SASTA OLIPHANT SCIENCE AWARDS

SOUTH AUSTRALIAN SCIENCE TEACHERS ASSOCIATION

Prize Winner

Programming, Apps & Robotics

Year 5-6

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St Peter's College

Measuring G-force in Cars

My project is a car that measures g-force. In real life, sharp turns can lead to a lot of g-force, which may be dangerous. The aim of my project is to test cars to see how much g-force there is. I used Lego Spike Prime to build and program the robot.

How to Use the Robot

After starting the code, you will need to tell the robot if you want a gentle or hard turn. Press the left button on the hub for a gentle turn, or the right one for a hard turn. After that, the robot will go forward, turn for a while then go forward again. While it is driving, measurements are being recorded on a line graph. The blue line shows g-force and the red line shows angular velocity Z, which is degrees per second. You will see that they stay around 0 when going straight, then suddenly go up when it starts turning. This is because you only get g-force when turning, and there is only degrees of turns so angular velocity has 0. Also, the g-force formula includes the radius of the turn, and the radius will be inaccurate when going straight.

How the Program Works

When the program starts, it clears the line graph and moves the steering motor to position 0. It then sets the movement motors to ports A and B and the speed to 50%. Then it waits until a button is pressed. If the left button is pressed it sets the variable “turn” to 40 and “radius” to 0.8 for a gentle turn. If the right button is pressed it will set the “turn” to 78 and “radius” to 0.46 for a hard turn.

Later, the steering motor will turn to the position in the ‘turn’ variable. I have measured the radii of these turns and put them in the code for the variable ‘radius’. If you want the robot to do turns of different sizes to these, you will have to measure the radius of the turn and put it in the code, as the program needs it for an accurate g-force measurement. The radii can be slightly inaccurate on different surfaces.

After the setting the variables it will wait for 0.5 seconds, broadcast a message to another part of the program, then the robot will start moving forward. The message tells robot to start recording g-force and angular velocity. After 2 seconds of going straight, the steering motor will move to whatever position is in the ‘turn’ variable, depending on the button you pressed. It will keep turning for 4 seconds, then go straight again. To record the data, it plots angular velocity to the red line. It also plots this formula for g-force to the blue line:

$$Velocity^2 \div (radius * 9.8)$$

9.8 is a mathematical constant. It is the force of gravity acting on us every day.

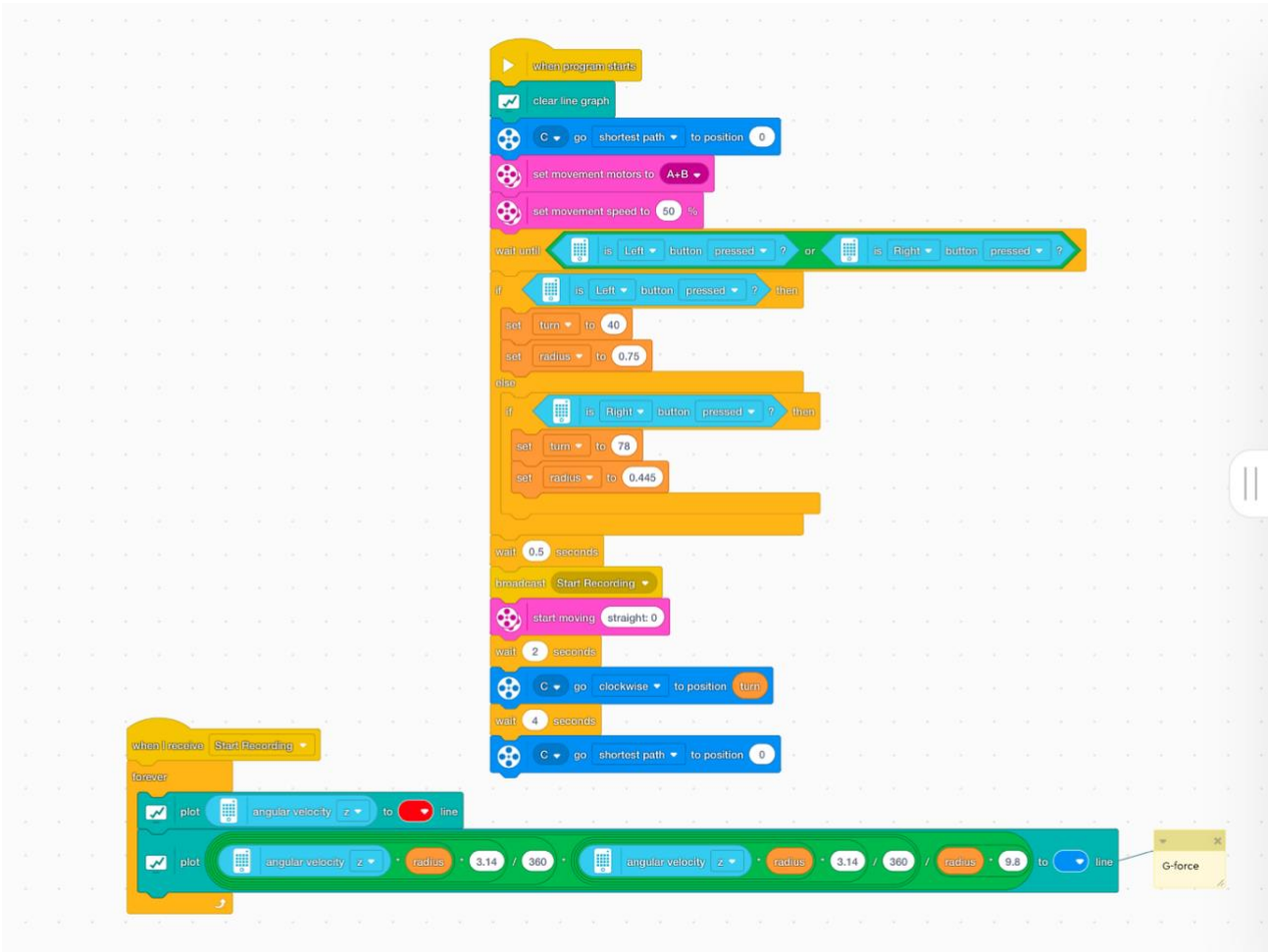
This is the formula for velocity:

((Angular velocity Z*radius)*pi)÷360

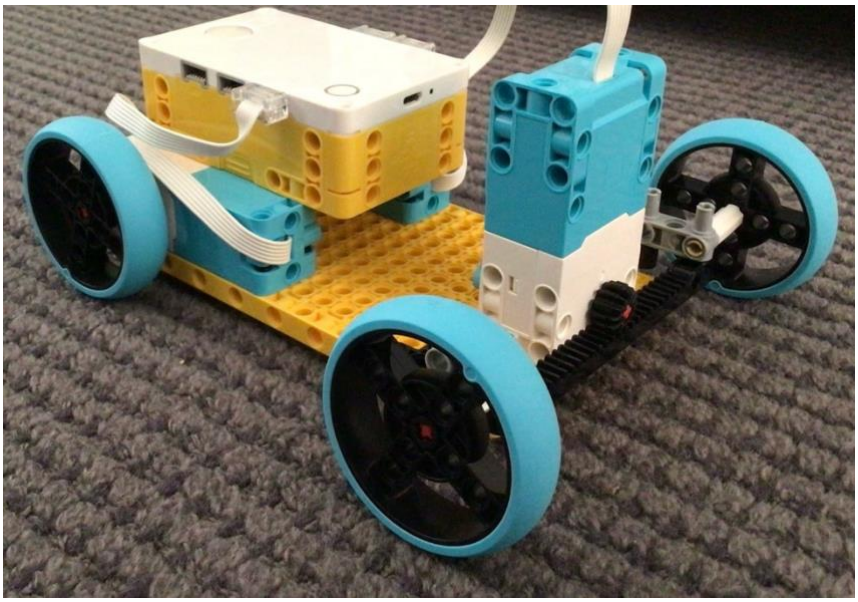
Conclusion:

In doing this project, I have figured out that sharp turns have more g-forces than gentle turns. This robot can be used to test new models of cars to see how much g-force they generate and assess their safety. I hope that this information and technology can be used to improve the safety of cars.

The Code:



Finished Model:

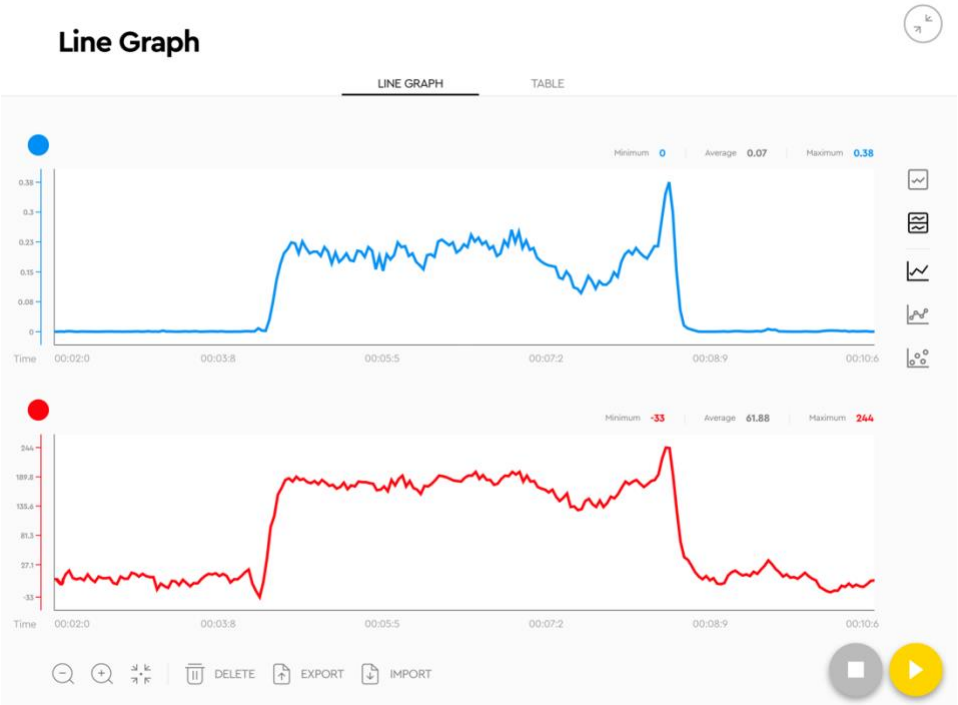


Line Graph for Gentle Turn:

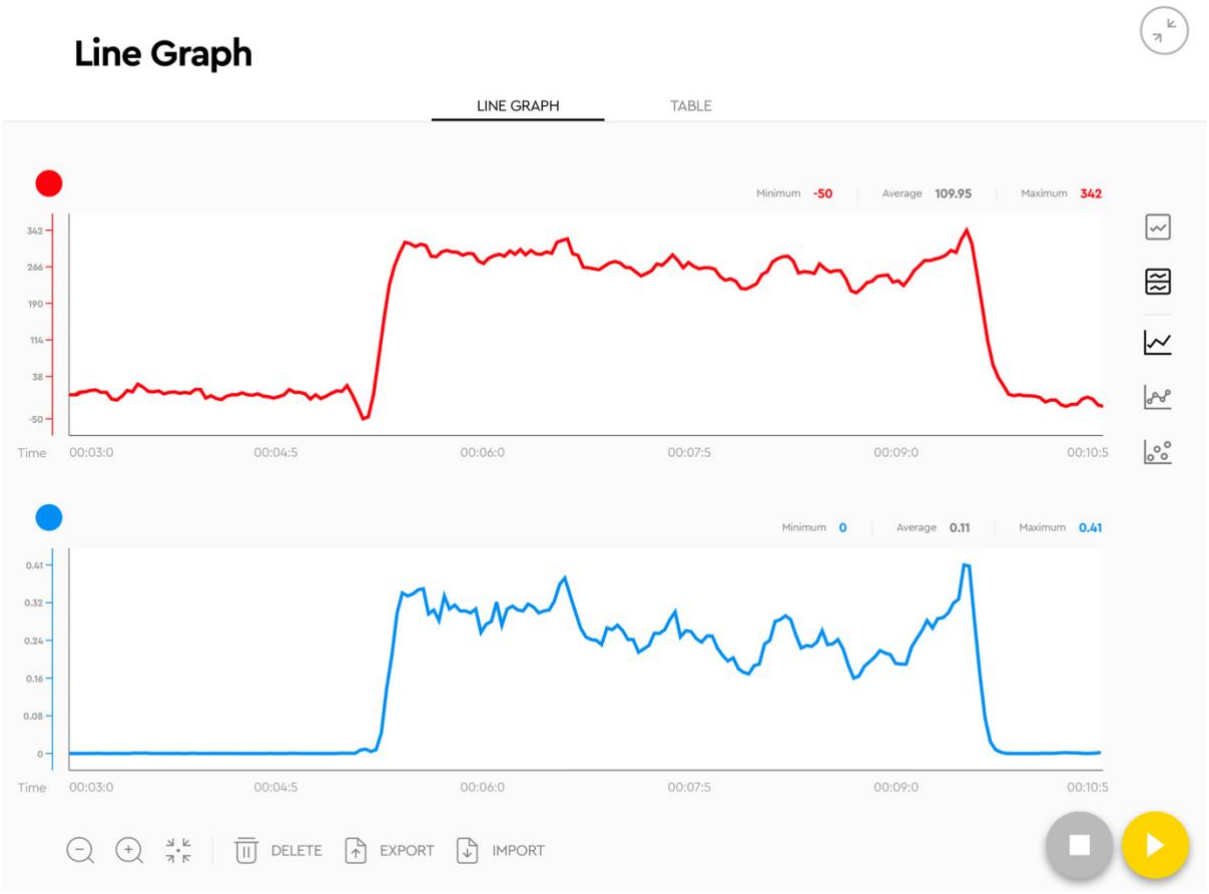
Red=Angular Velocity

Blue=G-force

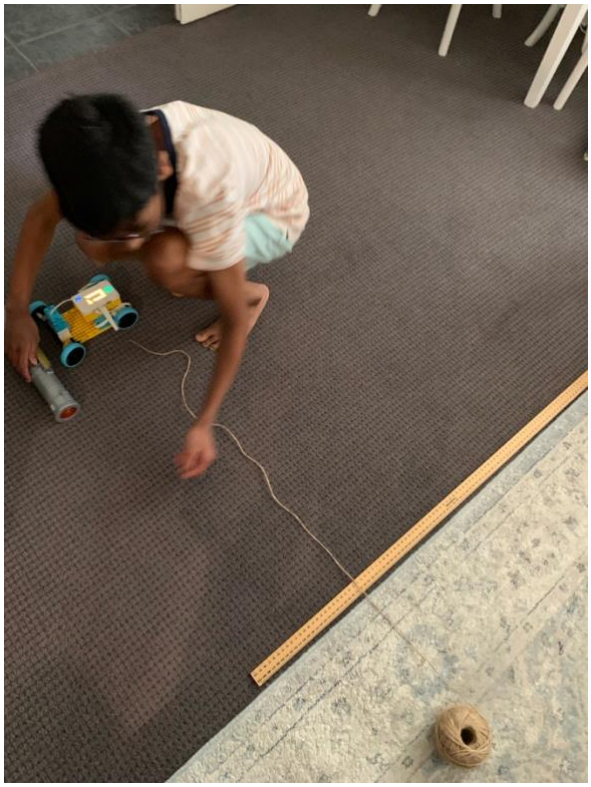
Line Graph


LINE GRAPH
TABLE
Minimum 0
Average 0.07
Maximum 0.38
0.38
0.3
0.23
0.15
0.08
0
Time
00:02:0
00:03:8
00:05:5
00:07:2
00:08:9
00:10:6
Minimum -33
Average 61.88
Maximum 244
244
189.8
135.6
81.3
27.1
-33
Time
00:02:0
00:03:8
00:05:5
00:07:2
00:08:9
00:10:6
DELETE
EXPORT
IMPORT

Line Graph for Hard Turn:



Measuring the Radius:



Acknowledgements

My dad helped with the project, and found formulas online.
These are some of the websites:

https://science.howstuffworks.com/science-vs-myth/everyday-myths/question633.htm
https://docs.pybricks.com/en/latest/hubs/primehub.html