

Line Following and Obstacle Avoiding Bluetooth Controlled Surveillance Robot

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Abstract:- A Robot is an electro-mechanical machine that is guided by control mechanisms. Robots are extensively used in factories replacing humans in performing repetitive and dangerous tasks because of extreme environment conditions. Prevalent use of blue tooth communication has led to its application in communication as interfacing microcontrollers like Arduino UNO with android. According to commands received from android the robot motion can be controlled. This robot is like a car that follows a designated path while avoiding obstacles on its pathway and spying via live camera stream.

Key Words: Arduino UNO, Bluetooth control, Line following, Obstacle avoiding, Live streaming, L293D motor driver, HC-05 Bluetooth Module, IR sensors

1. INTRODUCTION

A Robot is a machine that is usually designed to reduce the amount of human work where it is applicable. It is an analogy for any machine that is controlled by man varying from a simple toy to heavy machinery. Robots have even replaced humans in performing various tasks that they are unable to perform due to physical disability, size limitation or extreme environment [1].

It is usually developed to reduce risk factor for human work and increase comfort of any worker. Besides this, it helps to save our time by increasing its efficiency manifolds. Our modern civilization is going towards autonomous work day by day for reducing unnecessary human efforts on easy matters and ensuring more comfort and safety for the concentration on other important works.

We have designed a robot that has several tasks to perform besides following a line. We've had various encounters in our day to day life at the thought of which only one thing strikes our mind-what if this could be done autonomously? There are many tasks in a human's life that are quite time consuming with little output in return. The answer to this problem is automation. In our project we propose a robot design which is multi featured and on a relatively low cost. The line following mechanism can be applied to various places where one needs to monitor things.

2. SYSTEM OVERVIEW

The project consists of four main parts- Line follower robot, Bluetooth robot, Surveillance robot and Obstacle avoider. The

line follower is simulated using two IR sensors placed just in front of the robot and the directions are guided through the turning OFF and ON of the IR sensors. The Bluetooth module helps us in forming an interaction between our robot and the android phone. Connections are made on the Arduino with the Bluetooth module and it is interfaced with the phone using an android application. Surveillance is carried out using live streaming apps available. The obstacle avoider part of the robot is handled using IR sensors again. A basic block diagram of a robot is shown in figure 1.

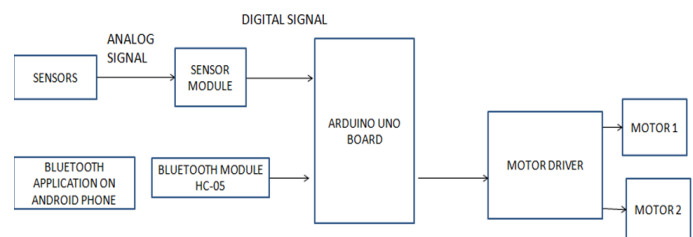


Fig -1: Block diagram of the Robot

The Arduino needs a power supply which is provided by DC batteries of 5 Volts. After the power supply has been connected the sensor starts sending analog signals to the sensor module which further sends the digital signal to the Arduino board. If the Bluetooth module is connected to any android device, commands can be received from the phone. The Arduino board further drives the motors which produce motion in the desired direction.

3. FLOWCHART OF THE PROJECT

The user has a choice to select one of the two operation modes available i.e. Bluetooth control and Line following.

If line following mode is selected, the two sensors placed on the front of the robot sense the path and move on black line accordingly. While following the path, if an obstacle is detected the sensor goes high and control can be switched to Bluetooth.

If Bluetooth mode is selected, characters are entered which perform the respective operations of moving either in left, right, forward or backward directions. The flowchart is given in the figure 2.

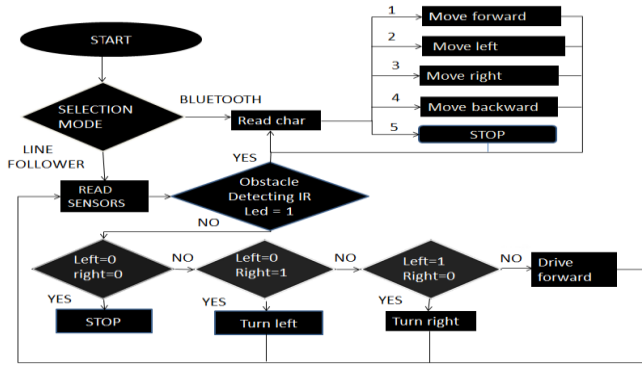


Fig -2: Flowchart of the robot mechanism

4. COMPONENTS

4.1 Arduino UNO

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor or turning on an LED. It can be connected to a computer via a USB cable or an AC to DC adapter. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, which runs on the computer, used to write and upload computer code to the physical board. Arduino microcontrollers are pre-programmed with a boot loader that simplifies uploading of programs to the on-chip flash memory.



Fig -5: Infrared sensor module [3]

Infrared Transmitter: It is a light emitting diode which emits infrared radiations. Hence they are called IR LED's. The radiation emitted is invisible to human eye. A simple infrared transmitter can be constructed using an infrared LED, a current limiting resistor and power supply. The schematic diagram of IR transmitter is shown below.

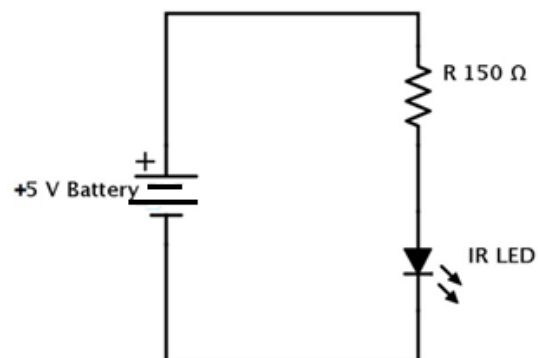


Fig -6: Infrared transmitter circuit diagram [5]

Infrared Receiver: Photodiodes are usually used as IR receivers. Different types of IR receivers' exist based on the wavelength, voltage, etc. The wavelength of the receiver circuit should match that of the transmitter. A typical infrared circuit using a phototransistor is shown below.

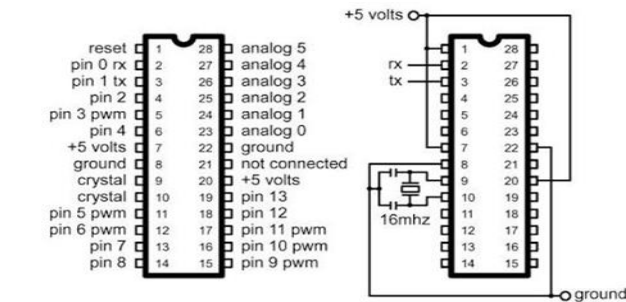


Fig -3: Pin diagram of Atmega328P microcontroller board [2]

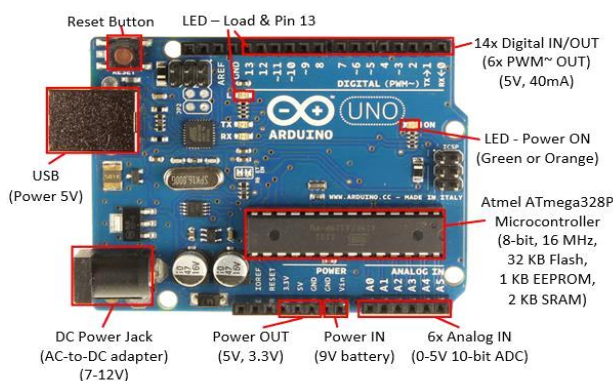


Fig -4: Arduino Uno microcontroller board [3]

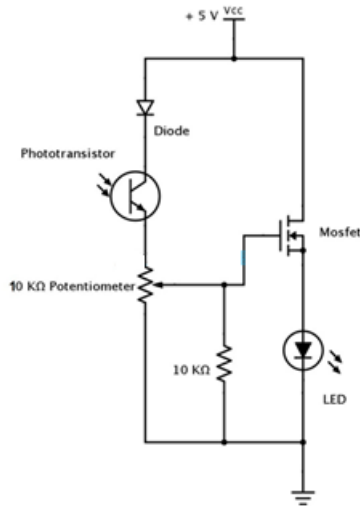


Fig -7: Infrared receiver circuit diagram [6]

4.3 HC05 Bluetooth Module

A Bluetooth module is a module designed for transparent wireless serial connection setup. HC-05 Bluetooth module is used in a robot controlled via Bluetooth to establish communication between mobile phone and the microcontroller. It operates at a voltage of a convenient 1.8 volts.

HC-05 has a range of 9m. It has four pins:

VCC (Power 3.3 – 6V), GND, TXD, RXD

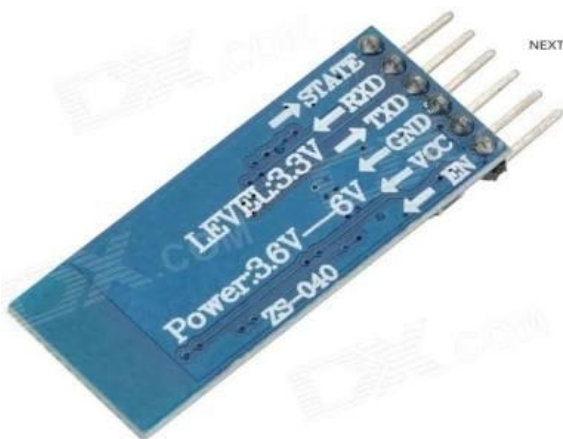


Fig -8: HC-05 blue tooth module [7]

4.4 L293D Motor Driver

L293D is a typical motor driver or motor driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction.

It works on the concept of H-bridge. H-Bridge is a circuit which allows the voltage to be flown in either direction. As voltage need to change its direction for being able to rotate the motor in clockwise or anticlockwise direction, hence H-bridge ICs are ideal for driving DC motor. In a single L293D chip there are two H-bridge circuits inside the IC which can rotate two DC motors independently.

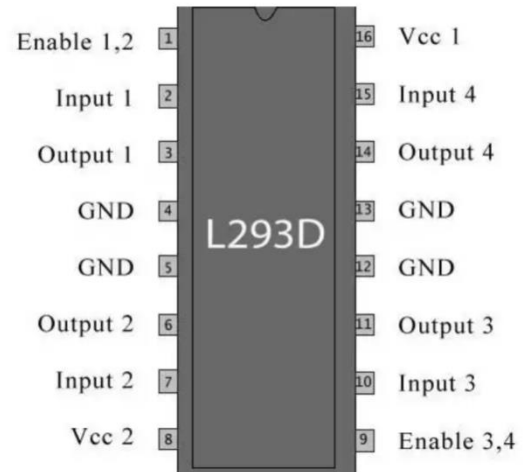


Fig -9: Pin diagram of L293D motor driver [8]

Working of L293D: There are 4 input pins for L293D: pin 2, 7 on the left and pin 15, 10 on the right. The pins on the left will regulate the rotation of motor connected across left side, and the pins connected on the right for motor connected on the right hand side. The motors are rotated on the basis of the inputs provided across the input pins as LOGIC 0 or LOGIC 1.

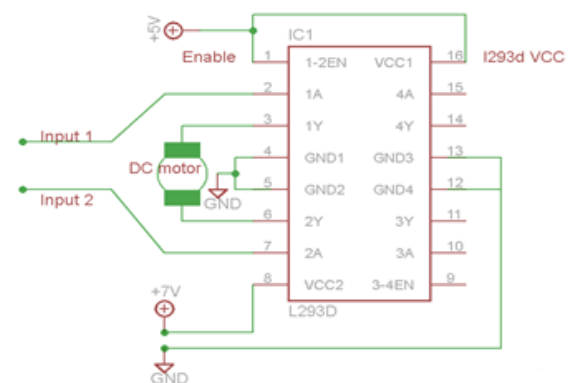


Fig -10: Connections of motor driver with Arduino [9]

L293D Logic Table: Let's consider a motor connected on left side output pins. For rotating the motor in clockwise direction the input pins has to be provided with Logic 1 and Logic 0.

Pin 2 = Logic 1 and Pin 7 = Logic 0 | clockwise direction

Pin 2 = Logic 0 and Pin 7 = Logic 1 | anticlockwise direction

Pin 2 = Logic 0 and Pin 7 = Logic 0 | Idle (no rotation) {hi-impedance state}

Pin 2 = Logic 1 and Pin 7 = Logic 1 | Idle (no rotation)

Similarly motor can also operate across input pin 15, 10 for motor on right hand side.

4.5 DC Motors

Almost every mechanical movement that we see around us is accomplished by an electric motor. Electric machines are means of converting energy. Motors take electrical energy and produce mechanical energy [10]. The working principle of a DC motor is: whenever a current carrying conductor is placed in a magnetic field, it experiences a mechanical force. The direction of this force is given by Fleming's left hand rule and its magnitude is given by $F=BIL$. Where, B=magnetic flux density, I=current and L=length of the conductor with in the magnetic field.

Fleming's left hand rule: If we stretch the first finger, second finger and thumb of our left hand to be perpendicular to each other and direction of magnetic field is represented by the first finger, direction of the current is represented by second finger then the thumb represents the direction of the force experienced by the current carrying conductor.

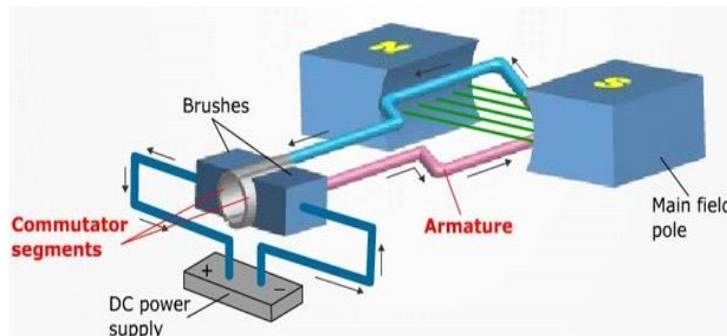


Fig -11: Working principle of DC motors [11]

When armature windings are connected to a DC supply, current sets up in the winding. Magnetic field may be provided by field winding (electromagnetism) or by using permanent magnets. In this case, current carrying armature conductors experience force due to the magnetic field, according to the principle stated above.

Commutator is made segmented to achieve unidirectional torque. Otherwise, the direction of force would have reversed every time when the direction of movement of conductor reverses the magnetic field.

4.6 Bluetooth android application

Smartphones are more affordable and efficient hand held devices which can be used to support collaborative activities in a community [12]. Bluetooth is mainly used for data exchange; add new features to smartphones [13].

The application used to control the robot is 'Arduino blue tooth controller' available for free on android play store. Initially a select menu pops up to connect to a given available device. After choosing HC-05 as the option, 'controller mode' is selected to set the command equivalents to be used in the application. The screenshots of the Bluetooth mobile application used is given below.

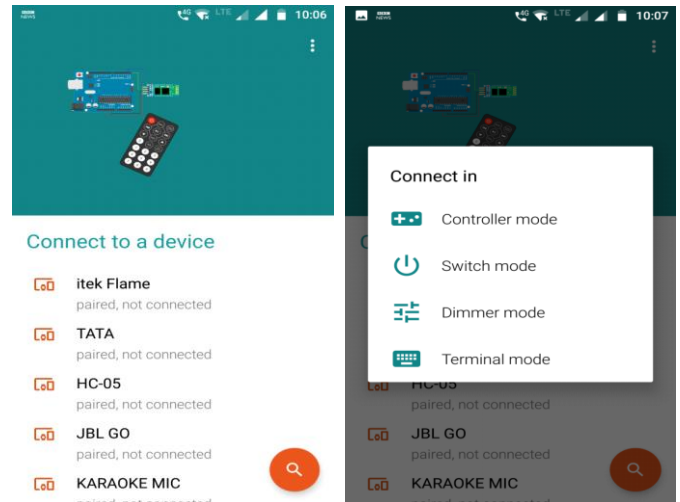


Fig -12: Snapshots of the application

The switching between line following and Bluetooth mode is done by selecting different buttons from the given options and further after selecting the Bluetooth mode, we can guide our robot into following the given four directions.

The line following mode is selected by clicking on the triangular button as shown in the above snapshot and the robot enters into an automatic line following mode where the guiding buttons do not respond. Likewise, for switching to Bluetooth the square button is selected and to stop the robot the circular button is clicked on.

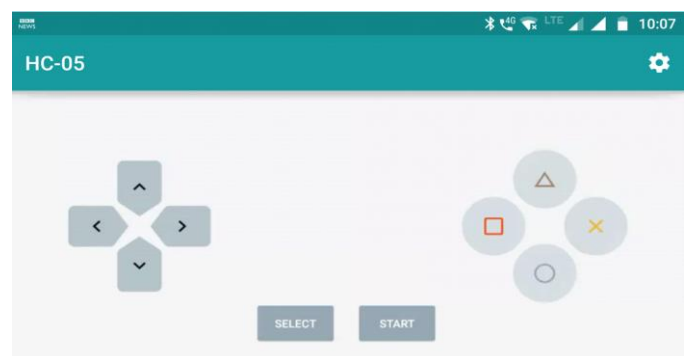
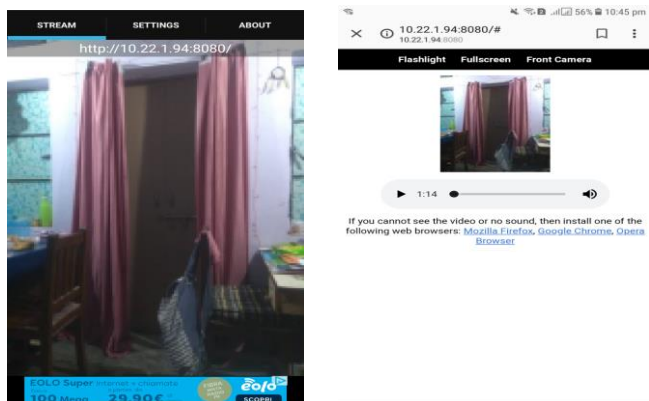


Fig -13: Control select screen

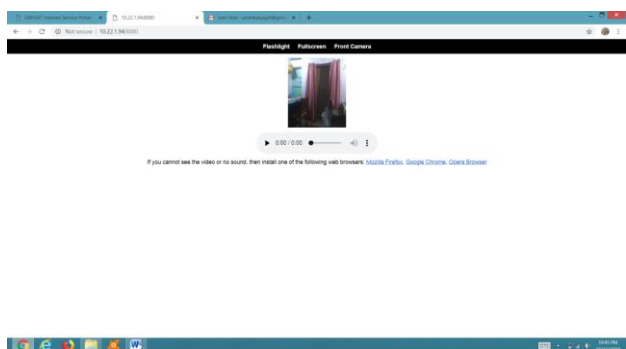
4.7 Live video stream application

For live video streaming, a streaming server and real-time protocols are used. The web server sends the selected file to watch to the streaming server, which in turn sends back the selected file directly to you in real time, using a real time protocol. The IP address from the source device is inputted into the destination device where the live streaming is to be

viewed. This application is compatible for PCs, laptops, iOS and android devices. For single source, multiple destinations can be connected at the same time.



(a)Recording of the host android phone and live stream on another phone



(b) Streaming on the laptop

Fig -14: .Snapshot of Live streaming application

4. EXPERIMENTAL RESULTS

The visible movement of the robot with the combined action of left and right motors has been observed. With the help of Bluetooth mechanism, we can move our robot the way we want. For the forward movement of the robot, the left as well as the right motor needs to move in clockwise direction. Similarly, for moving the robot in the left direction, only the right motor should be moved in clockwise direction and for moving the robot in the right direction, only the left motor should be moved in clockwise direction. Likewise, for reverse movement both the motors should rotate in anti-clockwise direction.

Table -1: Bluetooth controls

MOVEMENT	LEFT MOTOR	RIGHT MOTOR
FORWARD	CLOCKWISE	CLOCKWISE
LEFT	STOP	CLOCKWISE
RIGHT	CLOCKWISE	STOP
REVERSE	ANTI CLOCKWISE	ANTI CLOCKWISE

For following a path, the two sensors placed at the front of the robot have LOW value for OFF state and HIGH value for ON state. When the sensor lies on black line it turns LOW, while on the remaining white surface the LED is HIGH.

If the path is straight, both LEDs are on white surface and hence are ON which makes the robot move forward. Now if the path turns left, the left LED turns OFF as it falls on black line now and right LED is ON, which produces left movement. Likewise, the rest of the observations are tabulated below.

Table -2: Line following and obstacle avoiding controls

MOVEMENT	LEFT LED	RIGHT LED
STRAIGHT	ON	ON
LEFT	OFF	ON
RIGHT	ON	OFF
STOP	OFF	OFF

5. APPLICATIONS

The robot can be used for various applications in real-life scenario. It can be used for examining mini tunnels and can also be used in rescuing. Common situations that employ rescue robots are mining accidents, urban disasters, hostage situations, and explosions. Military robots are autonomous robots or remote-controlled devices designed for military applications [14].With few additions and modifications, this robot can be used in army for detecting and disposing hidden land mines. Sending skilled professional army personnel in a mine-laden field is quite hazardous.

A wireless camera is mounted on the robot vehicle for spying war fields and terrorist activities even in night time by using infrared lighting. These robots can be used as automated equipment carriers in industries replacing traditional conveyer belts.

These robots can also be used as automatic cars running on roads with embedded magnets. With the outburst of population, it's highly likely that we're going to run out of fuels in the near future henceforth utilizing the magnetic field of the earth is a highly sustainable idea in the course of technology.

Robots having line-following property like ours can be used at homes for domestic purposes like floor cleaning. They can also be used to switch the fans and lights of houses (home automation). The robots can be used in public places like shopping malls, museums etc. to provide path guidance. They can especially be used to guide blind people by detecting obstacles so that they can lead a better life without depending on others. A line following robot based health care management system can be very efficient in continuously monitoring the patients, whenever they need any help or medicine [15] and hence can be handled from a

single room. This gives the doctors more time to focus on the critical cases essentially and save energy and time.

. For continuous monitoring of the patients, health care system needs many personnel. From which the fee for the medical practitioner will hike. That robot based health care management system can reduce the fee for the patients so that they can easily pay that amount of money.

6. CONCLUSION

The cost of health care, military expenses, infrastructure majorly depends upon the expensive machinery, land and building and round the clock staff to maintain and use that machinery. In a country like India where the population is humongous and resources are scarce it becomes really difficult to set up such a capital extensive project at each and every location with availability of skilled staff. So what this system provides is an alternate to the existing system by replacing skilled labor with robotic machinery, which in turn can handle more tasks with better accuracy and a lower per capita cost.

7. REFERENCES

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