Bluetooth Applications: Gesture, Voice, G-Sensor based Motion control and Home Automation

[1]Smita Prajapati, [2]Ravindra Parab
[1]Assistant Professor, [2]Demonstrator
[1]School of Mechatronics,
[1]Symbiosis University of Applied Sciences, Indore, India.

Abstract : This paper presents the overall design of Bluetooth based multiple Applications like in Two wheel drive, Four wheel drive, Voice controlled drive and Home Automation System to control using mobile through Bluetooth communication. The advent of smartphone applications has tremendously influenced the way in which appliances can be automated. Blue-tooth is an industrial specification for wireless Personal Area Network (PAN). It provides a way to connect and exchange information between devices over a secure globally unlicensed short-range radio frequency. A Blue tooth service is an application acting as a server that provides some kind of assistance to client devices via Blue tooth communications. We present two wheel and four wheel drives or robots controlled by mobile phone via moving the robot forward, backward, left and right side by the android application. Secondly, we are going to Control the Robot through the G-sensor of our mobile phone and able to move the Robot just by tilting the Phone. If we add the joystick in the interface, the Robot can also be controlled by Joystick as well as by tilting the phone. Also modified it with voice controlled motion and at last Bluetooth is used for Home automation with variable control devices. Home automation involves the monitoring and control of activities such as lighting, heating, ventilation, air conditioning (HVAC) etc. having various advantages, such as comfort, increased security, and energy efficiency. Here we are using Bluetooth communication, interface microcontroller and android application. The proposed prototype of the system is implemented and tested on hardware and it gave the exact and expected results.

IndexTerms **- Bluetooth, Personal Area Network, G-Sensor.**

I. INTRODUCTION

Almost all the smart phones today, have the capability to communicate using Bluetooth. This is useful to mobile application developers whose applications require a wireless communication protocol. The objective of this proposed system is to explain how to use the Bluetooth tools available on Android and using instructions we can send and receive data to and from device wirelessly. The project aims in designing and implementing Bluetooth based multiple applications that can be operated using Android mobile phone. The controlling of the end node motion or application device is done wirelessly through Android smart phone using the Bluetooth feature present in it. Here in the project the Android smart phone is used as a remote control for all the controlling operations. The controlling device of the whole system is a Microcontroller. Bluetooth is being chosen with its suitable capability. Bluetooth with globally available frequencies of 2.4 GHz is able to provide connectivity up to 100 meters at speed of up to 3Mbps depending on the Bluetooth device class [1].

In wireless based automation system different type of technologies such as ZigBee, Z-Wave, Global System for Mobile (GSM), General Packet Radio Service (GPRS), Infrared, wireless fidelity (Wi-Fi) and Bluetooth are used, each technology has their own benefits and drawbacks. A Bluetooth based wireless system can be implement with a low cost and it is easy to install. In a research work proved that Bluetooth system are faster than wireless and GSM systems [2].

Home Automation, or Smart Home, has benefited from the critical innovations of Bluetooth technology can be used to connect devices such as mobile phones and laptops. Wired devices require a point to point connection but communication can be established between multiple devices with Bluetooth. A group of Bluetooth devices is called a Piconet and this technology is apt for building a Smart Home. Different appliances of the house (light, fan, etc.) are controlled via Bluetooth. Bluetooth provides a good platform as it is readily available in almost all the smart phones which are present in the market today and is easy to understand and use. This provides the flexibility to people of all ages to use Bluetooth in a handy manner [3].

II. BLUETOOTH SPECIFICATIONS

Bluetooth wireless technology is an open specification means that the specification is publicly available and royalty free. It is a low-cost, low-power, short-range radio technology for ad hoc wireless communication of voice and data anywhere in the world. Blue tooth wireless technology works anywhere in the world because it operates at 2.4 GHz in the globally available, license free, industrial, scientific, and medical (ISM) band [4]. Two or more Blue tooth-enabled devices come within range and establish a connection a personal area network is formed. A personal area network can either be a Pico net or a scatter net.

The modulation that occurs in Bluetooth is Gaussian phase shift keying. According to the official Bluetooth website [5], the communication via Bluetooth can be a point to point or a multipoint connection. Security is an important aspect while performing a wireless transmission, and Bluetooth guarantees that security. This is an important feature of Bluetooth connection. Other advantages of using a Bluetooth include cost-efficiency, ease of use, less complexity, and less consumption of energy. Bluetooth has an encrypted 128 bit long shared key that keeps the data secure when it is being transmitted and eliminates any questions about the security of data [3].

In principle, RF (Radio Frequency) emitted by Bluetooth can be regarded as the control which deals with the use of radio signal to remotely control any device [6]. The control of device involves three distinct phases: Perception, Processing and Action. The preceptors are sensors mounted on the device which is to be controlled, processing is done by the on-board microcontroller or processor, and the action is performed using motor or with some other actuators.

III. SYSTEM DESIGN

The design of the system is kept very simple and few things like cost-effectiveness and simplicity in design, low profile structure etc. have been kept in mind before designing the project. Our system aims to achieve the target to design a system that can provide following functionalities with a simple and easy-to-use interface:

a) Two and Four wheel drive using Bluetooth (Gesture and G-Sensor based) API
b) Voice controlled two wheel drive
c) Home Automation using Bluetooth

Hardware of this project consists of Arduino UNO, Bluetooth module and a motor driver IC or relay circuits. The Bluetooth module is connected with the Arduino UNO board for the connection with the user. Through the Bluetooth module for monitoring and controlling the particular device reaches the board and process accordingly and the output of the Arduino goes to the actuator or driver IC and it controls the particular task.

The system consists of following parts:

a) Arduino UNO (ATMEGA 328P)
b) Bluetooth module (HC-05)
c) Smart phone
d) Motor driver (l293D)
e) Arduino software (version 1.8.1)

The basic building blocks of the project have been described below:

3.1 Arduino UNO

Arduino is an open source physical processing hardware, which is based on a microcontroller board and an incorporated development environment for the board to be programmed. The Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter.

The Arduino Uno has in built ADC components and can process both analog and digital signals.

The Atmega328 has 32 KB of flash memory for storing code (of which 0.5 KB is used for the bootloader). It has also 2 KB of SRAM and 1 KB of EEPROM. The Arduino Uno has an operating voltage of 5V; a recommended input of 7V-12V can be applied to it. However, the Arduino Uno does not have a current driving capacity to drive all the DC motors attached to it- thereby requiring an intermediate motor driver circuit.

Each of the 14 digital pins on the UNO can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms.

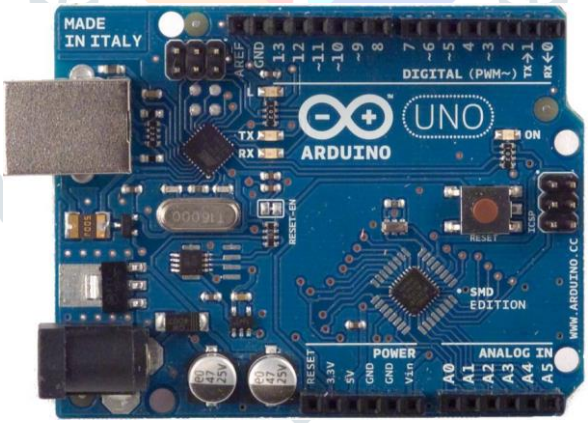


Figure.1. Arduino UNO

3.2 Bluetooth Module HC-05

For HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Bluetooth communication is an effective technology as the range of Bluetooth is found to be 100m. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Blue-core 04-External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature). It has the footprint as small as 12.7mmx27mm [7].

HC-05 Technical Specifications

1. Serial Bluetooth module for Arduino and other microcontrollers
2. Operating Voltage: 4V to 6V (Typically +5V)
3. Operating Current: 30mA
4. Range: <100m
5. Works with Serial communication (USART) and TTL compatible
6. Follows IEEE 802.15.1 standardized protocol
7. Uses Frequency-Hopping Spread spectrum (FHSS)
8. Can operate in Master, Slave or Master/Slave mode
9. Can be easily interfaced with Laptop or Mobile phones with Bluetooth
10. Supported baud rate: 9600,19200,38400,57600,115200,230400,460800

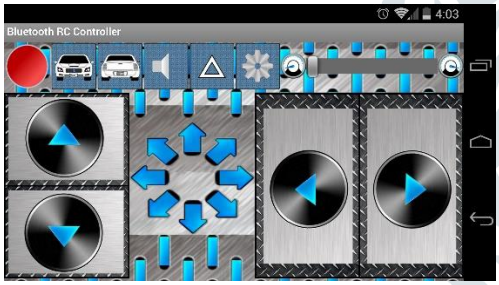
Figure.2. Bluetooth module HC-05

3.3 Smart Phone application

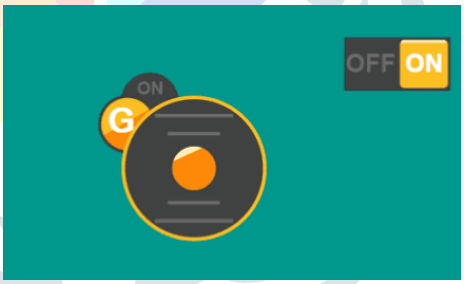
In order to operate the device motion or home appliances, we need to send message to Bluetooth module. This message is send using BlueArc application which is installed on Remote Mobile. The figure 3 is the screenshot of various applications to recognize the voice and control the robot motion using voice commands, Gesture control for both two wheel as well as four wheel drive and G-sensor based controlling app.

(a)

(b)



(c)



(d)

Figure.3. (a) Voice recgnition app (b) Gesture based app (c) RC control app for four wheel drive (d) G-Sensor based App

3.4. DC motors and Motor driver

The robot utilized two DC motors that drive the two wheels at the front while the two wheels at the back follow the ones at the front. According to the command voiced out to the app, the Bluetooth module. Motors which are used for motion of the robot are fixed to the bottom of the steel chassis, in the four wheel drive system which we have used in the configuration of our circuit; the motors on both the sides are managed independently of one another. L293D is a typical Motor driver IC which allows DC gear 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 means that you can control two motors using the concept of Dual H-Bridge. H-Bridge is a circuit which allows the voltage to be flown in either direction .In a single L293D chip there are two H-Bridge circuit inside the IC which can rotate two DC motors independently [8]. Even we can use L298N motor driver. It is a high voltage, high current dual full-bridge driver de-signed to accept standard TTL logic level sand drive inductive loads such as relays, solenoids, DC and stepping motors.

Features:

1. Can be used to run Two DC motors with the same IC.
2. Speed and Direction control is possible
3. Motor voltage Vcc2 (Vs): 4.5V to 36V
4. Maximum Peak motor current: 1.2A
5. Maximum Continuous Motor Current: 600mA
6. Supply Voltage to Vcc1 (Vss): 4.5V to 7V
7. Transition time: 300ns (at 5Vand 24V)
8. Automatic Thermal shutdown is available
9. Available in 16-pin DIP, TSSOP, SOIC packages

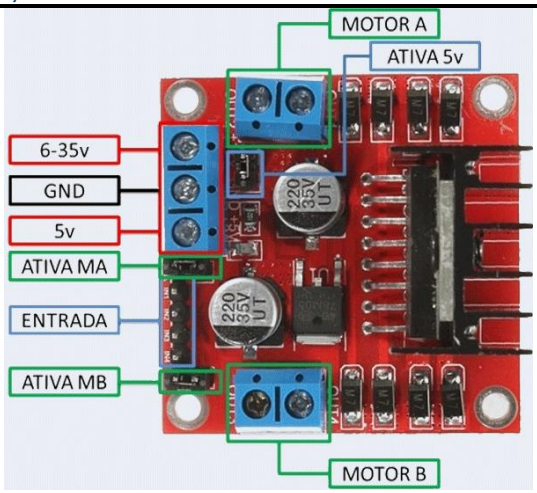


Figure.4. L293D Dual Motor Driver

IV. METHODOLOGY

Here Smartphone is used as remote mobile which operates the device using Android Application and Bluetooth module to send instruction to microcontroller. Bluetooth module is used for wireless communication between the devices. The instructions from Bluetooth module microcontroller plays an important role and it sends its output to Motor driver so that motor can rotate and hence the robot can be moved from one location to another.

Figure.5. Block Diagram of Proposed System

4.1. System Design for two and four wheel drive control

Here in this project the user (android application) is the input section. This device is connected with the Arduino board (microcontroller section) by the means wirelessly i.e. Bluetooth module. The system can now be connected with the motors (output section) to be controlled via wireless connectivity. The circuit diagram of this project is shown below in figure 6.

4.1.1. Gesture Based Motion control:

The microcontroller has one input, the Bluetooth receiver unit is used to receive a command from the android device, this Bluetooth receiver has 4 pins, which are, VCC, Tx, Rx and GND, the Tx pin is connected to pin 2 of the microcontroller and both the power and GND are connected from the microcontroller. The microcontroller is the brain of the circuit called the control unit, it has a program that receives the RF/ voice command from the Bluetooth transmit it to the appropriate unit for execution and take action. The DC motor is an electric motor converting direct current electrical energy into mechanical energy and it is connected to pin 9 on the microcontroller. The motor driver unit is connected to the microcontroller [9].

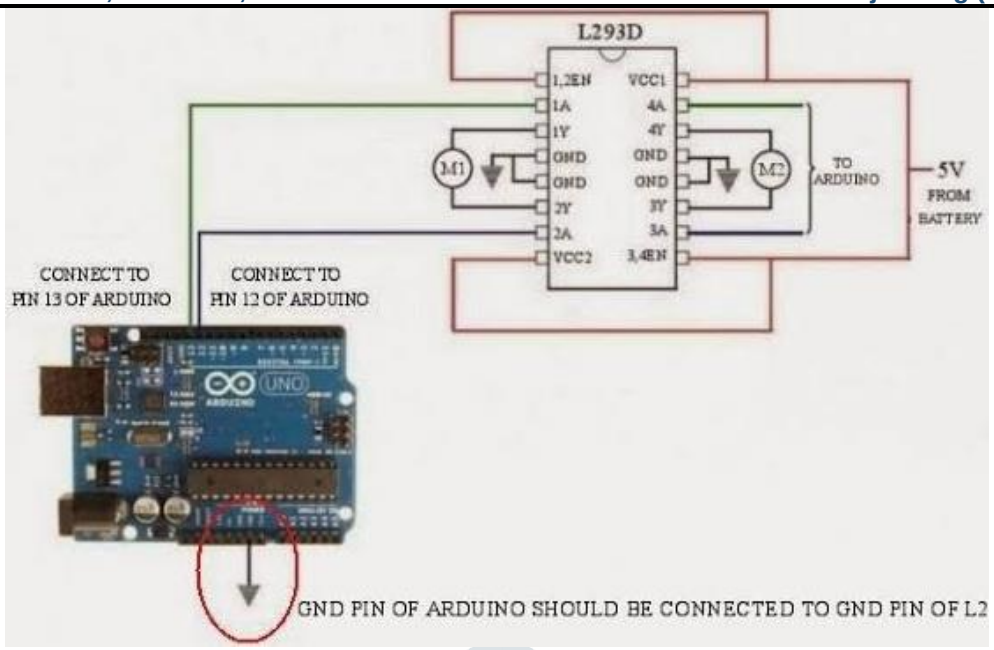


Figure.6.Interfacing of Arduino UNO with L293D motor driver IC

App Instructions:

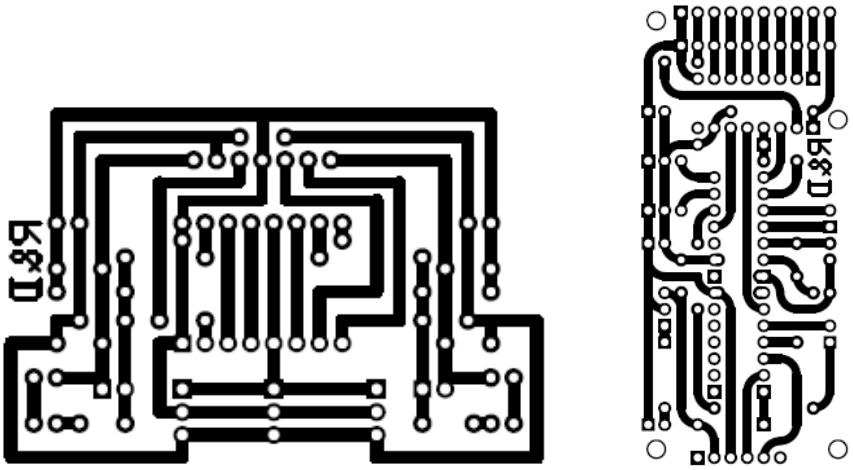
1. First make sure your HC-05 Bluetooth Module is paired with your mobile. The default password for pairing is "1234" or "0000". Check the manual of Bluetooth module.
2. Click on "SELECT DEVICE" icon to select paired Bluetooth module.
3. When you tilt mobile "FORWARD" it sends the data "A" to Bluetooth Module connected with the circuit. When Microcontroller detects "A" the drive moves FORWARD.
4. When you tilt mobile "BACKWARD" it sends the data "B" to Bluetooth Module connected with the circuit. When Microcontroller detects "B" drive moves REVERSE.
5. When you tilt mobile "LEFT" it sends the data "C" to Bluetooth Module connected with the circuit. When Microcontroller detects "C" the drive turns LEFT.
6. When you tilt mobile "RIGHT" it sends the data "D" to Bluetooth Module connected with the circuit. When Microcontroller detects "D" the drive turns RIGHT.
7. When the mobile phone is not tilted in any direction (screen upward position), it sends the data "E" to Bluetooth Module connected with the circuit. When Microcontroller detects "E" the drive gets STOPPED. You can also stop the robot by pressing STOP button which is in the center of remote.
8. Click on "DISCONNECT" icon to disconnect paired Bluetooth module.

4.1.2. G-Sensor based Motion control:

In this drive, we have controlled the direction and speed through the G sensor (Gravity Sensor) of our mobile phone and were able to move the robot just by tilting the Phone. We also used Arduino and Remote XY app for this G-Sensor Controlled Robot. RemoteXY app is used to create the interface in the Smart Phone for controlling the Robot. We will add the joystick in the interface so that Robot can also be controlled by Joystick as well as by tilting the phone.

G-Sensor or Gravity sensor is basically Accelerometer in Smart phone which is used to control the screen orientation of the phone. Accelerometer senses the X, Y, Z directions of the Gravitational force and rotate the Screen according to alignment of the Phone. As more sensitive and accurate Gyroscope sensor is used in mobiles for deciding the orientation of the Screen. In our Project, two wheel drive will move, according to the direction in which phone is being tilted, like when we tilt the phone forward, then car will move forward and we tilt it down then car will move backward.

4.1.3. Voice controlled robot: It consists of the smartphone that recognizes the voice commands and are being wirelessly transferred to the Bluetooth module HC05. The module then converts the command to text and the string of characters are sent to the Arduino for further processing. It uses google speech to text to recognize and process human voice. This processed text is sent to the microcontroller through Bluetooth. The microcontroller further processes the commands to control the robot accordingly. The Arduino microcontroller decodes the string obtained and correspondingly performs further functions. The signals are sent to the motor shield that hence powers and drives the motors connected to it. The commands accepted by the robot are Forward, Backward, Left, Right and Stop [10].



(a) (b)

Figure.7 PCB layout for Two and Four wheel drive

4.2. System design for Home automation system

The proposed home automation system implemented on hardware using Arduino Uno, Bluetooth module HC-05, four relays to control home appliances and smartphone. Bluetooth module TXD and RXD pins were connected with Arduino Uno RX and TX pins respectively. The home appliances lamp, electric motor and fan were connected with Arduino Uno digital output ports with the help of relays. The project will allow any person who has a Bluetooth enabled Android mobile phone to download an application from the Google Play Store. With the help of this application, a user can control all the appliances in the house via Bluetooth receivers. The proposed system allows the clients to have access to all the appliances in the house including air conditioners, and lights, with a single click on a mobile phone to turn it either ON or OFF. The steps to test the connection are as follows:

1. Open the application installed on the mobile phone.
2. With the help of the application, search for the Bluetooth devices.
3. Connect to the Bluetooth module (HC-05).
4. If the blinking of the light stops in the Bluetooth module, then it is working correctly, and the connection is established.

In our system we can manage four different devices out of these one device speed control is possible.

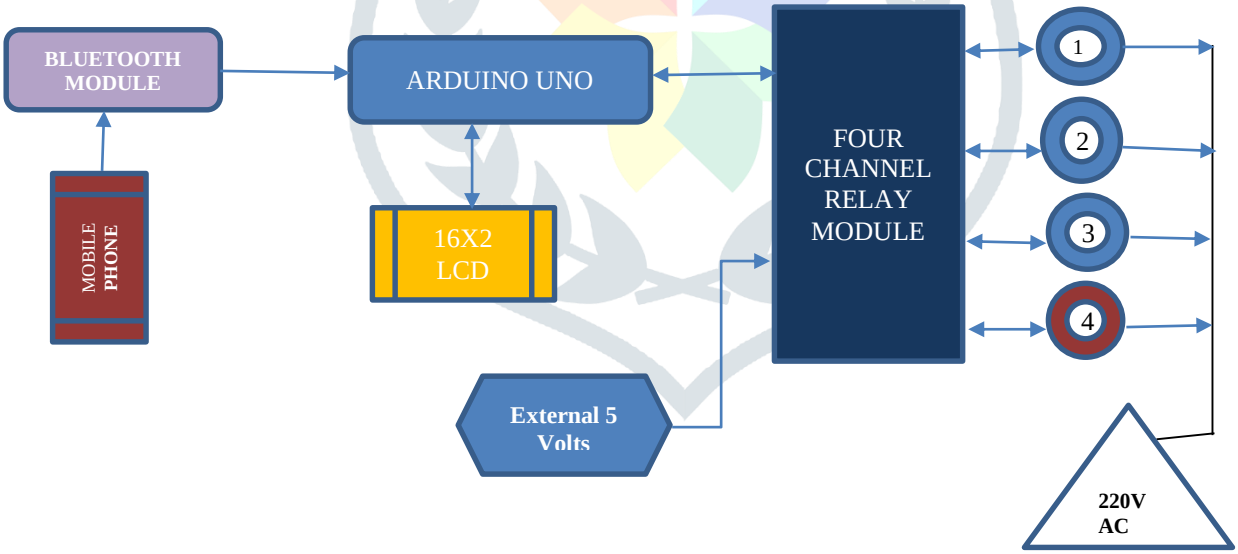


Figure.8. Connection diagram for home Automation

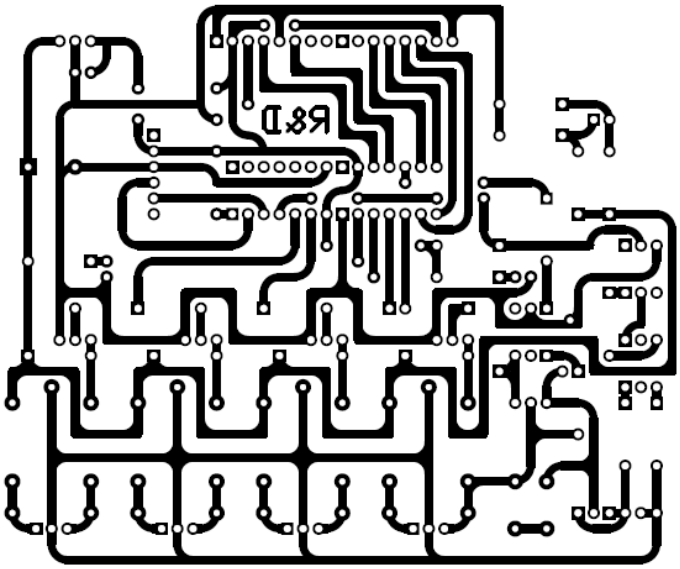


Figure.9. PCB Layout for Home Automation with speed control

V. RESULTS AND DISCUSSION

Proposed Bluetooth applications in motion control and home automation system implemented on hardware using Arduino Uno, Bluetooth module HC-05 and smartphone. Fig. 10 demonstrates the two wheel drive and four wheel drive designed and tested successfully for all the direction of motion. Fig. 12 illustrates the home automation system controlling four devices out of which one device speed control is done using Bluetooth and the status is shown on the 16x2 LCD display.

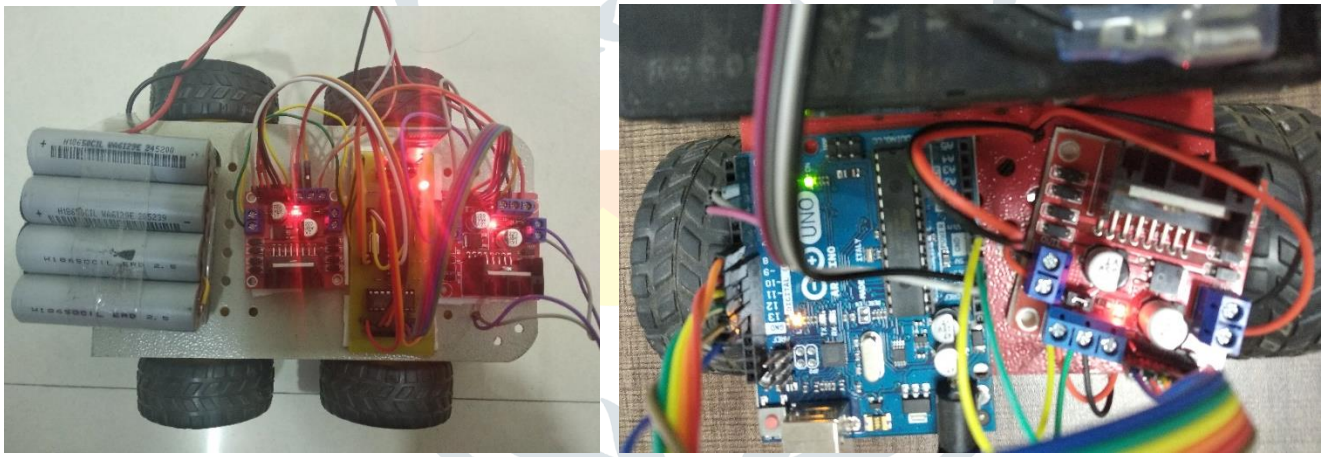


Figure.10 (a) Four wheel drive testing (b) Two Wheel Drive Testing

Figure.11 Home automation with display showing the results

Table 5.1: Application Testing

Bluetooth Application	Control Principle	Control variables	Application Used
Two wheel Drive	Gesture Control	Four Direction Motion Control (Left, Right, Forward, Backward)	Bluetooth RC control App
	G-Sensor Control		Remote XY
	Voice Control		AMR Voice Recognition
Four Wheel Drive	Gesture/ Accelerometer Control	Eight Direction motion control	Bluetooth RC control App
Home Automation	Gesture Control	Four Devices control with one device speed control	Bluetooth control

Conclusion

These are cost-effective and efficient applications. The novelty lies in the fact that Bluetooth is a cost-effective, along with a simple and easy to use interface compared to existing ones. Also the Bluetooth RC Controller application is more user friendly and helps for controlling direction as well as speed. With few additions and modifications, this robot can be used in army for detecting and disposing hidden land mines. The robot can be used for surveillance. In future we can interface sensors to this robot so that it can monitor some parameters and we can improve the efficiency using Internet of Things (IoT) technology. We can also add wireless camera, in order to incorporate other security features. Proposed home automation system is only able to control the appliances within short range, for future research work it is recommended to increase the range and interface more sensors and it should be a low cost and user friendly system. Moreover home automation system can be interfaced with biomedical signals. It will be beneficial for especially abeled people, they will be able to control the appliances using their muscle's movement.

REFERENCES

[1] D.Jaya Sree 1 M.Jhansi Lakshmi, "Android Mobile Based Home Automation Using Bluetooth", International Journal of Advanced Research in Computer Engineering & Technology (IJARCET), Volume 3 Issue 9, September 2014.

[2] Muhammad Asadullah, Khalil Ullah, "Smart Home Automation System Using Bluetooth Technology", 2017 International Conference on Innovations in Electrical Engineering and Computational Technologies (ICIEECT), DOI: 10.1109/ICIEECT.2017.7916544

[3] Ayush Kumar, "Home Automation via Bluetooth Using the Arduino Uno Microcontroller", ProQuest Number: 10195769 10195769, Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree Master of Science in Electrical Engineering, December 2016.

[4] Alan Bensky, "Short-range Wireless Communication", Third Edition, 3rd Edition, 2019, https://doi.org/10.1016/C2017-0-02356-X

[5] Bluetooth. (2016). Fast Facts. [Online]. Available: http://www.bluetooth.com/Pges/Fast-Facts.aspx.

[6] Leong Man Hong, "Bluetooth Remote Home Automation System Using Windows and Android Application", dissertation submitted, Faculty of Electronic and Computer Engineering Universiti Teknikal Malaysia Melaka, June 2013.

[7] Mali Tejas Dilip, Shinde Niteen Maruti, Desai Sandeepkumar Maruti,Prof. Gaikwad S.A, "Bluetooth Based Automation and Security System", IJSRD - International Journal for Scientific Research & Development| Vol. 3, Issue 01, 2015 | ISSN (online): 2321-0613.

[8] Pooja Gangan, Amol Joglekar, "Cell Phone Operated Car Using Bluetooth Technology and Android Application, IJRET: International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308, Volume: 04 Issue: 06 | June-2015, pp. 465-468.

[9] Emmanuel Gbenga Dada, Abdulkadir Hammidu Alkali, Dauda Elijah Mshelia and Abdul-Azeez, "Bluetooth Activated Robotic Car", International Journal of Computer Engineering and Information Technology VOL. 10, NO. 8, August 2018, 151–158, E-ISSN 2412-8856 (Online)

[10] Mamatha K R, Shalini Ragothaman, Krithika Raj D, Susmi Zacharia, "Implentation Of Voice Controlled Robot Using Android Application", International Journal of Latest Research in Engineering and Technology (IJLRET) NC3PS-2016, ISSN: 2454-5031, PP. 165-168.