FIRE FIGHTER ROBOT

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CERTIFICATE OF CORRECTNESS AND APPROVAL

It is certified that the work contained in this thesis "FIRE FIGHTER ROBOT", was carried out by SaadSaleem, HanzlaCheema, Roheb Ali and Fateullah under the supervision of Col Dr. Imran Touqir for partial fulfillment of Degree of Bachelor of Telecommunication Engineering, is correct and approved.

Approved by

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Col Dr. Imran Touqir

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MCS

Dated:_____

ABSTRACT

The project is designed to develop a firefighting robot using android technology as remote operation. The robotic vehicle is loaded with water tanker and a pump which is controlled over wireless communication to throw water. An Arduino series of microcontroller is used for the desired operation.

At the transmitting end using push buttons, commands are sent to the receiver to control the movement of the robot either to move forward, backward and left or right etc. At the receiving end two motors are interfaced to the microcontroller where two of them are used for the movement of the vehicle and the remaining one to position the arm of the robot. The android application device transmitter acts as a remote control that has the advantage of adequate range, while the receiver have Bluetooth device fed to the microcontroller to drive DC motors via motor driver IC for necessary work. A water tank along with water pump is mounted on the robot body and its operation is carried out from the microcontroller output through appropriate signal from the transmitting end. The whole operation is controlled by an Arduino series microcontroller. A motor driver IC is interfaced to the microcontroller through which the controller drives the motors.

Further the project can be enhanced by interfacing it with a wireless camera so that the person controlling it can view operation of the robot remotely on a screen.

DECLARATION

No portion of the work presented in this dissertation has been submitted in support of another award or qualification either at this institution or elsewhere.

DEDICATION

In the name of Allah, the Most Gracious, the Most Beneficent,

Dedicated to our parents, our teachers and especially Military College of Signals.

ACKNOWLEDGEMENTS

There is no success without the will of ALLAH Almighty. We are grateful to ALLAH, who has given us guidance, strength and enabled us to accomplish this task. Whatever we have achieved, we owe it to Him, in totality. We are grateful to our parents who supported us both morally and financially. We thank our friends for their admirable support and their critical reviews.

Due extension of gratitude to our project supervisor Col Dr. Imran Touqir for his continuous technical guidance and moral support throughout the project. His calm nature ensured smooth work and his composed manner helped us work around obstacles with perseverance.

Table of Contents

Table of Figures

List of Tables

List of Abbreviation

A.C	Alternating Current
CW	Clockwise
CCW	Counter Clockwise
D.C	Direct Current
IR	Infrared
LED	Light Emitting Diode
ISP	In-System Programmable
I/O	Input/output
MAC	Media Access Control
MCU	Multipoint Control Unit
RF	Radio Frequency
USB	Universal Serial Bus
UART	Universal Asynchronous Receiver Transmitter

CHAPTER 1

1.1 Introduction

Robot is an essential part in automating the flexible developing system that one significantly demand these days. Robots are now above a engine, as robots have become the key of the future as cost labor salary and clients order. Even if the cost of acquiring robotic system is relatively costly but as today's swift growth and a very high challenging superiority with IS0 (International Standard Organization) standards, human are no longer skilled of such demands. Research and development of future robots is moving at a very fast rate due to the continuously improving and improving of the quality standards of goods. Robot and automation is engaged in order to change human to carry out those responsibilities that are regular, unsafe, and boring and in a unsafe area. In a world of complex technology today, Automation significantly increases production ability. Improve product quality and lower manufacturing cost. It takes just a few people to plan or check the computer and perform routine preservation.

It is desirable in many applications to have robotic vehicle. To lower the risk of loss of the lives of the fire fighters it was essential to build a prototype which gives an alternative way for fire fighters to extinguish the fire. In the past there were many cases of the fire fighters burning while saving the lives of the people. So the alternative way is to use a robotic vehicle for that purpose so that they can replace the humans.

1.2 Background

During the past few years automation is done in industries. In many areas robots are implemented in assembly lines for increasing the quality as well as efficiency and also to reduce the production cost. We have to analyze that at what places human are better and at what place machines are powerful. Instead the most important tactic today is that how both robots and human work together .Several projects have been developed to increase the cooperation between human and machines. It is very important to have a good communication between workers whether they are machines or human.

In making of a Fire Fighting robotic vehicle there is usually a robotic kit which is used. These kits act as a base of the robot. And all the other modules are implemented on it using different layers of the robotic kit.

Figure 1: Robotic Kit

1.3 Objectives

- Programming Arduino for communication between Arduino and Bluetooth module.
- Development of the mechanical structure of the firefighting robotic vehicle.
- Interfacing of the other hardware modules and their installation on the robotic kit.
- Implementation of the circuit in Wire Shark for the motor movements.
- Development of the Fire Extinguisher System on the robotic kit.
- Choosing the Android Application for the movement of the robot.

1.4 Outline of Tasks

Firstly research was carried out about the chassis for the robotic vehicle. Robotic kit was used for this purpose. Then for the robot movement and controlling we choose Arduino

Nano which is a development platform. Next we did the programming for the Arduino. The circuits were implemented in the Live Wire for the movement of the motors. Then there was the interfacing of the Bluetooth module with the Arduino. After that there was the installation of the fire extinguishing system on the robotic kit. For the live video streaming a camera was interfaced on the robotic kit which will give the live video streaming at the back end using RF Receiver.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

The android application device transmitter acts as a remote control that has the advantage of adequate range, while the receiver have Bluetooth device fed to the microcontroller to drive DC motors via motor driver IC for necessary work. A water tank along with water pump is mounted on the robot body and its operation is carried out from the microcontroller output through appropriate signal from the transmitting end. Arduino is used to control the process.

2.2 Robot

Robot is a machine that looks like a human being and performs various complex tasks. Robots are meant to aid people, making a task easier or aiding a person who wants or needs help. The main use of robots has so far been in the automation of mass production industries, where the same definable tasks must be performed repeatedly in exactly the same fashion. Also, domestic robots are now available that perform simple tasks such as vacuum cleaning and grass cutting.

Recently, there has been interest in sending robots into situations that are too dangerous to send a person. Some examples of these situations are buildings on fire and buildings that are partially collapsed after an earthquake. In these situations, it is safer to send a robot into the building to investigate it, before the rescue team enters. Some other robots are used in other dangerous situations such as bomb disposal, mining, or cleaning of toxic waste.

In order to control the robot, a tether may be used. The problem with using a tether is that it can become snagged; the tether may also be heavy or inflexible. For these reasons, robots could use wireless communication as an alternative. In this project is to build a Firefighting robot device that can response or detect and extinguish a fire on its own is long past due. Many house fires originate when someone is either sleeping or not home. With the invention of such a device, people and property can be saved at a much higher rate with relatively minimal damage caused by the fire. The motivation behind of

firefighting robot is the desire to save human lives. Currently, we rely on human beings to enter burning buildings and extinguish fires. Using a robot to put out fires will eliminate the risk of injury or death to the fire fighter.

2.3 Previous Robot Overview

The figure below shows the robot which has a function of detection of fire and then extinguishing it.

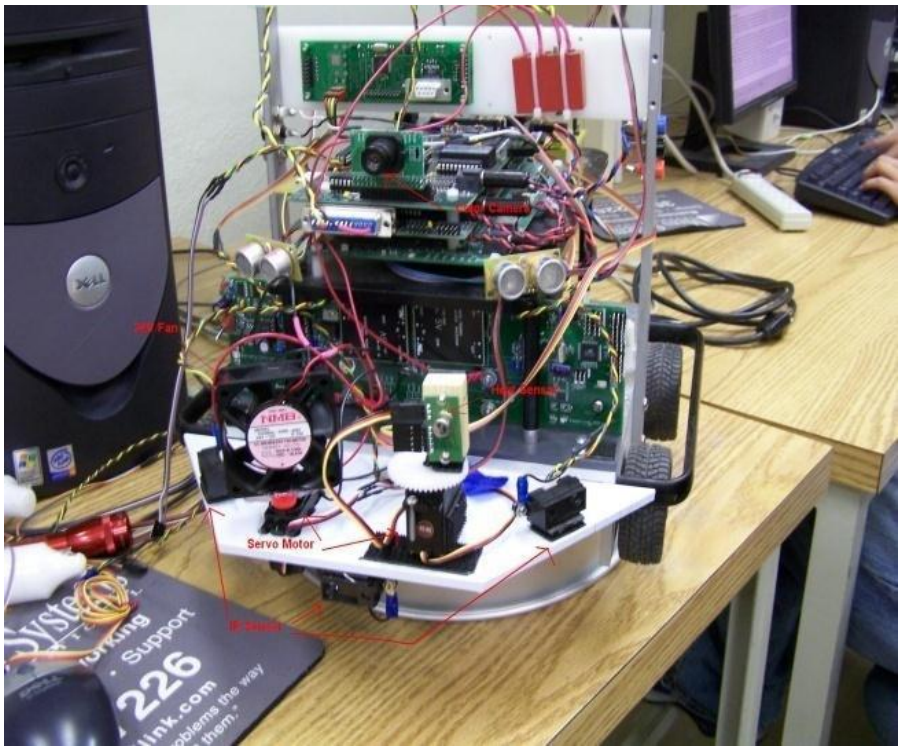

Figure 2: Fire Protection Robot

This robot designed to enter a room and seek out a spot where there is extreme heat possibly due to a fire. Upon entering the room, the robot will once again use the color camera to pinpoint a spot where there is a large concentration of light. Once the robot has driven up to the light source, the heat sensor is activated to check and see if there is a large amount of heat being generated. If there is an excessive amount of heat generated, the fan is turned on and rotated quickly with a servo motor to put out the flame. If the flame is not put out the fan will turn on again and continue to blow on the flame. Once the flame is extinguished, the robot leaves the place.

2.4 Arduino Nano

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.x) orATmega168 (Arduino Nano 2.x). It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one. The Nano was designed and is being produced by Gravitech.

Figure 3: Arduino Nano Front

Figure 4: Arduino Nano Rear

Specifications

Microcontroller	Atmel ATmega168 or ATmega328
Operating Voltage (logic level)	5 V
Input Voltage (recommended)	7-12 V

Input Voltage (limits)	6-20 V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	8
DC Current per I/O Pin	40 mA
Flash Memory	16 KB (ATmega168) or 32 KB (ATmega328) of which 2 KB used by bootloader
SRAM	1 KB (ATmega168) or 2 KB (ATmega328)
EEPROM	512 bytes (ATmega168) or 1 KB (ATmega328)
Clock Speed	16 MHz
Dimensions	0.73" x 1.70"
Length	45 mm
Width	18 mm
Weight	5 g

Power

The Arduino Nano can be powered via the Mini-B USB connection, 6-20V unregulated external power supply (pin 30), or 5V regulated external power supply (pin 27). The power source is automatically selected to the highest voltage source.

Memory

The ATmega168 has 16 KB of flash memory for storing code (of which 2 KB is used for the boot loader); the ATmega328has 32 KB, (also with 2 KB used for the boot loader). The ATmega168 has 1 KB of SRAM and 512 bytes of EEPROM (which can be read and written with the EEPROM library); the ATmega328 has 2 KB of SRAM and 1 KB of EEPROM.

So the labeled Arduinonano is shown below as

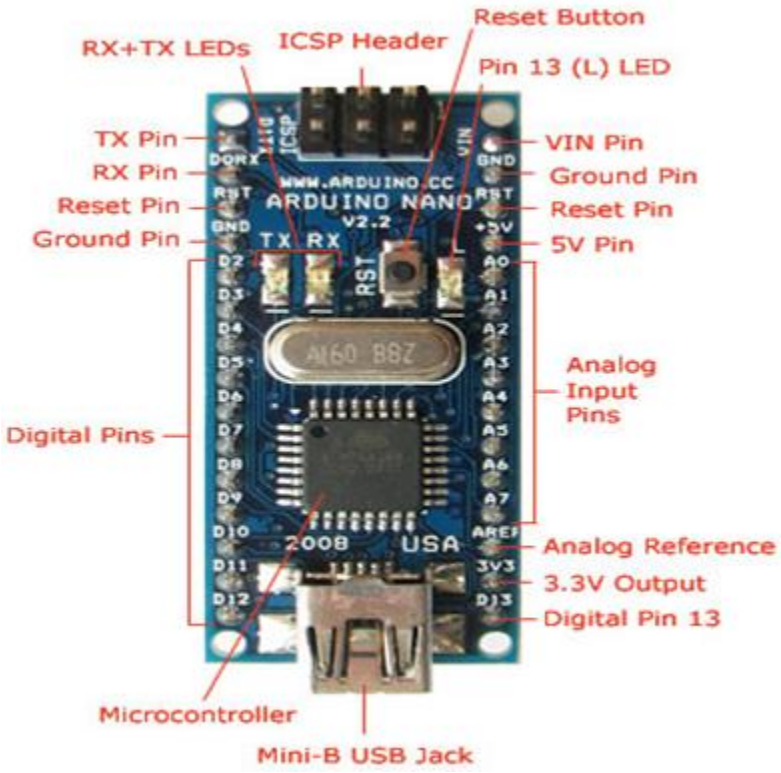

Figure 5: Arduino Nano Labled

2.5 Sensor

A sensor is a device that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument.

2.5.1 Flame Sensor

These types of sensors are used for short range fire detection. And have a range of about 3 feet. These sensors are very sensitive to IR wavelengths of about 760 nm ~ 1100 nm light. An infrared sensor is an electronic device that is used to sense definite individuality of its environment by either emitting or detecting infrared radiation. It is also able of measuring heat of an item and detecting movement. Infrared waves are not visible to the human eye. Infrared radiation is the region having wavelengths longer than visible light wavelengths in the electromagnetic spectrum, but lesser than microwaves.Detection angle

about 60 degrees, it is sensitive to the flame spectrum. Comparator chip LM393 makes module readings stable. Operating voltage of 3.3V-5V. Digital and Analog Output
DO digital switch outputs (0 and 1) and AO analog voltage output. So there are four pins of the module. Sensitivity can be adjusted by potentiometer.

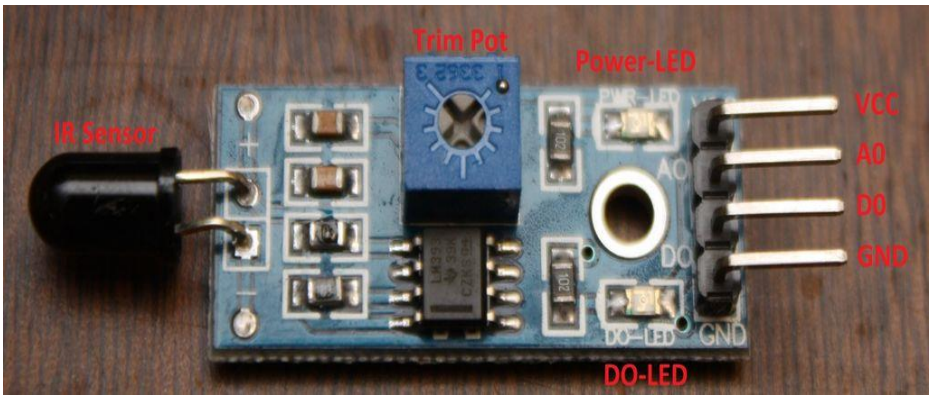

Figure 6: Flame Sensor

2.5.2 Infrared Source

All objects above 0 K emit infrared energy and therefore are infrared sources. Infrared sources also consist of blackbody radiators, tungsten lamps, silicon carbide, and a variety of others items. For active IR sensors, infrared Lasers and LEDs of definite IR wavelengths are used as IR sources.

2.5.3 Transmission Medium

Three major type of transmission medium used for Infrared transmission are vacuum, the atmosphere, and optical fibers.

2.5.4 Infrared detectors

Different types of detectors are used in IR sensors. Most important condition of detector is Photosensitivity. It is the Output Voltage/Current per watt of incident energy. Higher value is better for future use.

2.6 Types of Motor:

Several different motors are accessible in the market like stepper, servo, dc motors with and without gears. These different motors are used according to their applications and necessities for e.g. If we want high torque and accurate position we need to use servo

motors, if we want to only position and if high torques are not mandatory then stepper motors are used .DC geared motors are used where we need high torque .For only smooth motion DC motors are used.

2.6.1 DC-Motor

DC motors appear in a range of shapes and sized even if most are cylindrical. They characteristic an output shaft which rotates at high speeds usually in the 5 000 to 10 000 rpm range. Although DC motors rotate very rapidly in common, most are not strong (low torque). In order to reduce the speed and amplify the torque, a gear can be used. DC motors can function in clockwise (CW) and counter clockwise (CCW) rotation.

2.7 Motor Driver

Since the Arduino board can supply only 5v which is insufficient for driving motor, motor driver is used. L293D is a dual H-bridge motor driver integrated circuit (IC) Motor driver act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors.L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction.

H-bridge is a series of four controllable switches in which there are two sets of two switches. One set of switches when closed allows electricity to flow one way. The other set of switches allows electricity to flow in the opposite direction. Another important characteristic of an H-bridge is that it typically can use a smaller voltage (5VDC from a micro controller, for instance) to control a much larger voltage (12VDC used to power a motor). These two separate voltage sources are kept isolated from one another. H-bridges can be made with either 4 relays or 4 transistors.

2.7.1 Working

H Bridge which we are using is composed of relays. What this means for you is that the motor will spin as fast as it can in one direction and then when reversed, spin as fast as it can in the other direction. When the coils on "Relay 1" and "Relay 4" are pulled high (electricity is flowing through them), then the motor will spin forwards (see "Figure7").

When the coils on "Relay 2" and "Relay 3" are pulled high (electricity is flowing through them), then the motor will spin backwards (see “Figure 8"). When the coils on "Relay 1" and "Relay 2" are pulled high (electricity is flowing through them), then the motor will stop spinning (see “Figure 9"). When the coils on "Relay 3" and "Relay 4" are pulled high (electricity is flowing through them), then the motor will stop spinning (see “Figure 10").

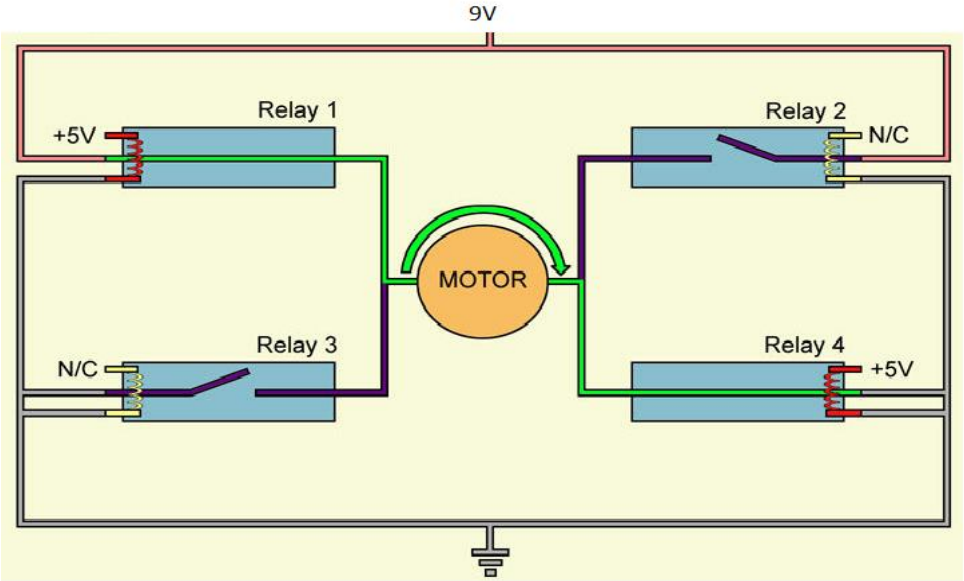

Figure 7: Forward Motor Movement

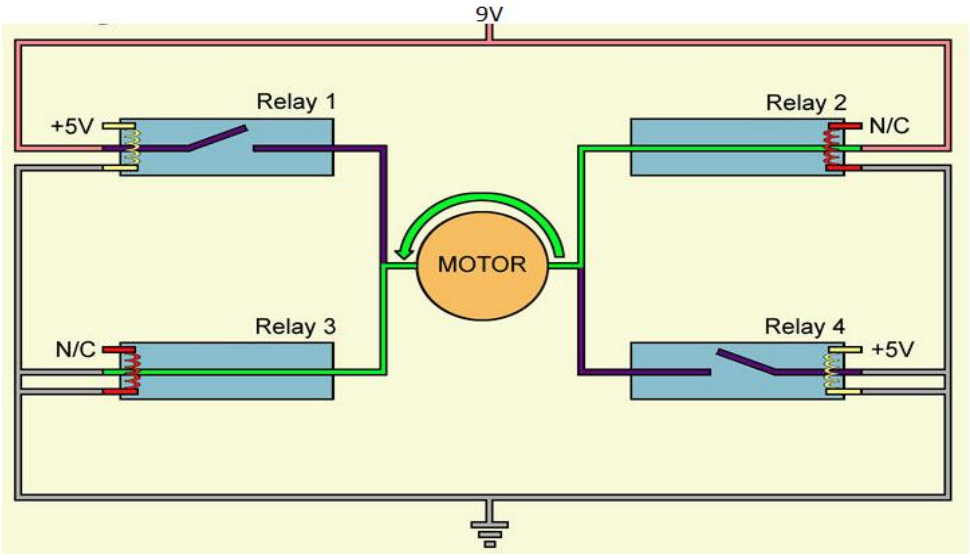

Figure 8: Backward Motor Movement

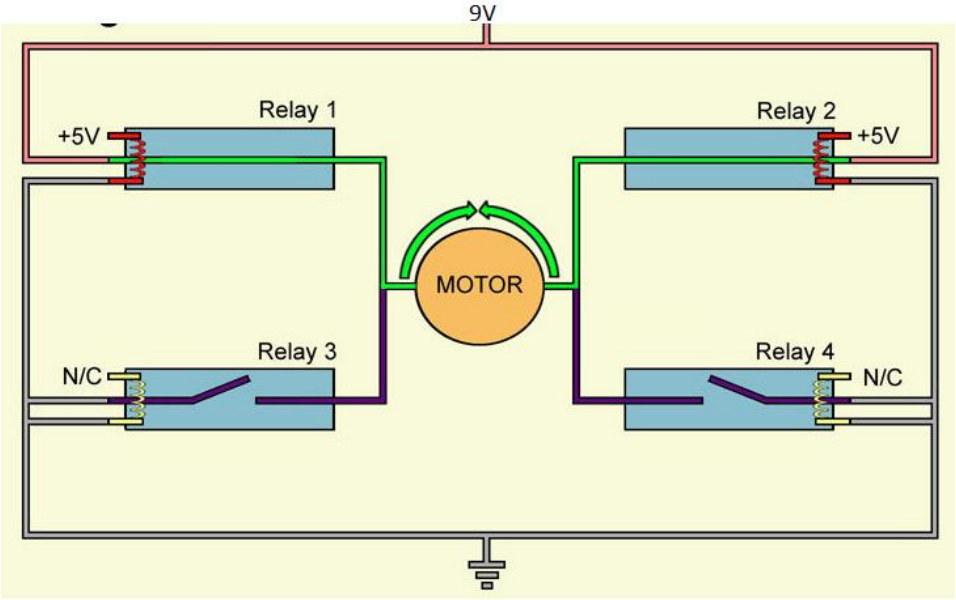

Figure 9: Relay 1 & 2 Pulled High

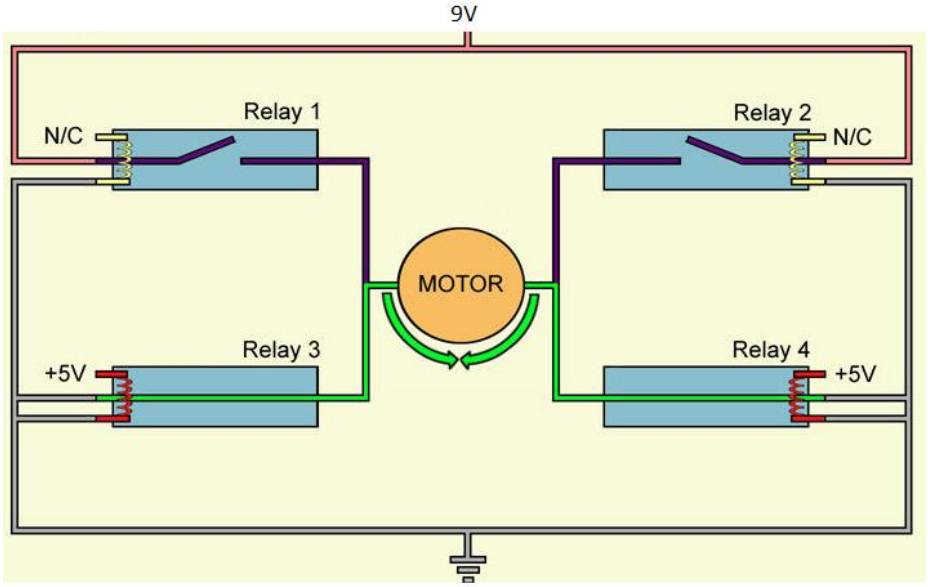

Figure 10: Relay 3 & 4 Pulled High

2.8 Bluetooth Module

In our project we have to connect the android mobile with Robotic vehicle. So Bluetooth module is required to do it. HC 06 is a slave Bluetooth to serial adapter. It measures a dimensions of only 28mm x 15 mm x 2.35mm.It is easy to handle and can be used as

wireless UART Communication from PC to any microcontroller. HC-06 is a slave only device. By default, HC-06 has Baud Rate of 9600 and Pairing Code of 1234.

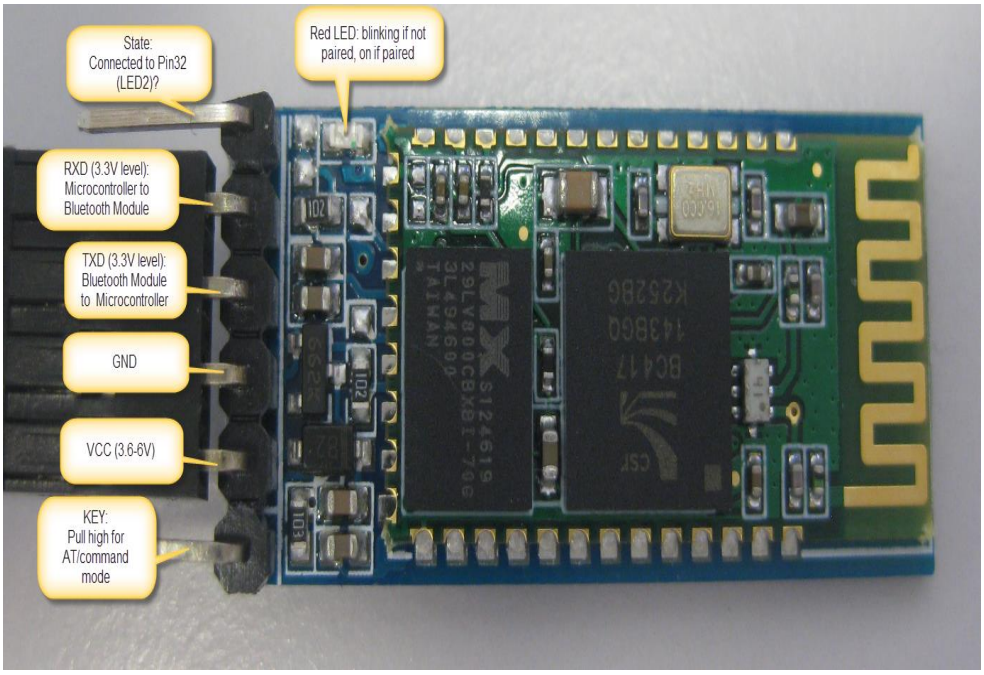

Figure 11: HC-06 Bluetooth Module

The module is shown above. Following are the pins of the module

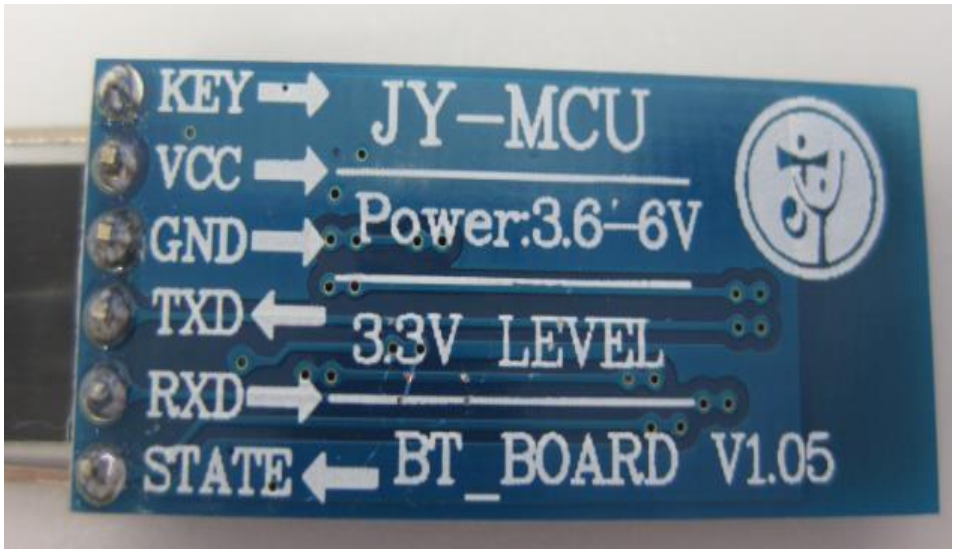

Figure 12: HC-06 Bluetooth Module Pins

There are four main pins of the module that are important. VCC, GND, TXD and RXD. Where VCC is indicated in the range of 3.6V-6V. The module worked for me both with 3.3V and 5V. GND is Ground. TXD is serial output of the module, to be connected to RX of the microcontroller. Note that this signal is using 3.3V logic level. RXD is serial input of the module, to be connected to the TX of the microcontroller. Note that this signal is using 3.3V logic levels.

2.9 Android Application

An android application is needed for the connection of Android Bluetooth with the Bluetooth module in the robotic vehicle. With the help of these applications the movement of robot can be controlled by Android device. Android application act as a remote control for the movement of the robot whether its forward, backward, left or right. With Bluetooth module having a pairing code of 1234 as in HC-06. It will find the Bluetooth module and by entering the pairing code device will be connected to the robotic vehicle.

Figure 13: Arduino Robot Control Application

2.10 RF Transmitter

An RF module (radio frequency module) is a small electronic device used to transmit and/or receive radio signals between two devices. In this project RF transmitter is required to provide the live video streaming at the backend. The output coming from the camera attached on the front of the robotic vehicle is fed into the RF transmitter module. It is displayed at the back end where there is a receiver.

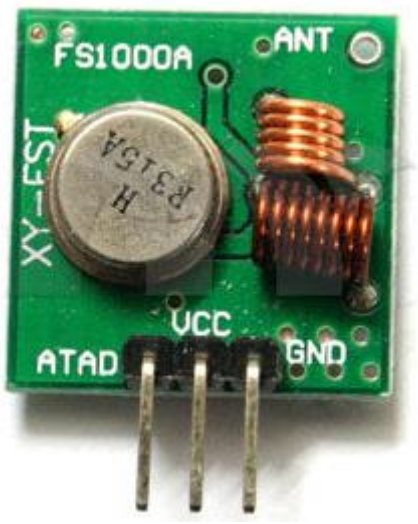

Figure 14: RF Transmittor Module

So there are 4 pins that are Ground, Data, VCC and Antenna. Data pin is for the serial data input.

2.11 CAMERA

A camera is the one which gives live video streaming at backend. By this the live video of the place will be seen easily and movement of robot will be adjusted according to that. There can be any obstacle that can come and my provide difficulty of controlling the vehicle so camera interfaced will be providing the live video streaming at the back end so that it is easy for the movement of the robot.

The output of the camera is connected to the RF transmitter module and that signal is detected by RF receiver or any receiver device.

Figure 15: Camera

CHAPTER 3

DESIGN AND DEVELOPMENT

3.1 Design summary

The following figure shows the overview of the project which is being carried out

We have any android device that this via Bluetooth module is interfaced with Arduino Nano. Then again there are motor drivers that are basically relays that are interfaced with it. When command is send to the Arduino it further sends the command to the motor drivers and motors move forward, backward, left or right.

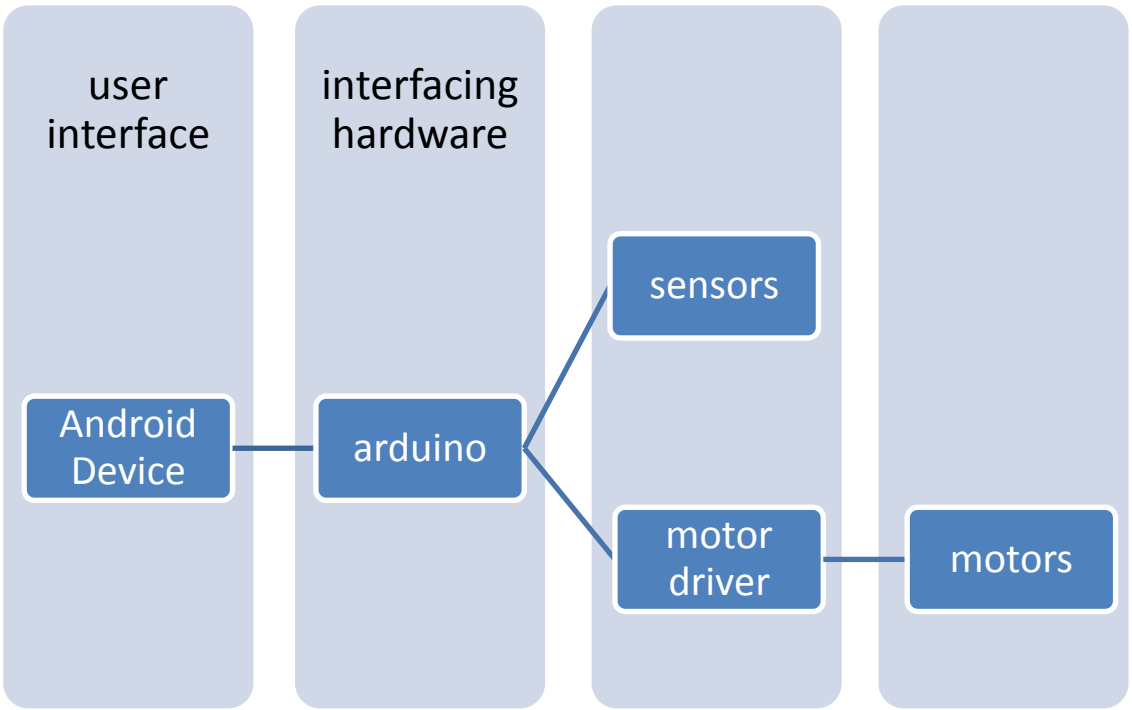

Figure 16: Design Summary

The figure bellows shows the block diagram of the whole project the components involved in the project and how they are connected.

3.1.1 Block Diagram

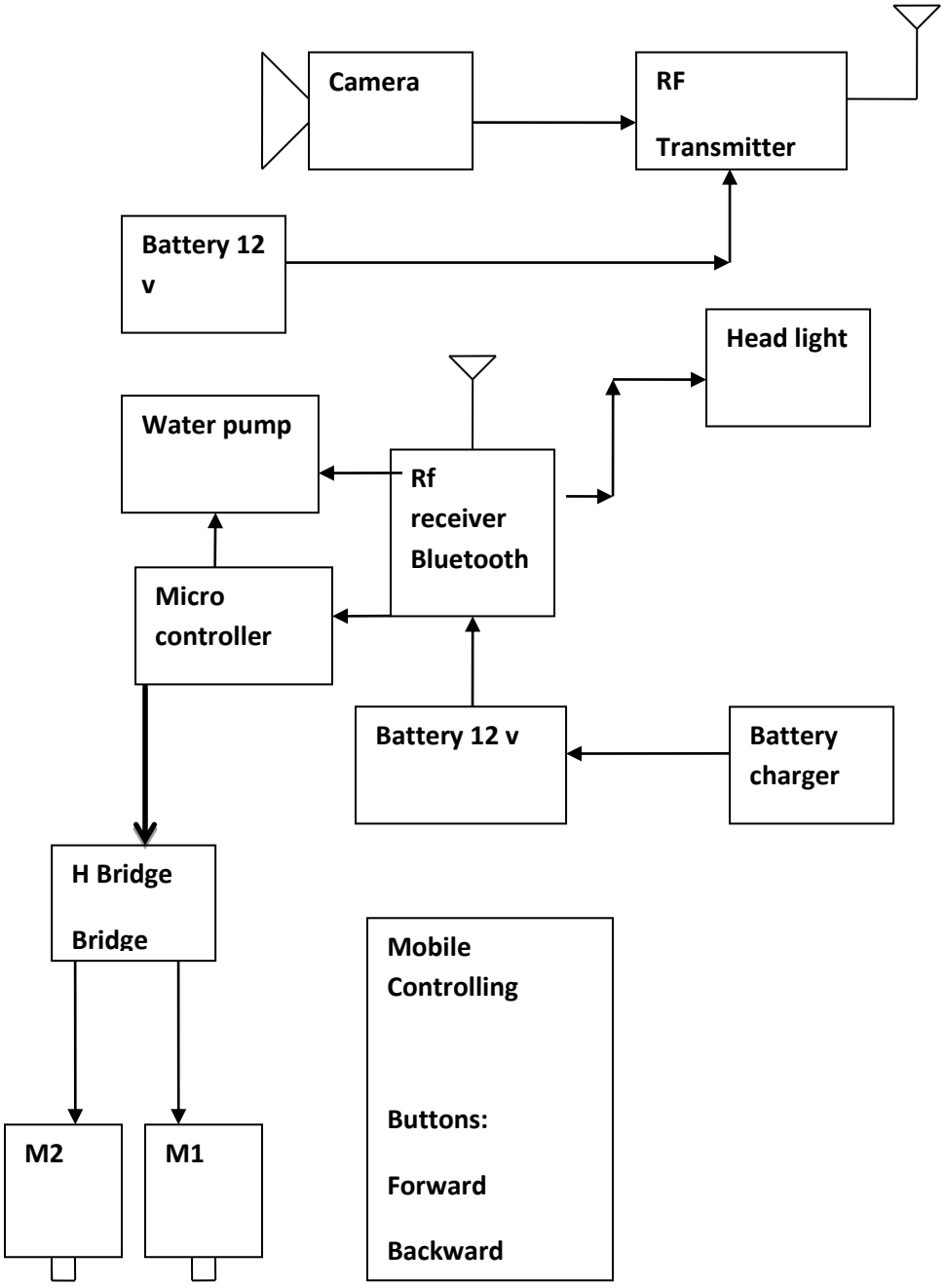

Figure 17: Block Diagram

3.2 Mechanical part

Chassis

The first thing to do is to assemble the chassis. The chassis is a robotic kit that is beginning step for the fire fighter robot. It contains the plate as well as motors. So we have to assemble all the robotic parts to make a chassis. The specifications are displayed in the table 1.

Specifications

Dimensions
27.7 x 16.3 x 5.6 cm
Operating Voltage
3V to 6V DC
Plate Quality
Acrylic material with mounting holes
Weight
0.5 kg
One Torque Force
0.8 KG to 1 KG

Table 1: Chassis specifications

The following figures show the building of chassis. This chassis help in the flexibility of the project and rapid movement of the robot on the floor. There are some holes that are already mounted on it so that different hardware modules may be added. There are two layers of this chassis which is required for this project so that in the lower layer than can be modules installed and in the upper layer water bottle and pump systems may be installed.

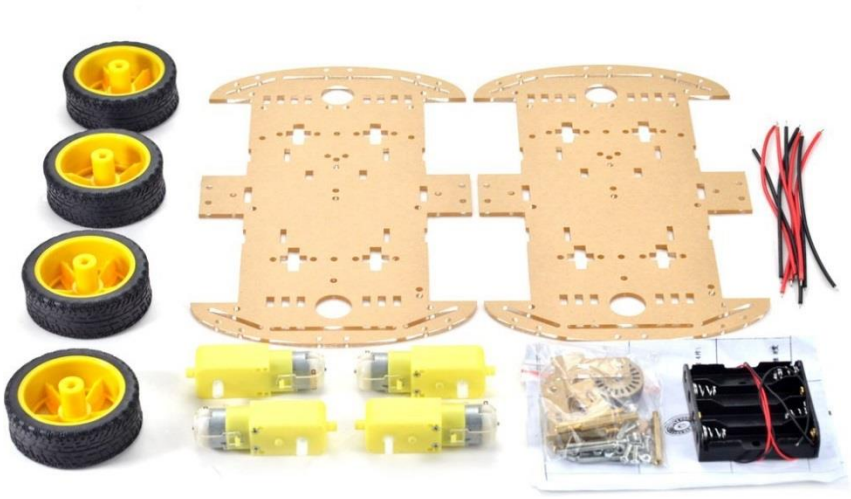

Figure 18: Robotic Kit

There we rubber tires which were used which have good grip and stability.

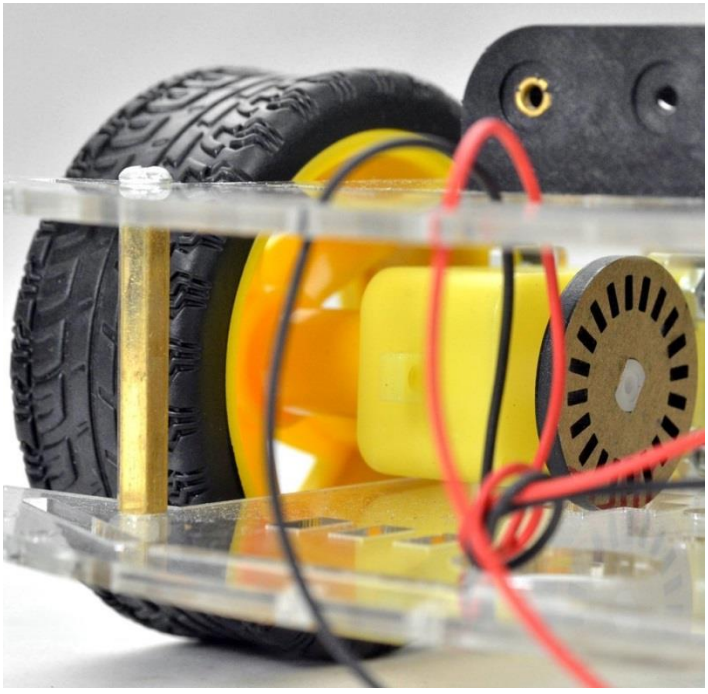

Figure 19: Assembling Tires & Motors

The final look of the assembled kit is shown below.

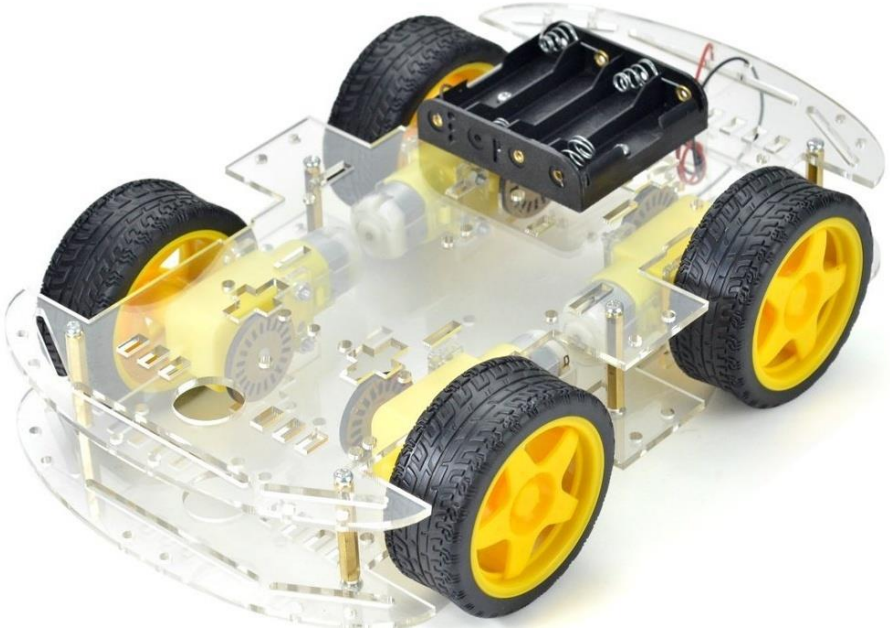

Figure 20: Assembled Chassis

Motors

Motors we used in this project is DC motors. Since the Arduino board can supply only 5v which is insufficient for driving motor, motor driver is used.

With the help of motor driver, clockwise and anticlockwise rotation of motor can be easily achieved Since this robot needs to carry a fire extinguisher, dc gear motor having enough torque must be selected. We used metallic gear motor with 60rpm, having 10-12kg/cm torque.

Figure 21: DC Motor

Principle

It is based on the principle that when a current-carrying conductor is placed in a magnetic field, it experiences a mechanical force whose direction is given by Fleming's Left-hand rule and whose magnitude is given by

Force, F = B I l Newton

Where B is the magnetic field in weber/m^2.

I is the current in amperes and

L is the length of the coil in meter.

Construction and Working

Its construction is based on the following

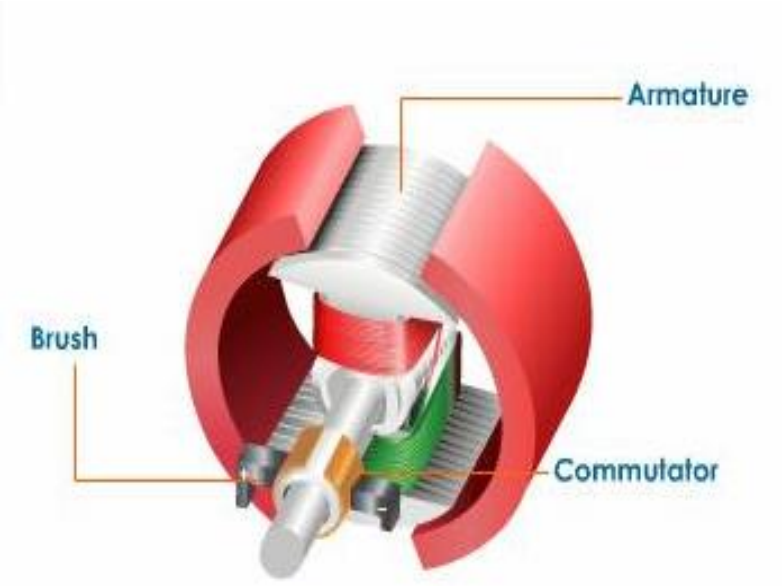

Figure 22: DC Motor Construction

Armature

A D.C. motor consists of a rectangular coil made of insulated copper wire wound on a soft iron core. This coil wound on the soft iron core forms the armature. The coil is mounted on an axle and is placed between the cylindrical concave poles of a magnet.

Commutator

A commutator is used to reverse the direction of flow of current. Commutator is a copper ring split into two parts C_1 and C_2. The split rings are insulated from each other and mounted on the axle of the motor. The two ends of the coil are soldered to these rings. They rotate along with the coil. Commutator rings are connected to a battery. The wires from the battery are not connected to the rings but to the brushes which are in contact with the rings.

Brushes

Two small strips of carbon, known as brushes press slightly against the two split rings, and the split rings rotate between the brushes.

The carbon brushes are connected to a D.C. source.

Working of a DC Motor

When the coil is powered, a magnetic field is generated around the armature. The left side of the armature is pushed away from the left magnet and drawn towards the right, causing rotation.

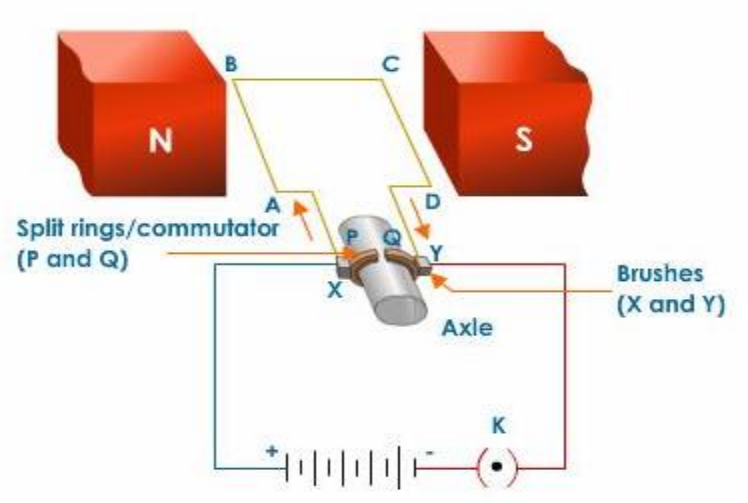

Figure 23: Working of DC Motor

When the coil turns through 90^0, the brushes lose contact with the commutator and the current stops flowing through the coil. However the coil keeps turning because of its own momentum.

Now when the coil turns through 180^0, the sides get interchanged. As a result the commutator ring C_1 is now in contact with brush B_2 and commutator ring C_2 is in contact with brush B_1. Therefore, the current continues to flow in the same direction.

3.3 Software part

After the assembling of the chassis there was the development of software parts. Before implementing it on the hardware it is necessary to run on software first.

Coding Part

The code for the movement of the motors of the robots was written in the Arduino software. The code is shown in the appendix A of the thesis. There was code for the four movements and also for the movement of the camera. The commands were forward, backward, left and right. Moreover there was also a code for the movement of the camera so that its position may be adjusted accordingly. The height of the camera was set with this.

Live Wire

The circuits for the H Bridge and motor movements were tested on the Live Wire. The H-Bridge that we use comprised of group of relays and switches. The following circuits were implemented in Live Wire. First is the circuit showing the running of the motors

And the next one is the implementation of H-bridge circuit. There are relays which were used for the project. For the running of the motors four relays were used and there was switching between them. By pressing one switch will turn on the respective motor and it will start rotating.

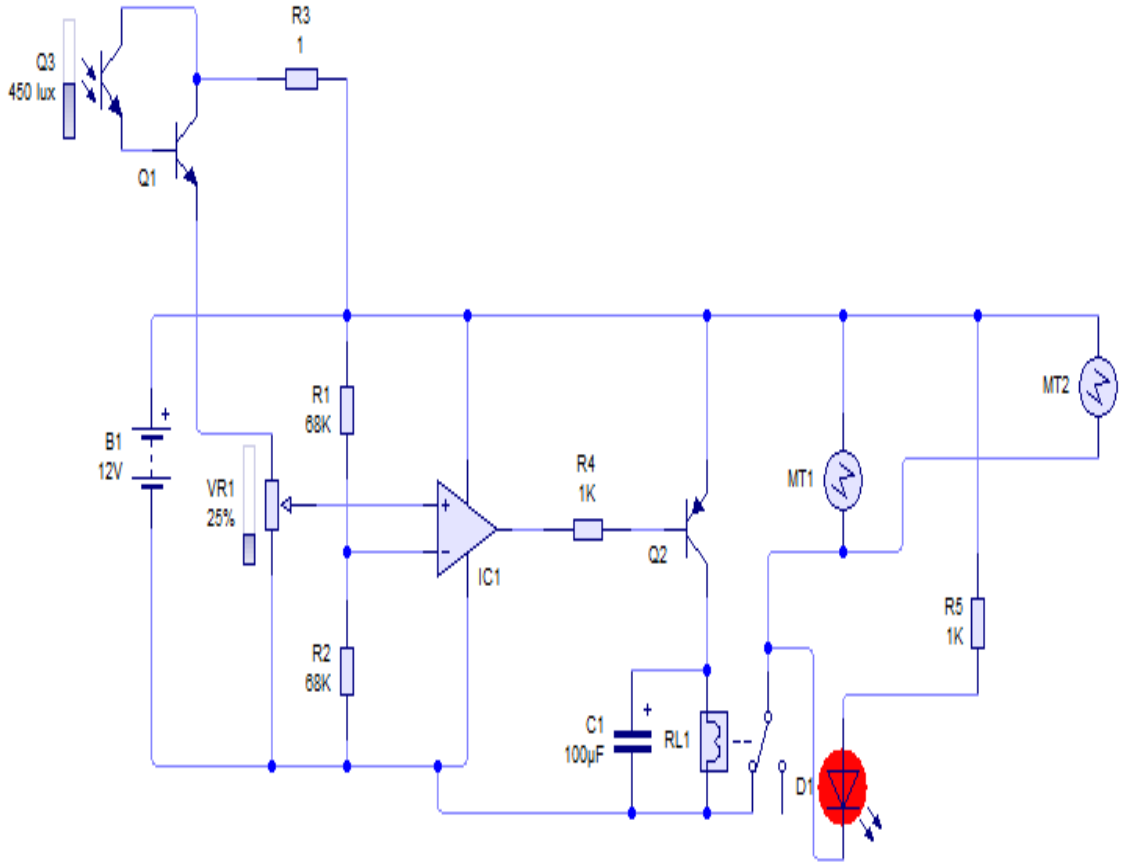

Figure 24: Running of Motors in Live Wire

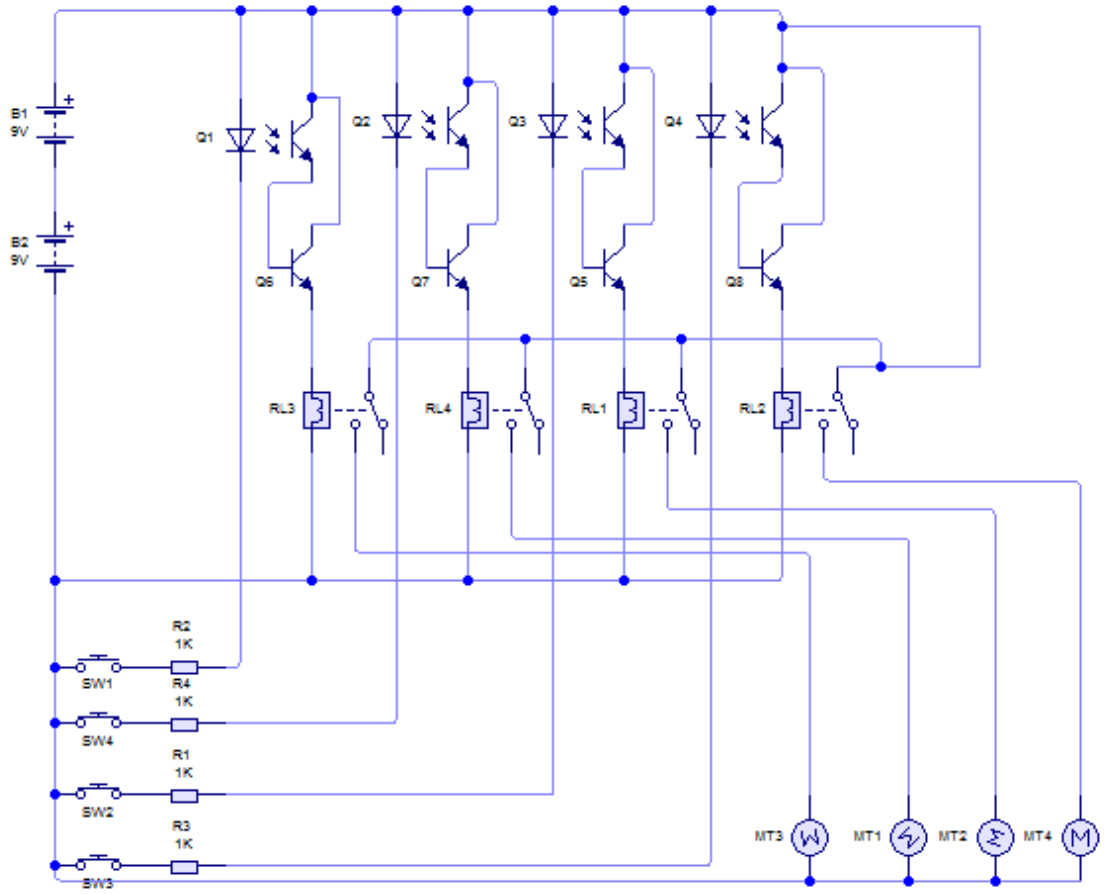

Figure 25: H-Bridge Implementation on Live Wire

3.4 Electrical part

Arduino Board:

There was a code that was written for the Arduino. After that there was interfacing of the Bluetooth module with the Arduino board.

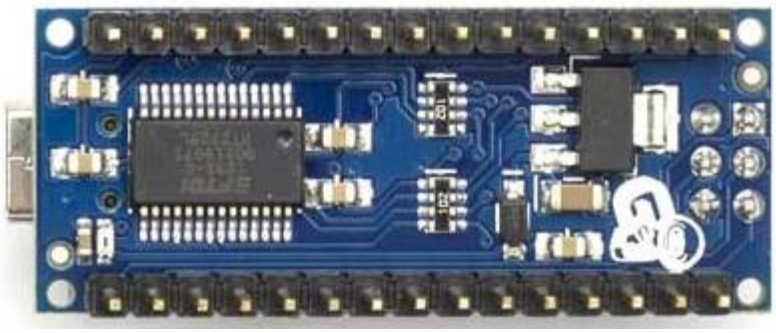

Figure 26: Arduino Board

Specification

Microcontroller	Atmel ATmega168 or ATmega328
Operating Voltage	5V recommended 7-12V
Input Voltage limit	DC-20V
Digital I/O Pins	14
Analog Input Pins	8
Flash Memory	16 KB
SRAM	1KB
EEPROM	512 Bytes
Clock Speed	16 MHz
Dimensions	0.73" x 1.70"
Length	45mm
Width	18mm
Weight	5g

Table 2: Arduino Nano specifications

Function

Arduino is used to provide interfacing between Arduino and bluetooth module.

There are pins of HC-06 module that is connected with the pins of Arduino board for the connection.

Bluetooth Module

Specifications :

Dimensions	28mm x 15 mm x 2.35mm
Baud Rate	9600
Pairing Code	1234

Table 3: Bluetooth Module Specifications

The HC-06 Module communicates with the Arduino Uno via serial connection. Four pins are used which are

VCC is used to power the module. It is connected to the Arduino 5v pin.

GND is the ground pin. It is connected to the Arduino Ground pin.

TXD is used to send data from the module to the Arduino. It is connected to the serial receive pin (RX) of the Arduino, which is pin 0 in case of the Nano. Incase different Arduino board is used, and then its schematics has to be checked in order to make sure that the right pins are used.

RXD is used to receive data from the Arduino. It is connected to the Arduino serial transmit pin (TX), which is pin 1 of ArduinoNano.

Code

The code is shown below

```
void setup ()

{
```

```
Serial.begin(9600);//set the baud rate

Serial.println("start");//send data to the android phone

}

void loop()

{

Serial.println("Hiii, Android");// send data to the android phone

delay(10000)

}
```

The interfacing of HC-06 module and Arduino is shown below

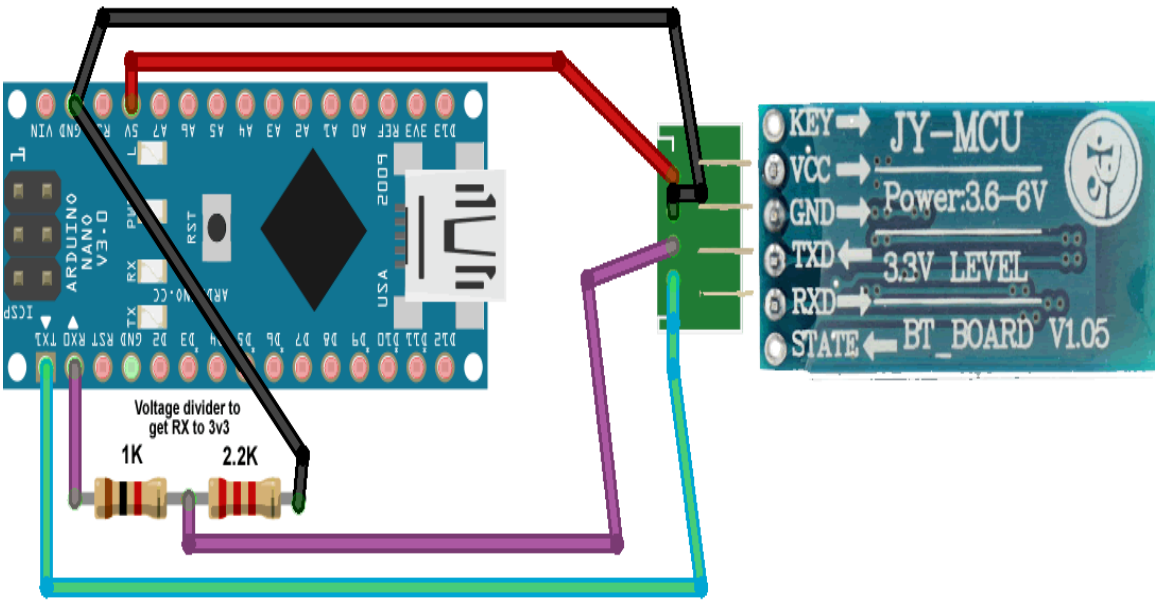

Figure 27: Interfacing of HC-06 with Arduino

Camera Installation

For the live video streaming a camera is needed so as to display the whole picture are the back end. The camera which we used is shown below. It is having three wires which are indicating ground, VCC and Video input. The front of the camera from where focus level of the camera can be adjusted.

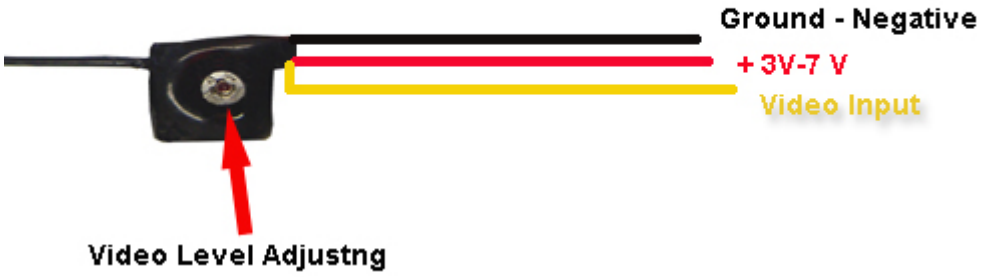

Figure 28: Camera

The camera which we are using in this project is CCD camera which has better performance than CMOS cameras. CCD is a sensor method in the camera which stands for charged coupled device.

Specifications

Image Sensor	1/3 inch CCD
Total Pixels	795 x 595
Power	12 V/ 120 mA
Lens	3,6,8 mm
Weight	60 g

Table 4: CCD Camera Specifications

Working

A CCD, or charged coupled device, is a device used in digital photography that converts an optical image into electrical signal. CCD chips can detect faint amounts of light and are capable of producing high resolution images. In theory, CCDs are linear-producing accurate images, transmitting the value they detect in a 1:1 ratio.

The CCD is a special integrated circuit consisting of a flat, two dimensional array of small light detectors referred to as pixels. The CCD chip is an array of Metal-Oxide-Semiconductor capacitors (MOS capacitors), each capacitor represents a pixel. Each pixel acts like a bucket for electrons. A CCD chip acquires data as light or electrical charge. During an exposure, each pixel fills up with electrons in proportion to the amount of light that enters it.

The CCD takes this optical or electronic input and converts it into an electronic signal. The electronic signal is then processed by some other equipment and/or software to either produce an image or to give the user valuable information.

The following connections are made for connecting camera with RF transmittor. The video input is connected at the data pin of the RF transmitter.

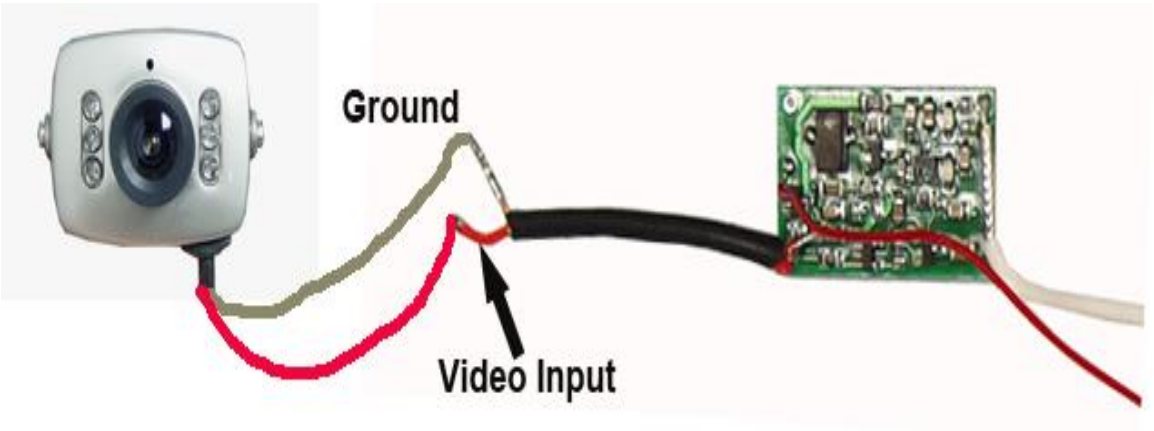

Figure 29: Camera Connection with RF Transmitter

Flame Sensor and Water Pump

Arduino flame sensor is being used for this project. It detects the IR radiations then LED light up which indicates the detection of a flame or IR radiations.

Specifications

Voltage	5V
Dimensions	3.0 cm x 1.5 cm x 0.5 cm
Weight	8g
IR wavelength	760 nm ~ 1100 nm

Table 5: Flame Sensor Specifications

Working

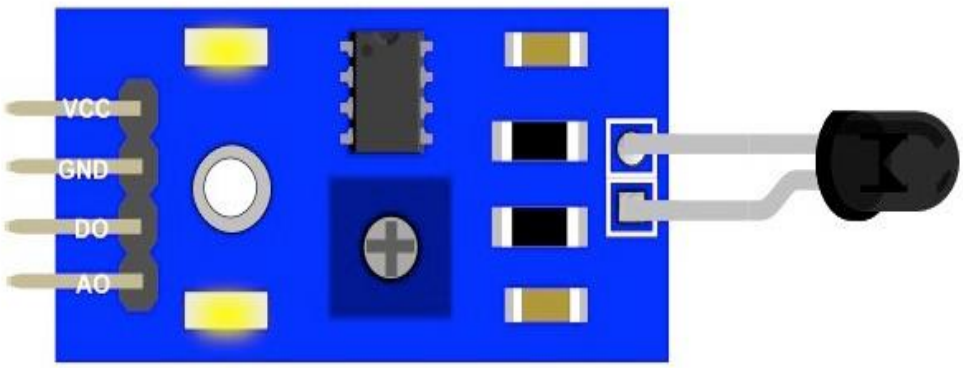

Figure 30: Arduino Flame Sensor

In order to show the working of the sensor connect the sensor to 5V voltage and connect the ground terminal. When flame will come near to the IR then D0 light will be generated. As DO is the output switch either 0 or 1 and AO is the Analog voltage output. By AO we will be generating the output voltage.

So when it will sense the flame there will be LED the will be glowing. Moreover the voltage signal will be generated which will be appeared at terminal A0 of the flame sensor.

There is a water pump that is installed in the robotic kit. When it will get the signal from the sensor it will start throwing water on it as long as the flame is present and is being detected by the sensor. So along with throwing the water it will also start fan which is located just beside the water spray. Flame sensor has sensitivity that can be controlled by potentiometer.

So both fan and water spray will help to extinguish the flames. When IR sensor will not detect any flame then not water will be sprayed and no fan is turned on. It will only be possible when there is some flame present around the robot. The sensor has 3 feet long sensing of any IR radiations.

The water is sprayed from a water bottle fully filled through a spray nozzle. All the running of fan and spraying of water are dependent of the flame sensor. When it will detect the flame and when a voltage signal will come at the analog output A0 then it will start the extinguishing process.

There is a comparator that is present in the flame sensor module. It measures voltages at two different points and compares the difference in quantity of voltage. If the first point has a higher voltage than the second point, the switch is turned on. However, if the first point has a lower voltage than the second point, the switch is turned off.

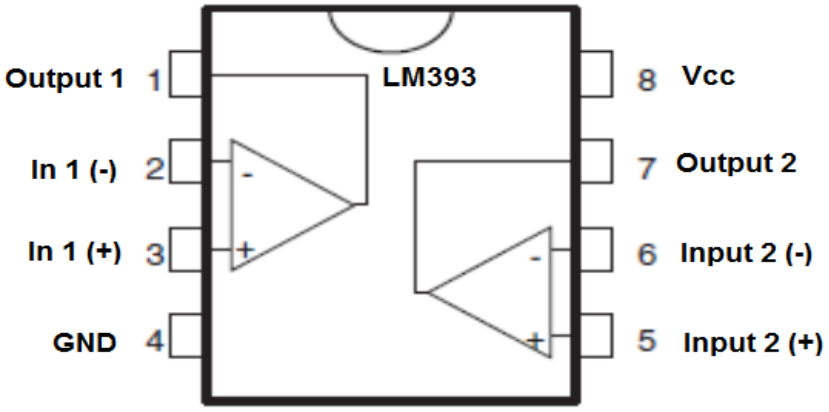

Figure 31: LM 393 IC

LM393 stands for “Low Power, Low Offset Voltage, Single Supply, Dual, and Differential Comparators. Where Low Power is an indication that the chip uses little electricity. This can be very useful for a robot that runs on low voltage batteries. Low Offset Voltage is an indication that the chip can compare voltages of points that are very close together. Single Supply is an indication that the chip uses the same power supply as the points being compared and Dual is an indication that there are two comparators in the chip. Differential is an indication that the chip is comparing the amount of voltage of each point to each other.

CHAPTER 4

PROJECT DEVELOPMENT

4.1 Robotic kit

The following robotic kit was developed first and after that hardware modules are installed on it. There was some extra material that was added on to the body of the robot to install camera and extinguishing system on it. The water bottle and extinguishing system were installed on the top of the vehicle where as other hardware modules were installed at the bottom of the robotic vehicle. Extra plates were added for the stability of the robot and to provide easy connections.

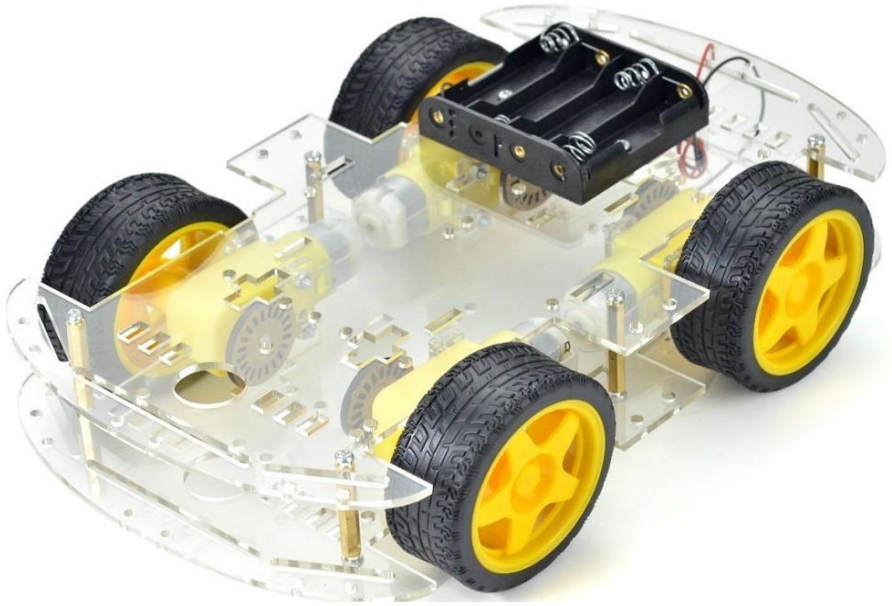

Figure 32: Robotic Kit

4.2 Robotic Vehicle

The final shape of the robot looks like this as shown in the figure. Camera is installed at the highest point so as to give to proper live video streaming at the back end. More the

fan is also adjusted in a position such that It is closer to the flame and can extinguish the flame quickly one it has been detected.

Figure 33: Robotic Vehicle

4.3 Testing

Testing is being done on the robot. We had an android Application which is Arduino Robot Control. The Bluetooth module and Arduino was turned on. The application searched the Bluetooth device nearby and found the HC-06 module. It first got paired with it by entering the pairing code of 1234 which is the pairing code of HC-06 module.

Once it got connected the commands on the mobile were making it to move forward, backward, left and right. Here we checked the movement of the robot, its stability and its speed. The range of Bluetooth was also checked and it got a good range of 10 m while testing. Next was the checking of the functioning of the sensor and its working in all conditions and the live video streaming.

Figure 34: Testing Robot

The functioning of the sensor was tested initially with the small flame. We we move the flame closes to the Sensor the water started spraying and fan also started running. They keep on running unless the flame is extinguished. Live video streaming is being shown at the lCD device.

Figure 35: Flame Sensor & Video Streaming

4.4 Motor Driver

The H-bridge circuits were implemented and their PCB designs are shown. They are the combinations of relays. There were total of four relays that were used for the two motors. The design for one motor is shown below.

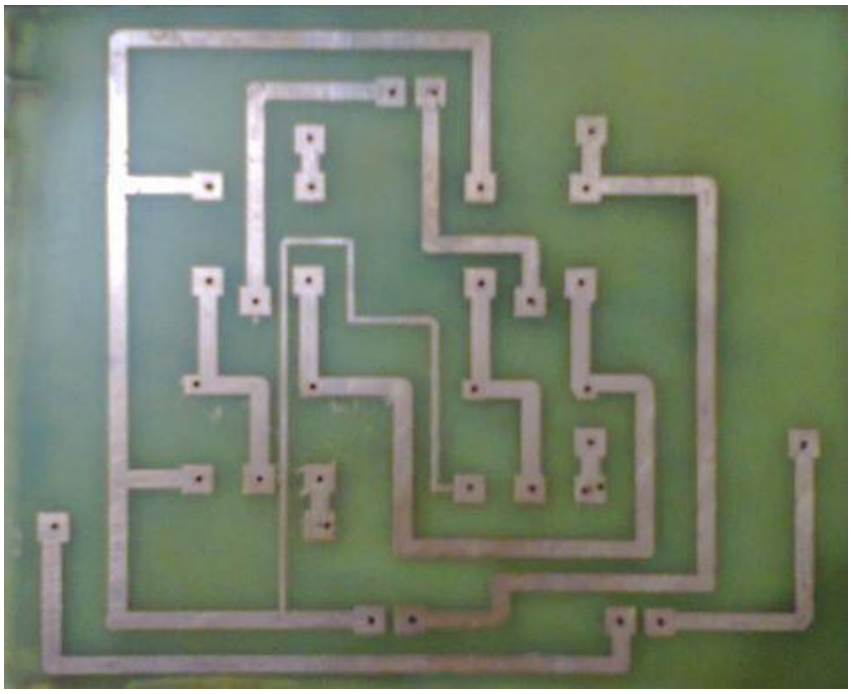

Figure 36: H-Bridge PCB Design

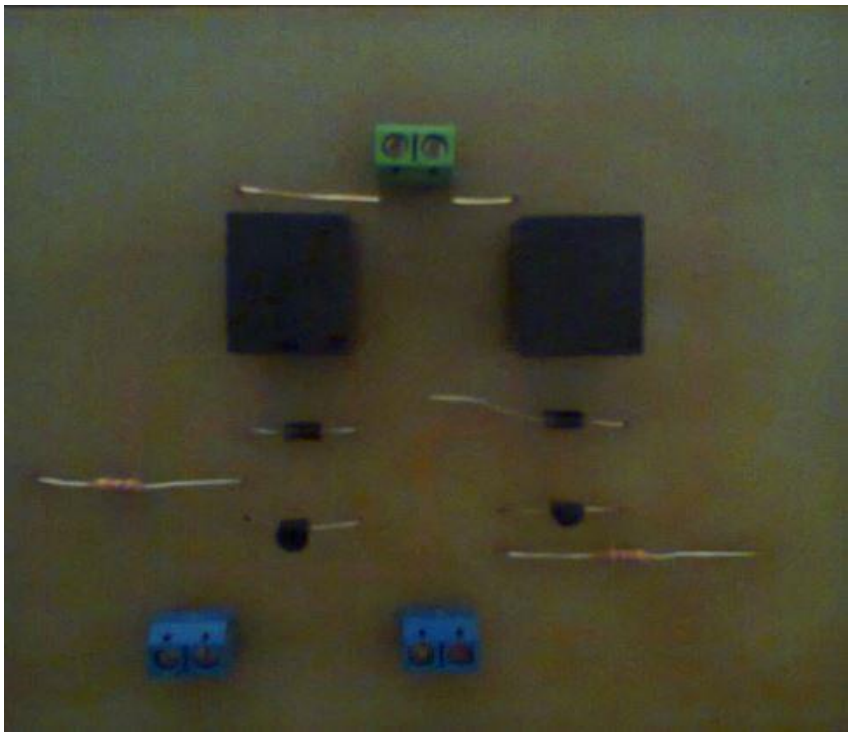

Figure 37: PCB Motor Driver

4.5 Flame Sensor

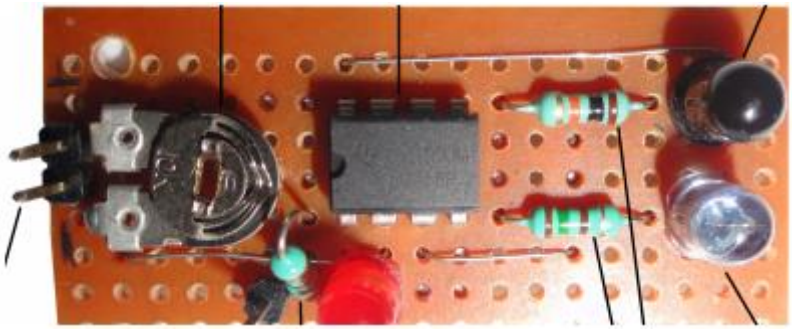

Figure 38: Flame Sensor on Vero Board

4.6 Faulty Works

The following figures are of faulty motor drivers. They were not etched properly and there were some design problems which are solved by redesigning the PCB.

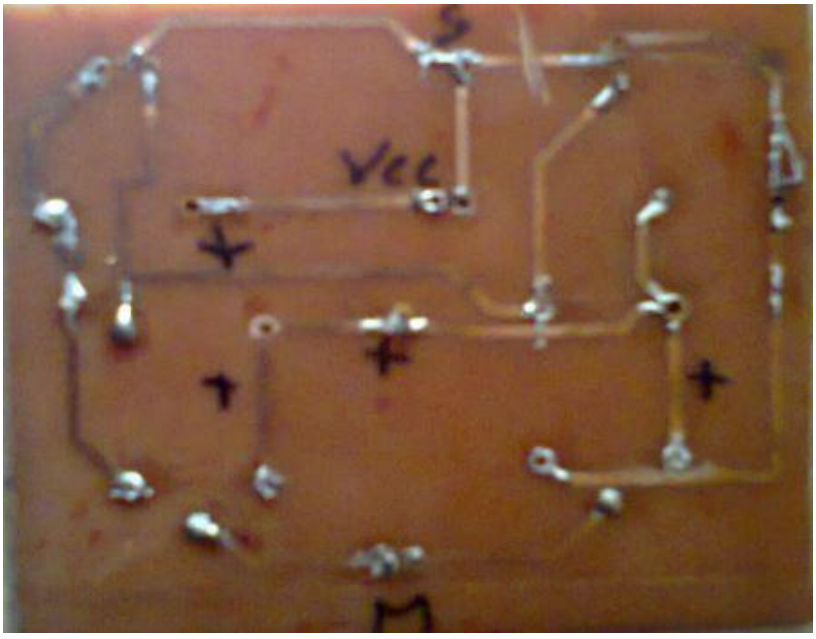

Figure 39: Improperly Designed

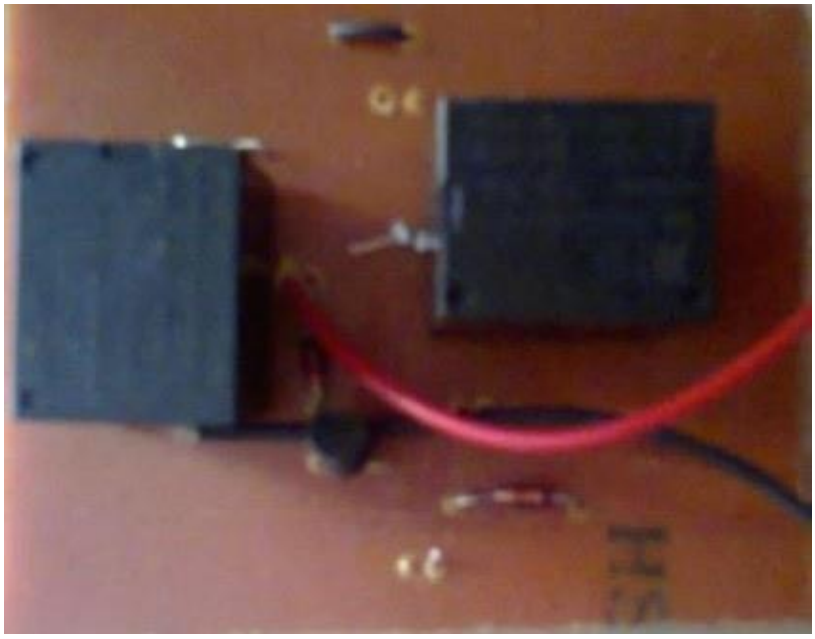

Figure 40: Improperly Designed

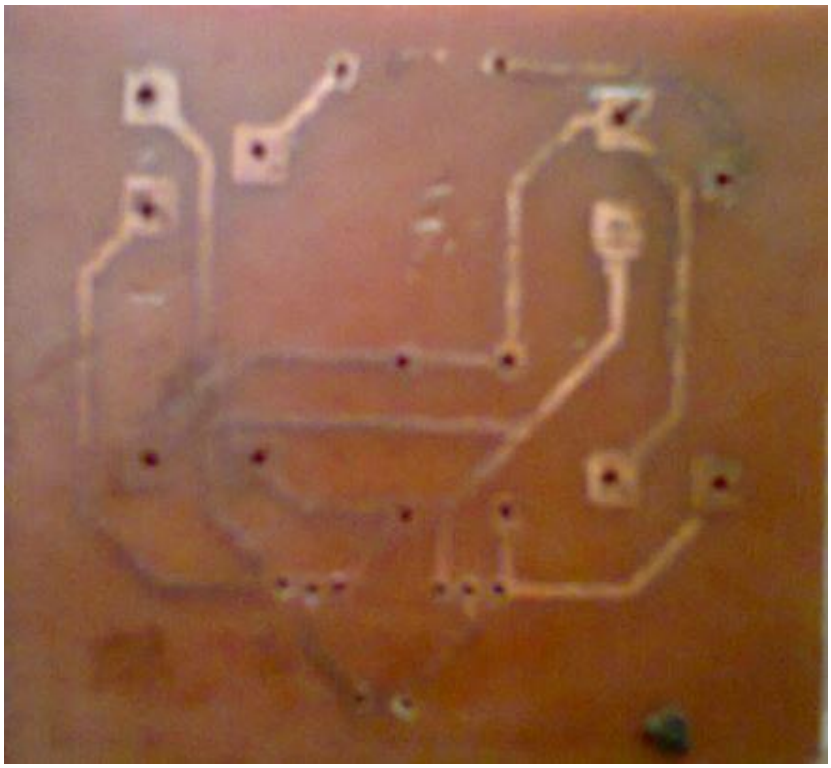

Figure 41: Improperly Etched

CHAPTER 5

RECOMMENDATIONS FOR FUTURE WORK

- Having this type of project is not only helpful for the individual but also the lives of the fire fighters can be saved with it.
- Here we have use the flame sensor module which will sense the flame and will automatically extinguish the fire. This project involved the use of android device as a remote control and its functions are operated by it
- In future more robotic vehicles like this can be made and implemented for any purposes that should be useful for the people and for the lives of the fire fighters with latest technology.
- Further Wifi can be used for the connection of android device with the robotic vehicle so as to increase the range.

CHAPTER 6

CONCLUSION

6.1 Overview

In conclusion, our approach of modular design strategy was a good solution in implementing the firefighting robot as it made it easier for individuals to work on their tasks independently.

The extensive use of Arduino ensured the integration step to be simpler. There were still some problems at integration step but they were solved easily because debugging can be done on each module. Therefore, our final model of the robot can successfully extinguish the fire after sensing.

Also, we managed to construct the robot comfortably within the budget of $200. Throughout the project, our technical knowledge was put to practical use and hence learnt many technical skills. With this we learnt many skills with the Arduino board also.

6.2 Objective Achieved

We have successfully designed and manufactured the robotic vehicle controlled by android device.

We have successfully interfaced Arduino with our Bluetooth module for the movement of the robot.

We have designed, simulated and fabricated the motor drivers and infrared sensors.

CHAPTER 7

BIBLIOGRAPHY

7.1 Previous Work Done

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[3] “Fire Protection Robot”, Viet Do, Ryan Norder, and Ryan Spraetz, Moscow.

[4] Microprocessor and Microcontroller, Second Edition, Department Of Computer Engineering, Faculty Electrical & Electronic Engineering, UniversityTunHussienOnn Malaysia (UTHM), Malaysia, 2008.

[5] Microcontroller Cookbook PIC & 8051, Second Edition, Mike James, Newnes, Reed Educational and Professional Publishing Ltd, Jordan Hill, Oxford, United Kingdom, 2001.

7.2 References

[1] Microcontrollers Theory and Applications, Ajay V Deshmukh, McGraw-Hill, Tata McGraw-hill Publishing Company Limited, New Delhi, 2005.

[2] Autonomous Robot Control Board Instruction Manual (SK40C), Cytron Technologies SdnBhd, Nov 2007.

[3] Designing Autonomous Mobile Robots, Elsevier Inc, John Holland, 2004

[4] Joga D. Setiawan, MochamadSubchan, and AgusBudiyono “Virtual Reality Simulation of Fire Fighting Robot. Dynamic and Motion.” ICIUS, October 24-26 2007.

[5] Gerald Weed, Michael Schumacher, Shawn McVay, Jack Landes “PPPPokey the Fire-Fighting Robot. A Logical Design Using Digital and Analog Circuitry”, May 11 1999.

[6 Chris Flesher, Devona Williams, Sean Benbrook, SomendraSreedhar “Fire Protection Robot.Final Report” p. 1-78, 2004. 50.

[7] Myles Durkin, Kevin McHugh, Ryan Ehid, Brian Lepus, Stephen Kropp “Firefighting Robot. A Proposal.” May 5 2008.

[8] Mountney, P.; Stoyanov, D. Davison, A. Yang, G-Z. (2006). "Simultaneous Stereoscope Localization and Soft-Tissue Mapping for Minimal Invasive Surgery". MICCAI 1: 347–354. 6doi:10.1007/11866565_43.

[9] Durrant-Whyte, H.; Bailey, T. (2006). "Simultaneous Localization and Mapping (SLAM): Part I The Essential Algorithms". Robotics and Automation Magazine 13 (2): 99–110. doi:10.1109/MRA.2006.1638022.

APPENDICES

APPENDIX-A

The code is shown below for the movement of the robot via android device

```
#include <Wire.h>
#include <math.h>

#define forward 4
#define backward 5
#define left 6
#define right 7
void setup(){
  Serial.begin(9600); // Bluetooth Baudrate

  pinMode(forward, OUTPUT);
  pinMode(backward, OUTPUT);
  pinMode(left, OUTPUT);
  pinMode(right, OUTPUT);
  /*
digitalWrite(forward,HIGH);
digitalWrite(backward,HIGH);
digitalWrite(left,HIGH);
digitalWrite(right,HIGH);

delay(1000);
*/
digitalWrite(forward,LOW);
digitalWrite(backward,LOW);
```

```
digitalWrite(left,LOW);
digitalWrite(right,LOW);

while (!Serial) {
    ; // wait for serial port to connect.
  }
}// void setup()
  int i = 0;
void loop(){

  if (Serial.available()) {
    processInput();
  }
  delay(100);
}// void loop()



voidprocessInput (){
  byte c = Serial.read ();
  switch (c)
  {
  case 'f': // Go FORWARD
    go_Forward();
    break;

  case 'b': // Go BACK
    go_Backward();
    break;

  case 'r':
    turn_Right();
```

```
    //Serial.write("right");
    break;

  case 'l':
    turn_Left();
    //Serial.write("left");
    break;

  case 's':
    stop_Robot();
    break;

  case 'e'://bottom right
    bottom_right();
    break;
  case 'c'://top right
    top_right();
    break;

  case 'd'://top left
    top_left();
    break;

  case 'h'://bottom left
    bottom_left();
    break;

  } // end of switch
}  // end of processInput
```

```
voidstop_Robot()
{
  digitalWrite(forward,LOW);
  digitalWrite(backward,LOW);
  digitalWrite(left,LOW);
  digitalWrite(right,LOW);
}

voidgo_Forward()
{
  digitalWrite(backward,LOW);
  digitalWrite(left,LOW);
  digitalWrite(right,LOW);
  digitalWrite(forward,HIGH);
}
voidgo_Backward()
{
  digitalWrite(forward,LOW);
  digitalWrite(left,LOW);
  digitalWrite(right,LOW);

  digitalWrite(backward,HIGH);

}
voidturn_Left()
{
  digitalWrite(forward,LOW);
  digitalWrite(backward,LOW);
  digitalWrite(right,LOW);

  digitalWrite(left,HIGH);
```

```
}
voidturn_Right()
{
  digitalWrite(forward,LOW);
  digitalWrite(backward,LOW);
  digitalWrite(left,LOW);

  digitalWrite(right,HIGH);

}
voidbottom_right()
{
  digitalWrite(forward,LOW);
  digitalWrite(left,LOW);

  digitalWrite(backward,HIGH);
  digitalWrite(right,HIGH);

}
voidbottom_left()
{
  digitalWrite(forward,LOW);
  digitalWrite(right,LOW);

  digitalWrite(backward,HIGH);
  digitalWrite(left,HIGH);

}
voidtop_left()
{
```

```
  digitalWrite(backward,LOW);
  digitalWrite(right,LOW);

  digitalWrite(forward,HIGH);
  digitalWrite(left,HIGH);

}
voidtop_right()
{
  digitalWrite(backward,LOW);
  digitalWrite(left,LOW);

  digitalWrite(forward,HIGH);
  digitalWrite(right,HIGH);

}

//-----------------
```

APPENDIX-B

FIRE FIGHTER ROBOT

Extended Title: Wirelessly Controlled Fire Fighter Robot Based on Android Technology
Brief Description of The Project / Thesis with Salient Specs: This project ensures a construction of Wireless Controlled Fire Fighting Robot whose movement can be controlled using an android application from smart phone within a given parameter with live video streaming.
Scope of Work: This project has large scope as it can be used commercially. Human loss will be reduced and the lives of fire fighters can be saved.
Academic Objectives: The main goal of the project is the proof of concept. This project implements the use of image processing and the concepts of wireless communication. The focus is on fire sensing and fire fighting mechanisms.
Application / End Goal Objectives: The practical application domains where robotic technology is most likely to be used are Civil defence Search and rescue, Fire fighting Domestic services like cleaning , arranging Security/surveillance patrol, observation.
Previous Work Done on The Subject: Previously it was used to extinguish the candle flame using suitable sensors technology. This is wirelessly controlled using a smart phone. http://engineering.pages.tcnj.edu/2013/02/26/automated-fire-fighting-robot/ , http://mechanical.poly.edu/academics/senior/sen98/robomouse/default.html , http://www.ecsel.psu.edu/users/avanzato/robots/contests/firefighting/
Material Resources Required: The project uses RF communication using microcontroller. Bluetooth module is used for controlling the robot via smart phone. Sensors are needed to detect the vicinity of the flame. Camera installed on the robot can give the live coverage of the place.
No of Students Required :4
Special Skills Required : Android Development on visual basic Proteus for simulation Microcontroller Programming

Approval Status:

Supervisor Name: Lt .Col Imran Tauqeer

Supervisor Signature:

Assigned to: GC Saad Saleem

GC Roheb Ali

GC Hanzla Liaqat Cheema

FC Fatehullah

HoD Signature: 31/3/2014.

Coordinator Signature: 1/4/14

APPENDIX-C

COST BREAKDOWN

Index	Equipment	Quantity	Unit price	Cost
1.	Motors(60 RPM)	4	4000	16000
2.	Motors(150 RPM)	2	1000	2000
3.	Arduino (nano)	1	3400	3400
4.	Fibre PCB	2	450	900
5.	Relays(12 V)	4	35	140
6.	Resistors	13	1	13
7.	Transistors	8	5	40
10.	Limit Switches	8	100	800
11.	Robotic kit(material)	1	2500	2500
12.	Bluetooth Module	1	1000	1000
13.	Camera	1	5000	5000
14.	Miscellaneous	1	4000	1000
15.	Printing	1	3000	3000
16.	Flame Sensor	1	1000	1000
17.	RF transmitter	1	500	500
	Total Cost			37293