ENEL 387 Project – Pandemic Version

The Corover

Final Project Report

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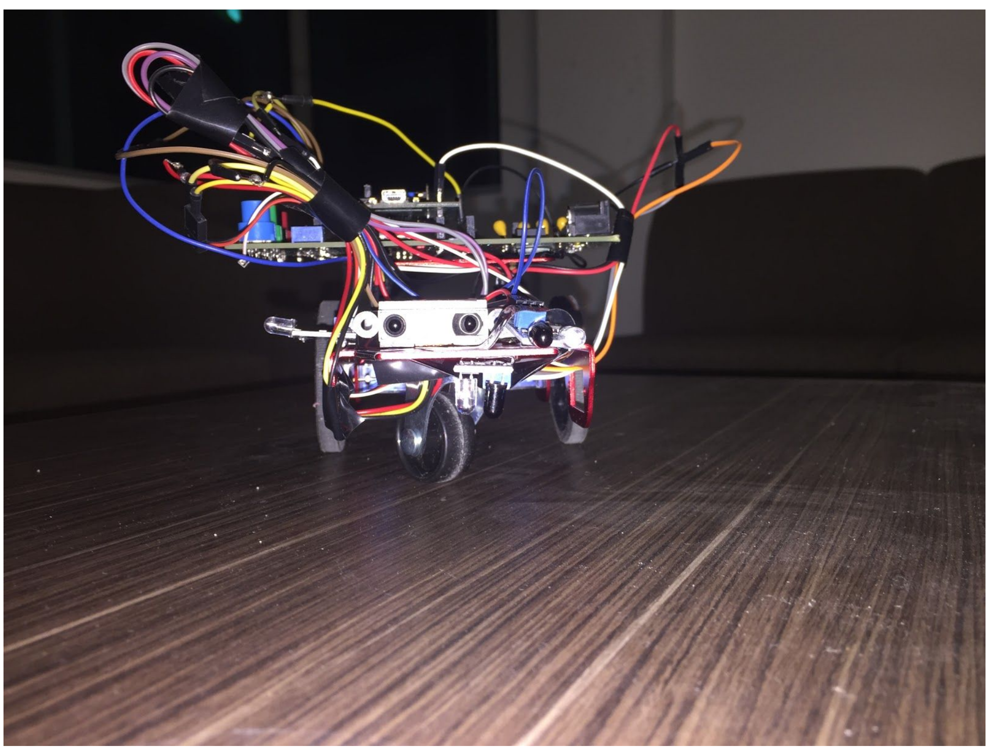

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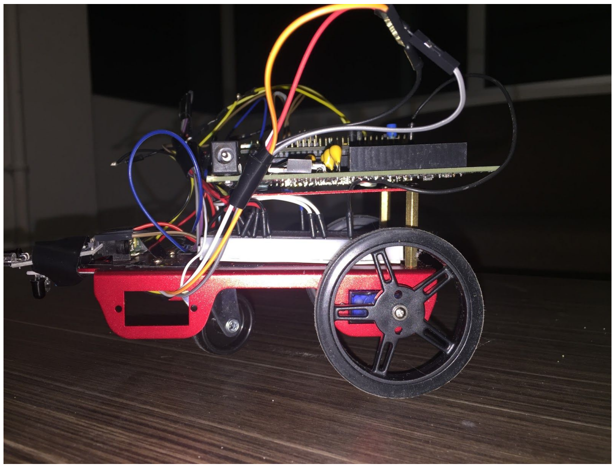
1. System Overview

The self-driving 2-wheel drive mini robot rover prototype, a.k.a “The Corover” is designed to control its way through the pandemic to deliver supplies to the elderly people restricted at home during these tough times. This rover has features such as: path following, obstacle avoidance and target reading. With so many features, this robot is only powered by a 9V battery that can be placed into the battery holder for rover utilization. Additionally, for elderly individuals who are not electronic enthusiasts, this rover has easy functionality, as it is turned on by the blue pushbutton. As a prototype, this robot was tested for all its features during the testing stages.

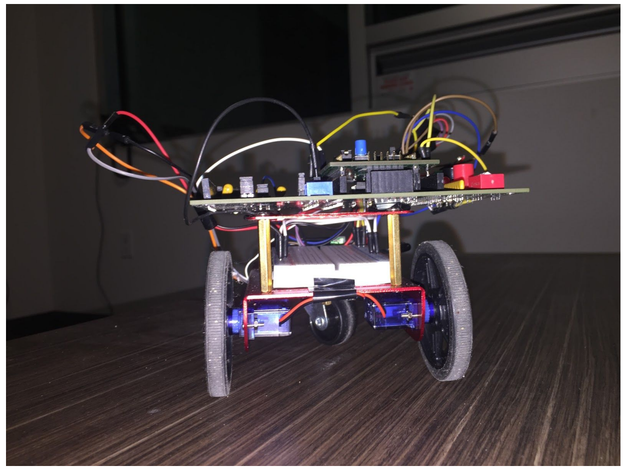
The robot was tested on a rectangular track to check for normal operation. Additionally, the testing process also checked for the rover’s ability to avoid an obstacle on its path. Finally, as an additional feature, the rover has the capacity to read different targets, and then display via LEDs the representation of each target.

2. Prototype Images

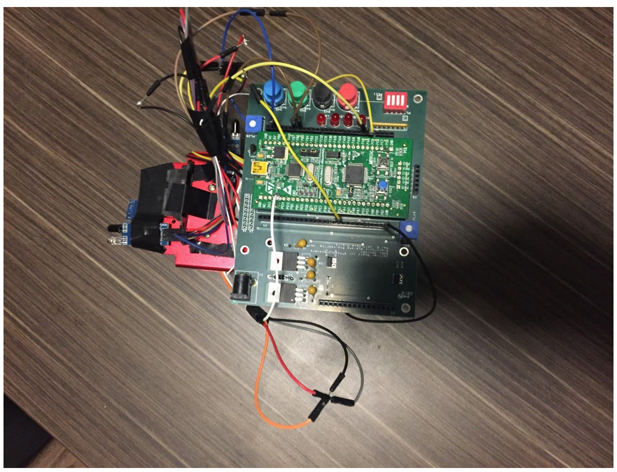
Left Side View:



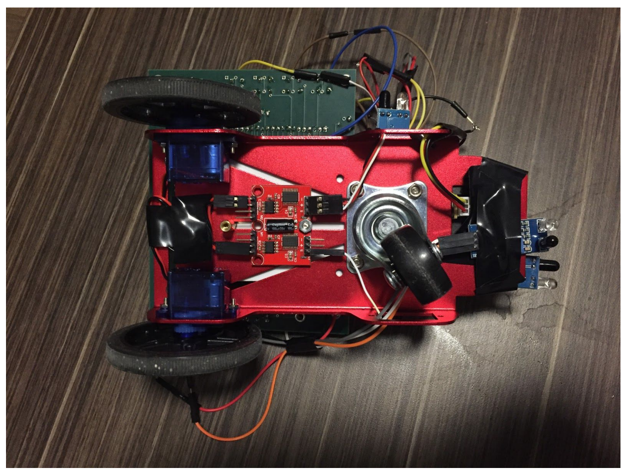
Back Side View:



Top View:



Bottom View:



3. System Specifications

The track consists of a 26x26 cm obstacle. The aluminum alloy chassis of the rover measures to be 14 x 6 cm. With two 6 cm rear plastic wheels, the two DC motors will be powering those wheels directly attached to the gear shaft. The rover will also have a powerless universal wheel on the front end. The operation of this rover is like that of an RWD motor vehicle, in which power is going to the two rear wheels which push the front wheel forward for full motion. The Cortex M3 controller will be hard coded and plugged into the carrier board. This carrier board will be powered via a battery pack outputting 5V transmitted through a direct power jack cable. The motor controller will be wired beneath the chassis of the robot. Additionally, four sensors will be assembled on to the rover for coordination and avoidance purposes.

All the objectives the rover achieves are being done via different interface systems. These are, PWM, Analog Input, and GPIO's.

I: Parts List

- 2x FM90 DC motor gearboxes
- 1x Mobile Platform Frame
- 1x Floor Frame
- 1x Motor Driver Controller FT-SMC-2CH
- 1x Cortex M3 STM32F100RB Board
- 3x Digital Obstacle IR Sensors
- 1x GP2Y0A21YK0F Analog Distance Measuring Sensor

II: Budget

The prototype's approximate cost was $85. This includes the shipping prices for the chassis, sensors, wires, breadboard, and motor. The controller and PCB board used to do the output interface implementation for this rover are separate. This rover was made on a low budget to allow more demand for our clients.

III: Absolute Ratings

FM90 Motor/FS90R Servo

Parameter	Ratings
Operating Voltage Range	4.8V-6V
Running Current (No Load)	110mA – 130mA
No Load Speed	80RPM – 100RPM

FT-SMC-2CH (Motor Controller)

Parameter	Ratings
Operating Voltage Range	4V-9V
Idle Current	10mA
1Ch Load Current	1.3A

IR Sensor

Parameter	Nominal Rating	Range
Operating Voltage		3.3-5V
Distance Range		2 – 30 cm

GP2Y0A21YK0F Distance Sensor

Parameter	Rating	Recommended Rating
Supply Voltage	-0.3V to +7V	4.5V – 5.5V
Output Voltage	-0.3 to (V_{cc} + 0.3V)	
Distance Range		10 – 80 cm

4. Operation

The system will startup once the blue user button is pressed on the STM controller. Upon startup, the line sensor will start detecting for a line on the rectangular path. Once detected, the rover will go forward following the line. It will then face an obstacle which it will have to avoid. To do this, the robot goes off the black line, and makes a series of turns to avoid the obstacle and then get back on the track. When back on the track the robot will continue its straight- line path until it reaches a turn. The line sensor will guide the rover to make a right turn or left turn according to the path. When it finishes the track, the rover is designed to stop at “home”, which is displayed as the “H” sign in the operational videos. The sensor will read that sign, and will stop the rover, hence completing its path.

Another operational feature the rover has is to detect target lines. For the target with one black line, the blue LED will flash. For two black lines, the green LED flashes. And for three black lines, the blue and green LED will alternatively turn on and off. To display completion of all targets, the rover will have the blue and green LED on when it moves away from the third target.

The idea behind these sample operations was to depict practical scenarios the rover will face. For obstacles, it will face many when getting or delivering supplies to its user. During this, the rover will have to avoid these obstacles so that it does not get damaged or the user is left without any supplies. The target’s operation is used to mimic a situation where the user needs the rover to read or measure something outside.

5. Testing

During the development of this project many problems were faced with. A major one was that whilst engineering this rover, a pandemic hit world-wide pausing the development process and altering the needs of our clients. Fortunately, the new client needs were able to be adapted onto the rover as it was still in the early stages of development. Originally, the rover was going to use infrared sensors that detected the presence of a wall. According to that, it was going to be hardcoded to follow a set of instructions for further operations. But now the infrared sensors are used for the rover to follow a path. Also, the original development process required the prototype rover to be developed via a state-based design. This amended prototype does not involve that design process as it does not have as many states for it to operate through.

Another difficulty that was faced during the prototype design was the wheel alignment. Because of bad wheel alignment, the rover failed to go straight on the path. As a result, the rover sways off the line. To adjust this the rover is programmed to make turns according to what side of the path it deviates to. For example, if the rover starts going off track on the right side, the rover will stop, make a left turn, a right turn, and then continue back on the path. A constraint that was faced when designing this adjustment was there was no way to fix the rover's deviation from the path via angles, since the rover was only able to make 90 degree turns. So rather than using a typical line sensor, the rover uses a digital IR sensor that senses a logic level high when there is a line under it. According to this, the rover was coded to implement PWM whenever the sensor was high.

The sensors and motors all are supplied with 5V, and the carrier board for the STM controller needed a 9V power source. Using the 5V pin from the STM controller, a separate breadboard was powered from that pin so that all sensors and motors are powered from the breadboard. This allowed the rover to only have one external battery source, rather than two. Also, that one 5-volt pin is powering a lot of loads, but the rover did not have any 5-volt sensors or loads that were not capable of operating at 100% from that one pin. So, an external power supply was not really needed.

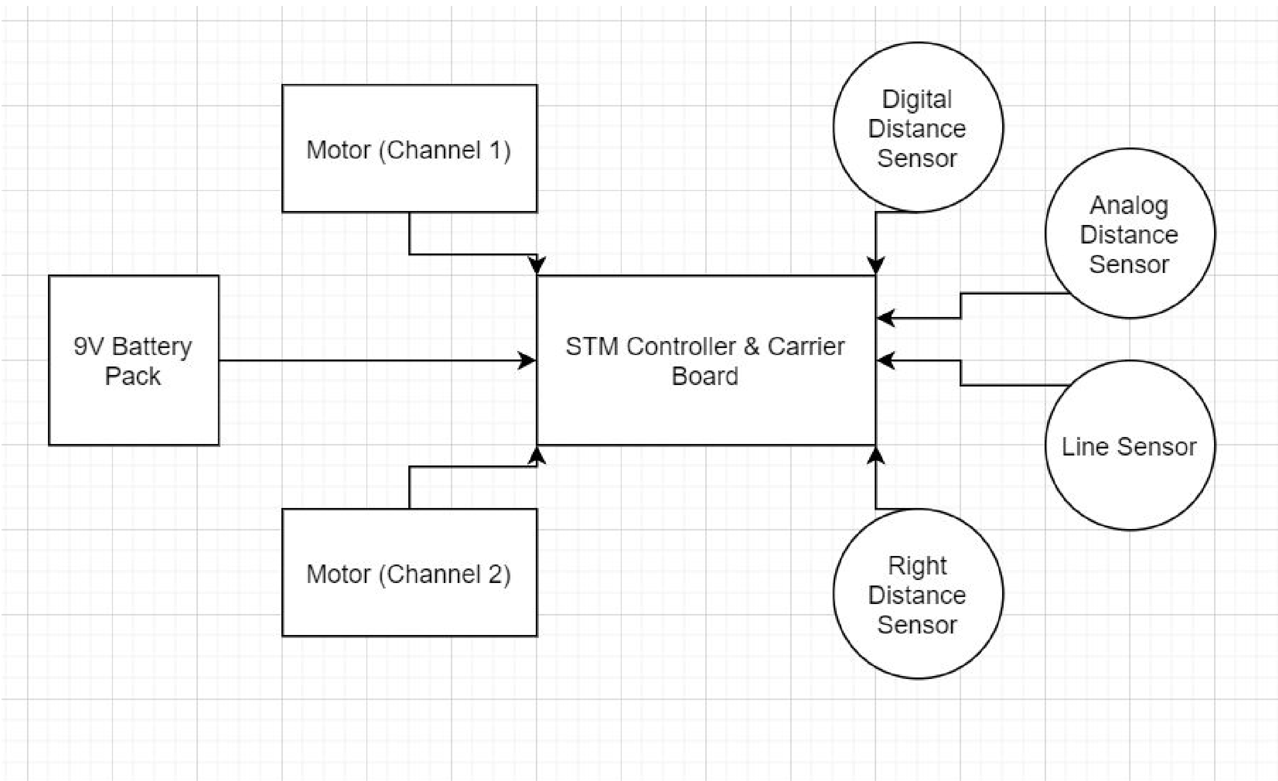
The rover was designed to be compact for easy and quick transportation for the user. As a result, the LCD display from the carrier board had to be disassembled because of weight distribution purposes on the rover. With the wheel alignment already bad, the rover needed proper weight distribution for it to sway at minimum. Originally the targets were going to be displayed on the LCD screen, but because of this constraint, the LEDs were used to show the representation for the targets. This caused a constraint to the user because he or she would have to read the legend for the meaning of each LED signal, while on an LCD a direct message can be shown about the targets. The client has been told to consider this as only a prototype.

6. Diagrams & Tables

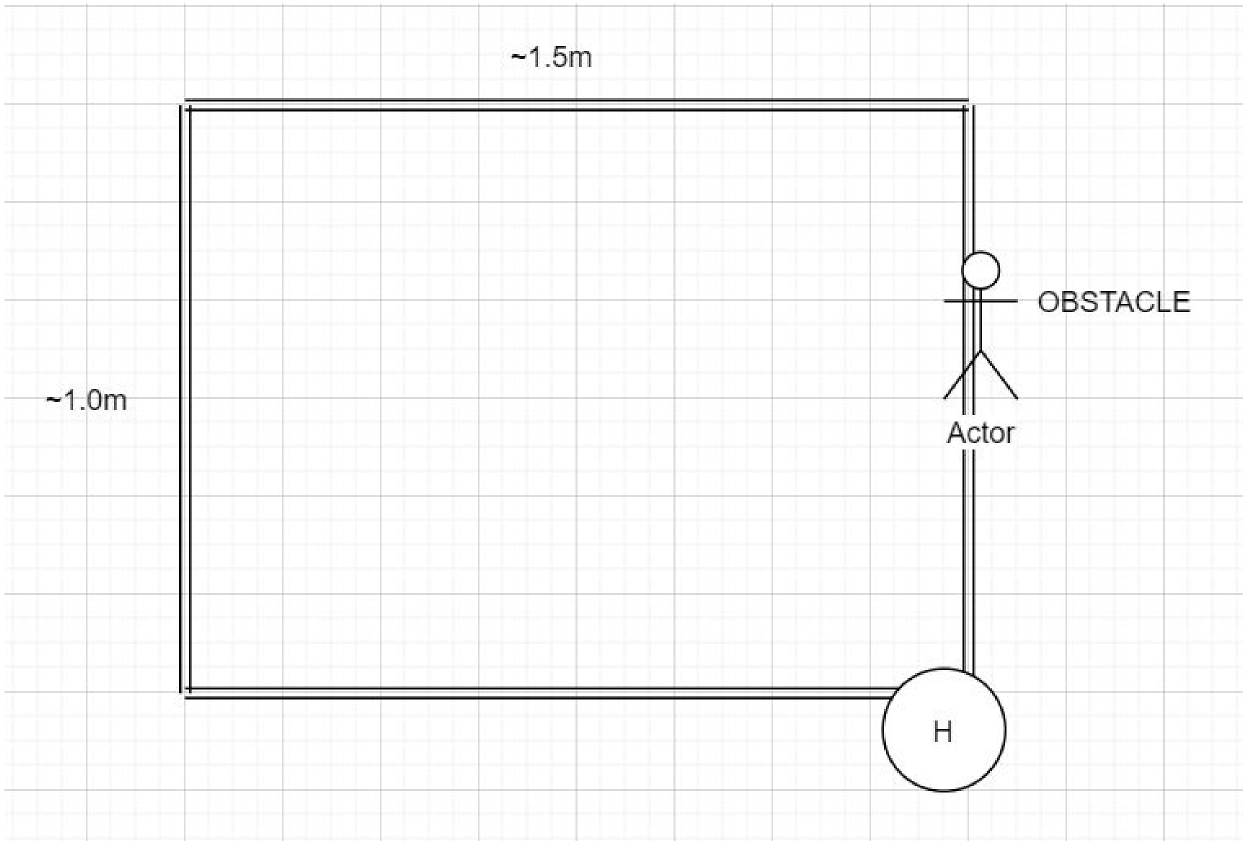
Legend for Targets:

Target 1 (1 black line)	Blue LED Flash
Target 2 (2 black line)	Green LED Flash
Target 3 (3 black line)	Blue & Green Alternate On/Off

Block Diagram



Prototype Track



7. Link to Video

https://drive.google.com/file/d/1GYk8fNXn8_ga-KvEAsRj1gB8WI1aEzRA/view?usp=sharing

8. Labels

MODEL: ______________________________

SERIAL NUMBER: ______________________

SOFTWARE VERSION: ___________________

MANUFACTURE DATE: ___________________

FACTORY TESTED: YES/NO   PASS/FAIL

UPDATE/REPAIR NOTES: ________________

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