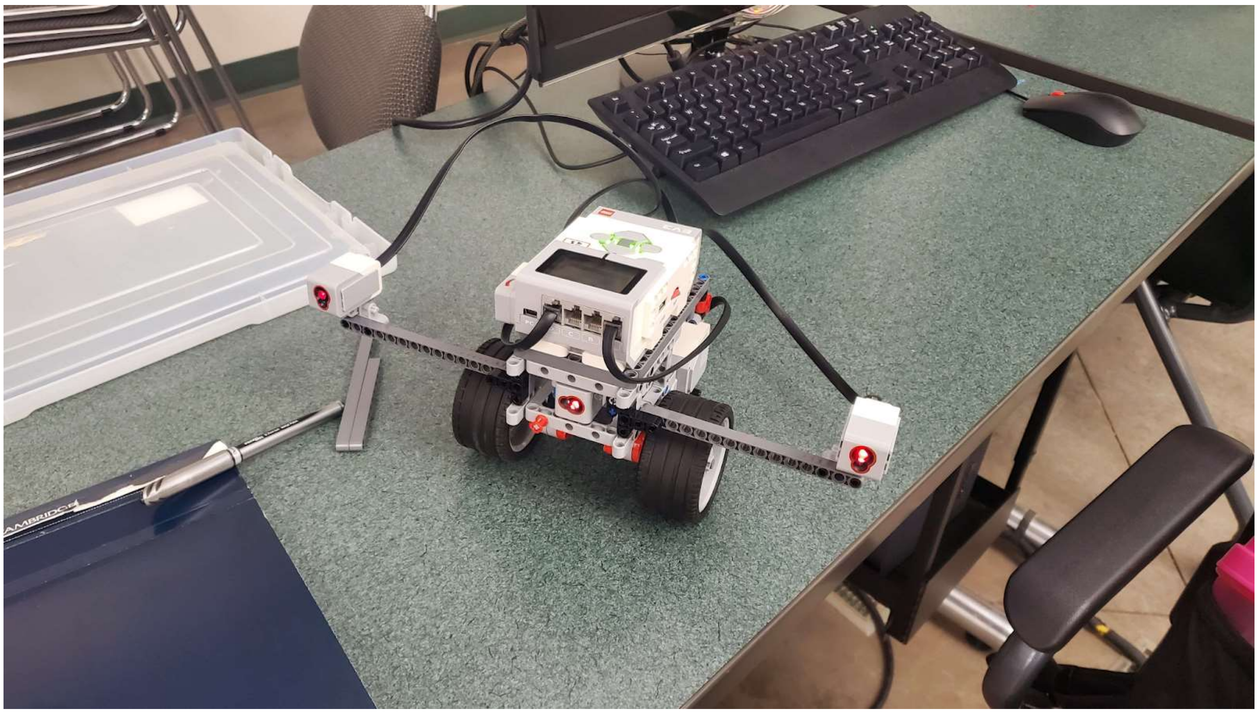
CMPUT 312 – Lab 1 Report

Group members names & ccids: Justin Valentine (jvalenti), Minh Luu (mqluu), Yash Bhandari (yashaswi)

Q1)

Our robot:

First design iteration: the robot frame is constructed and the light sensors are mounted



Second design iteration: Pen holders are added to complete lab 1 question 3

Q2)

Code located in the function straight in dead_reckoning.py

We are using the following methods to measure the error of our robot when it is moving in a straight line:

- ○ **Method 1:** Use the tacho counter on the motor to find the number of wheel rotations.
- ○ **Method 2:** Measure the distance with a physical ruler

- Comparing our two methods we find that both work well, but the physical ruler is more reliable because the tacho counter has potential sources of error such as wheel slip's.

We are using the following methods to measure the error of our robot when it is rotating:

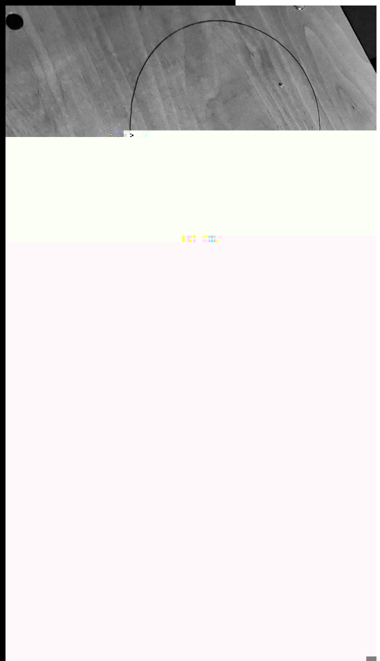
- ○ **Method 1:** Measure angle with a physical ruler protractor
- ○ **Method 2:** Measure angle with a gyroscopic sensor

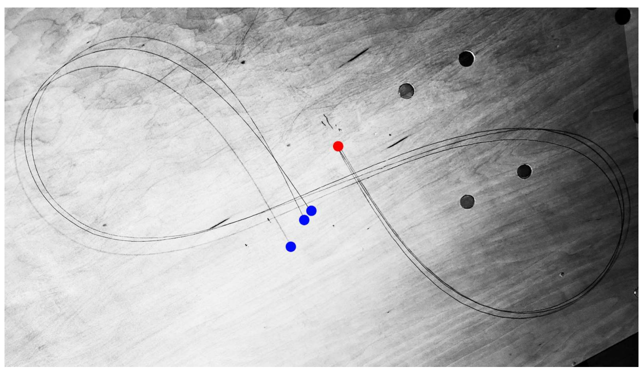
- Comparing our two methods we found that the gyroscope has trouble keeping up when the robot is rotating very quickly.

How does error accumulate in rotation and linear movements of your robot, as a function of the power applied to the ro

- As we apply power to the wheels we cause them to accelerate. This acceleration in the angular velocities of the wheels leads to two related sources of error. Firstly, accelerating the angular velocities of the wheels can cause them to slip, an ration, all of which affect the angle of rotation of the robot, as well as the width of each tire which adds a lot of friction when trying to make sharp turns which leads to a lower than expected turning rate. Lastly is how we orient the cars. If the car's orientation aligns closely with the (x and y axis), errors can be reduced since it allows the car to draw a better 90 degree angle.

- **Conclusion:** Comparing the 3 images, the final corners are not closed and the three rectangles are not exactly the same. This can be attributed to the car orientation, inconsistent surfaces, frictions, etc (mentioned above). Ultimately when tracing the rectangle, the errors in our angles (mentioned above) accumulated over time which affect





[redacted]n:

[redacted]ve tried to implement a more general solution by numerically calculating the [redacted]ar ing parametric equation to [redacted]sc[redacted]te

$$[redacted](t) = (x(t),\ y(t)) = \left(\frac{a\cos(t)}{1+\sin^2(t)},\ \frac{a\sin(t)\cos(t)}{1+\sin^2(t)}\right)$$

[redacted]lo[redacted]ing equation to calculate the radius of curvature at each time step

$$R(t) = \left|\frac{(x'(t)^2 + y'(t)^2)^{(3/2)}}{x'(t)y'(t) - y'(t)x''(t)}\right|$$

- Provided is smooth this

v_r h can be seen by rewriting eq of V and R

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keep the speed low. This might be due to more error accumulation when the car is traveling at a greater speed.

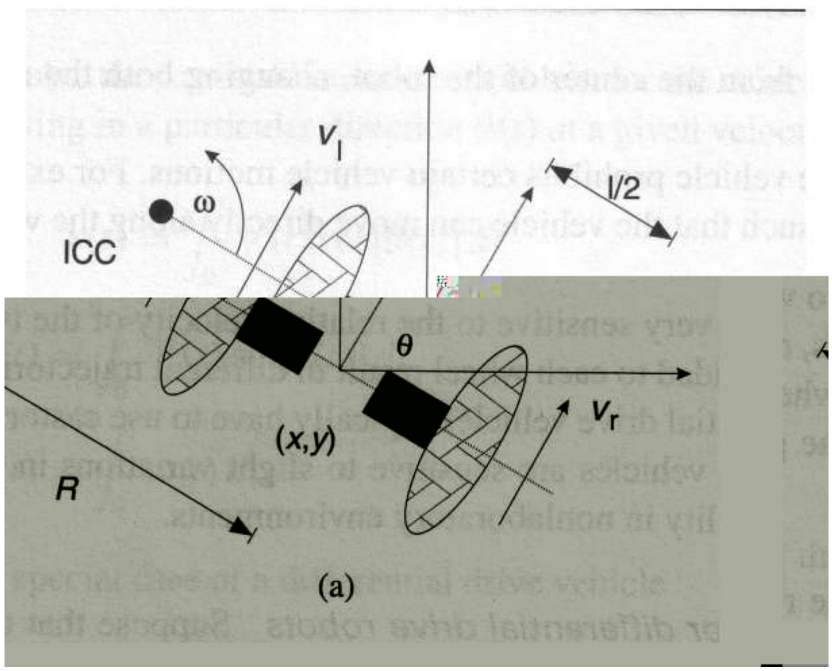
Similar to the other shapes our sources of error included wheel slippa[1]

ly, error in the angle accumulates over time which also affects the final shape.

Q4)

Code located in dead_reckoning.py

Implementation:



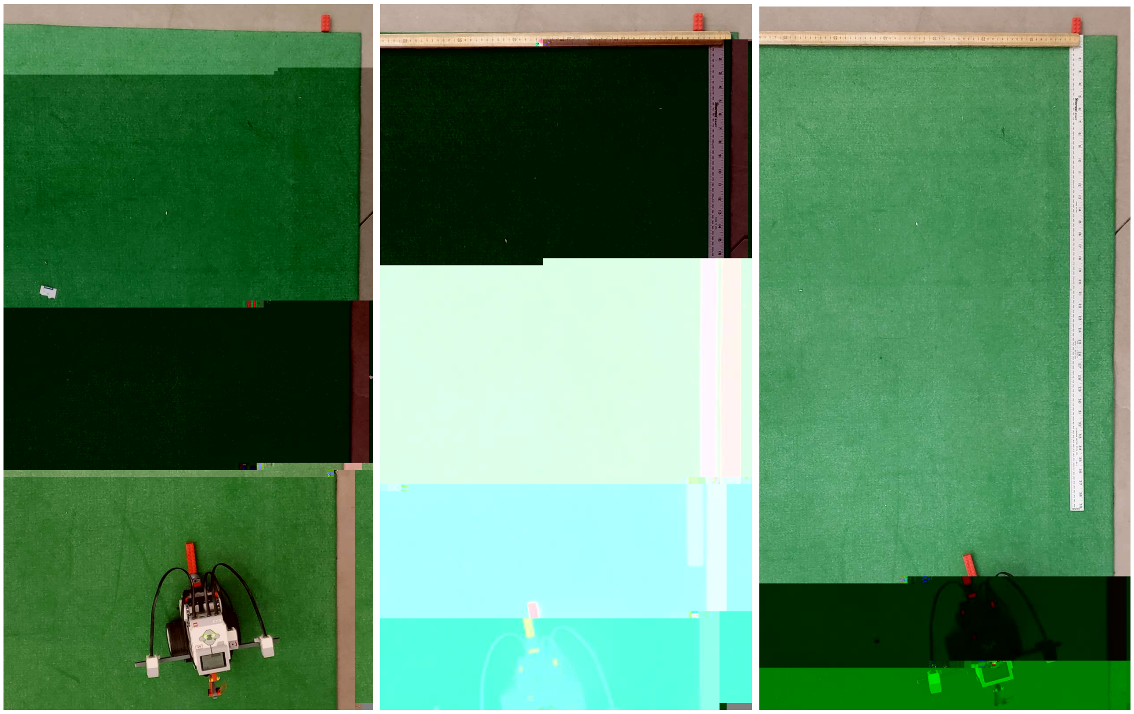
Formulas used for dead-reckoning:

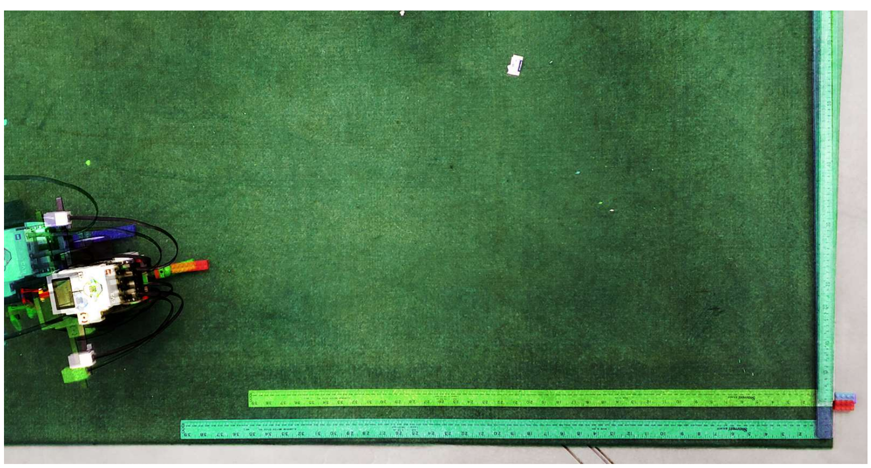
$$R = \frac{l}{2}\frac{v_l + v_r}{v_r - v_l} \quad \textbf{(1)} \qquad \omega = \frac{v_r - v_l}{l} \quad \textbf{(2)} \qquad V = \omega R \quad \textbf{(3)}$$

$$v_r = \omega(R + \frac{l}{2}) \quad \textbf{(4)} \qquad v_l = \omega(R - \frac{l}{2}) \quad \textbf{(5)}$$

$$\theta(t) = \int_0^t \omega(t)\, dt \quad \textbf{(6)}$$

Trajectory:





Q5)

Code located in bb.py

Love:

https://drive.google.com/file/d/1jGujTWRZfYZYKz6t19UTPtOtk6WEwub4/view?usp=sharing

Aggression:

https://drive.google.com/file/d/1haQhW1q7uQ8lAsC-6MPR8p9h2sIlRFTP/view?usp=sharing

Cowardice:

https://drive.google.com/file/d/1m0BUz0AshuNPjMynWO9Zc37_9-oK79Lp/view?usp=sharing