Design and Construction of a Fire Fighter & Surveillance Robot

A Thesis

By

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SUBMITTED TO :

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Lecturer

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In partial fulfillment of the requirement for award of the degree

Of

Bachelor of Science in Mechanical Engineering

September.2023

LETTER OF TRANSMITTAL

September, 2023
To
Md. Istiaque Zahur
Lecturer
Department of Mechanical Engineering
Sonargaon University (SU)

Subject: Submission of Project Report.

Dear Sir,
We are pleased to submit the project report on**" Design and Construction of a Fire Fighter & Surveillance Robot".** It was a great pleasure to work on such an important topic. This project has been done as per instruction of your supervision and according to the requirements of the Sonargaon University.

We expect that the project will be accepted by the concerned authority we will remain happy to further explanation that you may feel necessary in this regard.

Thank You
Sincerely yours,

Md. Sultanul Arefin Alif
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DECLARATION

We done hereby solemnly declare that, the work presented here in this project report has been carried out by us and has not been previously submitted to any university/ Organization for award of any degree or certificate.

We hereby ensure that the works that has been prevented here does not breach any existing copyright.

We further undertake to indemnify the university against any loss or damage arising from breach of the foregoing obligation.

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Abstract

Fire incident is a disaster that can be the reason of loss of life, property damage and permanent disability the affected victim. Human can also suffer from prolonged psychological trauma. We declare our Design and Construction of Fire Fighter & Surveillance Robot. Fire incidents, are often exposed to higher risks when extinguishing fire, especially in hazardous environments, such as in petroleum refineries and gas tanks. Even a lot of precautions taken for accidents, man-made disasters do occur now and then. In the event of a fire breakout, to rescue people and to put out the fire, we are forced to use human resources which not safe. With the advancement of technology especially in Robot it gives very much response location of fire for fighting to fire. This would improve the efficiency of fire fighters and would also prevent them from risking their lives. In this work we have built a prototype robot using Arduino, which will automatically sense the fire and put off the fire. Flame sensor detect the fire and then start the water pump and servo motor. The locations of fire automatically detected and ability to extinguish fire remotely at particular distance of 20 cm from the fire. The robot is made for finding the location of fire and spray water into fire and reduce the amount of damage.

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Chapter 1

Introduction

1.1 Introduction

There are a variety of robotic systems being developed to support firefighters due to the wide range of fire events including fires involving structures, vehicles, aircrafts, ships, and wild lands. These robots which we used for detect and extinguish fire by means of various sensors. The use of robotic systems in firefighting is being increasingly studied due to firefighters routinely being exposed to dangerous conditions to save lives. A robotic system is a mechanical device that performs a task using sensors to perceive its environment, computer programs to control the robot based on its environment.

1.2 Background Information of the Study

Today, humanity can be classified as living in a "machine society" where technological tools are predominantly at different levels, interfacing in the day–to-day activity of man. These livelihood activities constitute and deliver economic, social and political benefits and potential risks to the survivability of nations –especially developing nations like ours. A robot is an automated device which performs functions usually attributed to humans or machines tasked with repetitive or flexible set of actions. Numerous studies have shown that robot can be beneficial in medicine, rehabilitation, rescue operation and industry. Over the years, robotics has been introduced in various industries. The industrial robots are multi-function manipulators designed for more specialized materials, divisions, gadgets or devices through various programmatic movements to perform various tasks. In line with the Fourth Industrial Revolution (4IR), there is demand for a one system that can control, communicate and integrate different robots regardless of their types and specifications. Machine learning has also heated up interest in robotics, although only a portion of recent development in robotics can be associated with machine learning. Recent robotic development project has embedded machine learning algorithms to increase the intelligence in robots. This will increase the productivity in industry while reducing the cost and electronic waste in a long run. Studies on the use of humanoid robots are actively

carried out to minimize firefighters' injuries and deaths as well as increasing productivity, safety, efficiency and quality of the task given. Robot can be divided into several groups such as Tele-robots, Tele presence robots, Mobile robots, and Autonomous robots and Androids robots. Tele presence robot is similar to a tale-Robot with the main difference of providing feedback from video, sound and other data. Hence, tale-presence robots are widely used in many fields requiring monitoring capability, such as in child nursery and education, and on improving older adult's social and daily activities. Mobile robot is designed to navigate and carry out tasks with the intervention of human beings. Meanwhile, autonomous robots can perform the task independently and receive the power from the environment, as opposed to android robots which are built to mimic humans. Additionally, having a compact size and automatic control also allows the robot to be used when fire occurs in small and narrow spaces with hazardous environments such as tunnels or nuclear power plants. Termite and Fire Rob are two current available fire fighter robots that have been used widely in industry. This robot is designed for use in extreme danger areas, such as planes fires, processing factories, chemical plants or nuclear reactors. Fire Robot is a fire-fighting vehicle controlled by a single operator. In this study, a compact and small firefighter robot has been developed. This robot is named robot, which is short form of Rescue Robot. This robot can evade obstacles, search and extinguish fire. Furthermore, this robot can increase the productivity, safety, efficiency and quality of the task given. Robot is more compact and more flexible compared to Termite and Fire Rob robot. Another advantage of robot is in its ability to enter location with small entrance or narrow space.

1.3 Statement of the Problem

The Bangladesh environment is considered to be hazards prone brought about by man-made and natural disasters due to its geographic circumstance which is exposed to catastrophic, floods droughts and fires. Based on the reports; devastations of these natural hazards and Disasters including fires have increased in recent years. Our lifestyle of negligence and adapting to emerging technological solutions puts us at the risk of loss to fire and related occurrences as seen in markets, homes and other public places. The risk of fire occurrence is high especially during the dry season, Christmas and New Year celebration due to firecrackers. In the case where house fires are prevalent, it has effect to

derail the economic growth, destroy social and physical capital including infrastructures, which resort to reallocation of ongoing programs to finance relief operations to fatalities and inhabitants and reconstruction efforts which diverts funds to social services. Fires are considered natural and manmade hazards. In fire prevention and fire suppression; it requires the adoption of uniform fire safety standards, the incorporation of fire safety, construction and provision of protective and safety devices in buildings and structures.

1.4 Objectives

The main purpose of these project is to design a Design and Construction of Fire Fighter & Surveillance Robot that can mitigate the loss of life with maximum efficiency. Our fundamental goal was to design and manufacture an electromechanical robot that would be able to locate and extinguish a flame. So there are some burning objective for these project, they are:

- To study Fire Fighter & Surveillance Robot.
- To design a Fire Protection system.
- To express the accuracy of the robot.
- To send SMS with live location.

Chapter 2

Literature Review

2.1 Introduction to Fire and Fighter Robot

Fire is a self-sustaining, chemical chain reaction with varying degrees of light and heat. Temperature and smoke sensing alert system is motivated to sense the temperature and smoke and send the alert in an intelligent fashion in case of emergency situation due to fire blow.

- Fuel
- Oxygen
- Heat
- Chemical Chain Reaction

By removing one of these four components the fire will go out. Fire extinguishers are designed to do just that.

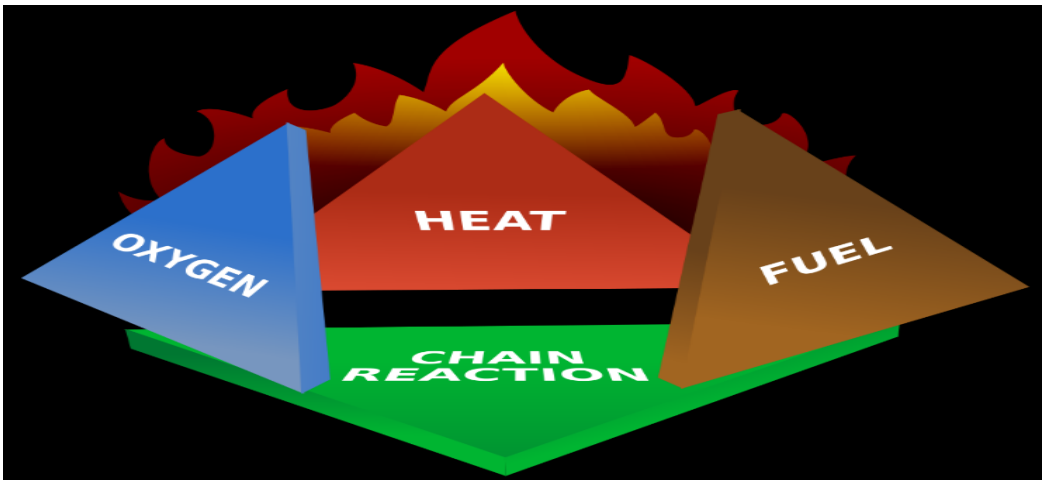

Figure 2.1: Fire Tetrahedron

A firefighting robot used primarily to evacuate the premises in the event of occurrence of a fire condition and then secondarily to extinguish the fire.

2.2 Types of Fire Extinguishers

Labeling on the fire extinguisher identifies which class of fire it is appropriate for; Class A, B, C, D or K and instructions on how to use it. Dry Chemical: Dry Chemical is the most widely used type of fire extinguisher and is also recognized as a multi-purpose ABC fire extinguisher. The agent works by interrupting the chemical chain reaction. Also, on a class A fire it creates a barrier between the fuel and the oxygen. Carbon Dioxide: Works by separating oxygen and heat. Usually ineffective against class Dry Powder: Works by separating fuel from oxygen and/or removing heat. Effectiveness is based on the type of class D fire it is designed to extinguish. Ineffective on class A, B, C fires (metal fires) only. Wet Chemical: Works by forming a soapy foam blanket over the burning material and cooling it below its ignition temperature. Designed for restaurant type kitchens. Clean Agent: Works by interrupting the chemical chain reaction [1].

2.3 Fire Incidents in Bangladesh

At least 16,000 incidents of fire have occurred around the country in the last 10 years; the number of fires has increased more than threefold across Bangladesh since 1997 with the year 2018 seeing a daily average of 53.

Figure 2.2: Chawkbazar's Churihatta area of Old Dhaka

Fire Service and Civil Defense statistics showed that around 250,000 fires occurred in the country between January 1, 1997 and December 31, 2018, according to the online database Dataful. These fires also caused an estimated financial loss of around Tk6,400 crore to the

nation. At least 1,970 people were killed in around 200,000 fires across the country between 2004 and 2018, according to available fire service data. Urban experts attribute the sharp rise in fires to unplanned urbanization, the violation of rules for constructing buildings, carelessness among the public, increased use of gas cylinders and devices, plus a lack of supervision by the authorities concerned. Last year saw the highest number of fires: of 19,642. However, the highest number of casualties —365 dead and 1,385 injured—was recorded in 2011.In terms of financial losses, 2015 was the deadliest year as the country suffered a loss of an estimated Tk850 crore in 17,488 fires. According to fire service data, around 5,802 fires occurred in 1997, but these increased more than threefold over the years. However, the number of casualties has been dropping over the last few years; except in 2018.In 2006, 9,542 fires killed 91 people and injured 873 more. Seventy people were killed and 210 others were injured in 17,830 fires in 2014; while 68 died and 216 were injured in 17,488 fires in 2015.Analyzing the data provided by Bangladesh Fire Service and Civil Defense, a rising trend in the fire related incidents is seen starting from 2006 to 2018. [2]

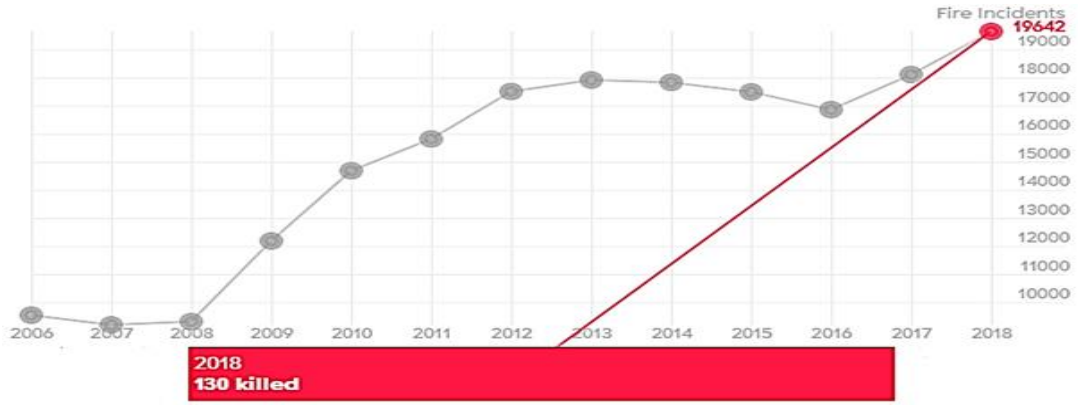

Figure 2.3: Chat Deaths in Bangladesh fire incidents 2006-2018

In 2006, a total of 9, 542 fire incidents took place all over the country in which 91 people lost their lives and 873 were injured; whereas, the casualties including 130 deaths and 664 injuries took place in 19,642 fire incidents in 2018.Bangladesh has been passing an anxious situation. Banani FR Tower and Gulshan DNCC Market fire incidents are the latest cementation to this misfortune. Before that, the nation witnessed in February a massive fire break-out in old Dhaka's Chawkbazar. It further provides installation of fire extinguisher machine or any other alternative arrangement as much as necessary in a conspicuous place

of the building along with fire alarms as an indication to leave the building. Chapter 4 of the Bangladesh National Building Code 2006 controls the design, construction and arrangement of building components to provide a reasonably safe means of escape therefrom. Buildings shall be evacuated during any repair or alteration works unless the existing means of escape and fire protection system are continuously maintained or other exit and protection measures are taken to provide an equivalent degree of safety. All buildings constructed for human occupancy or storage shall be provided with adequate exit facilities to permit safe and quick unaided escape of the occupants in the event of fire or other emergency. Paragraph 3.3.5 provides that the owner of the building shall be responsible for the safety of all occupants. Usually used stairways or lifts cannot be regarded as emergency exit. This code also enunciates some exit requirements for different occupancies such as health care, educational, institutional, dwelling houses and industries [3].

Figure 2.4: FR Tower of Banani in Dhaka

In recent cases, we have seen that fighting fire incident in high-rise buildings is of a matter of extreme difficulties for our fire fighters. Pressure on firefighting equipment in tall building is supposed to be reduced by water supply zones with automatic fire pump or intermediate gravity tank. Unfortunately, in most of the cases, the fire fighters do not find existence of any of such Section 4 of the Fire Prevention and Extinction Act 2003 provides that if any person wants to use any building as warehouse or workshop, he shall have to take license from the Directorate General of Fire Service and Civil Defense. Contravention of this section will cause imprisonment for 3 years or fine and the building along with goods kept in it shall be forfeited. Section 7 depicts, notwithstanding anything contained in any other law, without approval of the Directorate General of Fire Service and Civil

Defense regarding fire prevention or extinction, no structural design or layout of multi-storied commercial building shall be approved or amended. Section 18 connotes that contravention of section 7 shall be dealt with imprisonment for 6 months or fine. Section 8 (3) directs every owner of the building to take precautions and other measures necessary for public safety. The Fire Prevention and Extinction Act 2003 is supplemented by the Fire Prevention and Extinction Rules 2014 which enumerates that owner of the building shall have to apply for occupancy certificate of the building at the end of the construction (Rule 22). These enable the authority to inspect the building, to examine whether the owner met all the requirements of the building code for the public safety or not.If an owner fails to insert these basic safety measures in the structural design of the building, his application must be rejected but somehow they get the approval and get on with it. Back in 2010, the High Court Division of Bangladesh, in response to a writ petition (Writ Petition no. 718/2008) filed by BLAST and Safety & Rights Society jointly, directed RAJUK, City Corporation to implement the National Building Code 2006 properly and also dictated to form Code Enforcement Agency within a year. After almost eight years, where we faced fire incidents like Tazreen Garments, Nimtoli, Chawkbazar, Banani and Gulshan DNCC Market tragedies, still there is no ostensible implementation of statutory provisions as well as verdict given by the High Court Division.

Considering the above problems, it appears that the problems are caused by the fact that the roads are small because fire service personnel have to deal with the problem of taking their cars. If it can be made on a larger scale then these problems will be easier to solve. And the amount of damage will be reduced. So we think this robot will play an important role at that time [4].

2.4 Review of Related Work

The firefighting robot design was built around techniques for digitalizing analogue signals obtained from flame sensor used to monitor temperature of the room and the light intensity of the room. The room temperature to be monitored, being analogue, is measured through the use of a sensor, while the light intensity of the room is detected using Light Dependent Resistor (LDR). The LDR's resistance increases with reduced light intensity causing the voltage input into the inverting input of the comparator used to be higher than the reference

voltage set at the non-inverting input of the comparator which makes the comparator to output a LOW. The flame sensor resistance decrease with increase in temperature and this would cause a decrease in the voltage input to the non-inverting input of the comparator thereby causing the voltage reference set at the inverting input to be greater. In this state the comparator outputs a LOW, to indicate high temperature (i.e. fire). The two LOW outputs were Robot and coupled to the stable stage of the circuitry. The system developed in has come to light through the way of inspiration to develop a compact system, based on the fundamental ideas of safety, security and control. Once this system is installed to operation specifying temperature threshold, in case of any emergency situation due to increasing temperature and/or smoke at place surpassing the threshold, the system immediately start fighting agonist fire,. The user gets total control over the robot, even from the distant location, that auto stop when the emergency situation is overcome.[5]

2.5 Autonomous Robot

An autonomous robot is a robot that performs behaviors or tasks with a high degree of autonomy (without external influence). Autonomous robotics is usually considered to be a subfield of artificial intelligence, robotics, and information engineering Gain information about the environment Work for an extended period without human intervention Move either all or part of itself throughout its operating environment without human assistance Avoid situations that are harmful to people, property, or itself unless those are part of its design specifications An autonomous robot may also learn or gain new knowledge like adjusting for new methods of accomplishing its tasks or adapting to changing surroundings. A programmable robot, as the name suggests, is a first generation robot with an actuator with the facility of each of its joints being reprogrammable according to the kind of application. The function and application of the robots can be changed just by reprogramming the robot, however once programmed, they perform a specific function in a fixed sequence and fixed pattern. All the industrial robots are of programmable type which would perform a monotonous motion both in the presence or absence of any part in its grip. The main drawback of this type of robot is that, once programmed, it can be used to hold an object of a specific type and shape and that too placed in a particular position [6].

Chapter 3

Hardware and Software Analysis

3.1 Introduction

The method used in the execution of this project comprises the combination of programming logics with embedded system. In other to establish the aim of the project these methods were combined from the design stage to the construction and performance results of the system. Using carefully selected materials and software implementation to drive the complete system as seen in the final construction. This chapter entails the design procedure of the system detailing the theoretical analysis, choice of components and values and construction and packaging materials. Indicating calculations, schematics and drawings.

3.2 Hardware Design Analysis

We are using some components. There are:

- Arduino Mega
- Flame Sensor
- Ultrasonic Sonar Sensor
- Servo Motor
- Water Pump
- 12 V DC motor
- 12 V Battery
- Wheel
- Hex
- Mount
- Relay Module
- Buck Module

3.3 Arduino Mega

Arduino is an open source physical computing platform based on simple input/output board and a development environment that implements the Processing language (www.processing.org). Arduino can be used to develop standalone interactive objects or

can be connected to software on your computer. The boards can be assembled by hand or purchased preassembled; the open source IDE (Integrated Development Environment) can be downloaded for free from www.arduino.cc

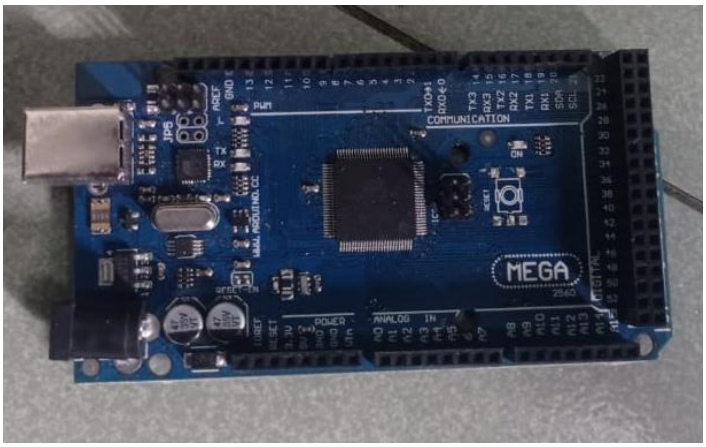

Figure 3.1: Arduino Mega

3.4 Flame Sensor

A flame detector is a sensor designed to detect and respond to the presence of a flame or fire, allowing flame detection. Responses to a detected flame depend on the installation, but can include sounding an alarm, deactivating a fuel line (such as a propane or a natural gas line), and activating a fire suppression system.

Figure 3.2: Flame Sensor

When used in applications such as industrial furnaces, their role is to provide confirmation that the furnace is working properly; in these cases, they take no direct action beyond

notifying the operator or control system. A flame detector can often respond faster and more accurately than a smoke or heat detector due to the mechanisms it uses to detect the flameD0 – Give Zero output for nothing detected and One for a +Ve detection.

A0 – Give values in range representing the flame probability/size/distance and must be connected to Arduino input.

Optical Flame Detectors:

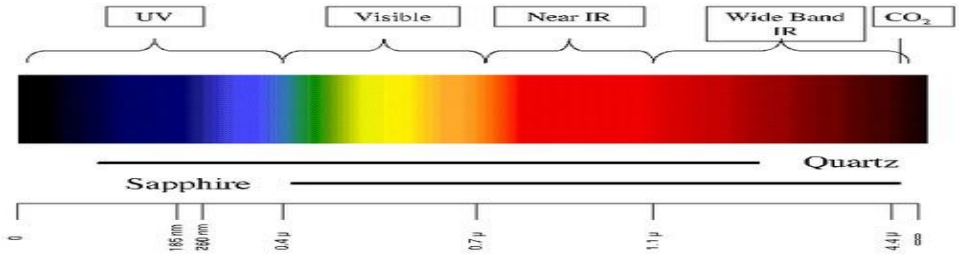

Figure 3.3: Optical Flame Detectors

Ultraviolet (UV) detectors work by detecting the UV radiation emitted at the instant of ignition. While capable of detecting fires and explosions within 3–4 milliseconds, a time delay of 2–3 seconds is often included to minimize false alarms which can be triggered by other UV sources such as lightning, arc welding, radiation, and sunlight. UV detectors typically operate with wavelengths shorter than 300 nm to minimize the effects of natural background radiation. The solar blind UV wavelength band is also easily blinded by oily contaminants.

3.5 12 V DC Motor

A DC motor is any motor within a class of electrical machines whereby direct current electrical power is converted into mechanical power. A 12v DC motor is small and inexpensive, yet powerful enough to be used for many application [6].

Main Types of DC Motors

- Permanent Magnet DC Motors. The permanent magnet motor uses
- Series DC Motors. In a series DC motor,
- Shunt DC Motors.
- Compound DC Motors.

Figure 3.4: 12 V DC Motor

DC motor is any of a class of rotary electrical motors that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor. DC motors were the first form of motor widely used, as they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings.

3.6 Sonar Sensor

Ultrasonic transducers and ultrasonic sensors are devices that generate or sense ultrasound energy. They can be divided into three broad categories: transmitters, receivers and transceivers.

Figure 3.5: Sonar Sensor

HC-SR04 Sensor Features

- Operating voltage: +5V
- Theoretical Measuring Distance: 2cm to 450cm
- Practical Measuring Distance: 2cm to 80cm
- Measuring angle covered: <15°
- Operating Frequency: 40Hz

HC-SR04 Ultrasonic Sensor –Working

As shown above the HC-SR04 Ultrasonic sensor is a 4 pin module, whose pin names are Vcc, Trigger, Echo and Ground respectively. This sensor is a very popular sensor used in many applications where measuring distance or sensing objects are required. The module has two eyes like projects in the front which forms the Ultrasonic transmitter and Receiver. The sensor works with the simple high school formula that, Distance = Speed × Time.The Ultrasonic transmitter transmits an ultrasonic wave, this wave travels in air and when it gets objected by any material it gets reflected back toward the sensor this reflected wave is observed by the Ultrasonic receiver module.

3.7 Servo Motor

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors. Servomotors are not a specific class of motor, although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system. Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing.

Figure 3.6: Servo Motor

Servos are controlled by sending an electrical pulse of variable width, or pulse width modulation (PWM), through the control wire. There is a minimum pulse, a maximum pulse, and a repetition rate. A servo motor can usually only turn 90° in either direction for a total of 180° movement. The motor's neutral position is defined as the position where the servo has the same amount of potential rotation in the both the clockwise or counter-clockwise direction. The PWM sent to the motor determines position of the shaft, and based on the duration of the pulse sent via the control wire; the rotor will turn to the desired position.

The servo motor expects to see a pulse every 20 milliseconds (ms) and the length of the pulse will determine how far the motor turns. For example, a 1.5ms pulse will make the motor turn to the 90° position. Shorter than 1.5ms moves it in the counter clockwise direction toward the 0° position, and any longer than 1.5ms will turn the servo in a clockwise direction toward the 180° position. When these servos are commanded to move,

they will move to the position and hold that position. If an external force pushes against the servo while the servo is holding a position, the servo will resist from moving out of that position. The maximum amount of force the servo can exert is called the torque rating of the servo. Servos will not hold their position forever though; the position pulse must be repeated to instruct the servo to stay in position.

3.8 Water Pump

` Water pumps are fundamental to homes, structures and modern plants for providing water from underground sources. The particular ways they work rely upon the idea of utilization that they are required for. Since there are numerous reasons that these pumps serve, there is the same number of sorts accessible today.

Figure 3.7: Mini Water pump

3.9 Bluetooth Module

A Bluetooth module (Bluetooth module) is a chip that integrates Bluetooth functionality, which is used to provide short-range 2.4G wireless communication. Bluetooth modules are semi-finished products as far as the end-user is concerned. A common Bluetooth module, the HC-05 is capable of adding two way (full-duplex) wireless capability.

Figure 3.8: Bluetooth Module

3.10 Mini Piezo Buzzer

Apply 3V to 5V to this piezo buzzer module and you'll be rewarded with a loud 2KHz BEEP. Unlike a plain piezo, this buzzer does not need an AC signal. Inside is a piezo element plus the driver circuitry that makes it oscillate at 2KHz. The piezo buzzer is 5V TTL logic compatible and Breadboard friendly pin spacing. This buzzer is ideal when you need to fit a buzzer in a small place. It has its own built-in drive circuit. It offers low current consumption. Used in manufacturing applications such as laptops, alarms, pagers, etc.

Figure 3.9: Mini Piezo Buzzer

3.11 Relay

A relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations thereof. Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal.

Figure 3.10: Relay

Once is the Trigger Voltage; this is the voltage required to turn on the relay that is to change the contact from Common.NC to Common->NO. Our relay here has 5V trigger voltage, but you can also find relays of values 3V, 6V and even 12V so select one based on the available voltage in your project. The other parameter is your Load Voltage & Current, this is the amount of voltage or current that the NC, NO or Common terminal of the relay could withstand, in our case for DC it is maximum of 30V and 10A.

3.12 Motor Driver (L293D)

L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers 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. The motor operations of two motors can be controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively. Enable pins 1 and 9 (corresponding to the two motors) must be high for motors to start operating.

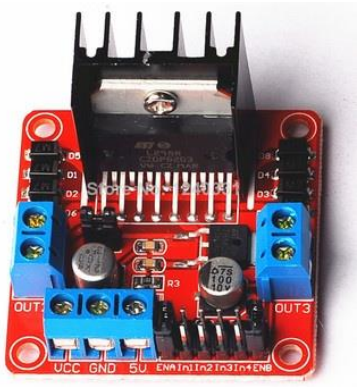

Figure 3.11: L293D Motor driver

3.13 ESP32 CAM

In this project we're going to build an IP surveillance camera with the ESP32-CAM board. The ESP32 camera is going to host a video streaming web server that you can access with any device in your network. The ESP32 CAM WIFI module Bluetooth with 2MP for face recognization has a very competitive small size camera module that can operate independently as a minimum system with a footprint of only 40×27 mm; a deep sleep current of up to 6mA and is widely used in various IoT Application.

Figure 3.12: ESP32-CAM

Here is a list with the ESP32-CAM features:

- The smallest 802.11b/g/n Wi-Fi BT SoC module
- Low power 32-bit CPU, can also serve the application processor
- Up to 160MHz clock speed, summary computing power up to 600 DMIPS
- Built-in 520 KB SRAM, external 4MPSRAM
- Supports UART/SPI/I2C/PWM/ADC/DAC
- Support OV2640 and OV7670 cameras, built-in flash lamp
- Support image WiFI upload
- Support TF card
- Supports multiple sleep modes
- Embedded Lwip and FreeRTOS
- Supports STA/AP/STA+AP operation mode
- Support Smart Config/AirKiss technology
- Support for serial port local and remote firmware upgrades (FOTA)

3.14 GSM Module

A little GSM modem called the SIM800L GSM/GPRS module may be used in a lot of IoT schemes. A mobile phone can do almost everything that this section does, including sending SMS script messages, making and receiving phone calls, connecting to the internet through GPRS, TCP/IP, and more. Last but not least, the module configures GSM/GPRS as a quad-band link, making its mechanism essentially universal. There may be a SIM800L GSM cellular chip starting with Sim Com next to the element's center.

The chip is a strong competitor for a pure LiPo battery option since its operating voltage varies from 3.4V to 4.4V. This designates it as a suitable replacement that may be inserted into projects without taking up a lot of room. The SIM800L GSM chip's necessary information pins are all fractured to a precise 0.1″ pitch. These include pins that are intended for communication with a microcontroller over UART. Through Auto-Baud recognition, the section maintains a baud frequency of 1200bps close to 115200bps. The element wants a net to become attached to an outside projection. Sometimes the construction block is welded to the PCB's internet pin, but other times it comes from a helical antenna. The board also features a U.FL instrumentation port in case you want to mount the antenna elsewhere.

Figure 3.13: GSM

3.15 GPS

GPS module is used for pinpointing the location of the device and also to synchronize the device time. If the device time drifts for more than 3 seconds from the GPS time, the device is resynchronized to it. This allows to be sure that the device records in server represents events that were happening at that exact time. GPS modules constantly outputs information packets to microcontroller containing information such as speed, altitude, longitude, latitude and the quality of the GPS signal.

GSM module is the link connecting GPS tracking device with the world. For this to happen the user has to insert a working SIM card to device. The communication consists of two main functionalities:

1. GSM communication. GSM connection is established when working SIM card is inserted and there is available operator for it to connect to.
2. GPRS communication. GPRS connection is used for device communication with server.

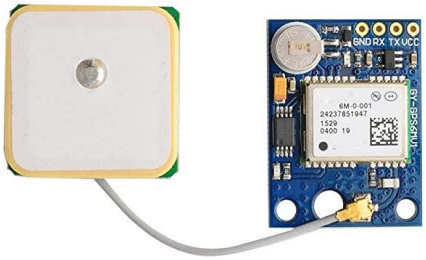

Figure 3.14: GPS

3.16 Software Analysis

3.16.1 Arduino Software

The smart microcontroller unit named as Arduino mega can be programmed with the Arduino software. There is no any requirement for installing other software rather than Arduino. Firstly, Select "Arduino Nano from the Tools , Board menu (according to the microcontroller on your board).The IC used named as ATmega328 on the Arduino Nano comes pre burned with a boot loader that allows you to upload new code to it without the use of an external hardware programmer.

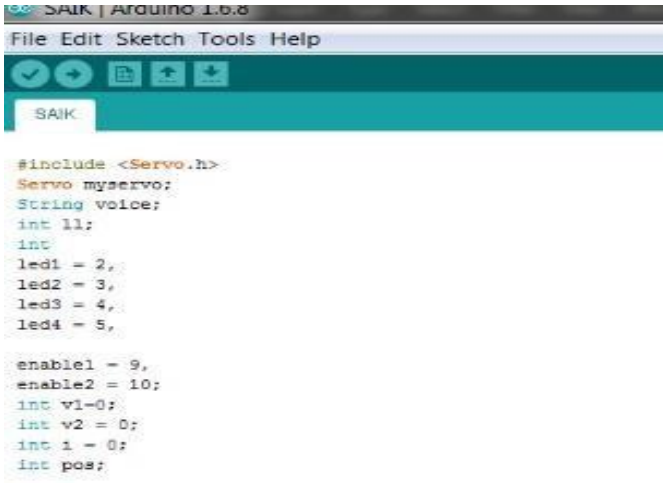

Figure 3.15: Arduino Software Interface IDE

Communication is using the original STK500 protocol (reference, C header files). We can also bypass the boot loader and programs the microcontroller through the ICSP (In Circuit Serial Programming) header. The ATmega16U2 (or 8U2 in the rev1 and rev2 boards) firmware source code is available. The ATmega16U2/8U2 is loaded with a DFU boot loader, which can be activated. On Rev1 boards: connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2. On Rev2 or later boards: there is a resistor that pulling the 8U2/16U2 HWB line to ground, making it easier to put into DFU mode. The Arduino Nano is one of the latest smart microcontroller units and has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL at (5V).

Which is available on digital pins 0 - (RX) for receive the data and pin no.1 (TX) for transmit the data. An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, an .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial Communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Uno's digital pins. The

ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus. Arduino programs are written in C or C++ and the program code written for Arduino is called sketch. First, make sure you have the Arduino AVR Core 1.16.21 or later looking at the Board Manager. Then, to program the NEW Arduino nano boards you need to choose Processor > "ATmega328P". To program old boards you need to choose Processor > "ATmega328P (Old Bootloader)". If you get an error while uploading or you are not sure which bootloader you have, try each type of processor 328P until your board gets properly programmed. Ever since computers first entered the world, programming has always been seen as a rather esoteric process. With all its codes and symbols, programming has never been very beginner friendly. It usually takes years and years of studying to get even the most basic concepts down and it's especially difficult to apply these codes to real work devices. Nowadays, however, knowing how to code and program is a very useful skill to have. Arduino IDE is a coding software that makes the programming world more accessible to beginners with its simple interface and community-driven system. One of the best things about the Arduino IDE is the fact that it's community-driven. Arduino has a very active forum where users can share their creations with other programmers and get feedback and troubleshooting tips. More advanced users can provide their own tips as well. What's great about the Arduino IDE is that this focus on community is accommodated by the software itself.

3.16.2 Proteus

The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards. The first version of what is now the Proteus Design Suite was called PC-B and was written by the company chairman, John Jameson, for DOS in 1988. Schematic Capture support followed in 1990, with a port to the Windows environment shortly thereafter. Mixed mode SPICE Simulation was first integrated into Proteus in 1996 and microcontroller simulation then arrived in Proteus in 1998. Shape based auto routing was added in 2002 and 2006 saw another major product update with 3D Board Visualization.

More recently, a dedicated IDE for simulation was added in 2011 and MCAD import/export was included in 2015. First make sure that you have Proteus installed in your operating system. If not, then download and install Proteus. After run the Proteus software, If you don't find Arduino in the library. Then, there is a .rar file download it and copy/cut the file. After that paste it into the Proteus library. Run the Proteus and draw the circuit like the picture. You can directly connect Led with pin 13.But it is a good practice to add a 220 ohm resistor with led in series. Resistor limits the current flow. Double click on Arduino and paste the .hex file in "Program File:".Run the simulation by clicking "Run the simulation" button. LED is blinking if everything is okay. The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards. The Proteus Design Suite is a Windows application for schematic capture, simulation, and PCB (Printed Circuit Board) layout design. It can be purchased in many configurations, depending on the size of designs being produced and the requirements for microcontroller simulation. All PCB Design products include an auto router and basic mixed mode SPICE simulation capabilities. Schematic capture in the Proteus Design Suite is used for both the simulation of designs and as the design phase of a PCB layout project. It is therefore a core component and is included with all product configurations. The templates provided in the Arduino IDE are extremely helpful. Of course, not all of them will be relevant to what you’re doing, but they are great for starting out. They have some very basic codes such as Blink and Keyboard Logout that users can utilize to create more complex codes. You can either use those codes to create other codes with similar functions, or you can add those codes to other codes to create multi-functional codes. Once the sketches have been created, users can easily upload their sketches to their chose Arduino boards.

Chapter 4

Methodology

4.1 Design and Architecture

Our methodologies for the project:

- Creating an idea for Design and Construction of a Fire Fighter & Surveillance Robot
- And designing a block diagram and circuit diagram to know which components need to construct it.
- Collecting the all components and programming for the microcontroller to control the system
- Sitting all components in PCB board and soldering then assembling the all block in a board and finally run the system and checking

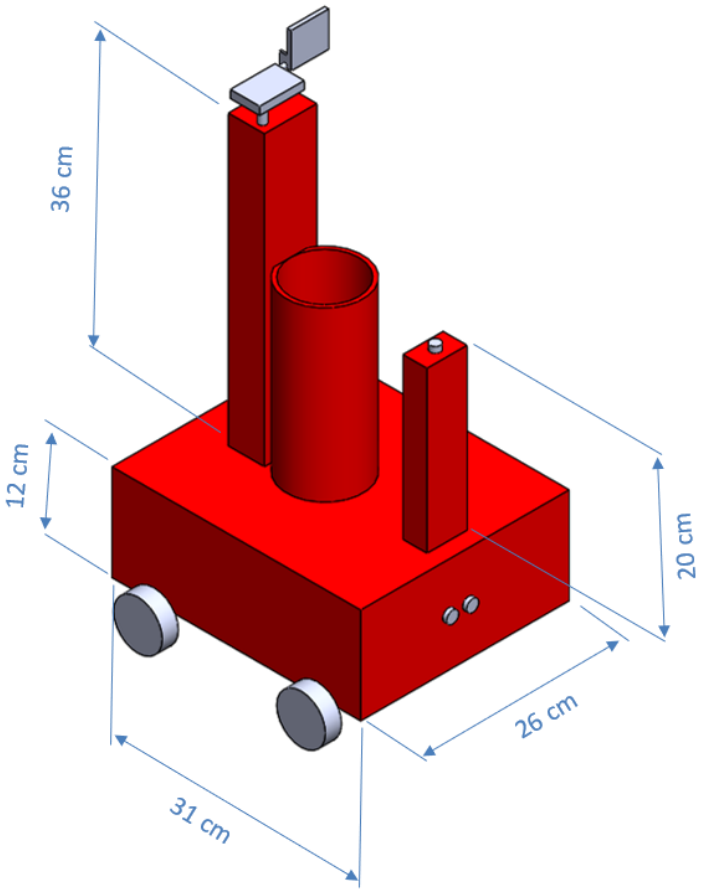

Figure 4.1: Structural View

4.2 Flowchart of Robot

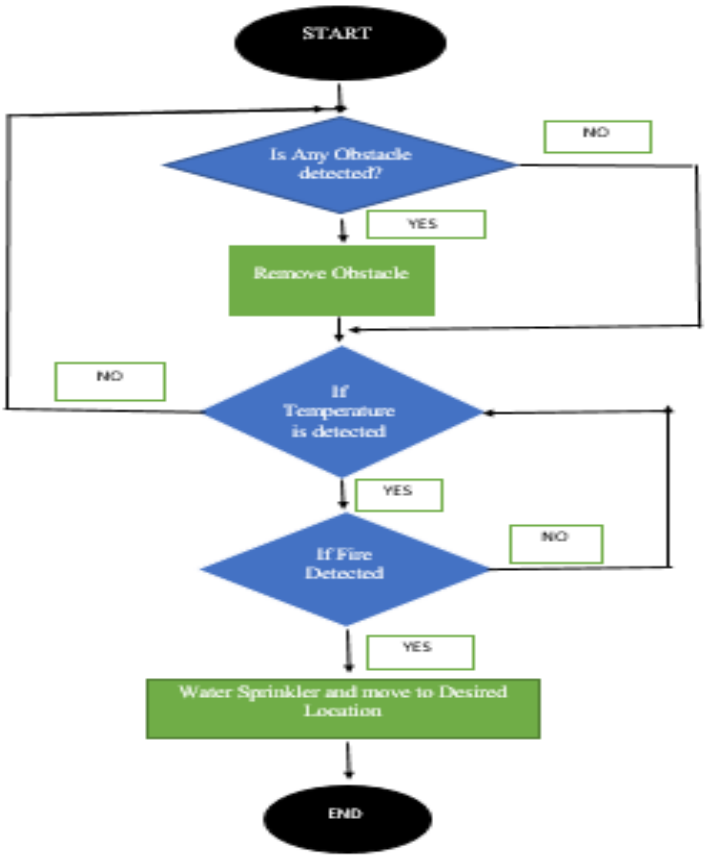

Figure 4.2: Flow Chart

Design and Construction of Fire Fighter & Surveillance Robot has been developed to find the location of fire. Robot has an ability to remove obstacle and find the location by using flame sensor. The flame sensor is functioning to sense the location of fire. Sensors are connected to Arduino Mega, which controlled the movement of DC motor. When flame sensor found the fire, the DC motor will stop at 30 cm from the fire. Then the water pump and servo motor start work automatically and finish fire.

4.3 Block Diagram of Robot

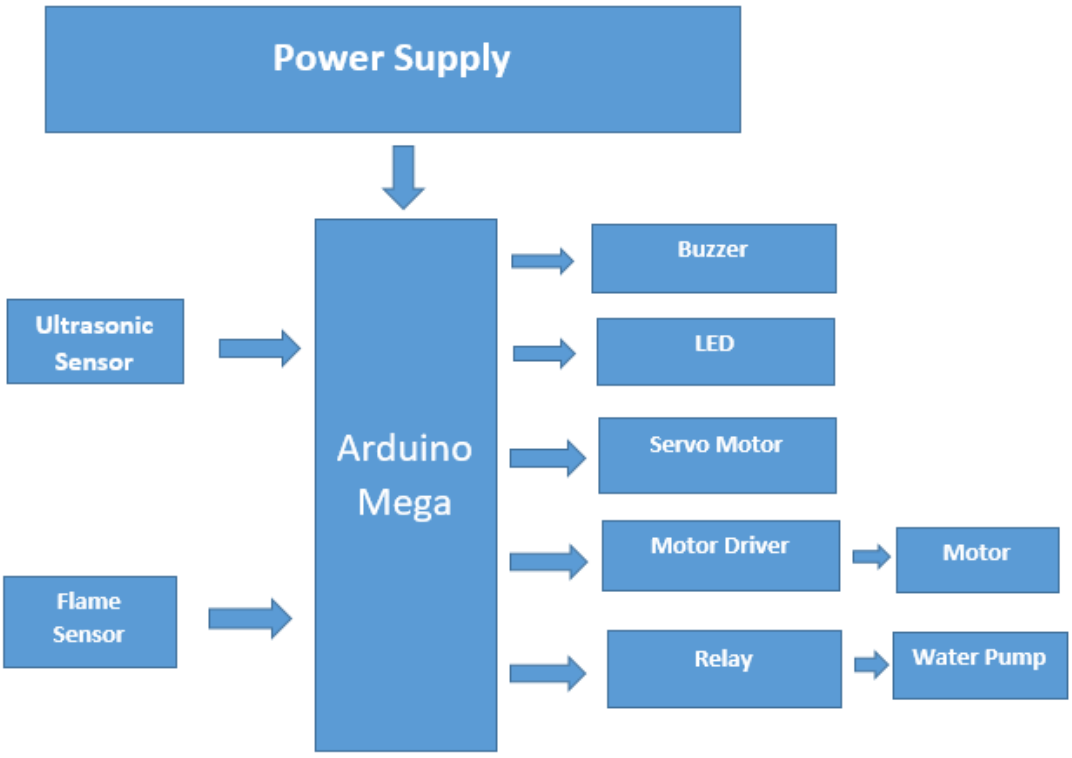

Figure 4.3: Block Diagram

When ultrasonic sonar sensor detected object and flame sensor detected fire pass the signal into Arduino then Arduino passing signal servo motor to remove obstacle if obstacle does not move then Arduino signal send to motor driver and motor driver send this data to left motor and right motor. After that state flame sensor in front of fire then Arduino pass the signal servo motor and water pump.

4.4 Our Final System View

Figure 4.4: Picture of our project

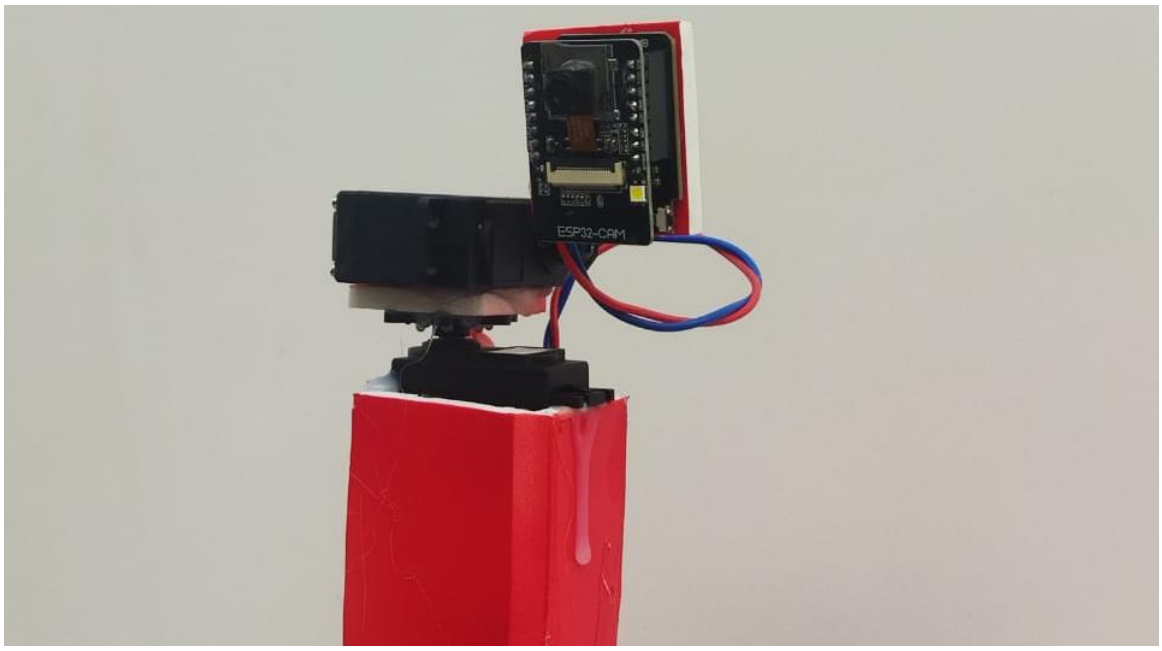

Figure 4.5: Camera Setup of the project.

Chapter 5

Results and Discussion

5.1 Results

Table 5.1 Result

No. of Test	Job Description	Output
Test -1	Manual Movement	Ok
Test -2	Fire Detection	Ok
Test -3	Live Video Stream	Ok
Test -4	Fire Alarm System	Ok
Test -5	Object Detection	Ok
Test -6	Fire Detect with Automatic Movement	Ok
Test -7	Fire Location SMS System	Ok
Test -8	Nozzle Movement	Ok

5.2 Cost Analysis

Table 5.2 Cost Analysis

Serial No	Components	Quantity	Price
01	Arduino Mega	01	1900/=
02	Motor	04	2000/=
03	Hex & Mount	04	1040/=
04	Motor Driver	02	300/=
05	Relay Module	01	120/=
06	Water Pump	01	100/=
07	Servo Motor	03	600/=
08	Flame Sensor	08	480/=
09	Sonar Sensor	01	100/=
10	Whell	04	1000/=
11	Camera	1	1200/=

12	GPS tracker	1	500/=
13	Buzzer	01	15/=
14	Led	04	04/=
15	Charger & Battery	01	1450/=
	Others		640/=
		Total	**11449/=**

5.3 Robot Behavior

The aim of the project is to make the robot to move around in the fire location, if the fire is right side then right flame sensor detect the fire tempter and send do signal to arduino according to program robot move right by left side wheel of motor. The water pump consumed so much battery power. The robot is worked properly but we face some sensor sensibility problem, sometimes sensor not working properly in this case we increase the resistivity of sensor, accuracy of fire detection after changed smoothly worked.

This robot has lot of advantage and disadvantage we described in below:

Advantage:

- It can be able to stop fire quickly and safely extinguish the fire,
- It is save operation.
- It can save valuable lives for fireman.
- Fast response.
- The technology we use it's so cheap.

Disadvantage:

- It cannot save himself from critical situation.

5.4 Application:

- Useful for controlling indoor and outdoor fires
- Can provide a low cost fire protection system with limited centralized fire protection

Chapter 6

CONCLUSION

6.1 Conclusion

Thus we will be developing a robot which will be used for Design and Construction of Fire Fighter & Surveillance Robot. This proposes a great chance for automation and will be useful at places where human cannot reach or is dangerous. In this paper as proposed an automatic fire fighting robot with water spray has been designed and implemented. It can be deduced from the design and test results that the project has met its objectives. This project has therefore as proposed provided a novel solution to the inadequacies of traditional firefighting robot. The sensor applied in this design provides sensing for fire temperature with fast response and high sensitivity. In this project we aim to reduce the effect of fires accidents which usually start from small flame, therefore people life and money would be saved. The robot can successfully find fire and reach it without running into obstacle.

6.2 Future Scope

In future it can be use as big truck with steel covered with big water tank and lot of extra sensor and equipment like, smoke sensor, etc. In industrial people can't go, but the robot can prevention fire easily its ideal for industrial safety proposes application. In other hand it also preferable for market, hospital and any typical place.

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Appendix

Program:

```
#include <Servo.h>
Servo myservo;
int pos = 0;
boolean fire = false;
/*-------defining Inputs------*/
#define Left_S 9      // left sensor
#define Right_S 10      // right sensor
#define Forward_S 8 //forward sensor
/*-------defining Outputs------*/
#define LM1 2       // left motor
#define LM2 3       // left motor
#define RM1 4       // right motor
#define RM2 5       // right motor
#define pump 6
void setup()
{
pinMode(Left_S, INPUT);
pinMode(Right_S, INPUT);
pinMode(Forward_S, INPUT);
pinMode(LM1, OUTPUT);
pinMode(LM2, OUTPUT);
pinMode(RM1, OUTPUT);
pinMode(RM2, OUTPUT);
pinMode(pump, OUTPUT)
myservo.attach(11);
```

```
myservo.write(90);
}
void put_off_fire()
{
   delay (500);
digitalWrite(LM1, HIGH);
digitalWrite(LM2, HIGH);
digitalWrite(RM1, HIGH);
digitalWrite(RM2, HIGH);
digitalWrite(pump, HIGH); delay(500);
   for (pos = 50; pos <= 130; pos += 1) {
myservo.write(pos);
delay(10);
  }
  for (pos = 130; pos >= 50; pos -= 1) {
myservo.write(pos);
delay(10);
  }
digitalWrite(pump,LOW);
myservo.write(90);
  fire=false;
}
void loop()
{ myservo.write(90); //Sweep_Servo();
   if (digitalRead(Left_S) ==1
&&digitalRead(Right_S)==1 &&digitalRead(Forward_S) ==1)
   {
```

```
    //Do not move the robot
digitalWrite(LM1, HIGH);
digitalWrite(LM2, HIGH);
digitalWrite(RM1, HIGH);
digitalWrite(RM2, HIGH);
    }
    else if (digitalRead(Forward_S) ==0) //If Fire is straight ahead
    {
    //Move the robot forward
digitalWrite(LM1, HIGH);
digitalWrite(LM2, LOW);
digitalWrite(RM1, HIGH);
digitalWrite(RM2, LOW);
    fire = true;
    }
    else if (digitalRead(Left_S) ==0) //If Fire is to the left
    {
    //Move the robot left
digitalWrite(LM1, HIGH);
digitalWrite(LM2, LOW);
digitalWrite(RM1, HIGH);
digitalWrite(RM2, HIGH);
    }
```