TECHNOLOGICAL INSTITUTE OF THE PHILIPPINES

938 Aurora Blvd., Cubao, Quezon City

COLLEGE OF ENGINEERING AND ARCHITECTURE

COMPUTER ENGINEERING DEPARTMENT

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FINALS

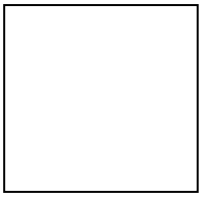
Microprocessor Systems

CPE 006

EC42FA1

Line Follower Robot

Design of a Wheeled Robot Using a Line Sensor and Arduino Uno



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Line Follower Robot

Design of a Wheeled Robot using a Line Sensor and Arduino Uno

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***Abstract*—A line follower robot or SumoBot is a robot that avoids an obstruction. By utilizing an Arduino Uno as a microcontroller to process the input of a sensor, it can control, with the help of a motor driver shield, a DC motor in order to build a line follower robot or a SumoBot.**

I. INTRODUCTION

A line follower robot or SumoBot is a robot that has one function, move forward unless there is an obstruction in front of it. It has three main parts, sensor which will act as the input, the microcontroller which will be the brains of the operation and the actuator which will be the output of the system. For this project, the proponents will be utilizing an Arduino Uno for the microcontroller, a line follower sensor for the input and a DC motor for the output.

The Arduino Uno is chosen for the microcontroller as it is widely used as an entry point for beginner electronics students to design and create various electronic projects. A person equipped with the basic knowledge of circuit wiring, electronic components and C++ programming can create various projects with different applications.

Although it seems easy enough, the process of building a Line Follower Robot or Sumobot has its own complexities, particularly on the programming side of things. While assembling the components is as straightforward as connecting part A to B with a wire, writing an Arduino program that will read the input of the sensor and crafting condition sets to control the actuator will require rigorous planning and testing to achieve the desired result.

II. OBJECTIVES

The general objective of the proponents is to design a line follower robot or a SumoBot using an Arduino Uno, line follower sensor, DC motor and a motor driver shield.

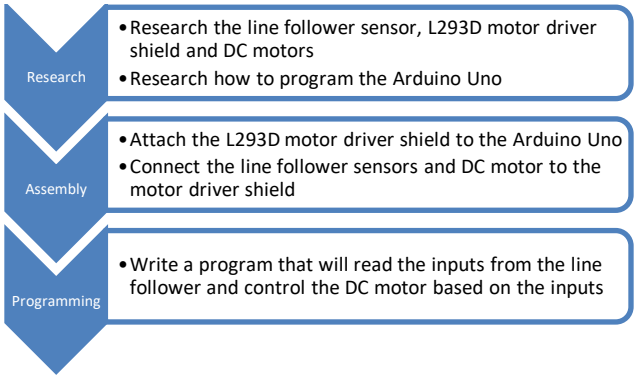
Specific Objectives

- Understand how to use an Arduino Uno
- Understand how to use a L293D motor driver shield to control two DC motors
- Comprehend how to use a line follower sensor as an input for the Arduino Uno
- Be able to assemble the Line Follower Robot or SumoBot
- Be able to write a program for the Line Follower Robot or Sumobot

III. METHODOLOGIES

The creation of the Line Follower Robot or SumoBot began with the research of the applications of an Arduino Uno as a microcontroller, the line follower sensor as a sensor, the DC motor as the actuator and the LM293D motor driver shield to control the DC motors. After which, assembly and programming is done to finish the project.

Conceptual Framework



IV. THEORY OF OPERATION

The Arduino Uno is an open-source microcontroller board based on the ATmega328. It has 14 digital input/output pins in which 6 can be used as PWM outputs, a 16 MHz ceramic resonator, an ICSP header, a USB connection, 6 analog inputs, a power jack and a reset button. This contains all the required support needed for microcontroller. In order to get started, they are simply connected to a computer with a USB cable or with a AC-to-DC adapter or battery.

Arduino uno microcontroller can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. The microcontroller is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing).

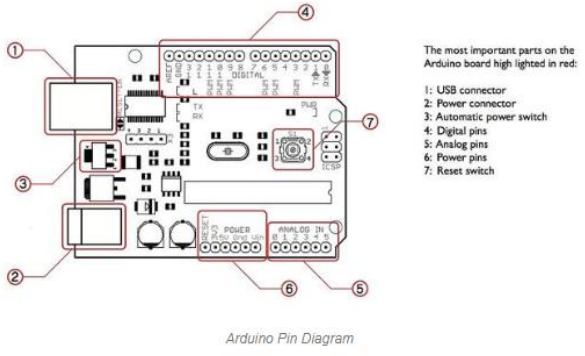


Figure 1. Arduino Pin Diagram

Programs written in Arduino are known as sketches. A basic sketch consists of 3 parts:

1. Declaration of Variables
2. Initialization: It is written in the setup () function.
3. Control code: It is written in the loop () function.

The sketch is saved with .ino extension. Any operations like verifying, opening a sketch, saving a sketch can be done using the buttons on the toolbar or using the tool menu.

The line follower sensor has two sensors that can detect white surfaces and dark surfaces. It works by emitting infrared light and recording how much is reflected. If a lot is reflected, it can be deduced that the surface is close to a white surface and if not, then the surface is dark or is not near any surface.

An electric motor turns electricity into motion by exploiting electromagnetic induction. The motor features a permanent horseshoe magnet called a stator and a turning coil of wire called an armature or rotor. The armature provided with a current by the battery is an electromagnet and it experiences a force which makes it spin.

To control the DC motor, the Arduino Uno alone cannot provide it with enough current, so a shield driver is needed. For this application, a L293D shield is a driver board based on the L293 IC, which can drive 4 DC motors, 2 stepper motors and a servo motor.

Each channel of the L293D module has the maximum current of 1.2A and doesn't work if the voltage is more than 25V or less than 4.5V. The module is designed to fit the Arduino Uno and while it is attached, 6 analog pins (which can also be used as digital pins), pin 2 and pin 13 are free for use. It is also possible to apply a separate power supply to the shield, but it requires that the user disconnect the jumper available on the shield.

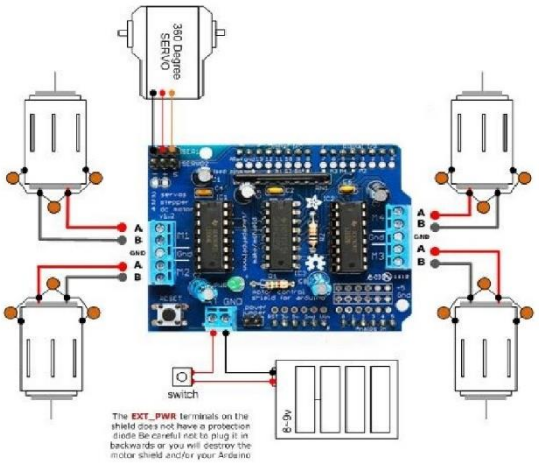


Figure 2. L293D Motor Driver Shield

V. System Diagrams

Flowcharts

The flow of the system begins with the sensors, aptly placed on the front of the robot. The two sensors will be named the left and right sensors, indicating its positions. The sensors will send signals to the Arduino Uno which will process it into four conditions. If both sensors do not see an obstruction, the robot will move forward. If the left or right sensor senses an obstruction, the robot will avoid it by turning to the opposite direction. And if the both sensors detect an obstruction at the same time, the robot will move backwards for 1 second and then turn left for 1 second. After the decision is made, the process will repeat at the beginning until the line follower robot loses power or turned off.

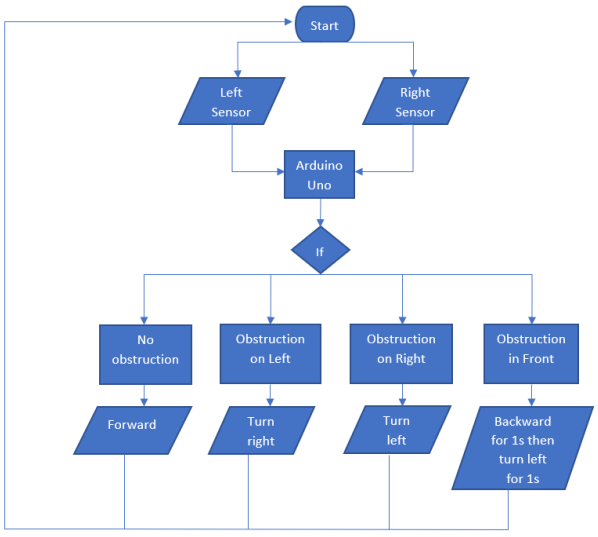
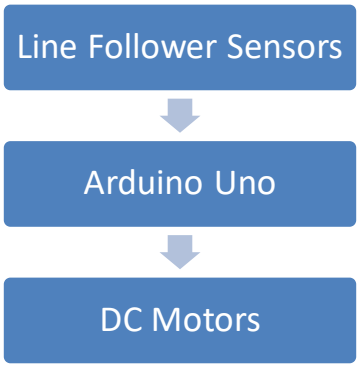


Figure 3. Line Follower Flowchart

Block Diagrams

Basically, the line follower sensors are the inputs that the Arduino Uno will process. The line sensor will be placed in front of the SumoBot so that it can better detect if the SumoBot has gone out of bounds and will send the appropriate signal to the Arduino Uno. The Arduino Uno will then process the signal from the line sensor to adjust the movement of the DC motors.



Schematic Diagrams

Since the L293D motor driver shield is connected to the Arduino Uno by putting the shield on top of the Arduino, the connections are made using the available pins on the shield. The DC motors are connected to the available motor connectors, the battery pack is connected to the power supply and the line follower sensor is connected to the analog pins and has a common Vcc and ground connection.

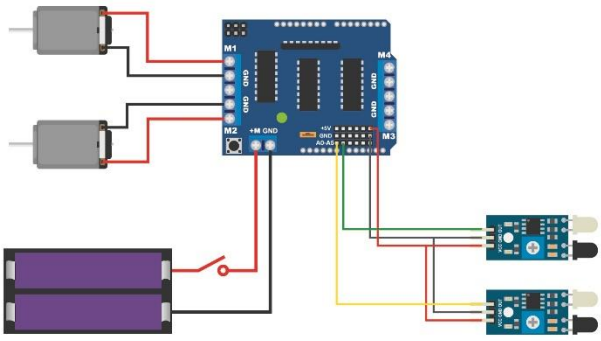


Figure 4. Line Follower Connections

VI. TESTING AND TROUBLESHOOTING

A. *Materials, Tools, Equipment and Testing Devices*

The materials, tools and equipment used by the proponents are listed below.

- 2 pcs. Line Follower Sensor
- Arduino Uno
- L293D motor driver shield
- 2 pcs. DC Motor with gear
- Smart robot chassis
- 2 pcs. Wheels
- Connecting wires
- 2 pcs. 9V battery
- 4 pcs. 1.5V AA battery
- Laptop
- Screwdriver
- Switch
- Soldering iron and solder
- Heat shrinks
- Cable tie

B. *Testing*

After assembling the line follower robot or SumoBot and uploading the program to the Arduino Uno, the robot was ready for testing.

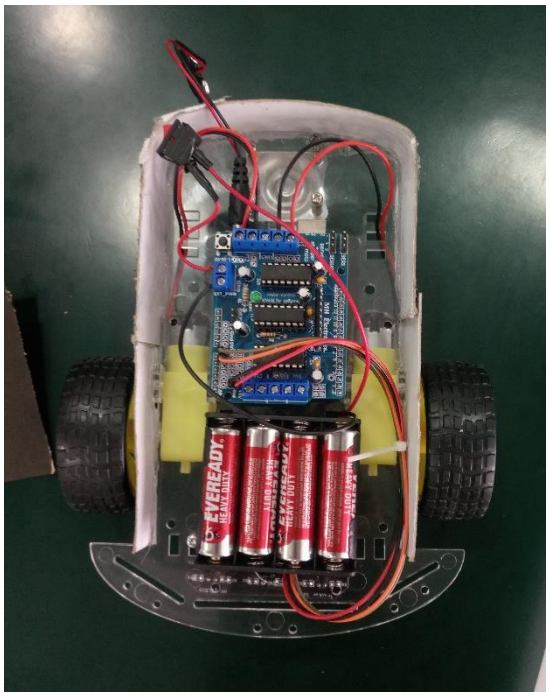


Figure 5. Line Follower Robot from above

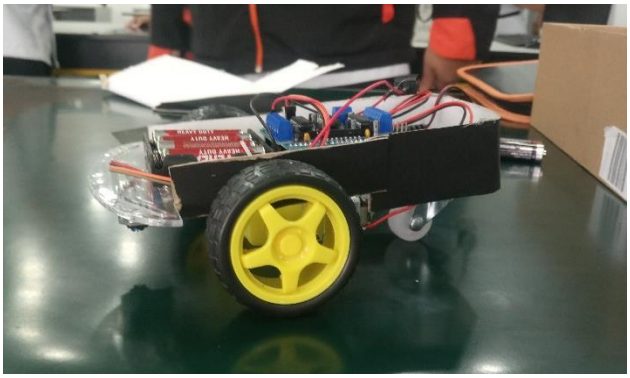


Figure 6. Line Follower Robot from the side

VII. Data and Results

After assembling the line follower and uploading the program to the Arduino Uno, the line follower robot was able to function as desired. To ensure that it does not have any issues, it was tested to run for two whole minutes inside a hexagon platform that has a black interior and white border.

During the testing period, the line follower robot did not show any issues and avoided the white borders as programmed.

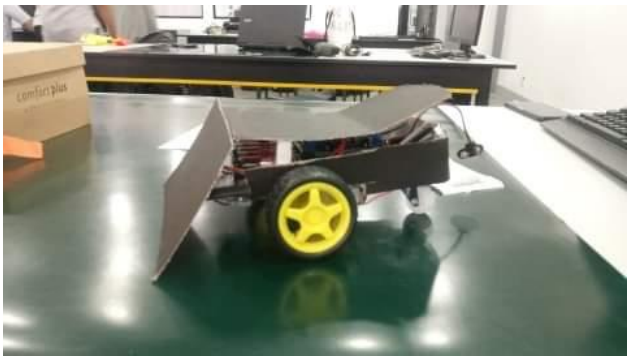


Figure 7. Line Follower Robot from the side

Figure 8. Line Follower Robot with the Proponents

VIII. Problems Encountered and Actions Taken

Problems Encountered	Actions Taken
• 1 Channel Line Follower Sensor Unavailable	• Purchased a 3 channel line follower sensor
• Difficulty programming the line follower robot	• Rewrote the code multiple times • Tested the code by running the line follower robot on the hexagonal platform

IX. Post Evaluations

A. Conclusions

The group can therefore conclude that the project was successful as they are able to understand how to use the Arduino Uno, line follower sensor, DC motor and the L293D motor driver shield to build a line follower robot or SumoBot.

While the assembly process of the materials was easy, the group faced difficulties on writing the program that will make the line follower robot avoid the white borders of the hexagonal platform. Initial programming resulted with the robot having delayed reaction upon recognizing an obstruction, the robot exiting the hexagonal platform and almost crashing to the floor and the robot getting stuck into one spot of the platform as it was essentially being directed to only go forward or backward if there is an obstruction directly in front of it. However, after numerous reprogramming of the Arduino Uno, the proponents were finally able to write a program that will make the robot go forward if there is no obstruction, turn left or right depending on where the obstruction is to avoid it and to move backward and then turn to the left if there is an obstruction directly in front of it.

B. Recommendations

Due to the difficulties faced by the group, it is recommended that an alternative for the parts required be ready in case that the primary material is unavailable for purchase. And to avoid taking too much time writing and rewriting the source code needed to properly run the line follower robot, the group recommends proper research of the application of the materials required and to make a flowchart of how the program should function.

Task Distribution

Task	***Person/s Assigned***
Conceptualization and Coordination	***Imperial***
Purchase of Equipment	***Imperial and Saguid***
Testing and Troubleshooting	***Dela Cruz, Francisco, Imperial, Saguid and Valenzuela***
Evaluation	***Dela Cruz, Francisco, Imperial, Saguid and Valenzuela***
Interpretation, Analysis and Comparison	***Dela Cruz, Francisco, Imperial, Saguid and Valenzuela***
Documentation	***Dela Cruz, Francisco, Imperial, Saguid and Valenzuela***

References

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APPENDIX B:

BILL OF MATERIALS

Part No.	Values and Ratings	Remark(s)	Purchased From	Quantity	Unit Cost (Php)	Gross Cost (Php)
Line Follower Robot						
	Arduino Uno		MakerLAB	1	250	250
	L293D		MakerLAB	1	250	250
	2WD Smart Robot Chassis		MakerLAB	1	300	300
	9V Battery Clip with Jack		MakerLAB	1	15	15
	3 Channel Line Tracking Sensor		MakerLAB	1	150	150
	Male to Female Arduino Connecting Wires		Lynx	5	7	35
	9V Battery		Lynx	3	30	90
	1.5V AA Battery		Lynx	4	89	89
					Sub Cost	**1179**
					Total Cost (Php)	**1179**