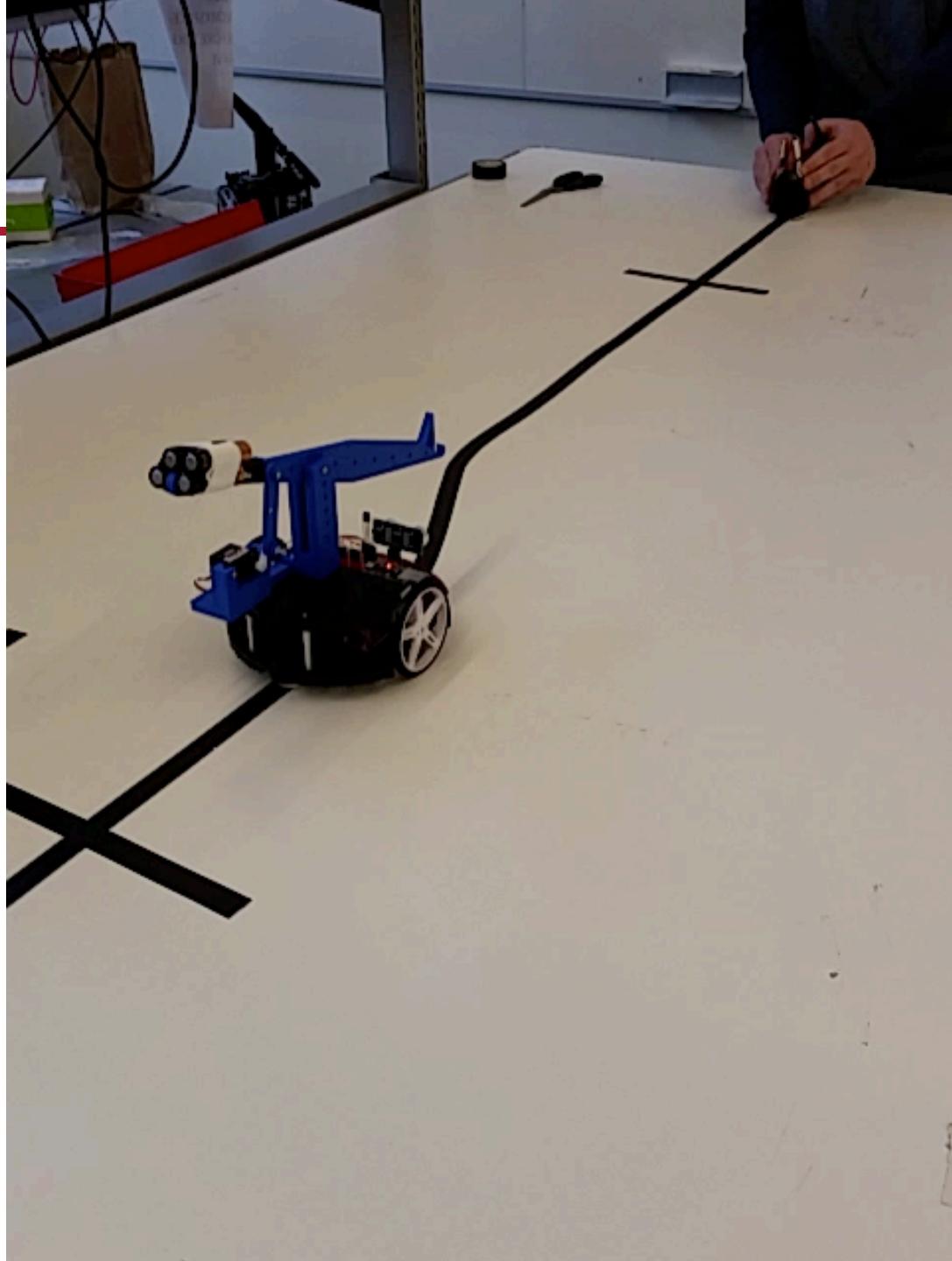
robot tracks:

- where it is
- where it is going
- where it needs to deliver

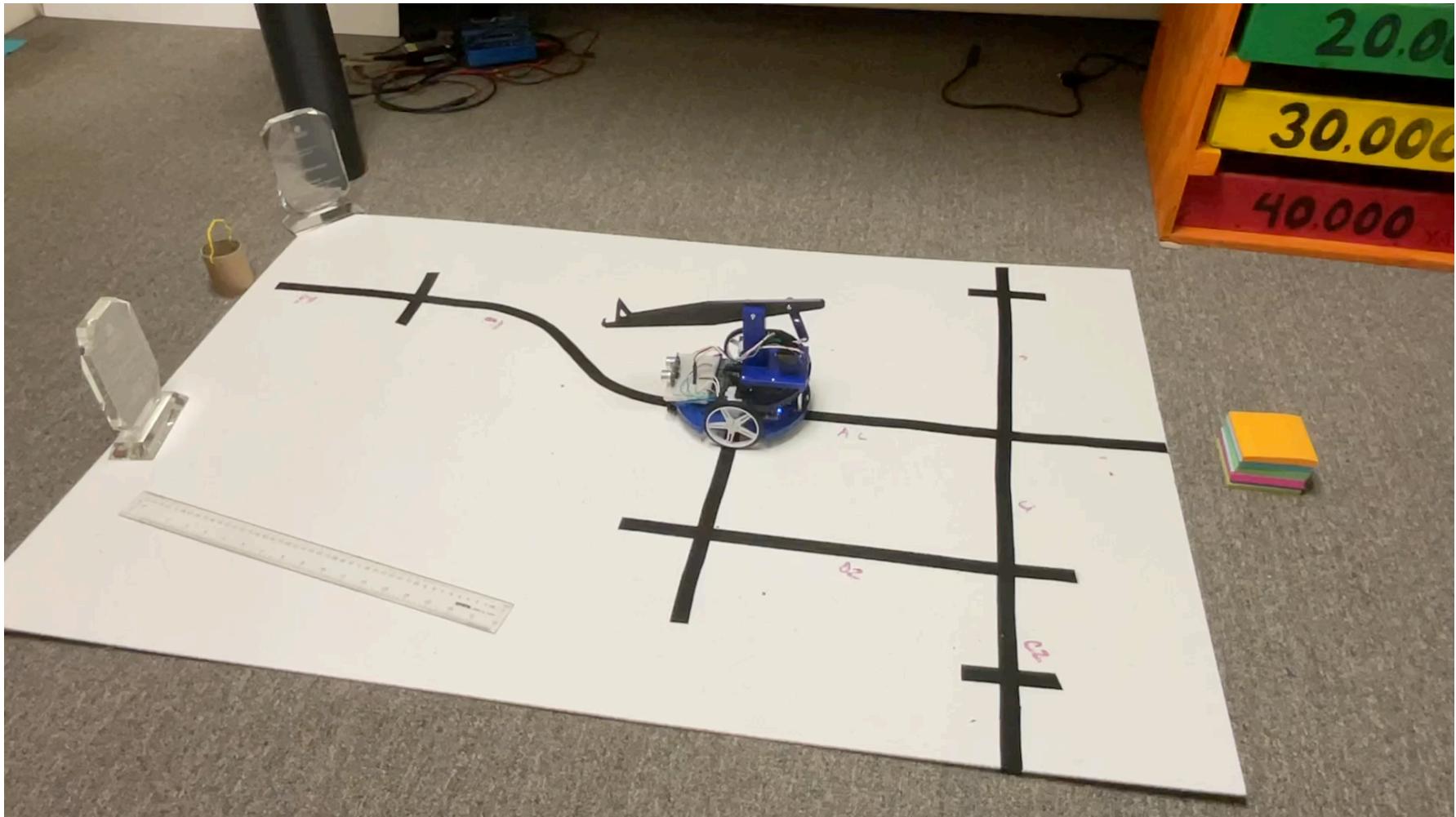
Deliveries



Roadblock



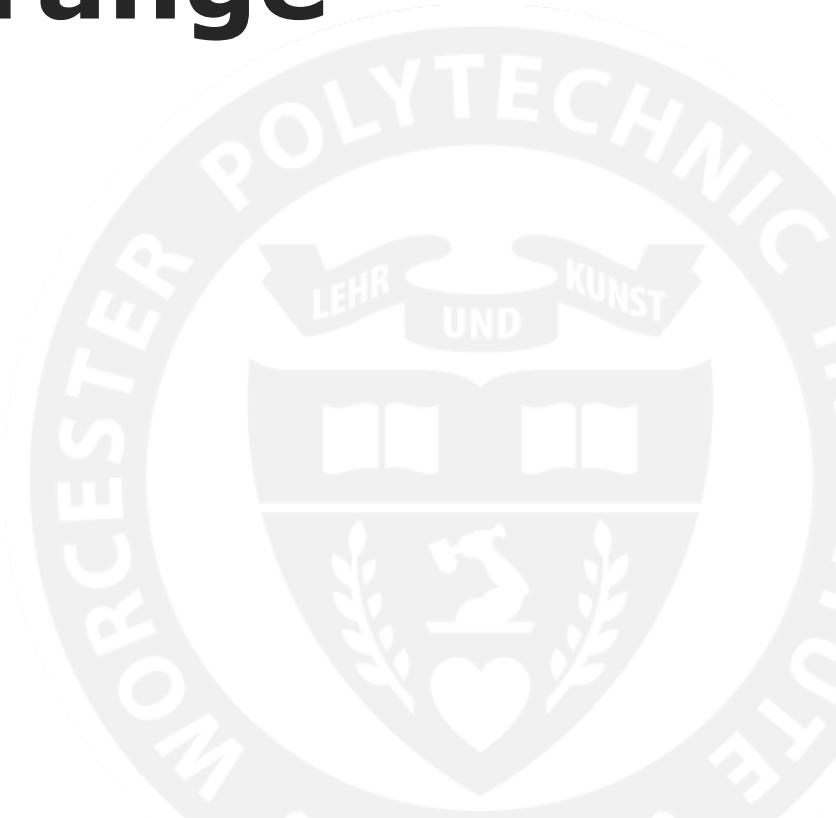
Testing and demonstration



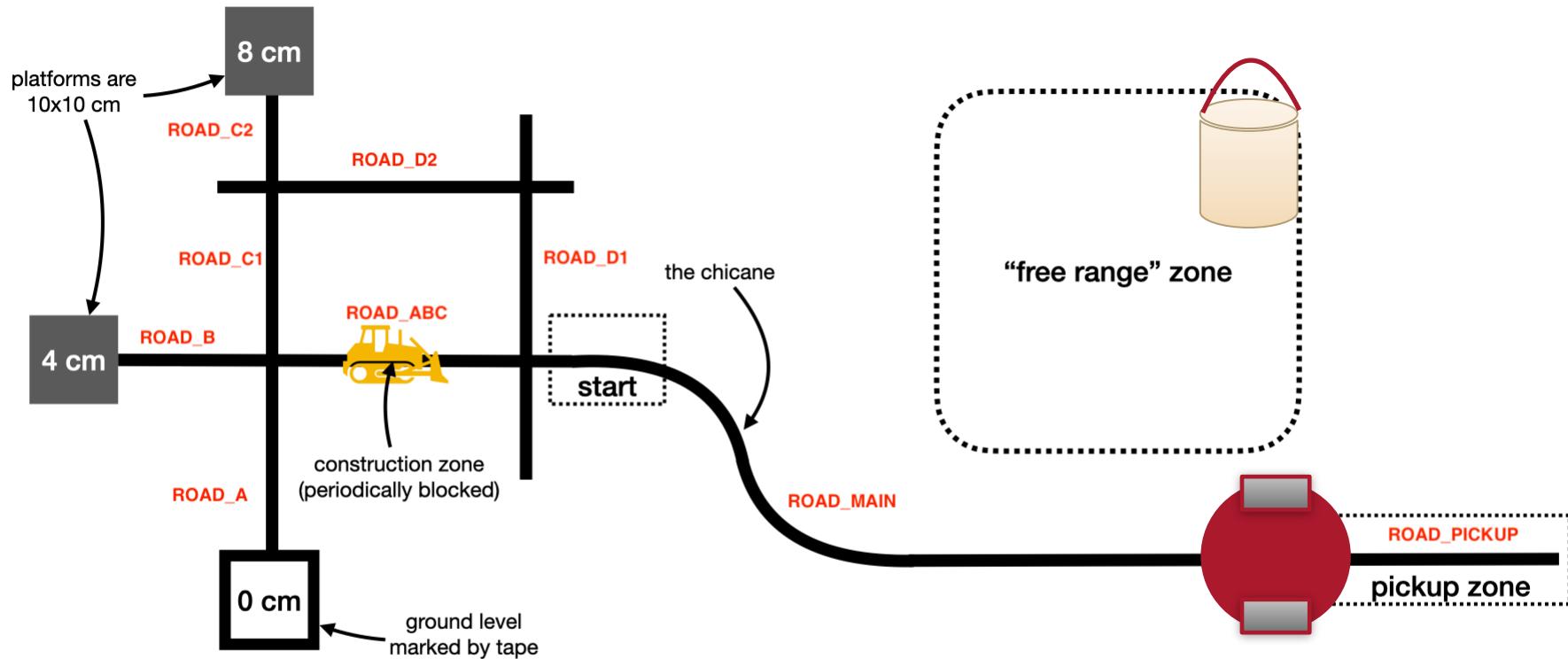


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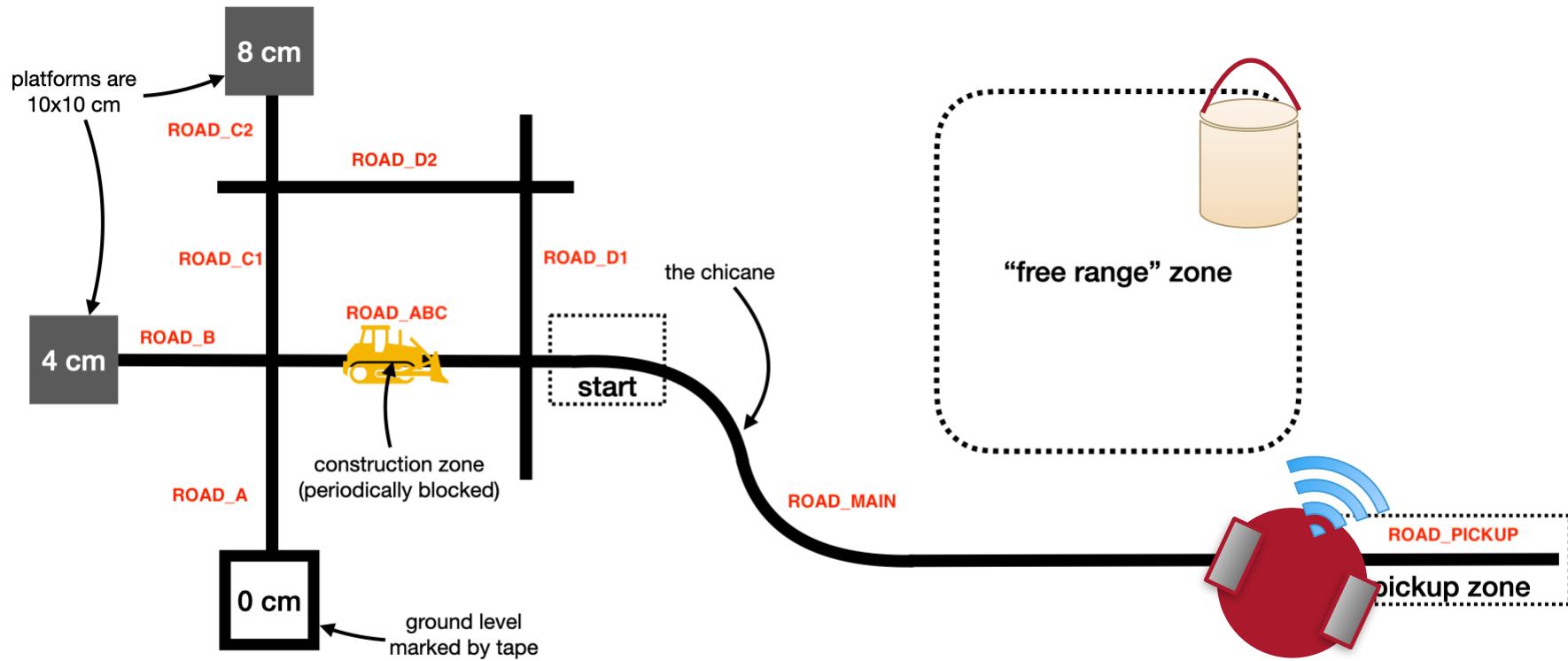
Activity 5: Free-range bag



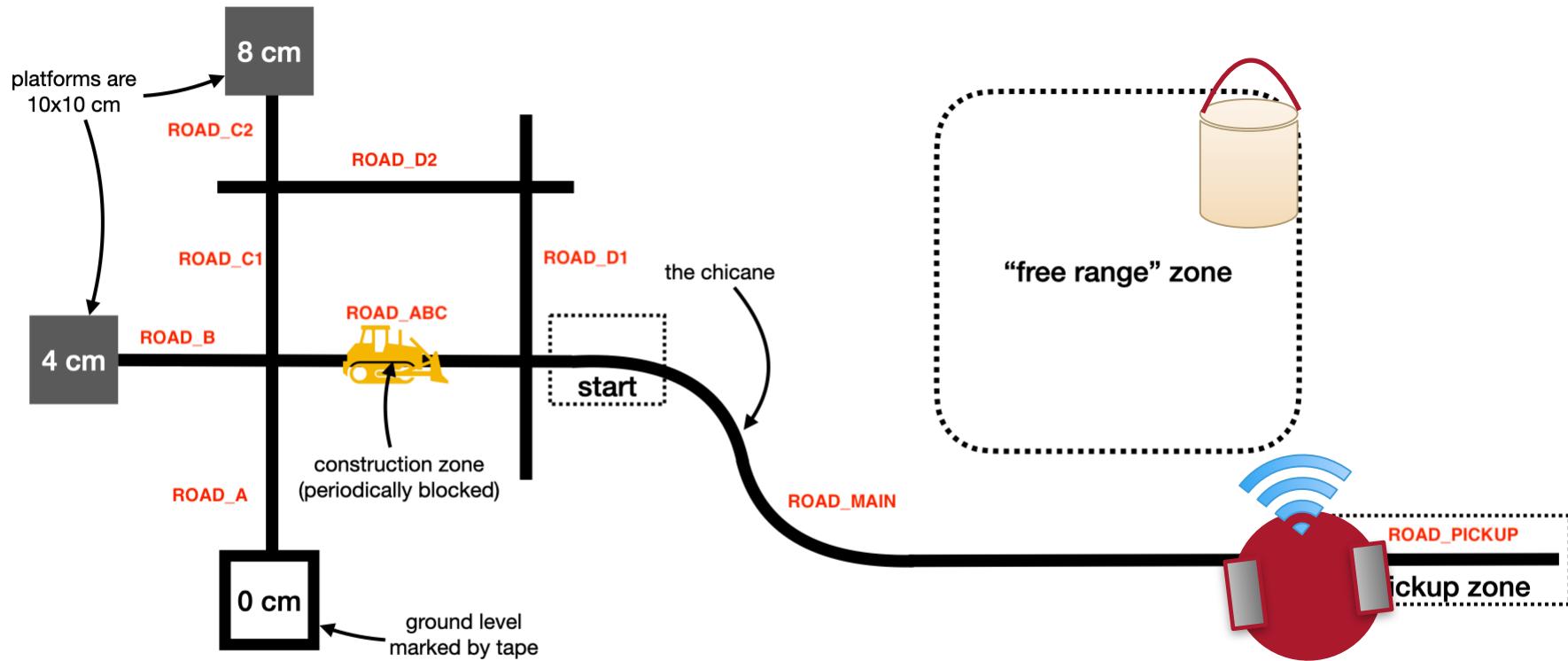
The “free-range” bag



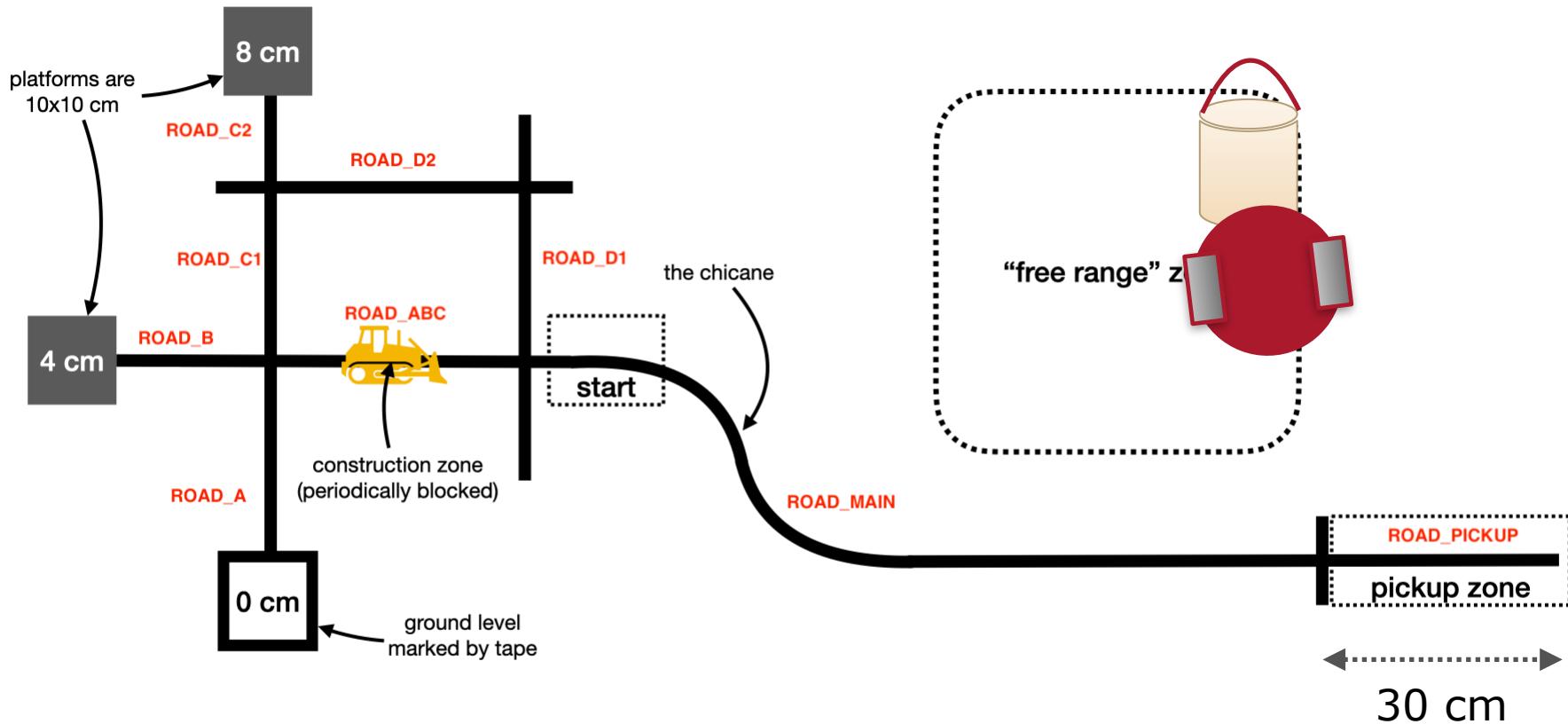
The “free-range” bag



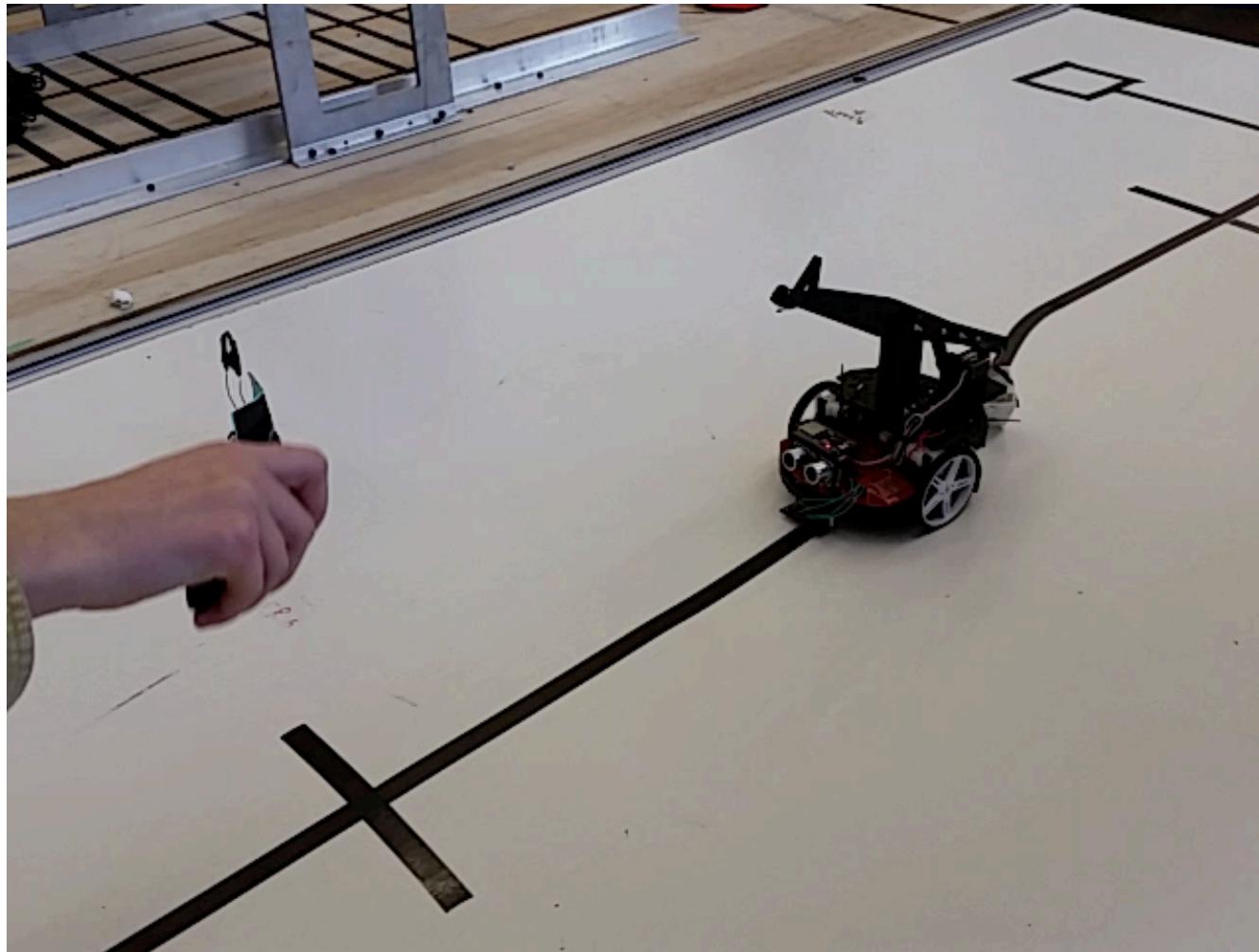
The “free-range” bag



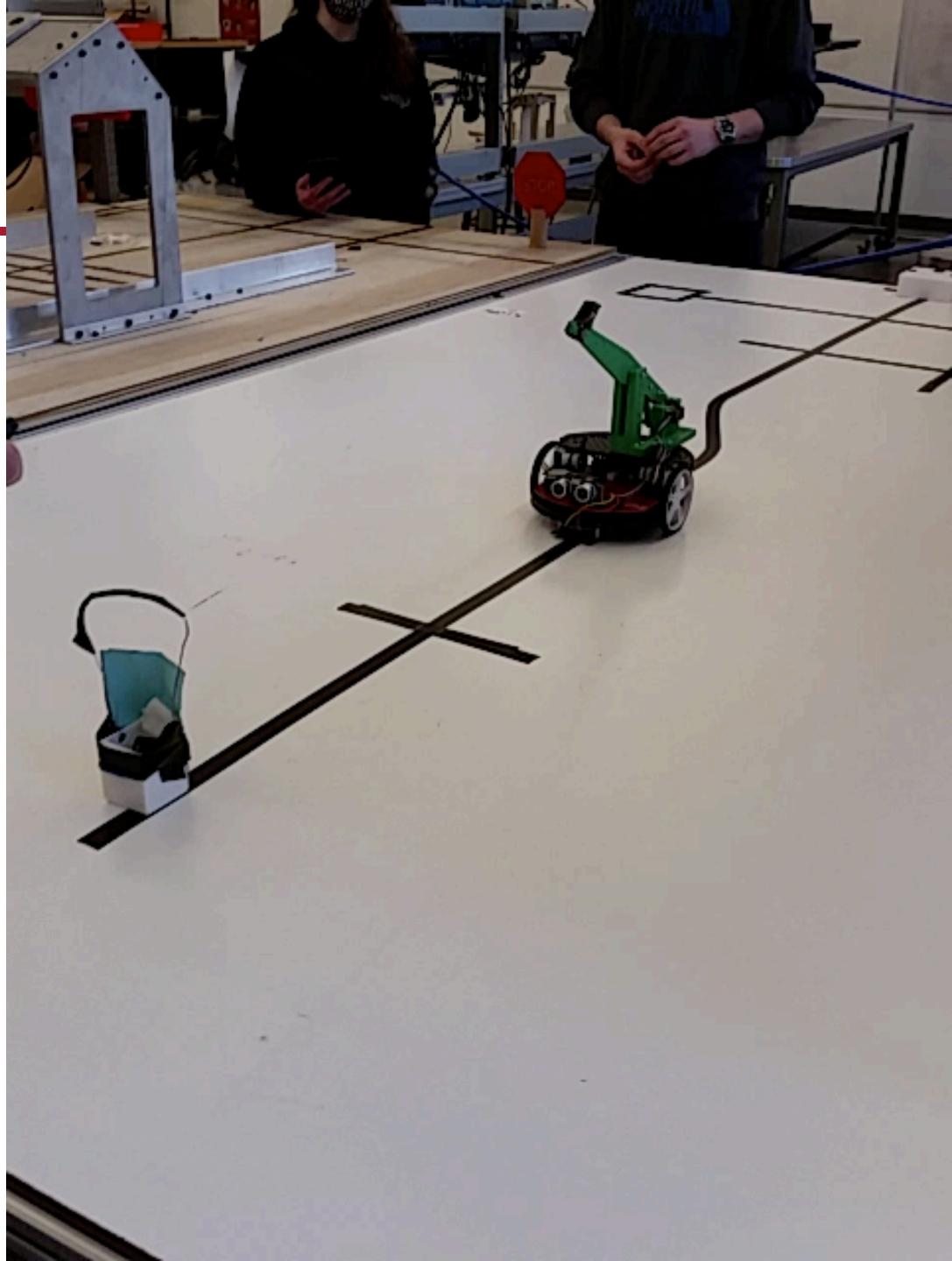
The “free-range” bag



Free-range bag



Things don't always go perfectly



Resources

- Workshop:

<https://github.com/WPIRoboticsEngineering/NSF-Intro-to-Robotics-Workshop>

- Library code:

<https://github.com/WPIRoboticsEngineering/wpi-32u4-library>