Design and Development of Path Following Robot with Spray Painting

[1]Abdullah Al Zubaer, [2]Bappa Sarkar, [3]Md. Nazrul Islam, [4]Sujit Kumar Mondal

CSE Department, Islamic University, Kushtia, Bangladesh

[1]zubaerranacseiu@gmail.com, [2]bappacse07@gmail.com, [3]shilunazrul@yahoo.com

[4]sujitiu@yahoo.com

Abstract:

A line follower robot is a device that has the potential to revolutionize many sectors like spray painting. An automated or semi-automated line follower is used to spray paint to reduce the cost and time that are spent in the manual process. For spray painting, the line follower robot follows black lines on a white surface or white lines on the black surface or invisible magnetic lines. Adequate motion and moving circuits are controlled. In spray-painting, a sprayer is attached to this robot. The sprayer is controlled by air pressure. In order to reduce cost and painting time, it is essential to develop an automated method for a line follower robot that is used for spray painting.

Keywords: IR sensor, Wiper motor, DC motor, Arduino UNO, Spray Nozzle

1. INTRODUCTION

The line follower robot is a mobile electronic device which is programmed to follow visible and invisible lines drawn on a surface or floor [1]. Generally, the lines or moving circuits are predefined and they can be visible or invisible like magnetic fields. The robot, following the predefined path, moves on the line as directed or programmed. The robot has an Infrared Ray (IR) sensor under the robot. The sensor detects the line. Then the sensing signal is sent to the processor. As per the signal, the processor runs the robot over the line. This is mainly how a line follower robot works in combination with other apparatus. Here, the robot will work with a sprayer for spray painting [2][9]. It requires that the robot should have the capacity of turning to any direction up to 90 degrees. For effective spraying, the system should be able to turn on and stop sprayer for a certain period of time. Here the design and pattern of the painting are important. Brush painter instead of sprayer can also be used. With a view to introducing an efficient line follower robot, we have tried to moderate and develop a line follower robot. In this paper, we have taken a line follower robot and tried to use it for spray painting. Therefore, we have investigated the technical and mechanical issues and problems [5].

Spray painting

Spray painting refers to painting on a surface by sprayer. It is a coating color on a surface [4]. Generally, compressed gas is used to spray. The sprayer applies color on a limited area on the surface and makes the design and pattern that are required. Another form of painting is airbrushing which is handheld. Airbrushes are used for fine arts, painting nails, and so on. Spray painting can smartly be done by a sprayer attached to a line follower robot.

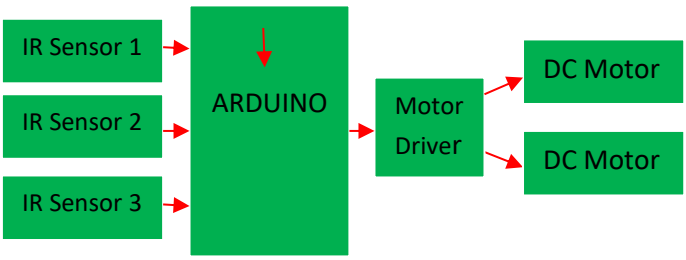


Fig.1: Block diagram of Spray painting robot

2. LITERATURE REVIEW

G.C.NANDY (1998): A dynamic model of a gyroscopic wheel, an important component of Grover, and a single-wheel robot developed at Carnegie Mellon University. The Grover robot consists of a single wheel and is actuated through a spinning flywheel attached through a two-link manipulator at the wheel bearing. [8]

MEHRAN PAKDAMAN (2009): The Line follower robot can detect and follow the line drawn on the floor. Basically, the predefined path can be either visible like a black line on a white surface or it can be invisible like a magnetic field. Definitely, this kind of Robot should sense the line with its Infrared Ray (IR) sensors installed under the robot. Thus the line follower robot follows the path. [6]

MATHIAS HAUAN ARBO (2018): The model predictive trajectory tracking controller and the model predictive path following controller are compared for a robotic manipulator. We consider both the collocation and Runge Kutta based discretization. We show how path-following can stop at obstructions in a way trajectory tracking cannot. [2]

MUHAMMAD SHAFAYAT BIN MOSTAFA (2019): Special types of delivery vehicles can't deliver their products to a specific location because of the terrible traffic congestion. During the heavy rainy season, vehicles can't move properly due to the flooded road. Also, there needs an extra man to deliver the documents or files inside an office or a building to another building of a company. To solve the problem and automate the delivery process, this research proposes an amphibious line following robot that can move in both lands and at a certain level of water.[1]

3. WORKING PROCEDURE

3.1 Circuit explanation of path-following robot

The Arduino line-follower robot can be divided into three sections. These are (1) Sensor section, (ii) Control section and (iii) Driver section.

3.1.1 Sensor section:

This section contains potentiometer, IR diodes, LED's and comparator. IR sensors are used to sense the line and provide a change in voltage at the comparator's one terminal and a Potentiometer is used for setting reference voltage at comparator's second terminal. Then the comparator compares both voltages and generates a digital signal at the output. In this line follower circuit, we have used two comparators for two sensors.

3.1.2 Control section:

Path-follower robot uses Arduino Pro Mini for controlling whole the process. The comparators outputs are connected to Arduino's digital pin numbers 2 and 3. Arduino read these signals and send commands to driver circuit to drive line follower.

3.1.3 Driver section:

The Driver section consists of a motor driver and two DC motors. Arduino does not supply enough voltage and current to motor. For this reason we add a motor driver circuit to get enough current and voltage for the motor. Arduino sends commands to this motor driver to drive motors.

3.2 Working procedure of path-following robot

The line following robot is a self-operating robots. That recognizes and follows a line drawn on the surface. The line is indicated by black line on a white surface or a white line on a black surface. This system must be sensed by the line. This application depends upon the sensors [7]. Here we are using two sensors for path detection purposes. That is a IR sensor and proximity sensor. The IR sensor used for obstacle detection and the proximity sensor used for path detection. These sensors are mounted at the front end of the robot.

3.3 Working procedure of spray painting

It is a machine which is used to apply cover layer for any object or a product in this air will be mixed in the paint will applying to product it works to process wiper motor will be placed in the tank which contains of paint and by the wiper motor paint will be injected into the pipe one end of the pipe is connected to the wiper motor and other to the nozzle, will paint injected in the pipe the mixture of paint and compressed air will sprinkle in the atmosphere the detail of our designed spray painting robot is given below.

Tank Capacity is 300ml, Discharge Range: 25cm - 30cm and Spray area range: 25-30mm.

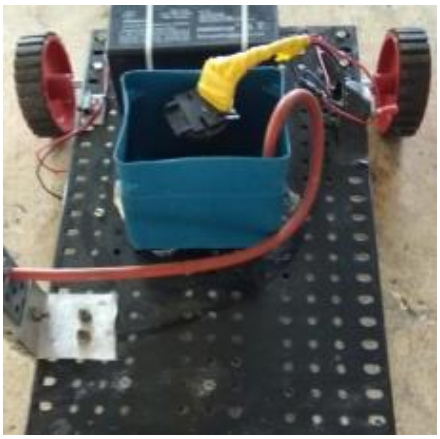


Fig.1: Spray painting system

Step 1: Working Procedure

Working of line-follower robot is very interesting. The line follower robot senses a black line by using sensors and then sends the signal to Arduino. According to sensor's output, the Arduino drives the motor.

Case 1:-

In this case, both the sensors don't detect the line. Both the motors rotate forward. As a result, the car moves forward.

Case 2:-

In this case, only the left sensor detects the line which means that the car requires turning in the left direction. The left motor rotates backward and the right motor rotates forward. As a result, the car turns left.

Case 3:-

In this case, only the right sensor detects the line which means that the car requires turning in the right direction. The left motor rotates forward and the right motor rotates backward. As a result, the car turns right.

Case 4:-

In this case, both the sensors detect the line. This means that the end has come. Both the motors stop rotating. As a result, the car stops.

Step 2: Assemble the chassis

Everyone may have a different chassis. So assemble your chassis accordingly. Most of the chassis comes with an instruction manual and even mine came with it so have a look at it and build our chassis accordingly. Then, attach the components to the chassis. A motor shield attached to the Arduino and a battery holder must be fixed on the chassis. Also, attach the proximity sensors at the front on either side, facing down. Make sure that they are attached to the corners. Attach the switch too. Solder wires to the motors and also switch and keep ready.

Step 3: Main Connections

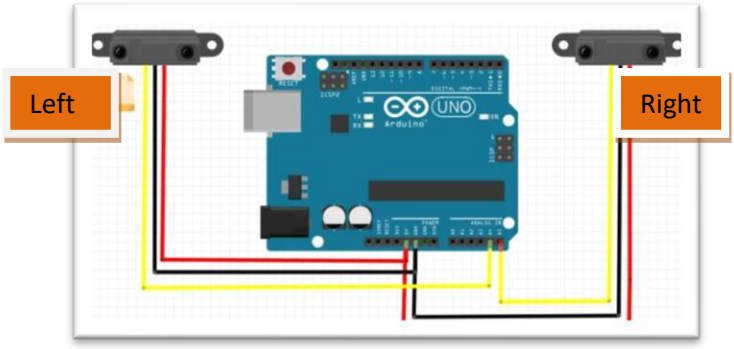


Fig.2: Main connection Layout

Now do the connections as per the diagram above.

Left Sensor>>Arduino:-

Vcc>>5v

Gnd>>Gnd

Out>>A4

Right Sensor>>Arduino:-

Vcc>>5v

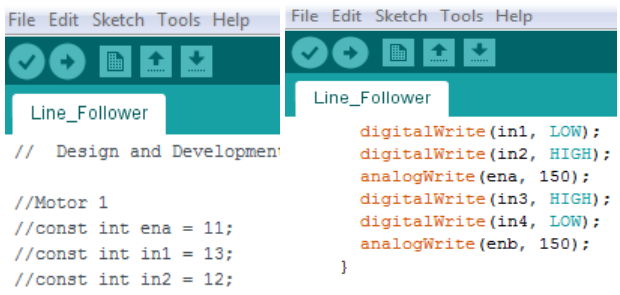
Gnd>>Gnd

Out>>A5

Connect the motors to the motor shield and plug the motor shield onto the Arduino board. Connect the battery holder to the shield through a switch. That's it for the connections; let's move on to the next step.

Step 4: Coding

In the program, first of all, we defined input and output pin, and then in the loop, we check inputs signals. According to inputs signals it sends output signal to the output pin for driving motor. For checking the input pin we used "if" statements.



4. COMPONENTS

- IR Sensors
- Battery

- Arduino
- Motor driver
- Dc gear motor
- Wiper motor
- Spray nozzle

4.1 Sensors (IR Sensor): IR sensors are used for detecting the line. It consists of Photodiode, an IR LED and some other components like comparator, LED, etc.

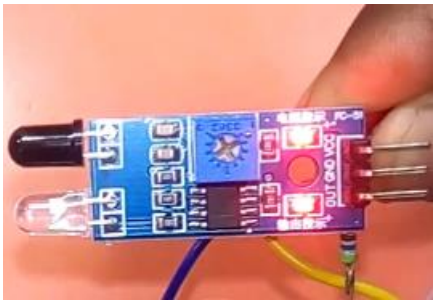


Fig.3: **IR reflectance sensors**

As mentioned earlier, we have used a pre–assembled IR Sensor.

4.2 Power Supply: The power is controlled from the motor driver IC. We have to choose the appropriate power supply which is sufficient for all the components including the motors.

Fig.4: 12v battery

4.3 Controller (Arduino UNO): In the project, Arduino UNO is the main controller. The data from the sensors (IR Sensors) will be given to Arduino and it generates corresponding signals to the Motor Driver IC.

Fig.5: Arduino microcontroller

4.4 Motors (Geared Motors): Our line follower robot uses two geared motors at the rear of it. These motors provide more torque than normal motors and can be used for carrying some load as well.

Fig.6: DC Motor

4.5 Wiper motor: Like other motors, the wiper motor rotates continuously in one direction which is converted into a back and forth motion. Its composition entails a lot of mechanical linkages each playing a role in initiating the movement. The gear head motor is the type of wiper motor known for its abundance in torque.

Fig.7: Wiper Motor

4.6 Spray Nozzle: A spray nozzle is a precision device that facilitates dispersion of liquid into a spray. Nozzles are used for three purposes: to distribute a liquid over an area, to increase liquid surface area, and create impact force on a solid surface.

Fig.8: Spray Nozzle

5. APPLICATIONS

- Line follower Robots are commonly used for the automation process in consumer, industries, military applications.
- They are very useful as they can work without any supervision i.e. they work as automatic guided vehicles.
- With additional features like obstacle avoidance and other security measures, line follower robots can be used in driverless cars.
- These robots can be used as automated equipment carriers in industries.
- These can also be used at homes for domestic purposes like floor cleaning.

6. CONCLUSION

We have come up with the findings that our line follower robot is pretty good for spray painting following a predetermined line. It can correctly sense the black lines on the white surface. By using the feedback mechanism, it is also capable of correcting the wrong moves. It has saved time and increased efficiency for spray painting. Our existing system may work better with the further development of the hardware used in this system. We are satisfied with our system and hopeful of better modification in the future if needed.

7. ACKNOWLEDGEMENT

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