LAWRENCE TECHNOLOGICAL UNIVERSITY ROBOFEST 2021 GAME

Stack Rolls

VEXcode V5 Software Game Workshop

This file can be found under the **eAcademy □ Workshops** page on the website

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LAWRENCE TECHNOLOGICAL UNIVERSITY ROBOFEST

2021 Workshops

Presented by

Lawrence Technological University

Computer Science

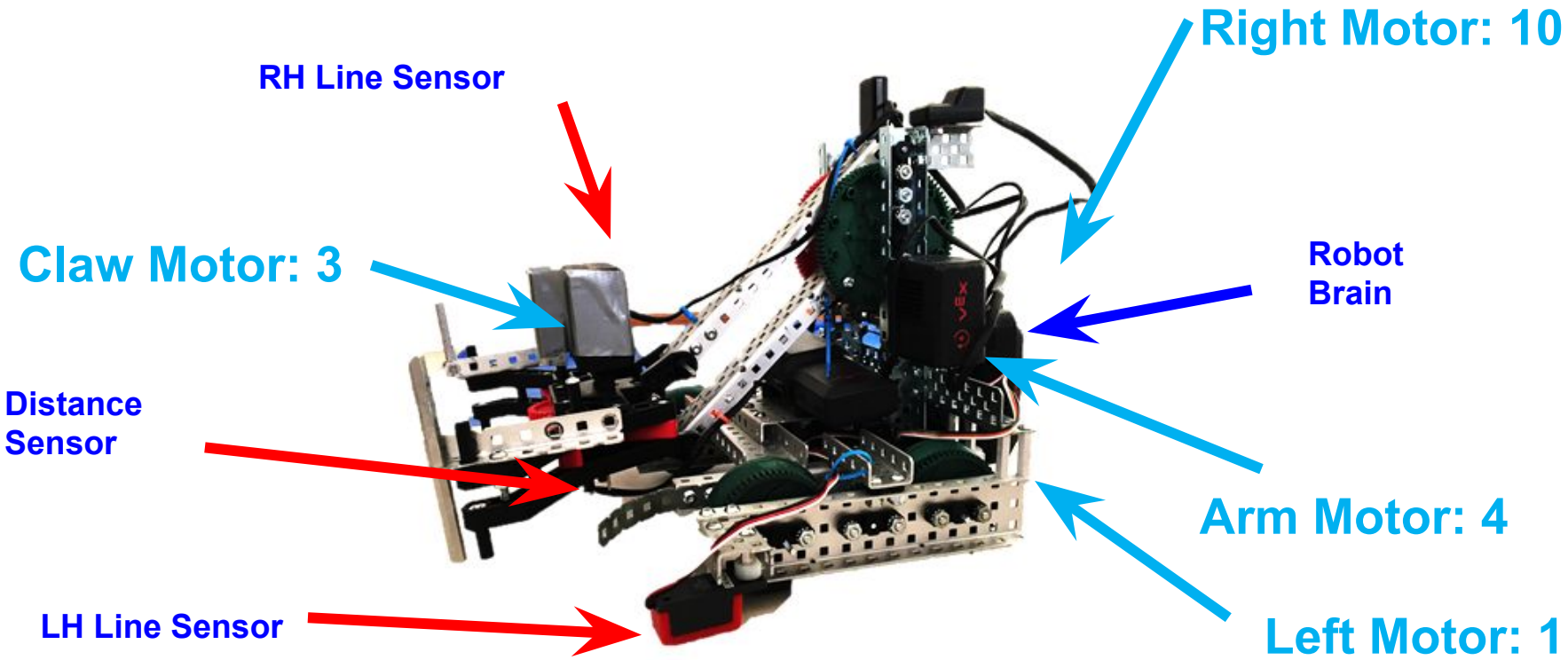
Course Overview

- 2021 Robofest competition Stack Rolls
  - Autonomous robot that get points by moving and stacking rolls
- Workshop robot introduction
- Using the workshop robot to solve the Stack Rolls challenge

2021 Robofest Competition

- Video overview
- Key tasks
    - Task 0: Finding the edge of the table
    - Task 1: Following the edge of the table
    - Task 2: Stop line following when you reach a corner
    - Task 3: Stop line following when you reach a given distance
    - Task 4: Finding a Paper Roll
    - Task 5: Turning the robot
    - Task 6: Aligning the robot to an edge
    - Task 7: Manipulating Paper Rolls
    - Task 8: Building MyBlocks

VEX V5 robot used



Remember the connections!

- Left Motor connects to **1**
- Right Motor connects to **10**
- Claw Motor **3**
- Arm Motor connects to **4**
- LH Line sensor connects to port no. **B**
- RH Line sensor connects to port no. **A**
- Inertial sensor connects to port no. **6**
- Distance sensor connects to port no. **2**

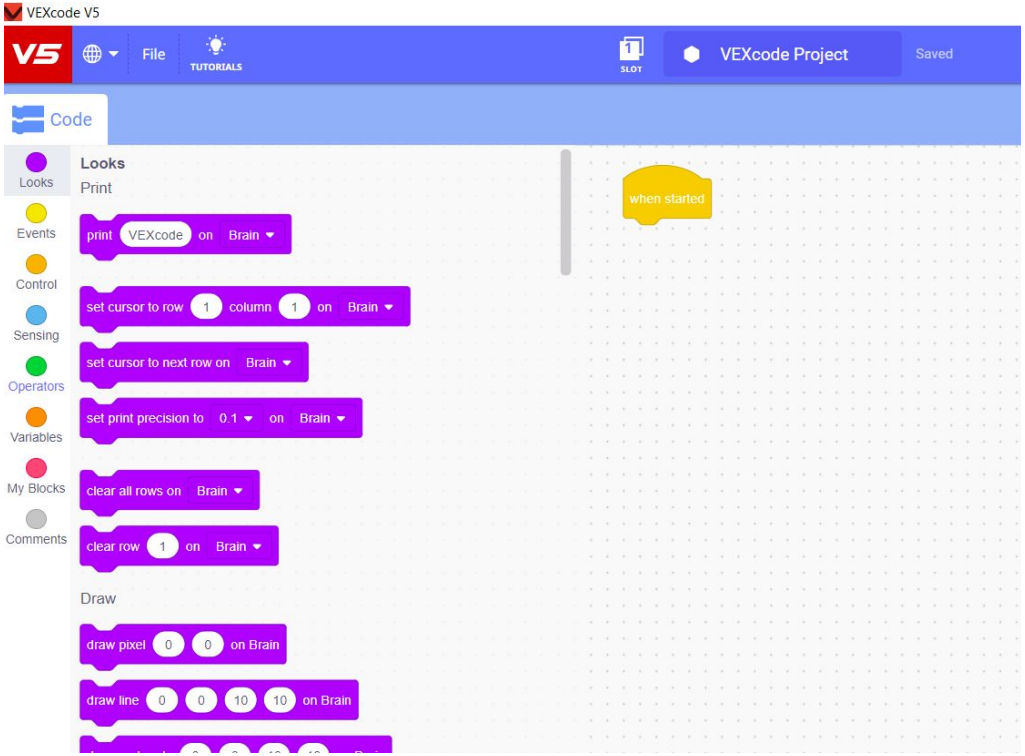
VEXcode V5 Software

- Programming software for VEX V5
- Uses a drag and drop interface

VEXcode V5 - v2.0.6

Getting Started

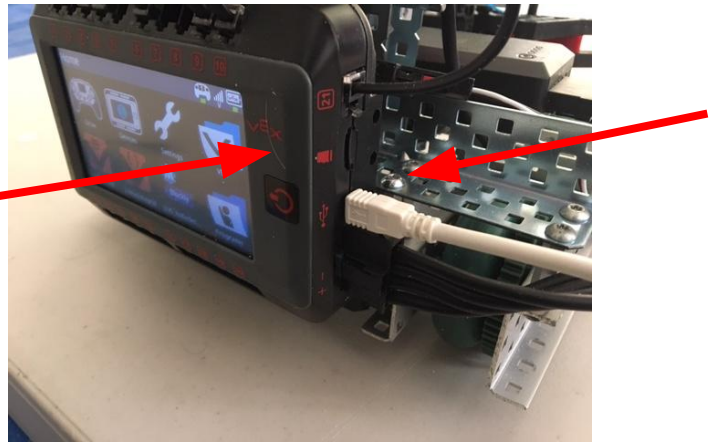
Double click icon to open software



Connect To Robot

- Connect one end of programming cord into computer
- Connect the other end to the robot brain
- Turn on the Robot by pressing the power button

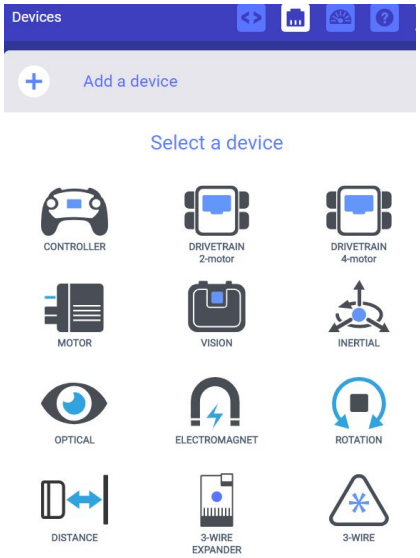
Power button



Programming cord

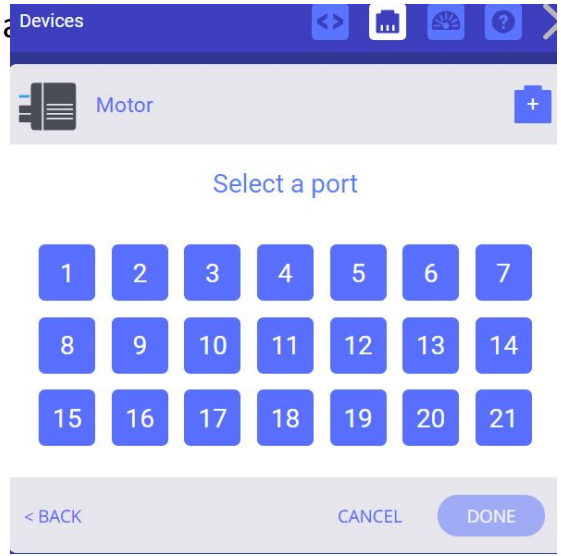
Motor and Sensor Setup

1. Click “Add a device”



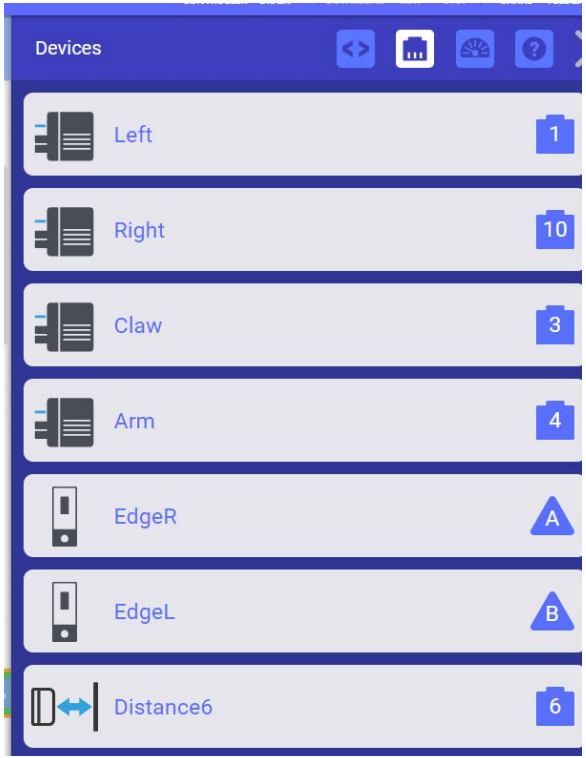
2. Select device

3. Select port



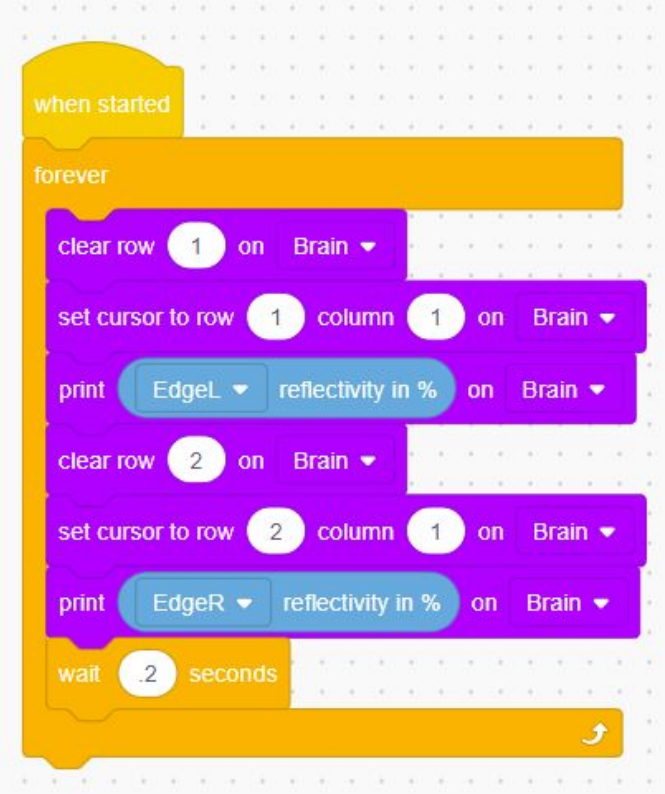
4. Change to names tha

Motor and Sensor Set Up



Display Sensor Values on LCD

Use the LCD Display to Display the Value of a Sensor

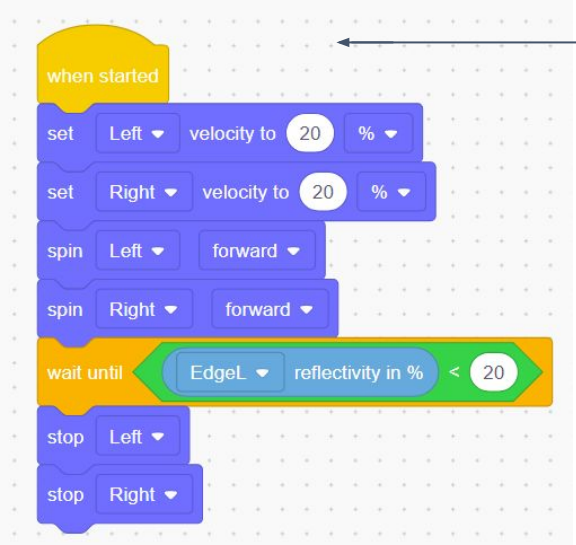


Note: these blocks are needed at the start of a program using line following

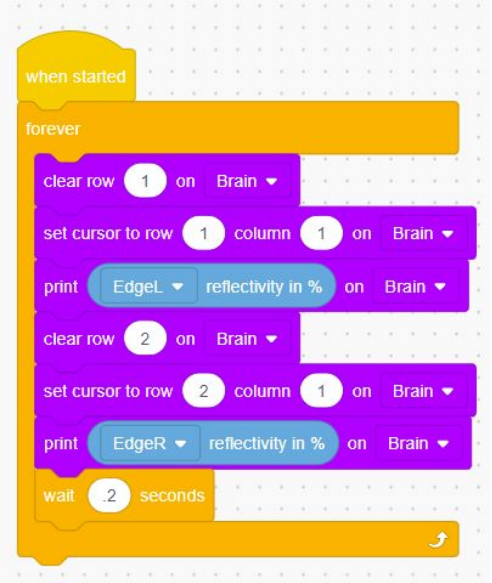
Task 0

Finding the edge of the table

Find the edge of the playing field



Note: leave this code while adding new code

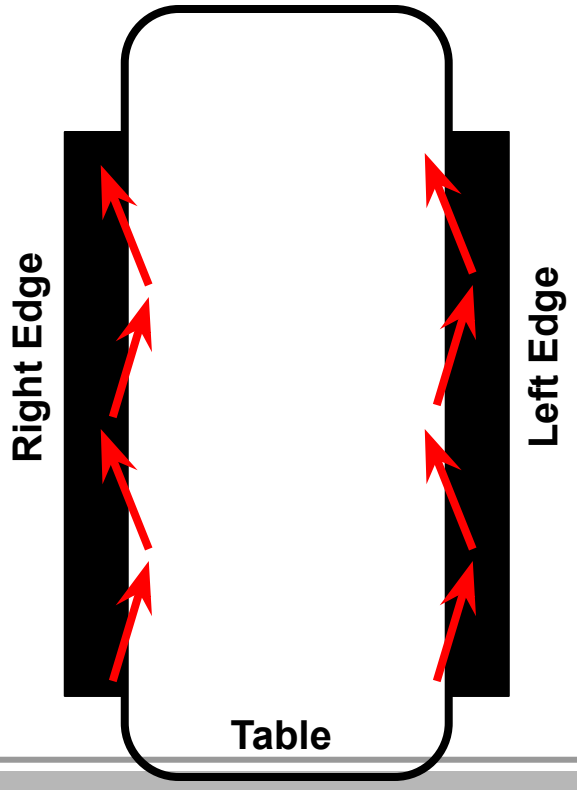


Task 1

Following the edge of the table

Following The Edge Of The Table

- Use the zig-zag method to follow the edge of the table
- Edge following is also referred to as line following
- We need to determine when the robot is on or off the table



Follow The Edge Of The Table

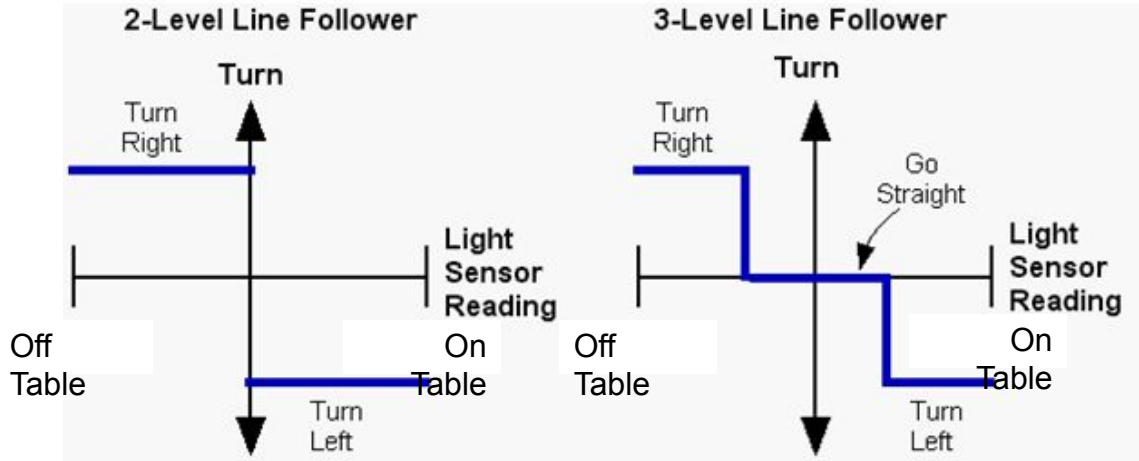
- Light sensor settings example
  - Off table = 5
  - On table = 35
  - Median threshold = (5+35)/2 = 20

- Two cases
  - Light sensor reading > 20. On table.
  - Light sensor reading < 20. Off table.

Simple Line Following Algorithm

How to improve our line following algorithm

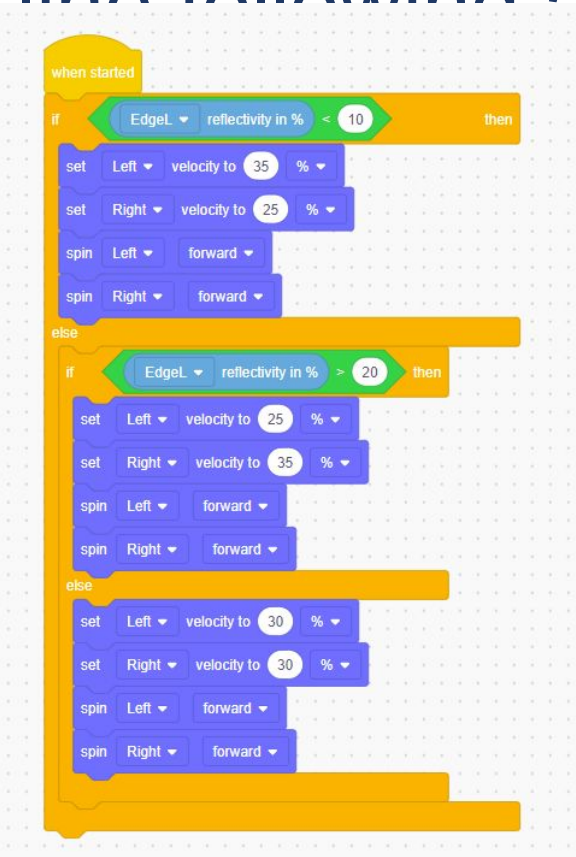
- The zig-zag method can cause a bumpy response
- To improve the response, you can use a 3-level line follower (concept shown below)



How to improve our line following algorithm

Determine upper and lower limits

Go straight if in between limits

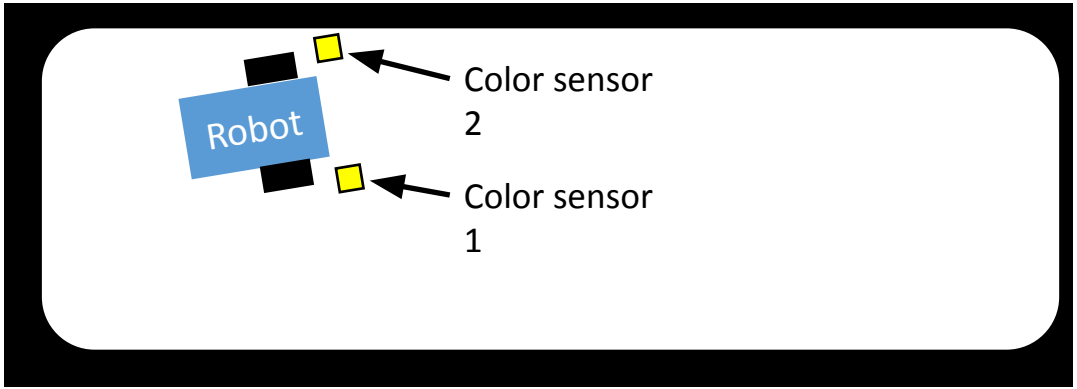


Task 2

Line following to the corner of the table

Line following to the corner

- One method of line following to the corner is to follow the edge of the table with one color sensor and detect the corners with a second color sensor
  - Sensor 1 used to follow the edge of the table
  - Sensor 2 used to locate the end of the table



Line following to the corner

Line following to the corner

- Couple comments regarding moving around the table
  - It is possible to travel around the edge of the table with only one color sensor, but it is more difficult and potentially less reliable
  - Remember that there are no markers to identify the four corners of the table
    - You need to count the corners has your robot reaches them

Travel around the table

- Recall our line following program
  - Let's modify the program to stop when the robot reaches the end of an edge of the table

Using this program, the robot will line follow continuously. How can we make the robot stop when it reaches a corner?

Follow the playing field edge until corner

YouTube: https://youtu.be/1z_GVJNjD94

Follow the Edge to the Target Zone

What is the light sensor reading for the target zone?

Task 3

Line following a given distance

Line following a given distance

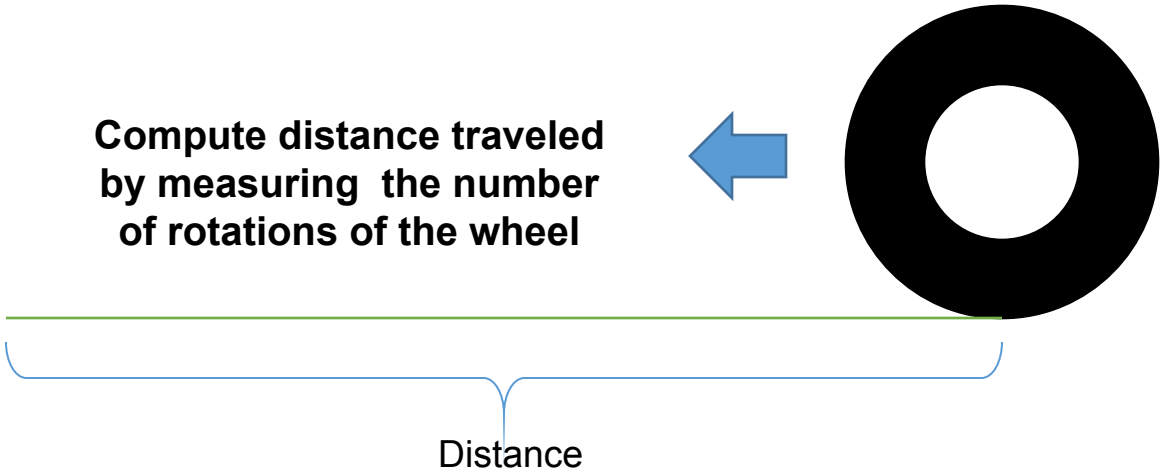
- Approach
  - Modify LineFollow program to stop when the robot travels a given distance

- Tools needed
  - Line following
  - Measure distance traveled

Measuring Distances

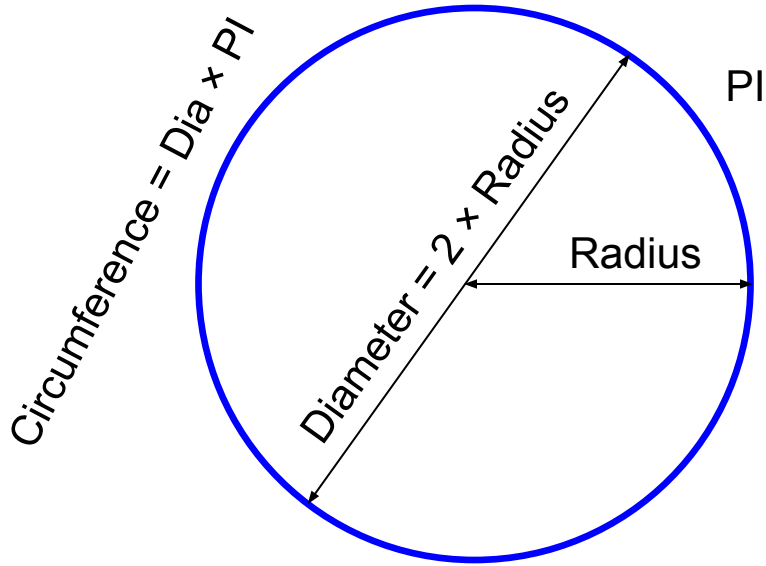
- How do we measure distance traveled?

- Let's determine how far the robot travels moving forward for 2 seconds



Measuring Distances

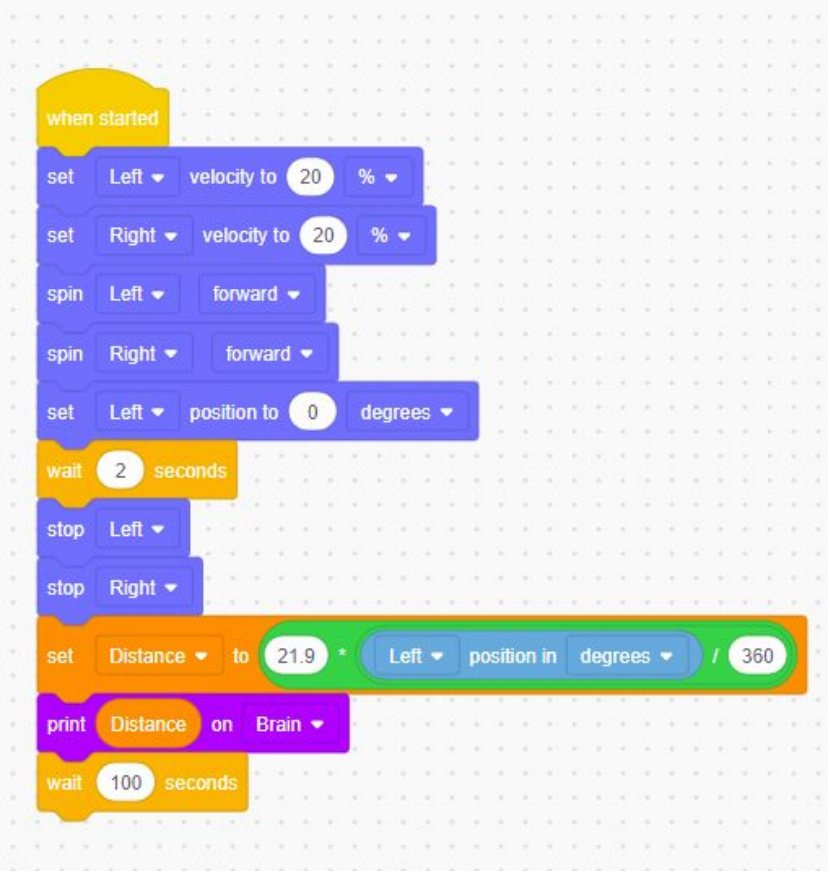
- Use the wheel geometry



How can we use this information?

Measure Distances

- For each rotation of the wheel, the robot will travel (Wheel Diameter) x (PI)
  - Distance = (Wheel Diameter) x (PI) x (# Rotations)
  - Distance = (69.85 mm) x (PI) x (# Rotations)
  - Distance = (21.9cm) x (# Rotations)



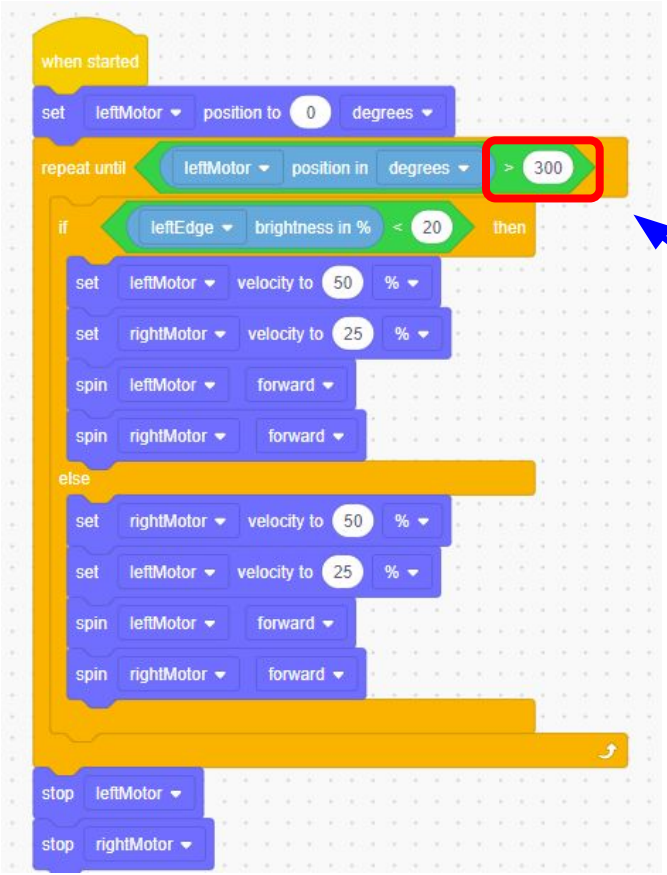
YouTube: https://youtu.be/9pqK0uBtbzE

Measuring Distances

- Example
  - Let's program the robot to line follow for 30 cm
    - Distance = 30 cm
  - Number of rotations
    - Distance = (Wheel Diameter) x (PI) x (# Rotations)
    - Solve for (# Rotations)

$$(\#\ \text{Rotations}) = \frac{\text{Distance}}{(\text{Wheel Diameter}) \times (\text{PI})}$$

$$(\#\ \text{Rotations}) = \frac{36\ \text{cm}}{(5.5\ \text{cm}) \times (\text{PI})} = 1.74\ \text{rotations}$$



Rotations must be converted to degrees

1.74 rotations x 360 degrees = 626

Change this number to go the desired distance

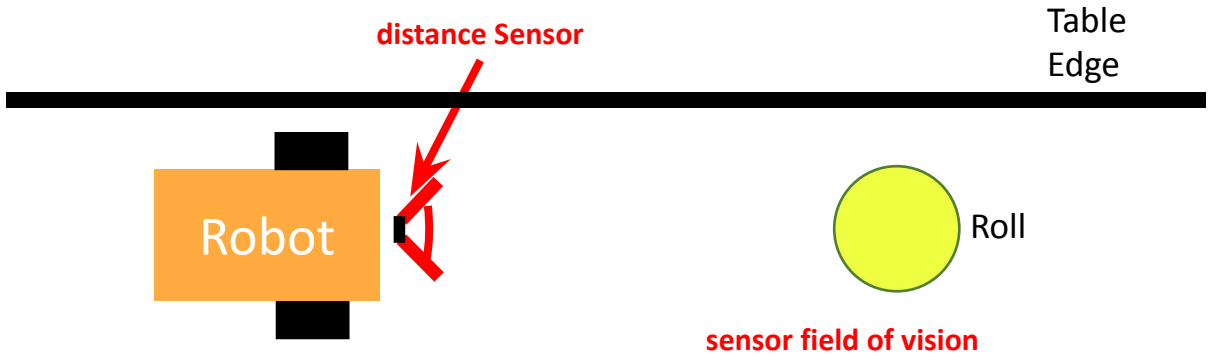
YouTube:
https://youtu.be/K1suXAzZuCA

Task 4

Finding a Roll

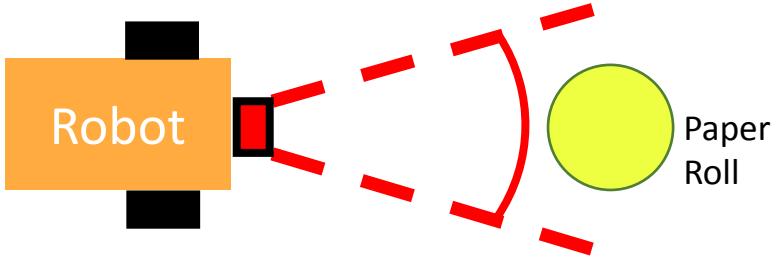
Finding a Rolls

- We can use a distance sensor to determine if an object is near the robot
- Here we will assume that we are following the edge of the table and wish to stop the robot once a Paper Roll close to the robot



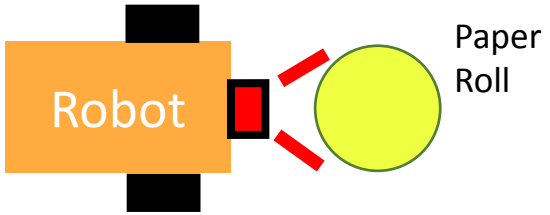
Finding a Paper Roll

- Here we will use our line following program to follow the edge of the table and stop the robot when the Paper Roll is close to the distance sensor



Distance sensor will read no value when the Paper Roll is far away

Starting Position

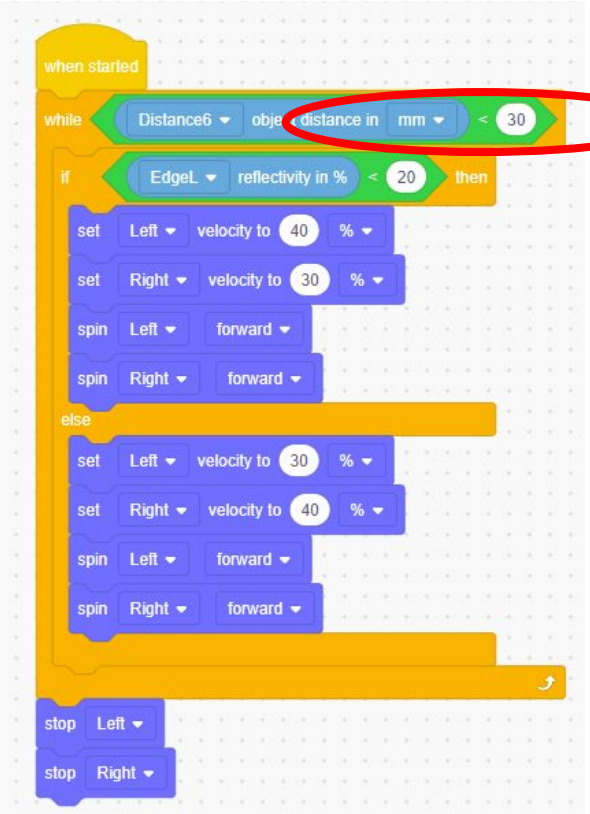


DIstance sensor will read values when the Paper Roll is close to the robot

Final Position

Finding a Paper Roll

- Now, we travel along the edge of the table and stop if we find a Paper Roll



We can determine the appropriate value by testing the sensor readings with a Paper Roll near the front of the robot.

Task 5

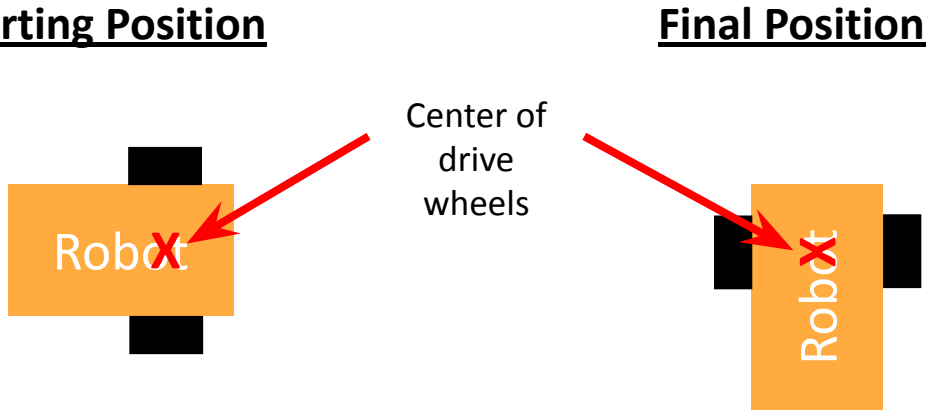
Turning the robot

Turning The Robot

- For our example here, we wish to turn the robot 90 degrees
- There are several methods for turning a tripod robot. We will focus on two methods
  - “Spin” turn
  - “Swing” turn

90 Degree Spin

- Let's have the robot spin 90 degrees CCW
- The robot will rotate about center of the drive wheels



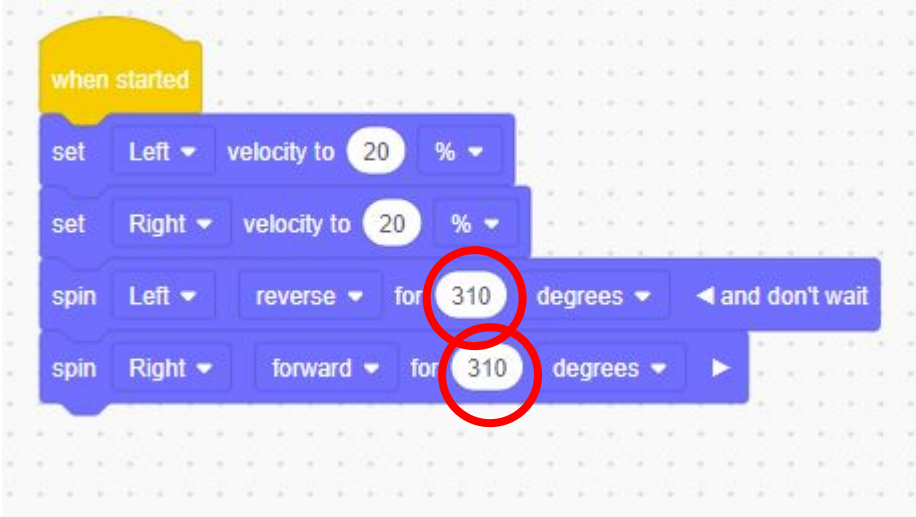
90 Degree Spin

- You can determine the proper number of rotations mathematically; however, the result typically needs some adjustment due to lash in the motors

- For today's class, we will use trial and error to find the number of rotations that cause the robot to turn 90 degrees

Spin 90 Degrees

- We can use the code below to spin the robot



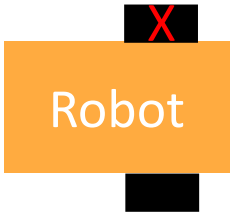
- For our sample robot, it takes 310 degrees to spin the robot 90 degrees

YouTube: https://youtu.be/AUqXzsnf0NI

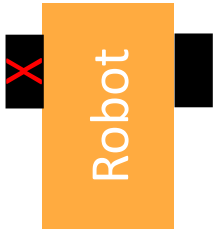
90 Degree Swing

- Let's have the robot swing 90 degrees CCW
- The robot will rotate about a locked wheel (denoted by red X)

Starting Position



Final Position



90 Degree Swing

- To swing, we lock the left motor and power the right motor to turn the robot

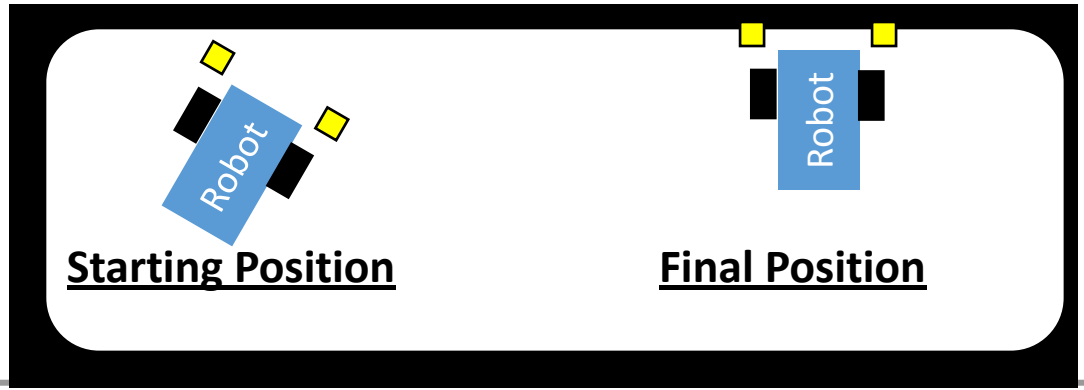
- For our sample robot, it takes 620 degrees to swing the robot 90 degrees

Task 6

Aligning the robot to an edge

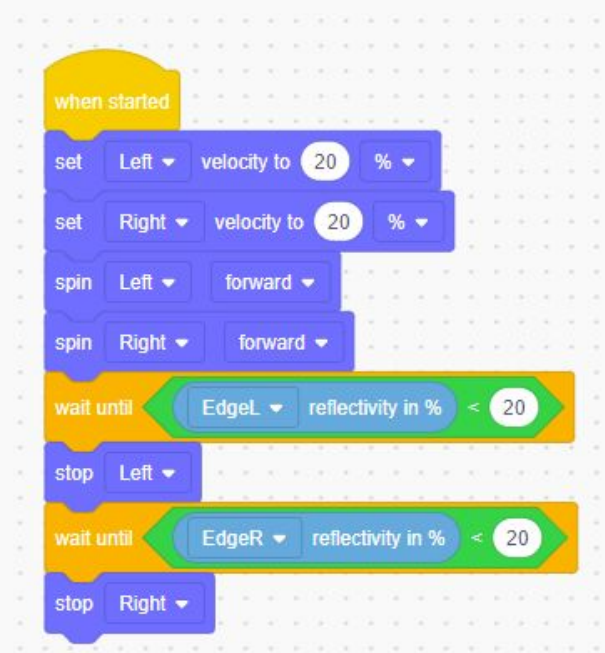
Aligning the robot to an edge

- In some situations we desire align with robot to an edge of the table as shown below
- Assuming the starting position below, how can we program the robot to reach the final position that is aligned with the edge of the table?



Aligning the robot to an edge

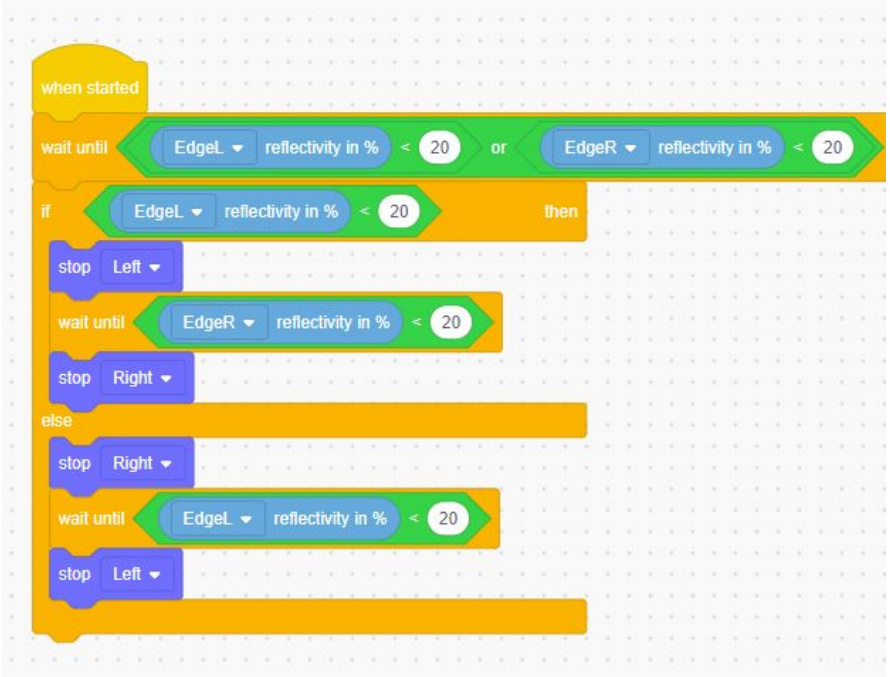
- Travel until LH color sensor reaches the edge, swing robot until it is aligned with the edge



YouTube:
https://youtu.be/Jq0L2ekQARk

Aligning the robot to an edge-either sensor

- Travel until either color sensor reaches the edge, swing robot until it is aligned with the edge



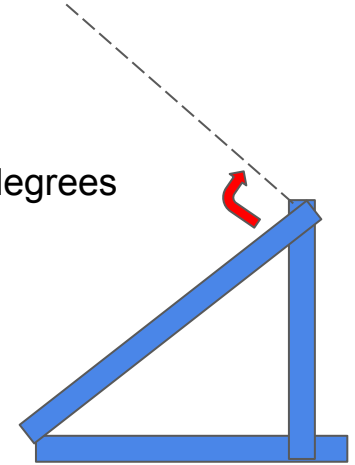
YouTube: https://youtu.be/Jq0L2ekQARk

Task 7

Manipulating Paper Rolls
Moving the Arm and Claw

How to Control the Arm and Claw

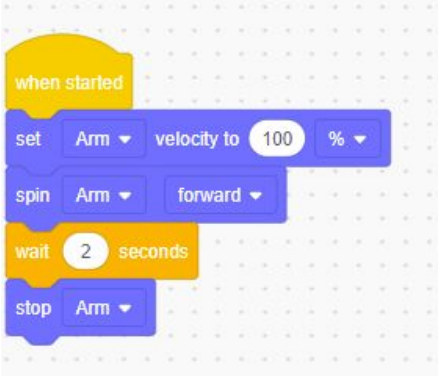
- Time
- Rotation(encoder degrees)



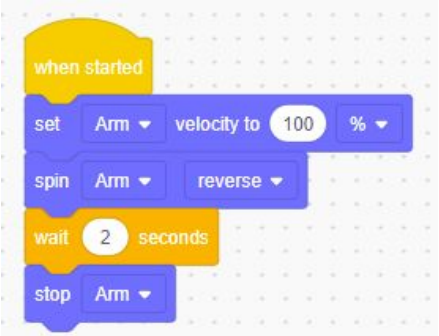
Arm all the way down
0 degrees

Moving the Arm- Using time

- Advantages
  - Simple
  - Easy to program
  - Will not get stuck
- Disadvantages
  - Can be imprecise
  - Repeatability
- How to do it
  - Set a motor block to “seconds”
  - Select the motor port
  - Select the direction
  - Select the duration



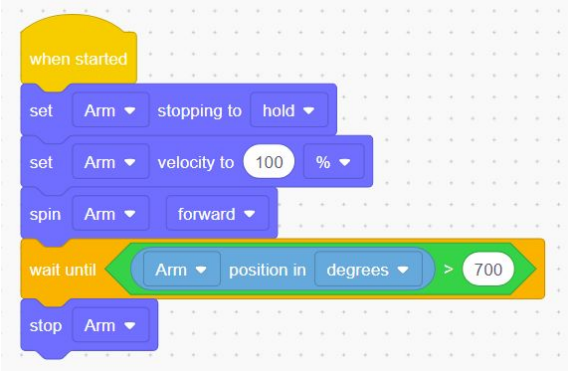
Raise Arm



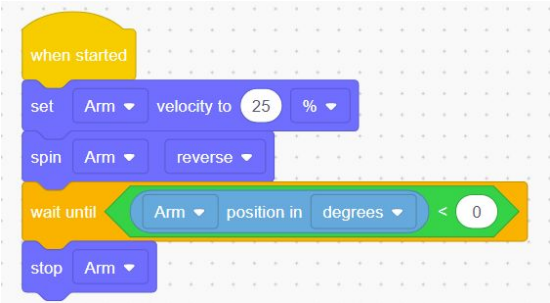
Lower Arm

Moving the Arm- Using encoder

- Advantages
  - More precise
  - More repeatable
- Disadvantages
  - More difficult to program
  - Can get stuck
- How to do it
  - Establish a “zero” point
  - Determine direction of motor
  - Set limits



Raise Arm

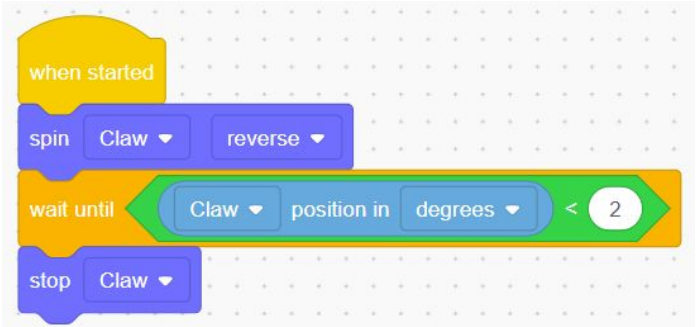


Lower Arm

Moving the Claw

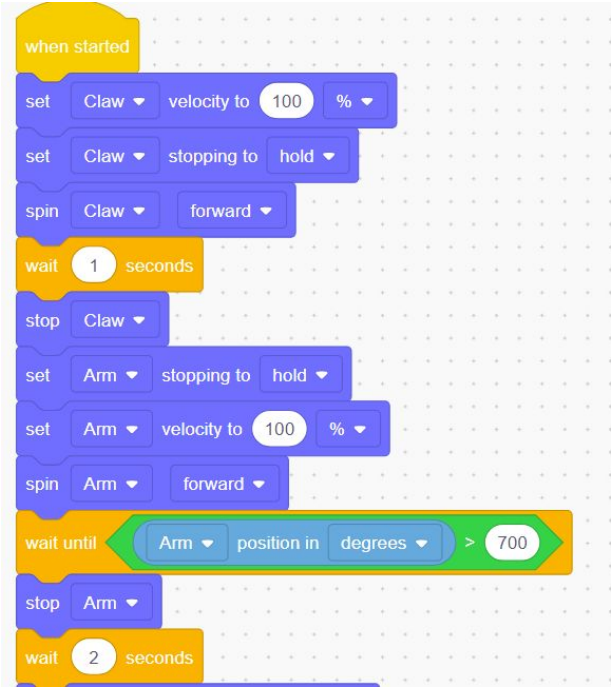
- As with the arm, may use time or rotation
- May need to overdrive motor to get enough grip
- May use encoder to open back to zero position

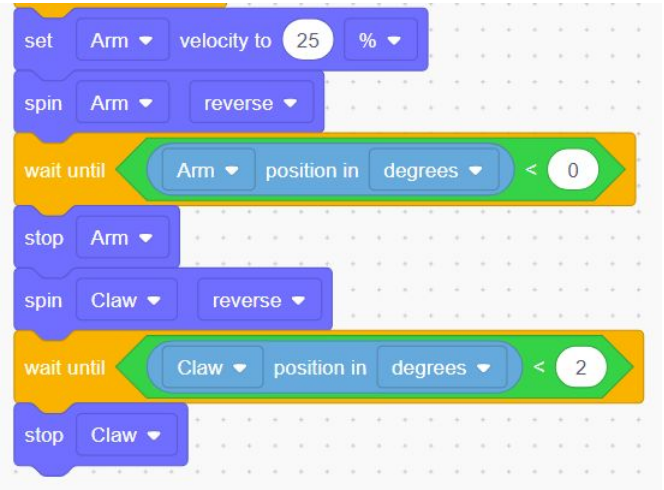
Use time to close



Use rotation to open

Combine Arm and Claw Movement





Task 8

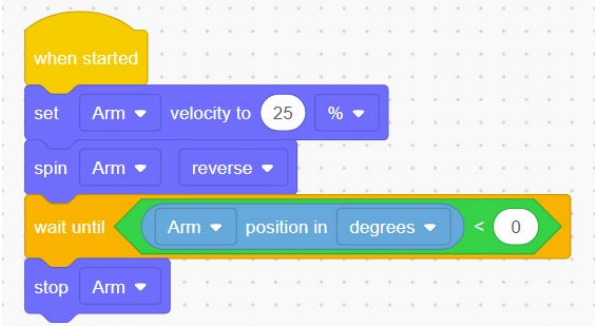
Building MyBlocks

MyBlocks

- Solving the Robofest Game challenge will typically require a fairly large program (around 100 blocks is not unreasonable)
- Very large programs can be difficult to understand, navigate and use
- To alleviate this issue, the Robot Mesh Studio software has “MyBlocks” to create custom blocks that can replace sections of your program
- Variables can be used to make the MyBlock more flexible

MyBlocks

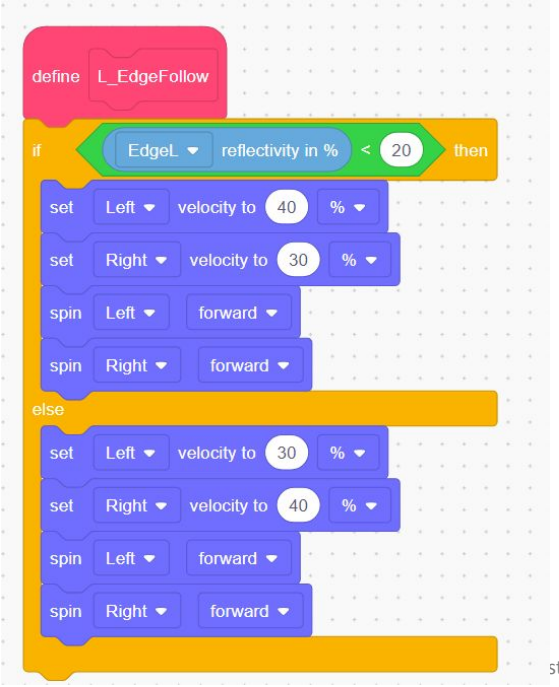
- For example, let's assume you have a section code that completes the following:
  - Move forward until the edge of the table is found with color Left Color Sensor, then stop
- The code may look like this



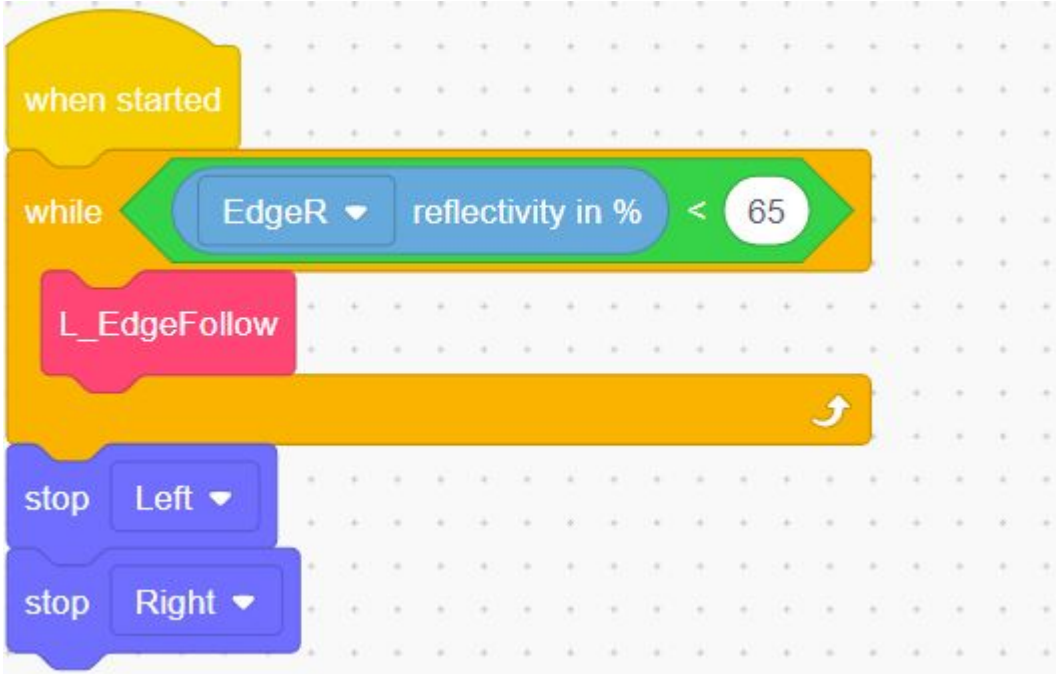
- My blocks will allow us to convert this to a single block

Create a Edge Following MyBlock

- Go to MyBlocks Menu
- Click “MyBlock”
- Name it “followLine”
- Drag the line following blocks and attach to the define MyBlock block



Use the MyBlock in the Program

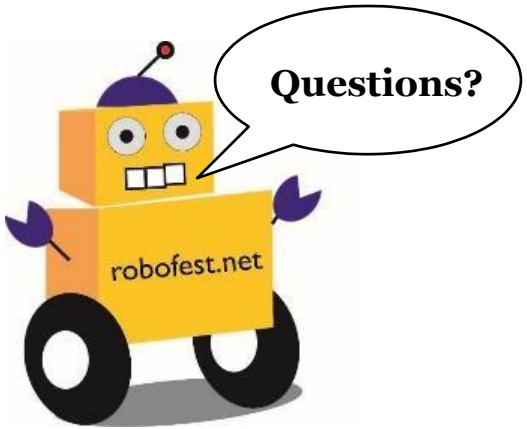


Putting It All Together

- In this course we learned about
  - Finding the edge of the table
  - Following the edge of the table
  - Stop line following
    - When you reach a corner
    - When you reach a given distance
  - Finding a Paper Roll
  - Turning the robot
  - Aligning the robot to an edge
  - Manipulating Paper Rolls
  - Building MyBlocks

LAWRENCE TECHNOLOGICAL UNIVERSITY ROBOFEST

Little Robots, Big Missions



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