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SHORTEST PATH FINDER ROBOT USING ARDUINO UNO

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Abstract:

Our aim is to develop a shortest path finder robot using Arduino Uno, a popular open-source electronic controller that is widely used in the field of robotics and automation. This involves designing and implementing a software algorithm that can calculate the shortest path between two points on a given graph, and then transmitting this information to the Arduino board, which controls the robot's movements. The algorithm used in this project is based on Dijkstra's algorithm, which is a well-known algorithm for graph search that can be used to find the shortest path between two nodes in a graph. The algorithm is implemented using C++ programming language, Arduino library and the Arduino IDE. The hardware used in this project includes an Arduino board, motor driver, IR sensors, DC motors and chassis . The system works by first detecting the starting and ending points on the graph using the sensors. Once the starting and ending points are detected, the algorithm calculates the shortest path between these two points and then transmits the instructions to the Arduino board, which controls the robot's movements. The robot then follows the instructions to navigate along the shortest path, avoiding obstacles along the way. The project is aimed at developing a low-cost and efficient solution for autonomous navigation of robots in various applications such as warehouse management, automated guided vehicles, hospital emergency direction detector and home automation. The system can be further improved by adding more sensors and using more advanced algorithms to optimize the path planning process.

Keywords: Arduino Controller, IR Sensors, Robot, DC Motor .

1.Introduction:

A shortest path finder robot is a type of autonomous robot that is designed to navigate through a given environment in order to find the shortest path between two points. These robots are typically equipped with sensors that allow them to perceive their environment and make decisions about which direction to move in. Shortest path finder robots typically use a variety of algorithms to determine the most efficient path between two points. These algorithms can range from simple techniques, such as breadth-first search and depth-first search, to more complex approaches, such as Dijkstra's algorithm . Overall, shortest path finder robots are an important type of autonomous robot that can be used in a variety of applications where efficient and effective navigation is necessary.

The robot basically have to perform two tasks are as follow

i. To drive through the maze using right hand rule or left hand rule and reach at the end point.

ii. To optimize the shortest path for returning back by avoiding dead ends.[1]

2. Components selection and hardware structure:

The various components that are required for our projects are:

- IR-Sensor
- Arduino Uno IC
- Geared DC motors
- L298N motor driver
- Lithium ion battery
- Chassis
- Jumper Wires
- Robot car wheel

2.1 IR Sensor

An infrared sensor (IR sensor) is radiation-sensitive optoelectronic component with a spectral sensitivity in the infrared wavelength range 780 nm … 50 µm. IR sensors are now widely used in motion detectors. There is a transmitter and a receiver embedded in the IR module for transmitting and receiving infrared wave. The wave hits the objects nearby and bounces back to the receiver of the device. Through this technology, the sensor can not only detect movement in an environment but also how far the object is from the device. In this robot an array of three IR sensor(made by sticking three in series) is used for detection of black line, so that the robot follow that line only.

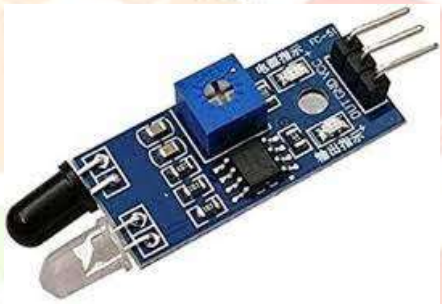

Fig 1 IR Sensor

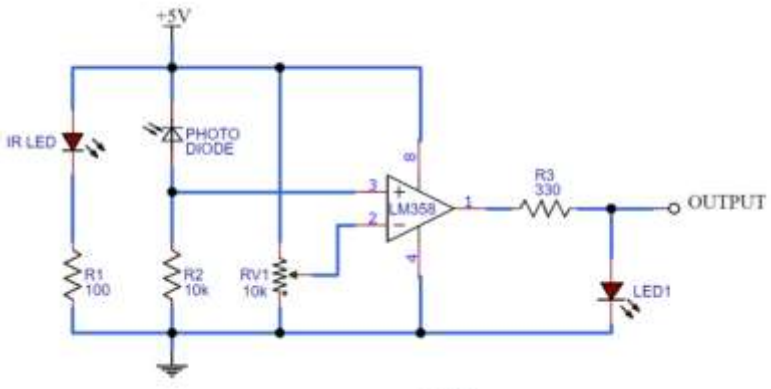

Fig 2 IR Sensor Circuit

2.2 Arduino Uno

The Arduino Uno is a microcontroller board based on ATmega32P. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. It have 28 pins , out of which there are 14 pin for digital output or input, 6 pins are analog pins, 1 for transmission and 1 for receiver, 6 PWM and 2 interrupt. ATmega328P microcontroller developed by Arduino.cc and initially released in 2010 and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by a USB cable or a barrel connector that accepts voltages between 7 and 20 volts, such as a rectangular 9-volt battery. It is similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

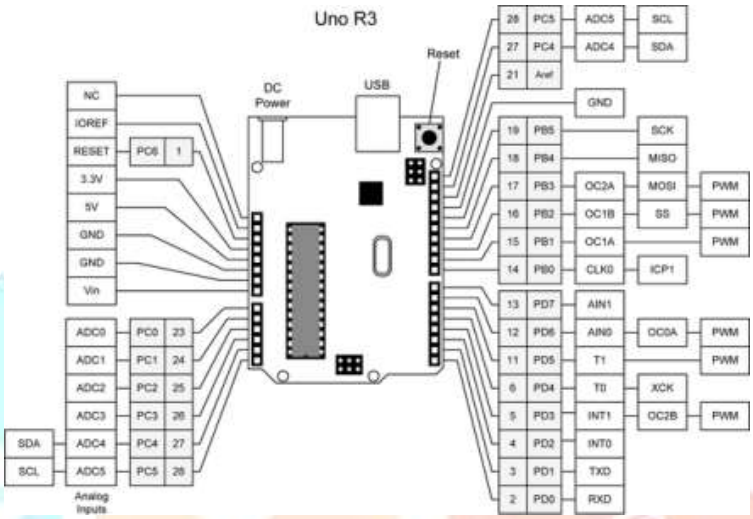

Fig 3 Pin diagram of Arduino Uno

2.3 Geared DC Motor

The geared DC motors are an advanced variation of the brush DC motors. They have a gear assembly attached to the motor. The speed of the motor is measured in Rotation per Minute (RPM). The speed of the motor is reduced with an increase in torque with the help of gear assembly. [2] It's used to adjust the whole mechanism's speed. This is important for various applications, like controlling conveyor belts or the speed of stirring mechanisms. In this project we have used two dc motor for driving two robot wheels.

Fig 4 DC Motor

2.4 L298N Motor Driver

L298N motor driver is used to control the speed of motors. The L298N Motor Driver module consists of an L298 Motor Driver IC, 78M05 Voltage Regulator, resistors, capacitor, Power LED, 5V jumper in an integrated circuit. To control speed of motors with help of Arduino Uno a motor driver is required. In order to control and drive the motors that we are using, the voltage of 12V is needed by the DC motors. The motor driver regulates in such a way as to provide speed and acceleration to the robot.[3] This motor driver uses double H bridge as driver chip thus we can drive two motors with a single motor driver. The driver voltage is between 5-35 volt.

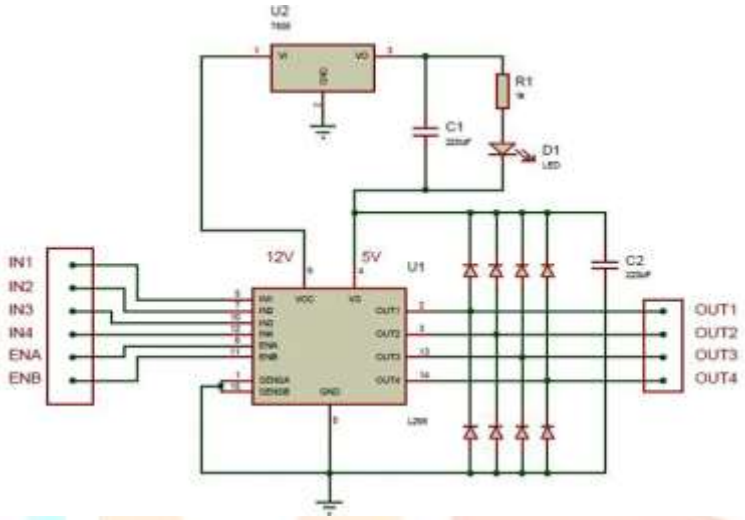

Fig 5 L298N motor driver module with connections

Pin Layout: In order to power the DC motors, two voltage supplies with different voltages are needed. The DC motor has an operating voltage of 12V. As the L298N module drops the voltage by more than 2V, the 5V voltage supply (USB) of the Arduino can't be used. Therefore, a second voltage supply of 9 to 12V is used.[2]

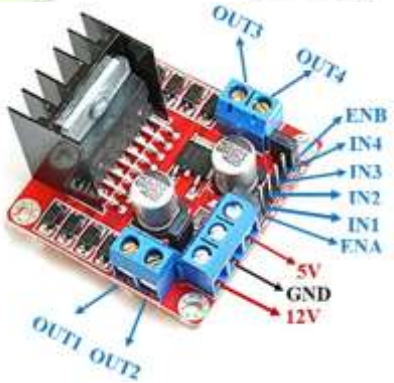

Fig 6 L298N pin diagram

2.5 Lithium ion battery

Lithium

Fig 7 Lithium ion Battery

2.6 Chassis

The chassis is the base of the robot. This chassis used to hold all the components and pcb of the robot. The Chassis used with coaster wheel is shown below

Fig 8 Chassis

2. 7 Jumper wires

Jumper wires are used here for making connections between the sensors and L298N motor driver module and Arduino's header pins. The photo view of the jumper wires is shown in figure 9

Fig 9 Jumper Wire

2. 8 Wheels

The wheels used shown below:

Fig Wheels

3. Shortest Path Finder Robot Algorithm

Two methods can be applied for traversing the maze or arena made up of black strip on white board. First is right hand method and second is left hand method.

Right hand method: In right hand method, the robot will take right turn first. If there is no possibility of right turn then it will go straight and at last if there is only left turn then it will take that turn.
The precedence order is as follows:
Right > Straight > Left

It can be illustrated as follows:

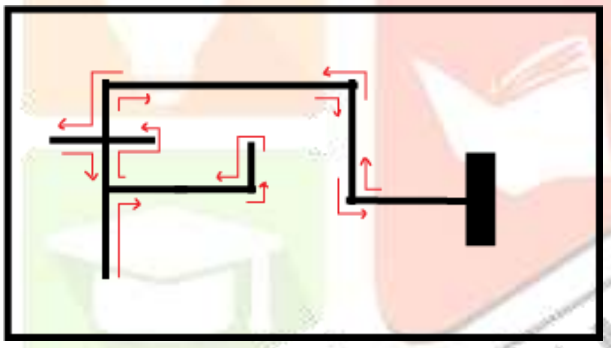

Fig Right Hand Path

Left hand method: In left hand method, the robot will take left turn first. If there is no left turn then it will choose straight path and at last if there is only right turn then it will take that turn.
The precedence order is as follows:
Left > Straight > Right

It is shown below :

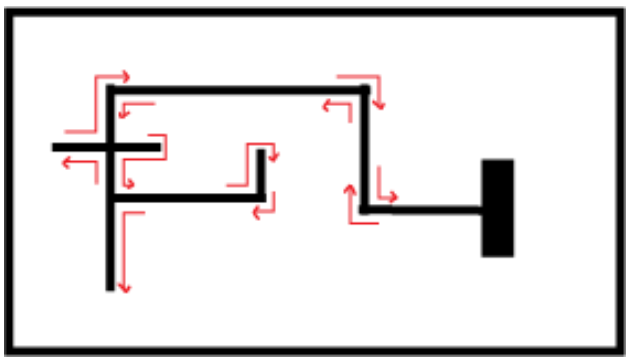

Fig Left Hand Path

4. Theory

In this project we will use left hand method. While traversing the path following cases can be encountered. These are dead end, bridge,+,T, ends.

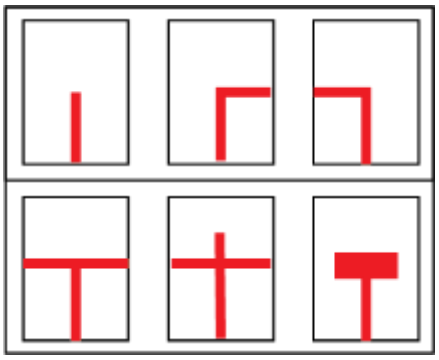

Fig Patterns in Arena

To memorize the path codes are given to them.

Left turn – L
Right turn – R
Straight – S
Backtrack – B

For example,in given path this code be written as:- LBLRRL

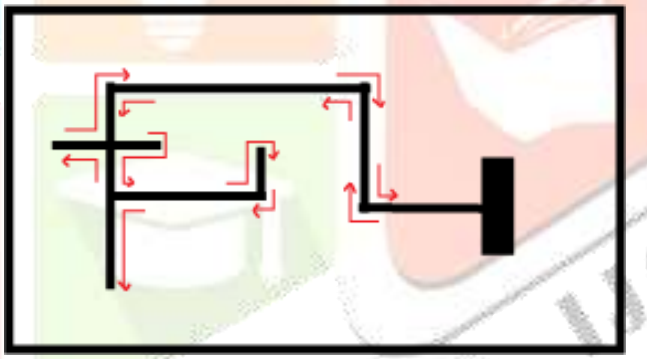

Fig Arena

Now this path can be reduced by replacing LBL by S
So the path can be written as SRRL and the whole list for substitution is :
LBL = S
LBR = B
LBS = R
RBL = B
SBL = R
SBS = B

5. Working

The IR Sensor detects the black strip. As IR sensor used here is analog sensor, so when the reading is more than threshold then the black strip is there and it can be assigned as 1 and vice versa. This data is then used to move the robot according to the given pattern and also stored in array for reading shortest path.

5. Conclusion

The development of a shortest path finder using Arduino provides a cost-effective and efficient solution for autonomous navigation of robots. By using Arduino, the system can be easily customized and modified according to specific requirements. However, the interaction with sensor has some limitations. Because due to intensity of environmental lighting effect leads to error in sensor signal. Moreover the battery should be recharged frequently making it suitable for various applications such as warehouse management, automated guided vehicles, and home automation.

However, the system can be further improved by incorporating more advanced algorithms and adding more sensors to optimize the path planning process. Overall, the project provides a solid foundation for the development of autonomous navigation systems using Arduino and can serve as a starting point for more advanced robotics applications.

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