Wave One

A rover that can ‘draw’ a sine wave.

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Introduction

Wave One is a Raspberry Pi, preprogramed rover that can ‘draw’ a sine wave with LEDs. A Raspberry Pi is a single board computer that can be used to control electronic devices. I wanted to do this project since I am interested in experimenting with Raspberry Pis, exploring their functions, and using them for various projects. Ever since I learnt about the Perseverance rover I have been intrigued about these vehicles and I’ve always wanted to build my own rover on a small scale. So, what’s better than using my engineering skills to achieve my goal?

How does it work?

Wave One’s chassis is constructed with the K’nex® building toy and operates using two 5v DC motors that are controlled by a Raspberry Pi. The model is coded in the Python programming language to move in a wave pattern by travelling a certain degrees right, and then left. Since the rover only has two motors, the vehicle turns when one of the motors rotates faster than the other. For example, to turn right, the motor on the right-hand side rotates at 40% speed while the left motor rotates at full power (100%).

To trace the path of the rover, LED lights (mounted on a mast) were used during the demonstration. A photo was taken using a digital camera with a slow shutter speed.

The photo below shows the first portion of the wave.

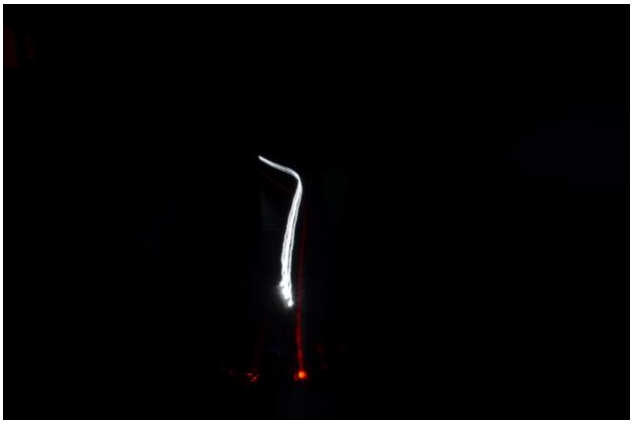


Figure 1: The path of the rover, (captured with a slow shutter speed)

Schematic

The schematic (electrical circuit diagram) below was referred to in the project. The schematic only shows how to control a single motor. I amended the circuit diagram to suit my project, which uses two motors. The green circuit board is the Raspberry Pi, which feeds power to the motor's driver (red circuit board) and tells it (motor driver) how to control the motor. The driver is connected to the motor and based on the code sent by the Raspberry Pi; the driver releases electrical signals to the motor, causing it to operate.

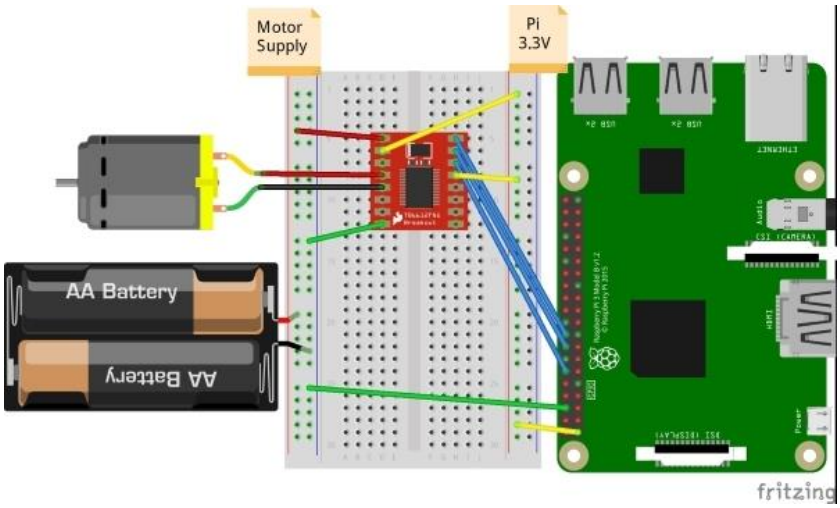


Figure 2: Circuit Diagram, (Clinton, 2018)

The Rover

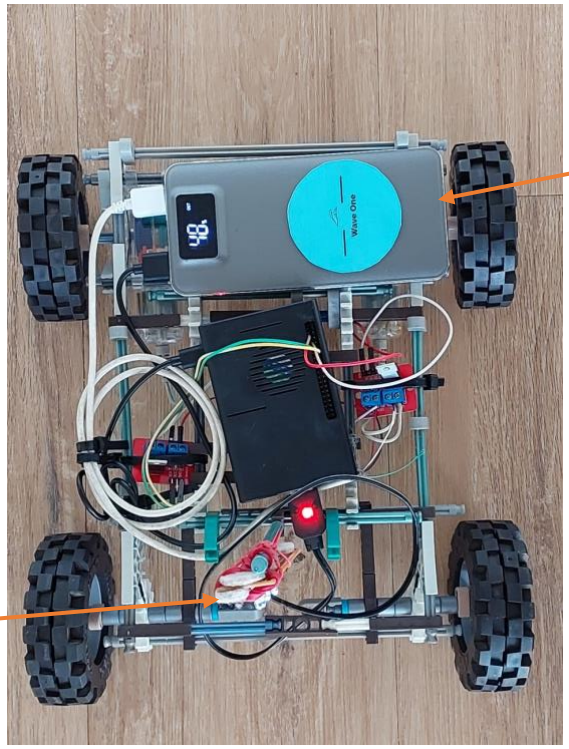


Figure 3: Wave One (Rover)

Programming

Below is an excerpt of the software written to move the rover in a sine wave pattern. The variables l and r represent the left and right motors. The text with the hashtags indicate comments, they are not part of the code.

```
l.start(100)  #left motor start at 100% speed
r.start(40)   #right motor start at 40% speed
time.sleep(15) #wait 5 seconds
l.start(35)
r.start(60)
time.sleep(7)
l.start(100)
r.start(40)
time.sleep(20)
l.stop()
r.stop()
```

Vehicle Statistics

Maximum Speed	620 m/h
Drivetrain	FWD (Front Wheel Drive)
Type of Robot	Preprogrammed
Dimensions	26 cm x 29 cm
Motors	2 x (5v DC motors)
Computer	Raspberry Pi 3 Model B
Battery	5v Power bank
Weight	520 g
Software Programming Language	Python

Figure 4: Rover Statistics

Learning new topics

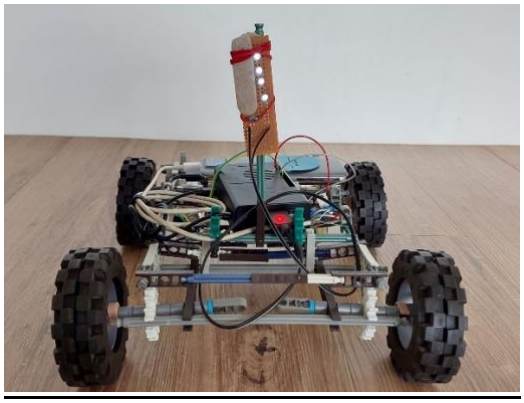
During this project, I learned about sine waves. Sinusoidal (sine) waves are a type of curve that depict a recurring oscillation represented by the trigonometric function $y = \sin(x)$.

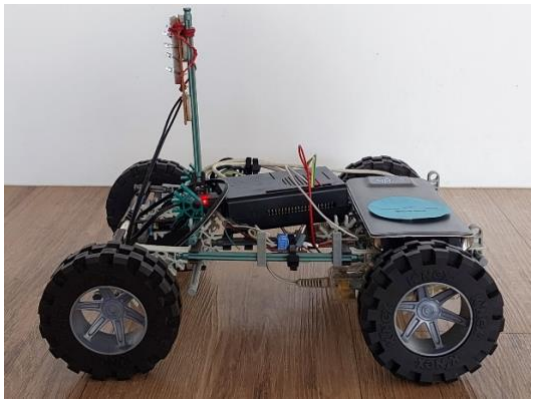
The electron flow in an AC (alternating current) circuit can be plotted as a sine wave.

Problem Solving

I encountered several obstacles throughout this project. When testing the rover, I found that it was not moving as quickly as expected even though the motors were running at full power. After investigating, I found that the Rover's distribution of weight was uneven, so I had to position the power bank at the front of the vehicle where the motors were and redesign the chassis.

Gallery





Reflection

Learning Experiences

I am satisfied with the outcome of this project. However, if I were to do this again, I would allocate more time to the testing and improvement phase of the project. When testing the rover, I found recurring issues in the software and the rover's movements. As a result, it took me a long time (almost 4 hours) to fix the rover and ensure that it was fully functional.

As mentioned, earlier, I have gathered many skills during this project and of course, learned about the different types of waves. I have refined my physical computing abilities; I understand the engineering design process and my knowledge in electronics (Raspberry Pi, motors, etc.) has expanded.

What's Next?

I think that Wave One can be developed further. I am interested in converting the vehicle to a 4-wheel drive so it can travel on challenging terrain. I also want to make the rover autonomous so that it will be able to 'draw' waves on its own accord, whenever it 'wants to.' To do this, I will need to add sensors to the vehicle (distance sensors, infrared sensors, etc), they will ensure that the rover is aware of its surroundings so that it can move without hitting objects.

Inspiration

The 21st century is an exciting time for rovers. Last year, NASA's Perseverance rover landed on Mars and has thus far driven more than 29 kilometers, released over 50 gigabytes of scientific data, and sent more than 100,000 images to NASA. What's more, Australia is also getting in on the action. At the end of 2021, NASA announced that Australia would be developing a small, semi-autonomous Lunar rover for the Moon to Mars and Artemis missions. The rover is set to be launched as early as 2026. The Australian Space Agency has invested 50 million dollars to allow businesses and research institutes to develop the rover. Researchers from the Queensland University of Technology (QUT) and CSIRO are currently building prototypes of the vehicle and conducting various tests.

Rovers have many uses, to name a few: space exploration, navigating in mines, assisting in humanitarian response, and even detecting explosives.

Maybe this sort of work could be a future career for me.

Bibliography

Clinton. (2018, November 23). *How To Control A Motor with the Raspberry Pi*. Retrieved from Core Electronics: https://core-electronics.com.au/guides/how-to-control-a-motor-with-the-raspberry-pi/

Electronics Notes. (2019, September 3). *What is a Sine Wave - Electronics Waveform*. Retrieved from Electronics Notes: https://www.electronics-notes.com/articles/basic_concepts/electronic-electrical-waveforms/sine-waveform.php

MacDonald, G. (2013, August 29). *Controlling a DC Motor with the Raspberry Pi*. Retrieved from https://youtu.be/W7cV9_W12sM

Raspberry Pi Foundation. (2022, January 3). *Build a robot buggy*. Retrieved from Raspberry Pi Foundation: https://projects.raspberrypi.org/en/projects/build-a-buggy