DESIGN AND IMPLEMENTATION OF AN IOT BASED FIRE AND SURVIVOR DETECTION DRONE

An Undergraduate CAPSTONE Project

By

1. HOSSAIN, MD.FAHIM	ID: 17-54775-2	DEPT: EEE
2. SEN, SHUVRO SANKAR	ID: 18-37524-1	DEPT: EEE
3. ASHIK, ASHRAF CHOWDHURY	ID: 18-38025-2	DEPT: EEE

Under the Supervision of

Mohammad Zohurul Islam

Senior Lecturer

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American International University - Bangladesh

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A CAPSTONE Project submitted to the Faculty of Engineering, American International University - Bangladesh (AIUB) in partial fulfillment of the requirements for the degree of Bachelor of Science in their mentioned respective programs.

1.	HOSSAIN, MD. FAHIM	ID: 17-54775-2	Dept: EEE
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American International University - Bangladesh

DECLARATION

This is to certify that this project is our original work. No part of this work has been submitted elsewhere partially or fully for the award of any other degree or diploma. Any material reproduced in this project has been properly acknowledged.

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Students' names & Signatures

1. HOSSAIN, MD. FAHIM

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2. SEN, SHUVRO SANKAR

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3. ASHIK, ASHRAF CHOWDHURY

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APPROVAL

The CAPSTONE Project titled **DESIGN AND IMPLEMENTATION OF AN IOT-BASED FIRE AND SURVIVOR DETECTION DRONE** has been submitted to the following respected members of the Board of Examiners of the Faculty of Engineering in partial fulfillment of the requirements for the degree of Bachelor of Science in the respective programs mentioned below on **January 2023** by the following students and has been accepted as satisfactory.

1.	HOSSAIN, MD. FAHIM	ID: 17-34775-2	Dept: EEE
2.	SEN, SHUVRO SANKAR	ID: 18-37524-1	Dept: EEE
3.	ASHIK, ASHRAF CHOWDHURY	ID: 18-38025-2	Dept: EEE

____

Supervisor
Mohmmad Zohurul Islam
Senior Lecturer
Faculty of Engineering
American International University-Bangladesh

____

External Supervisor
Abir Ahmed
Assistant Professor
Faculty of Engineering
American International University-Bangladesh

____

Prof. Dr. Md. Abdur Rahman
Associate Dean
Faculty of Engineering
American International University-Bangladesh

____

Prof. Dr. ABM Siddique Hossain
Dean
Faculty of Engineering
American International University-Bangladesh

____

Dr. Carmen Z. Lamagna
Vice Chancellor
American International University-Bangladesh

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1.	HOSSAIN, MD.FAHIM	ID: 17-54775-2
2.	SEN, SHUVRO SANKAR	ID: 18-37524-1
3.	ASHIK, ASHRAF CHOWDHURY	ID: 18-38025-2

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ABSTRACT

In this project, we designed and developed a firefighting drone system that can detect fires and provide assistance in rescue efforts during Fire hazards or fire incidents. The aim of this project is to design and implement a drone system for detecting and extinguishing fires, as well as locating and rescuing survivors. The system utilizes the Internet of Things (IoT) to connect various sensors and devices, such as temperature sensors, smoke detectors, and cameras, to a central control unit. The control unit processes the data from these sensors to identify the location and severity of a fire, and deploys the drone to the affected area. Once at the site, the drone uses specialized equipment, such as a thermal imaging camera, to locate survivors. The drone is also equipped with a communication system for coordinating with first responders and relaying information about the situation on the ground. The effectiveness of the system is evaluated through simulation and field tests. Overall, the IoT-based firefighting and survivor detection drone has the potential to greatly improve the efficiency and safety of emergency response operations.

Chapter 1

INTRODUCTION

1.1. Overture

The devastation of the fire was like a nightmare. Every year, a lot of people around the world lose their lives because of this. A statistical report provided by the "International Association of Fire and Rescue Services", based on official reports of fires in 34 countries, shows that 16.9 thousand people have lost their lives in the past year 2016 [1], and this is very unfortunate. This is the only official report, but the actual number of casualties could be much higher. It also shows an average fire frequency of 2.9 per 1000 population, which is relatively high. In Bangladesh, the average number of fires per year is 17,743 cases [2]. Therefore, timely and complete firefighting is an important task. When fighting a fire, two essential aspects are speed and safety. When a fire occurs, it is difficult for firefighters to assess the situation without sustaining damage. Sometimes firefighters cannot reach the area affected by the fire. As a result, the speed and safety of firefighters became a matter of doubt. One potential technical solution could be the use of unmanned firefighting equipment, to prevent further damage and protect first responders. Another possible benefit is that unmanned firefighting equipment will make the firefighting process more efficient and provide a better way to respond to fires. Drone technology is increasingly seen as a good candidate in this area. Depending on the incident situation, drones can be used for several purposes in fire practice, such as potential danger monitoring, hazard detection, and fire suppression. The firefighting drone has the property of being a firefighting device, and it can be an alternative for firefighters to effectively fight fires and carry out rescue operations. This drone can also be used to monitor the area after a fire. Such automation will detect the fire and use the appropriate fire suppression system accordingly. Fire robots could become an alternative to firefighters because drones are not affected by smoke or fire and do not require oxygen. Therefore, their use can minimize the number of injuries caused by fire.

1.2. Engineering Problem Statement

Casualties and property damage from fire continue to exist in fire disasters and new measures are continuously introduced. Toxic gasses and flames continue to threaten disaster victims and rescue workers alike. While a range of fire-fighting drones have been developed and put into action worldwide, they still have many things to contribute to the fight. Because of the increased warmth of our planet's atmosphere, everything becomes more combustible, increasing the likelihood of forest fires and fire tragedies in buildings and warehouses. Therefore, fire extinguishing drones are needed to reduce all the damage caused by natural or human made fire disasters. A drone finds it challenging to relay the data. Flight data is challenging to archive, which presents challenges for emergency situation research. It is impossible to combine data from many sensors to improve situational awareness. Sharing live data becomes challenging, which is exacerbated when there is fire. Since drones cannot be connected with emergency response systems like 911 operations centers, drone response cannot be automated. The project aims at designing an intelligent live video feedback location detector fire extinguishing UAV which can. The project aims to solve these limitations. in an IOT based drone system that will provide valuable insights into the situation with the help of cameras and sensors. The proposed system will help the firefighters to monitor the situation like checking if there is a human trapped inside or are there any explosives in the area near the fire, check for harmful gasses if any and devise a plan of action accordingly. The drone system will be controlled remotely through WIFI communication. The Drone will have a camera mounted on it for surveillance. During fire it gets hard to use a camera lens to observe a situation, the body of the drone can be harmed by soundings which are on fire and for sensors, it is extremely hard to detect survivors if they cannot get them in range and these are extremely complicated scenarios which need to be solved. As a result of resolving those challenges, this project will satisfy the requirements of complex engineering problems.

1.3. Related Research Works

One of the most important first steps when drafting a research paper is to conduct a thorough review of many publications related to the chosen topic. Here are some recently published research papers:

1.3.1. Earlier Research

The first invention of the quadcopter plane dates to 1907 when Louis Breguet invented and piloted the first quadcopter helicopter. Drones were then mainly used by the US military for military purposes. The literal birth of the quadcopter came in the late 2000s when advances in electronics allowed the production of inexpensive lightweight flight controllers capable of flying a drone. In addition, several sensors have been integrated into the flight controller to increase the stability of the quadcopter. These sensors are an accelerometer, gyroscope, and magnetometer. This has made quadcopters popular for small unmanned aerial vehicles. With their small size and maneuverability, these quadcopters can fly both indoors and outdoors. But these quadcopters in their initial stages lacked stability and basic controllability. As a result, modern designs have been introduced into quadcopters that use more stable sensors. These sensors have increased the stability of the quadcopter and allow it to travel at a preset height. At this time, the microcontrollers used were complex in nature, and flight control was also difficult due to controller output errors.

The introduction of advanced and stable sensors has increased the drone's stability when moving. Hover control is performed by the microcontroller's PID controller. This has led to an increase in demand for agricultural drones to monitor crops in an area [3]. But drones have not yet been upgraded enough to perform specific tasks. There is scope for further developments in the future. So, scientists introduced several other sensors like tilt sensors, infrared sensors, etc. to make drones more efficient in their missions. The tilt sensor monitors the pitch of the drone and the infrared sensor separates the object of interest from other objects by different radiation emitted by the body [4]. Drones at this stage are even less effective because they do not have sensors to track where they are flying and piloting the drones from afar is a challenging task. The scientists then added a GPS (Global Positioning System) module that locates the coordinates of the area it is flying in and sends them to the remote controller. At that time, the quadcopter and the remote were connected by Wi-Fi instead of traditional radio waves. This has increased the range of the controller many times and at that time, the quadcopter and the remote were connected by Wi-Fi instead of traditional radio waves. This multiplies the range of the controller and can be controlled remotely from a remote location. The quadcopter at this point can follow a predefined path loaded into the controller's memory [4],[5]. Drones fly comfortably indoors with low wind speeds. But it is subject to aerodynamic drag from the outside due to intense winds. The sensors used are not enough to overcome the external wind forces and lose their stability. This eventually caused the drone to fly into the wind [5]. To make the flight more stable, the sensors have been made more efficient. But the advanced sensors are not compatible with the older microcontrollers used. As a result, new microcontrollers have been introduced in the last decade, providing the necessary output for sensors and flight stabilization. The most popular microcontrollers in use today are the FY80, GY80, ARDUINO, and X-BEE because they are easy to use and program [6],[7].

1.3.2. Recent Research

One of the most important first steps when drafting a research paper is to conduct a thorough review of many publications related to the chosen topic. Here are some recently published research papers: In addition to conventional firefighting techniques, A drone demonstrates the use of drones to assist with forest fires using fire-fighting balloons [8]. A Hex copter with a payload of 15 kg and six balls of 0.5 kg each constitutes the proposed system. This involves the use of unmanned aerial vehicles (UAS) systems to detect fires on site and assess the likelihood of wildfires approaching the building. In addition, it transmits fire-fighting UAS-related information to facilitate situational control. However, these bullets are not effective against Class A and B flames. An autonomous drone was created for the important task of monitoring forest fires [9]. The device integrates algorithms to perform predefined area surveillance, automatic take-off and landing, trajectory planning, and fire monitoring. Thermal cameras, temperature sensors, and communication modules are included in this design so that the emergency response team can be notified of the fire (ERT). In the proposal of semi-autonomous drones for firefighting operations [10], to achieve a steady flight, receive and store Global Positioning System (GPS) data, and execute auto-landing, this article details changes to the existing hex copter. A fire extinguisher and other "firefighting" equipment was installed in the system. Two successive models were created, evaluated, and the findings have been favorable to the field of study. A quadcopter was created with the intention of examining the fire-damaged areas [11]. Due to its intuitive simplicity in production and affordability, the author chose the quadcopter with an arm length of 220 mm (about 8.66 in) after comparing several drone designs. The 10 x 4-inch propeller is employed with the intention of increasing stability. The materials for the propeller are selected with the temperature that the drone must endure when it is near the fire in mind. The idea of unmanned aerial systems in the fire department and the associated problems were covered [5]. The ability of the drone to fly, command and control the drones, and accident avoidance are given priority. Continued field testing of UASs is advised, as is polling fire chiefs to get their thoughts on the use of UASs. Additionally, the Federal Aviation Administration (FAA) and fire chiefs worked together to draft regulations on the use of UAS technology in the fire service. To achieve stable flight, receive and store the Global Positioning System & # 40; GPS & # 41; data, and perform auto-landing, this article details the changes to the existing hex copter. A fire extinguisher and other firefighting equipment have been installed in the system. Two consecutive models were generated, evaluated, and the results were favorable for the field of study. Another quadcopter was created for the purpose of inspecting fire-damaged areas [4]. Due to the visual simplicity of manufacturing and the affordable price, the author chose the quadcopter with an arm length of 220mm (about 8.66 in) after comparing several drone designs. 10 x 4-inch propellers are used for the purpose of increasing stability. The material of the propeller is selected considering the temperatures that the drone must withstand when near a fire. The idea of an unmanned aerial vehicle system in the fire department and related issues were mentioned in this paper [12], drone flight capabilities, drone command and control, and accident prevention are priorities. Field testing of the UAS should continue, as well as surveying fire chiefs to get their input on the use of UAS. Additionally, the Federal Aviation Administration (FAA) and fire chiefs worked together to draft regulations for the use of UAS technology in fire departments.

1.4. Critical Engineering Specialist Knowledge

To build this project, knowledge of Arduino Uno and Arduino programming is needed. Several types of sensors are used here, like smoke sensor, flame sensor, temperature sensor, and modules like GPS module and GRE module will be used. In the Arduino diverse types of coding will be needed according to the conditions. The current measurement of multiple sensors, the fire extinguisher, and the camera can be handled properly by doing the proper coding. And the sensor rating, priority settings of the sensors, or maintaining the sensors in a particular order must be done by coding. All those conditions need to be implemented in the code and that must be marched in one code with proper instructions and delays to perfectly work it out. To implement this code the basic of python language or C++ coding for Arduino coding needed such as how the loops, functions, and variable works, how to declare the variable, what they are the major function of coding, the library for each, and different equipment that are used to instruct with the code and how to march all the code in such a way that it works successfully and so on. The basic function of using Arduino is digital write (), pin mode (), and analog read (). The variable can be declared by using a float, int., and char. and so on. A thorough understanding of Arduino and the many kinds of equipment is also required. The readings and the GPS location of the affected area will be transferred to the PC using a Wi-Fi module, which will enable us to monitor the smoke level, and temperature, and detect fire if there is any. If the circumstances are unsuitable, the drone will automatically reverse direction. A quadcopter is operated by varying spin RPM of its four rotors to control lift and torque. The thrust is determined using altitude, pitch, and roll angles and is obtained from the ratio of the angles, getting to know about them is needed. System simulation software like 'Proteus' needs to be learned. The implementation of IoT needs to be learned.

1.5. Stakeholders

About 500 forest fires affect Mexico City annually, and while few people are injured, it is nevertheless critical to address the issue due to the variety of effects it has [13]. Mexico City is among the states with the most fires, as evidenced. Because it depends on the weather and human activity, spontaneous fire spreading over vegetation can happen at any time. Since conventional industrial methods including the use of fire will persist, it is impossible to eliminate massive fires; thus, alternative solutions must be developed and put into practice. Firefighters have been sent to the fire area to fix this issue; however, city traffic is a barrier. When the fire has burned too much of the forest, firefighters are called. There is a complementary approach that is only employed when the fire is out of control. It involves sending a helicopter to the nearest water source (such as a lake or ocean) to gather up water and drop it over the forest, but it also requires more time and money. Unmanned aerial vehicles (UAV) have a wide range of uses, including surveillance and fire extinguishing [18]. The potential for constructing a system that can help control or even extinguish a fire was created with the aim of expanding the scope of applications. A drone (or UAV) has the benefit of being quick, long-range, and able to visit places that a person would find difficult to get to. This research suggests that it may be possible to equip a drone with the ability to put out a fire, giving the user precise control over the damaged area when discharging fire extinguisher loads. For instance, a drone ambulance carrying a defibrillator and instructions for various first aid techniques are currently in operation [14]. Continuous surveillance is crucial yet challenging to get with a handheld camera. By deploying a drone with professional cameras on board, they can more easily get the ideal shot [17]. Utilizing the drone's accessibility, it can be used for challenging jobs like military and rescue missions, allowing the special teams to conduct these operations with no chance of endangering human lives [16]. We may research and observe how the climate impacts the area and its habitats by using a drone to monitor large land areas and the animals that live there [15]. The purpose of this work is to present a conceptual design for a drone that can support firefighters in the event of a fire. In this sense, our goal is to reduce the number of fires that occur, particularly in Mexico City and the surrounding area. Fires harm not only the environment but also people's lives. As a result, this project is a conceptual design for a hex copter that can be operated remotely. There are constraints. Our concept focuses on the direct connection with the environment rather than the use of sensors and cameras, which are only capable of monitoring from the air. By releasing fire extinguisher bombs we can diminish the risk area and assist firefighters. The frame of the unmanned aircraft has six arms, and each arm has a brushless motor that enables the drone to carry its own weight as well as payload, a dispenser, and other objects. This dispenser is manually operated using the same input RC device as the drone and is situated underneath the drone so that it may release the cargoes freely. The drone must grow and lift capacity to accommodate an extinguisher bomb dispenser. The fundamental contribution of this study is the ability to use a drone to carry fire extinguisher spheres and release them over a specific target with excellent precision. This work also considers proposing a proof-of-concept of the firefighter drone.

1.6. Objectives

The main goal of this project is to design and implement a cost-effective Fire Fighting Drone. The approach is to detect fire and localization with thermal sensors, a GPS tracking system, and a moving thermal infrared camera mounted on an Unmanned Aerial Vehicle (UAV). They are also extinguishing the fire using a fire extinguisher ball.

1.6.1. Primary Objectives

- To enter buildings or warehouses to provide firefighters with eyes and ears in the impacted area in cases of explosive, or structural hazards.
- To increase the safety of firefighters and rescue teams.
- To provide situational awareness so that firefighters can identify hot-spots.
- To prevent the spread of and extinguish significant unwanted fires.
- To avoid putting humans in unsafe situations.

1.6.2. Secondary Objectives

- To reduce the development cost of different commercial Fire Fighting Drones.
- To Send a minimal delay live stream.
- To Raise firefighters' awareness of the value of using modern rescue technologies.

1.7. Organization of Book Chapters

The organization of the remaining parts of this book is as follows:

Chapter-2: Literature Review with in-depth investigation

In this chapter, 1.1. Related Research Works of system, older and earlier research works have been analyzed properly. The validity and accuracy of the existing solution have been mentioned and a wide range of research works have been analyzed. Related research works have been analyzed thoroughly for the betterment of this project. Critical specialist engineering knowledge and state-of-the-art technology have been described.

Chapter-3: Project Management

S.W.O.T. analysis, Project schedule management, cost analysis, P.E.S.T. analysis, individual accountabilities, multidisciplinary components management, and project lifecycle have been described in this chapter of the book.

Chapter-4: Methodology and Modeling

The methods that have been used to develop this project such as flowchart, block diagram, 3d design used for modeling purposes, required software that has been used, etc. are described in this part of the book.

Chapter-5: Implementation of Project

In this part of the book, the working principle, methodology, required Software Tools and Hardware components have been discussed in detail. The simulation process of the whole circuitry and full prototype setup has been described thoroughly. Required software for simulation, the full circuit in simulation, designed prototype, and full setup also have been shown.

Chapter-6: Results Analysis & Critical Design Review

In this part of the book, the expected result outcomes have been analyzed properly. Simulated results have been described properly, and parameters have been that were required to measure to verify the proposed model, also the logic sequence of loads for each of the rooms has been described thoroughly in tabular format, and software observations have been revised to meet the expected values.

Chapter-7: Conclusion

The summarized findings have been discussed in this chapter. The novelty of the work, project finance, project sustainability, and future scopes, recommendations on future developments, limitations of the work ethical concerns have been described also.

Chapter 2

PROJECT MANAGEMENT

2.1. Introduction

We have chosen to make a drone which can be used for surveillance to find any survivor and it can also detect the victims in dire situation. We want to make this IOT based where it can take its own decision after a few simple commands. We team members co-operated to design and implement this project. We first held a meeting together to properly plan and arrange the necessary steps for this big project. Then we reviewed literatures similar to this project as many as we can to make this project possible. We then arranged a long-term schedule for this project. We all first divided this project in different parts to lessen the pressure for our team members. Then we researched the materials needed to make a "Fire-Fighting drone" which can detect through thermal and sonar sensor and can send images through camera in high temperature.

2.2. S.W.O.T. Analysis

2.2.1. Strengths

- First of all, this project can bring a new and innovative approach to solving the current situation of fire hazard.
- It can be implemented in real life which will be beneficial to all the common people and the fire-fighters who are fighting with their lives to save the victims who are trapped in fire.
- This project can be well designed and well-structured with proper materials for achieving the goals needed for this project.
- When it is manufactured and publicized correctly, we can make it available in our country.

2.2.2. Weakness

- **Cost Constraints:** The development and deployment of the drone system may be expensive, which can present a challenge for the project team in terms of securing funding and resources.

- **Maintenance and repair:** The drone may require frequent maintenance and repairs which could be costly and time-consuming.
- **Weather and Environment condition:** The drone's ability to operate effectively can be affected by the adverse weather conditions and environment such as too much temperature and high fires, strong winds and heavy rain, which can hinder its ability to fly or navigate properly.
- **Dependence on external technology:** The drone's ability to function effectively is reliant on the availability and reliability of external technologies such as GPS and wireless networking. If these systems fail or are unavailable, the drone may be unable to navigate or communicate effectively.
- **Legal and Regulatory hurdles:** Strict legal and regulatory constraints may apply to the use of drones in firefighting and survivor discovery, which could make it difficult for the project to get the appropriate rights and approvals.

-

2.2.3. Opportunity

- The project has the potential to improve firefighting and survivor detection capabilities.
- The project could help reduce the loss of life and property due to fires.
- The project could help improve the efficiency of firefighting operations.
- The project could help reduce the cost of firefighting operations.
- The project could help improve the safety of firefighters.
- The project could help improve the safety of civilians.

2.2.4. Threats

- One of the main threats of this project is that the drone may not be able to detect all survivors in a fire.
- Another threat is that the drone may not be able to navigate through the fire to get to the survivors.
- The drone may also have difficulty communicating with the survivors to let them know it is coming to help.
- The drone may not be able to carry enough supplies to help all of the survivors.
- The drone may not be able to stay in the air for long enough to reach all of the survivors.

- The drone may not be able to withstand the heat and smoke of the fire.

2.3. Schedule Management

We project team divided our schedule in three phases.

Phase 1: Project Planning

- Defining project scope and objectives.
- Develop project schedule and budget.
- Identifying and securing necessary resources.

Phase 2: Design and Development

- Research and evaluation of potential technologies for use in the drone.
- Design of drone hardware and software.
- Developing the drone.
- Testing and debug of the Drone.

Phase 3: Testing and Validation

- Conducting field tests of the drone.
- Analyzing the test results and making necessary modifications.
- Conducting additional tests as needed.

The Gantt Chart of the schedule of our project is shown below in Figure 2.2.

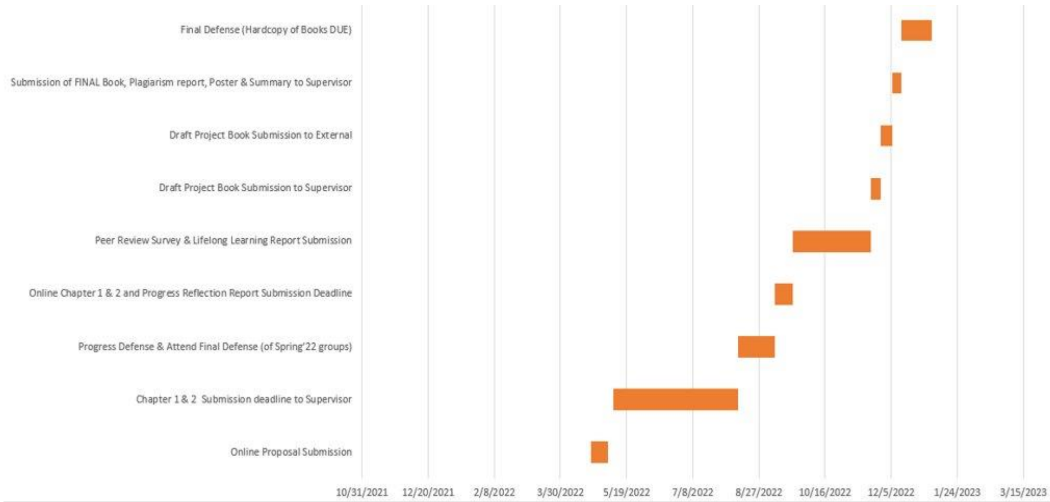


Figure 2. 1 Schedule of the Project

2.4. Cost Analysis

Serial	Amounts	Components	Price(TK)
1	4	Motor	3196
2	2	Arduino R3	2200
3	4	Propeller	420
4	4	ESC	4800
5	1	Frame	2100
6	1	esp32-cam	980
7	1	Ultrasonic Sensor	95
8	1	Gas Sensor (MQ2)	157
9	1	12c LCD	390
10	1	Flame Sensor	49
11	1	wire (m-f, f-f)	185
12	1	GPS module	606
13	1	Thermocouple	450
14	1	Breadboard Jumper wire set	200
15	1	5v fixed Output DC-DC step-down Converter	180
16	1	Heat Shrink Tube	70
17	1	Solder Lead 32 Gram	95
18	1	Fly Sky FS-i6 2.4G 6ch Transmitter with FS-iA6 Receiver	6000
19	1	5v 2A power Adapter	200
		Total Cost	22373

Table 2.1: Cost Analysis of Project with standard deviation part 1

Table 2.1 is our actual cost for this project. Though it has slightly crossed our estimated price range which was around 18000 (Eighteen thousand) taka. Because of the sudden rise of the price of Dollar currency, the electrical components price has raised too much. It was a hassle in our work. Also, we needed a few equipment for our projects.

Table 2.2 our estimated cost table that we had before buying the necessary components.

Serial	Amounts	Components	Price(TK)
1	4	Motor	2900
2	1	Arduino R3	1050
3	4	Propeller	400
4	4	ESC	4000
5	1	Frame	1500
6	1	esp32-cam	894
7	1	Ultrasonic Sensor	95
8	1	Gas Sensor (MQ2)	157
9	1	12c LCD	350
10	1	Flame	49
11	1	wire (m-f, f-f)	185
12	1	GPS module	590
13	1	Thermocouple	416
14	1	5v fixed Output DC-DC step-down Converter	180
15	1	Heat Shrink Tube	70
16	1	Fly Sky FS-i6 2.4G 6ch Transmitter with FS-iA6 Receiver	5160
		Total Cost	17996

Table 2.2: Cost Analysis of Project with standard deviation part 2

2.5. P.E.S.T. Analysis

PEST analysis is a framework used to analyze the external factors that can affect a project, business, project or organization. These factors or aspects can be categorized into 4 parts: Political, Economic, Social, and Technological. Here is the pest analysis of the “Design and Implementation of an IoT-based Firefighting and Survivor Detection Drone” project –

Political

- There may be legal and regulatory issues related to the use of drones for firefighting and survivor detection.

- There may be potential objections or resistance from the local authorities or communities.

Economic

- Cost of designing and implementation of the drone system can be varied through the progress and further development of this project.
- There are potential financial benefits of using drones for firefighting and survivor detection, such as reduced costs and increased efficiency.

Social

- In our survey when we were preparing for this project, we saw different public perception of using firefighting drones. Many had different opinions and different perception regarding this new system.
- Public also had potential ethical considerations such as privacy concerns or concerns about using the drones in emergency situations.

Technological

Since internet is available in our country, there are also many areas in our country that don't have good or updated networks like 3G or 4G which can be a hassle for using drone in those areas.

- There are also few challenges such as technical limitation or security risks which we will discuss briefly in later chapters.

2.6. Professional Responsibilities

We will discuss about what are the professional responsibilities of engineers related to our project topic.

2.6.1. Norms of Engineering Practice

- **Ensuring the safety and reliability of the drone**

  An Engineer is responsible for designing and implementing the drone in a way that ensures it is safe to use and reliable in emergency situations. This may involve incorporating fail-safe mechanisms, testing the drone under various conditions, and using materials and components that are resistant to damage.

- **Ensuring compliance with regulations and standards**

  An Engineer must ensure that the drone meets all relevant regulations and standards, including those related to aviation, safety, and privacy. This may involve obtaining necessary approvals and certifications, as well as incorporating features that meet these requirements.

- **Protecting sensitive data**

  An Engineer must ensure that the drone's data collection and transmission systems are secure and that personal data is protected in accordance with relevant laws and regulations. This may involve using encryption technologies, implementing robust security measures, and adhering to data privacy best practices.

- **Maintaining ethical standards**

  An Engineer must act ethically and in the best interests of the public at all times. This may involve refusing to participate in projects that could cause harm, speaking up if they see colleagues engaging in unethical behavior, and adhering to codes of conduct and professional standards.

- **Communicating Effectively with Stake holders**

  An Engineer must be able to clearly communicate their work and findings to a range of stakeholders, including project sponsors, colleagues, and the public. This may involve preparing reports, presentations, and other materials, and presenting them in a clear and understandable manner.

2.6.2. Individual Responsibilities and Function as Effective Team Member

As we are doing this project, we each divided our responsibilities as team members to make the work easy to do. We divided our works in three sections,

- **Design and Implementation**
  One member was responsible for designing the overall structure and functionality of the drone, including its sensor systems, navigation capabilities, and communication capabilities. Every member worked closely with one other to ensure that all components are properly integrated and functioning as intended.

- **Software Development:**
  2nd team member was responsible for writing codes in the software and developing algorithms that would enable the drone to navigate and detect fires and survivors. He worked closely with the 1st member to ensure that the codes were compatible with the hardware and meets the project's technical requirements.

- **Project Management**
  The 3rd member was responsible for overseeing the entire project, including coordinating the work of the other two team members, managing the budget and timeline and communicating with knowledgeable people. He played a critical role in ensuring that the project was completed on time and within the price range and all team members were working effectively and efficiently.

2.7. Management Principles and Economic Models

There are several engineering managements models and principles that could potentially be followed in the "Design and Implementation of an IoT Based Firefighting and Survivor Detection Drone" project. For this project we followed the waterfall method.

The waterfall model involves breaking the project down into sequential stages, such as requirements gathering, design, implementation, testing, and deployment. Each stage must be completed before moving on to the next stage.

For this project we first created a list of requirements where the cost, necessary materials were noted for us to organize our works. Then we created a design of the Fire Fighting drone with necessary components and sensors by using simulation. We coded by using IDE software for Arduino and used other software for the GSM and GPS navigation system. After that, we bought all the equipment and implemented them sequentially so that there is disruption or mistakes in the implementation. Then we tested if the codes are running properly for the Arduino and the other sensors and the receiver. Though there were a few errors at first. But we were able to fix them accordingly. In the end, we deployed the drone in the open field for final test.

2.8. Summary

The "Design and Implementation of an IoT-Based Firefighting and Survivor Detection Drone" project was managed systematically and effectively to ensure its successful completion. We began by conducting thorough research and gathering necessary resources to understand the requirements and challenges of the project. We then developed a clear project plan with defined goals, milestones, and timelines to guide the project execution.

We followed an agile development methodology to ensure regular progress and flexibility to adapt to any changes or challenges that may arise. Regular meetings and progress reports were held to track the progress and identify any issues that needed to be addressed. We also implemented a robust testing and quality assurance process to ensure the drone's functionality and reliability.

To ensure successful communication and collaboration, we utilized various tools and platforms such as project management software, video conferencing, and online task tracking. We also established clear roles and responsibilities among team members to ensure smooth operation and coordination.

Overall, the systematic and effective management of the project enabled us to complete the project on time and within budget, resulting in a successful outcome.

Chapter 3

METHODOLOGY AND MODELING

3.1. Introduction

In this chapter, the methodology and modeling of the project are described. The methodology is explained using a flow chart, and the basic idea of the project is presented through block diagrams. The prototype of the project is also shown, along with the orientation of the components within it. The proposed system is modeled to provide insight into the circuit design and architecture. The project is designed to be helpful in observing and controlling the overall scenario.

This research aims to uncover project management characteristics in order to improve the working process, progress, and project success. IoT technology is used in the drone system that will provide valuable information to the firefighters with the help of cameras and sensors. The project will be beneficial for firefighters to evaluate situations like checking if there is a human trapped inside or were there any combustible components in the area near the fire, check for harmful gasses if any and assess a plan of action accordingly. There are several basic engineering theories and methods that were applied to the design and operation of firefighting drones. These include:

- Control systems: The design and implementation of systems that allow the drone to be controlled and navigated in a precise and reliable manner. This includes the use of sensors, feedback loops, and algorithms to monitor and adjust the drone's position and orientation.
- Power systems: The design and selection of power sources and propulsion systems for drones, including electric motors, batteries, and fuel cells.
- Human-machine interface (HMI): The design of the controls and displays that allow operators to interact with the drone, including joystick controls, touch screens, and voice commands.
- Safety engineering: The design and implementation of safety systems and protocols to ensure that the drone can be operated safely and without causing harm to people or property.
- Environmental engineering: The consideration of the environmental impact of drone operations, including noise, air pollution, and wildlife impacts.

3.2. Block Diagram and Working Principle

Block Diagram

In this project, an Arduino Uno microcontroller is powered by a 2200mAh Li-Po battery. The Arduino Uno is equipped with an Atmega 328 microcontroller, which is part of the AVR series. The project also includes a flame sensor, a smoke sensor (MQ2), a temperature sensor (Thermocouple), a GPS sensor, an ESP32-CAM, and a GSM Arduino shield.

The flame sensor, smoke sensor, and temperature sensor are used to detect fires and send an alert through the Arduino to the cloud and via a message. If the smoke sensor reads a concentration of more than 500 ppm or the temperature is over 70 degrees Celsius, an alert will be sent through the app and via a message. The ESP32-CAM streams surveillance video through a local cloud server, and the GSM Arduino shield broadcasts data using messaging and the Blynk app via the Blink server. In Figure 3.1 the fire detection system is explained using block diagram.

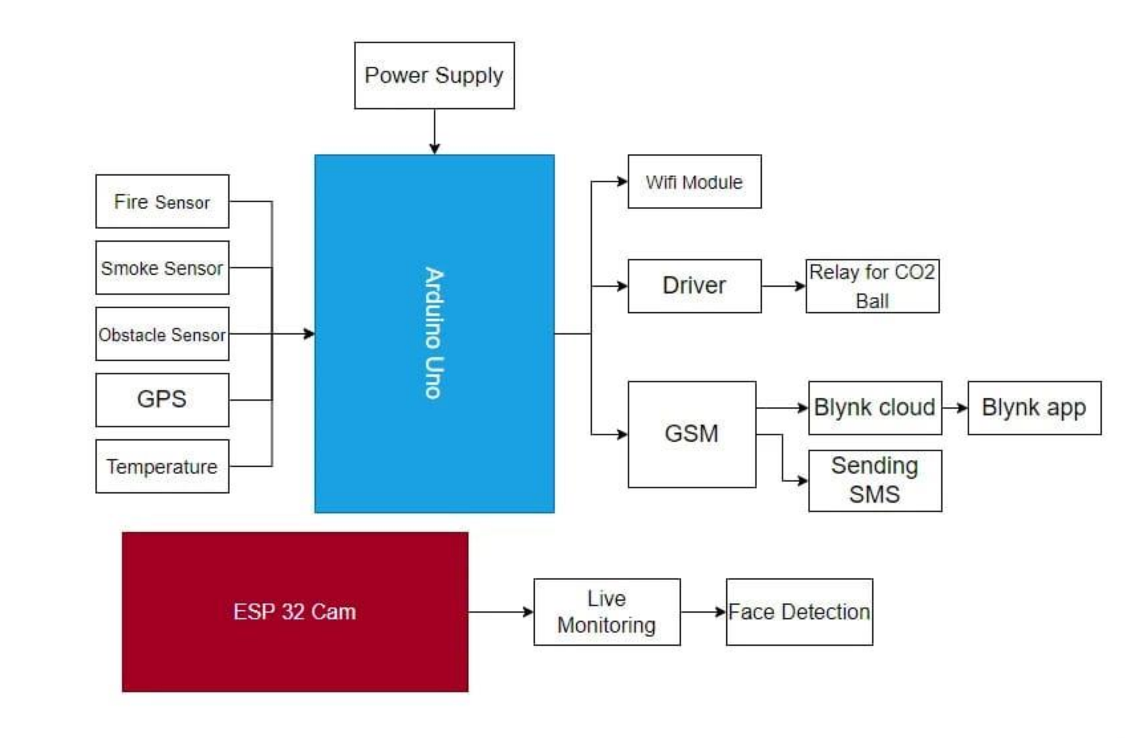


Figure 3. 1 Block Diagram of Fire Detection and Alert System

For flying the drone, we are using Arduino as flight controller and MPU6050 for gyro detection which is connected with receiver. One side Four Esc are connected Four brushless motor and side is to battery via drone board. A signal wire from each esc is connected to digital pin of Arduino and every ground pin is connected to ground in Arduino ground point. MPU6050 and receiver are both powered by 5v, which is supplied by Arduino. Receiver channel one to four is connected to Arduino in Digital Pin eight to eleven to communicate with ESC's. Arduino SCL, SDA pins are connected to MPU 6050 SCL, SDA pins to detect gyro change. The whole system is powered by a LI-Po battery. In Figure 3.2 whole system is shown using a block diagram.

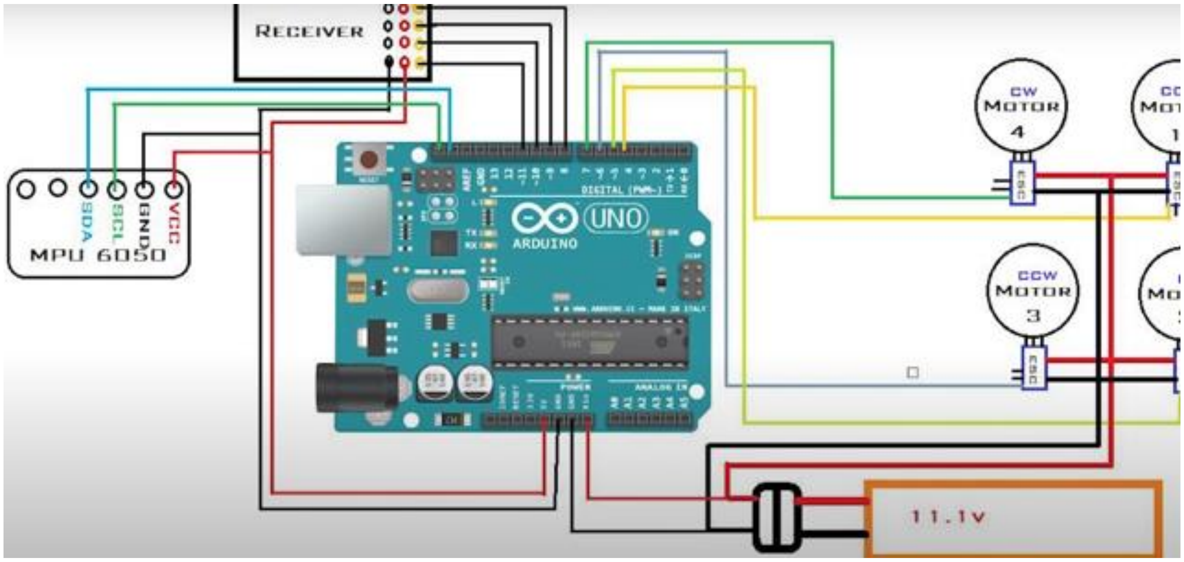


Figure 3. 2 Block Diagram of Fire Detection and Alert System [19]

Flow Chart

The purpose of the flowchart is to show the process and goals of the project, which includes detecting the presence of fire, finding survivors, and establishing a human-machine interface. The coding for this project was done using Arduino, and priority levels were established for the different tasks. The prototype of the project is designed to automatically respond to different levels of fire severity, as indicated by the flame sensor, smoke sensor, and temperature readings. When a flame is detected, a fire alert and location will be sent via app and message. Similarly, when the smoke sensor reading exceeds 500ppi and the temperature is over 70 degrees Celsius, a fire alert and location will be sent. In the case of a high flame and high smoke and temperature readings, a fire alert and location will also be sent. In Figure 3.3 the system is being described by Flow Chart.

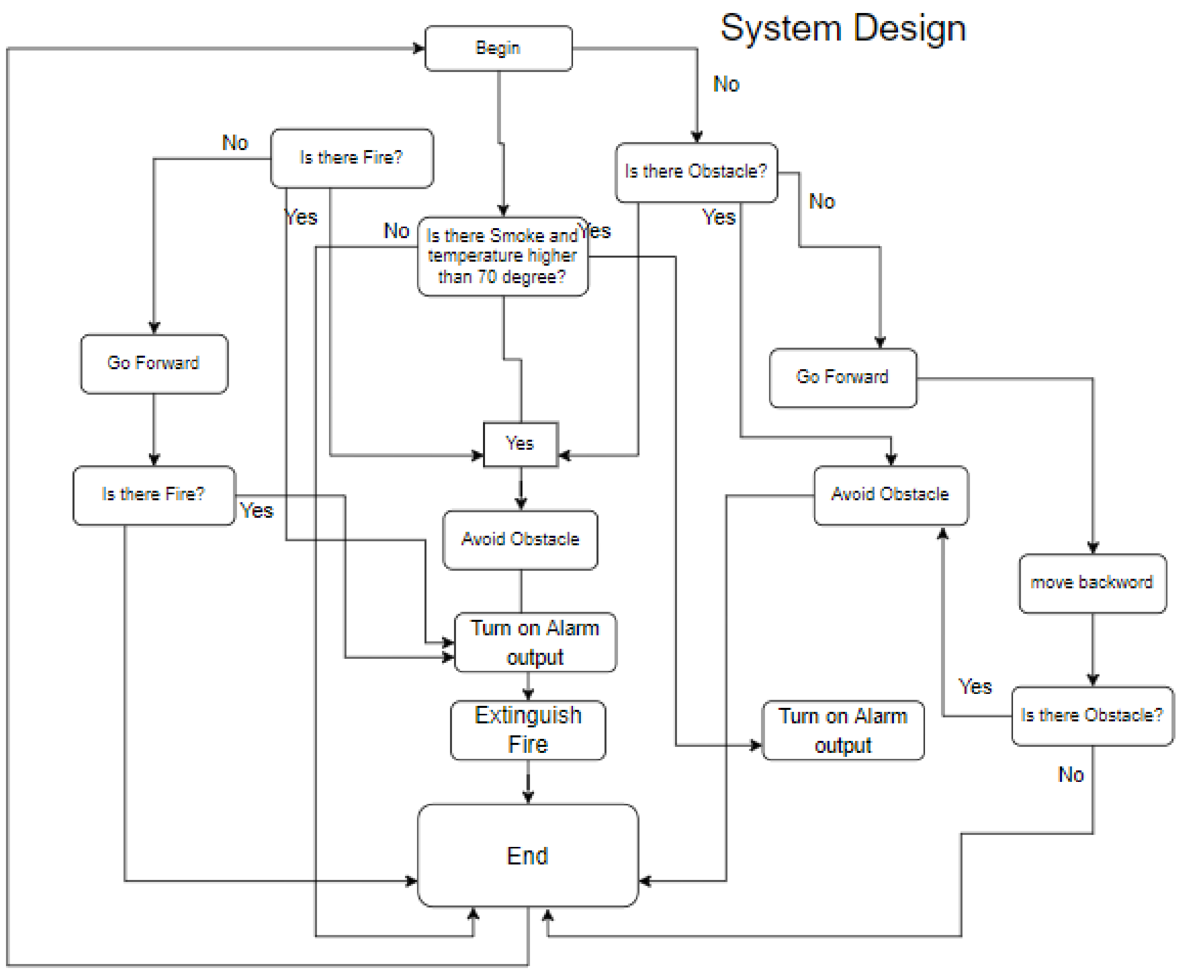


Figure 3. 3 Flow Chart of Fire Detection and Alert System

3.3. Modeling

Blender was used to create a 3D model of the firefighting drone. This software is a powerful tool for creating 3D models, animations, and simulations, and is widely used in a variety of industries.

Fritzing was used to design the electronic circuit for the drone. This software allows users to visually lay out a circuit using a range of pre-defined components and connectors, and to test the circuit using simulated inputs and outputs.

Proteus 8.12 was used to simulate the circuit design and test the behavior of the drone under different conditions. This software allows users to design and simulate the behavior of circuits using a range of pre-defined components and connectors.

The Blynk app was used to monitor the sensor values and control the gripper, which is a device used to grasp and hold objects. This app allows the designers to remotely access and control the drone, and to receive real-time updates on its status and performance.

Finally, the flow chart and block diagram for this project were created using the draw.io software, which is a web-based diagramming tool. These diagrams provide a visual representation of the project's methodology and overall design, and can be used to understand the various steps and components involved in the project.

Overall, these software tools were used to design and test the firefighting drone, and to ensure that it was able to meet the desired performance and functionality requirements.

Software Requirements

Proteus 8.13 Software

Proteus 8.13 is a software tool that is commonly used in the design and simulation of electronic circuits. It is a powerful tool for prototyping and testing electronic circuits, and is widely used in the fields of engineering, education, and research.

Proteus 8.13 allows users to design and simulate the behavior of circuits using a range of pre-defined components and connectors. The software includes a comprehensive library of electronic components, including microcontrollers, sensors, actuators, and power sources. Users can visually lay out their circuits using these components, and can then simulate the circuit's behavior using different input and output conditions.

Proteus 8.13 also includes a range of analysis and debugging tools that can be used to test the performance of the circuit and identify any issues or problems. These tools include oscilloscopes, logic analyzers, and waveform generators, which can be used to measure and analyze the circuit's behavior.

Overall, Proteus 8.13 is a valuable tool for designing and testing electronic circuits, and is widely used in a variety of applications and industries.

Blender

Blender is a powerful and versatile 3D modeling, animation, and rendering software that is widely used in a variety of industries, including film, television, gaming, and architecture.

Blender is free and open-source, and is available for Windows, macOS, and Linux. It has a large and active user community, and is constantly being updated and improved.

Blender has a wide range of features and tools that make it suitable for a variety of tasks, including:

- Modeling: Blender includes a range of modeling tools that allow users to create and manipulate 3D objects and shapes. These tools include a range of primitives, such as cubes, spheres, and cylinders, as well as more advanced tools for sculpting, texturing, and UV mapping.

- Animation: Blender has a robust animation system that allows users to create complex and realistic movements and actions. It includes features such as key framing, inverse kinematics, and physics simulation, which can be used to create realistic character animation and object dynamics.
- Rendering: Blender includes a powerful rendering engine that can produce high-quality images and videos. It supports a range of rendering techniques, including ray tracing, path tracing, and global illumination, and can be used to create realistic materials and lighting effects.
- Simulation: Blender includes a range of simulation tools that can be used to create realistic physical effects, such as fluids, smoke, and fire. These tools can be used to create convincing special effects for films, games, and other visual media.

Overall, Blender is a powerful and versatile software that is widely used in a variety of industries, and is an essential tool for many 3D artists and designers.

Blynk

Blynk is a mobile application that allows users to remotely control and monitor devices and systems using their smartphones or tablets. It is designed to be user-friendly and accessible, and is widely used in a variety of applications, including home automation, robotics, and IoT (Internet of Things) projects.

Blynk works by connecting devices and systems to the Internet through a range of communication protocols, such as Wi-Fi, Bluetooth, and cellular networks. Users can then control and monitor these devices using the Blynk app, which provides a simple and intuitive interface.

The Blynk app includes a range of features and tools that make it easy to build custom control and monitoring systems. These features include customizable widgets, such as buttons, sliders, and gauges, that can be used to control and monitor different aspects of the system. Users can also create custom dashboards and notifications to stay up to date on the status of their devices and systems.

Overall, Blynk is a useful tool for remotely controlling and monitoring devices and systems, and is widely used in a variety of applications and industries.

draw.io

draw.io is a web-based diagramming tool that allows users to create and edit a wide range of diagrams and charts. It is a free and open-source tool that is available for use in a web browser, and does not require any installation or download.

draw.io includes a range of templates and shapes that can be used to create diagrams and charts for a variety of purposes, including flowcharts, mind maps, network diagrams, and organizational charts. It also includes a range of formatting and customization options, such as text formatting, line styles, and fill colors, which allow users to tailor the appearance of their diagrams to their needs.

Fritzing

Fritzing is a software tool that is commonly used in the design and prototyping of electronic circuits. It is specifically designed to be user-friendly and accessible to people with little or no experience in electronics.

Fritzing allows users to visually lay out a circuit using a set of pre-defined components and connectors. The software includes a library of electronic components, such as microcontrollers, sensors, actuators, and power sources, which can be dragged and dropped onto the workspace. Users can then connect these components using virtual wires, and can test the circuit using simulated inputs and outputs.

Fritzing also includes a range of analysis and debugging tools that can be used to test the performance of the circuit and identify any issues or problems. These tools include oscilloscopes, logic analyzers, and waveform generators, which can be used to measure and analyze the circuit's behavior.

Overall, Fritzing is a useful tool for prototyping and testing electronic circuits, and is widely used in a variety of applications and industries. It is particularly popular among makers, educators, and students who are interested in electronics and robotics.

3D Model

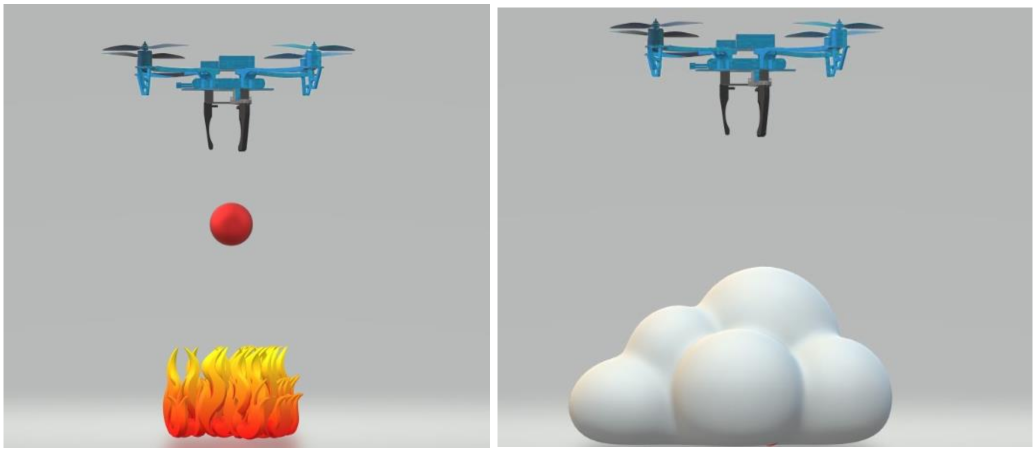
The 3D model shown in this project illustrates the design and structure of a possible firefighting drone, as well as its behavior when a fire is detected. The model was created using Blender, a 3D modeling and animation software. The 3D model and simulation can be used to visualize the operation of the drone and understand how it would respond to different scenarios.

The 3D model may include various components of the drone, such as the propellers, frame, sensors, and control systems. It may also show the movement and orientation of the drone as it responds to the presence of a fire. For example, the 3D model may demonstrate how the drone would navigate to the location of the fire, release a fire suppression agent, or communicate with a control center.

Overall, the 3D model and simulation can provide valuable insights into the design and operation of a firefighting drone, and can be used to optimize the performance of the drone for different firefighting tasks.

Figure 3.4 shows the shows the side view of the 3D model of our drone. Figure 3.5 (A) and Figure 3.6 (B) demonstrate the simulated result of our 3D model when fire is detected.

Figure 3.1 3D side views [5]



(A) (B)

Figure 3. 1 3D Simulation of the Drone [5]

Circuit Design

Fritzing is a software tool that is commonly used in the design and prototyping of electronic circuits. It is specifically designed to be user-friendly and accessible to people with little or no experience in electronics.

In the context of a firefighting drone, Fritzing can be used to design the circuit that controls the various components of the drone, such as the motors, sensors, and communication systems. The software allows the user to visually lay out the circuit using a set of pre-defined components and connectors, and to test the circuit using simulated inputs and outputs.

Using Fritzing, the designer can experiment with different circuit configurations and see how they affect the behavior of the drone. For example, they can test how the circuit responds to different sensor inputs or how it controls the motors and other actuators.

Overall, Fritzing is a useful tool for prototyping and testing electronic circuits, including those used in firefighting drones. It can help designers quickly and easily verify the functionality of their designs before building a physical prototype.

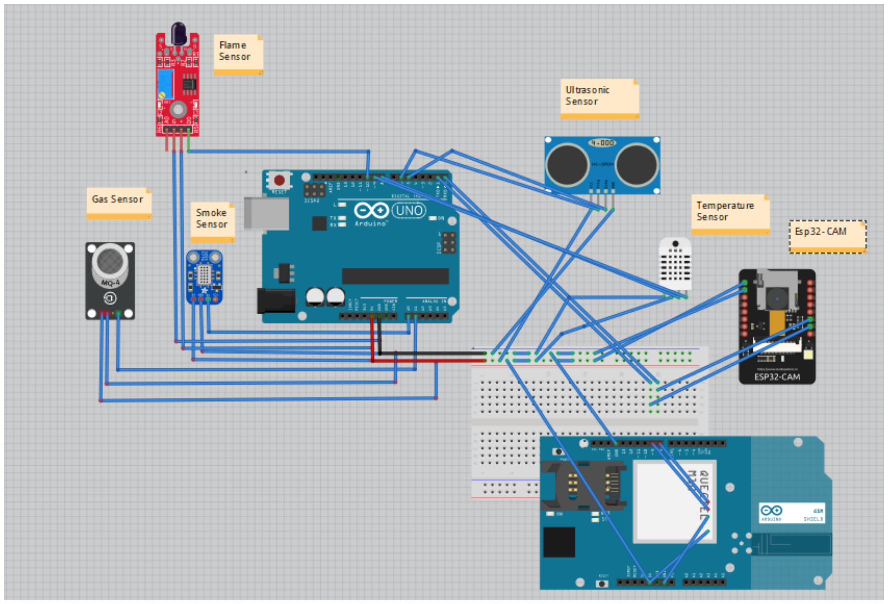


Figure 3. 2 Circuit Diagram of Fire & Survivor Detection Drone

3.4. Summary

In this chapter, the methodology of the project was described in detail, including the steps and processes involved in completing the project. It was emphasized that the project was done following a systematic and organized approach, using a range of software tools and other resources. A flowchart was also included in this chapter to illustrate the overall structure and flow of the project. The flowchart provided a clear and concise overview of the different stages of the project, and helped to demonstrate the logical progression of the work. In addition to the flowchart, a 3D model and a block diagram were also included to provide a visual representation of the project. The 3D model showed the physical structure and layout of the project, while the block diagram showed the various components and their connections, and helped to explain the role and purpose of each component. Overall, this chapter provided a thorough and detailed explanation of the methodology and structure of the project, and helped to clarify the process and purpose of the work. It described the use of various software tools and resources, and explained the purpose of each piece of equipment used in the project.

Chapter 4

PROJECT IMPLEMENTATION

4.1. Introduction

In order to implement this project, the team first had to understand the main theme of the fire detection system. Then we designed a block diagram based on this understanding, and selected the necessary components to build the system. The team then simulated the system using a range of software tools, but found that it was not possible to acquire live data in the simulation. As a result, we decided to move forward with the implementation of the project.

The overall prototype of the project was divided into two parts. The first part used an Arduino Uno as the flight controller for the drone, which was powered by a 2200mAh Li-Po battery and supplied power to four electronic speed controllers (ESCs) that were used to control the brushless motors. The second part used another Arduino for fire detection, IoT implementation, and gripper control. A GSM module was used to send alert messages and establish an IoT connection, while an esp32cam was used for live streaming.

The team chose to use two microcontrollers in this project because using just one microcontroller caused delays in the logic function, which impacted the overall performance of the system. By using two microcontrollers, we were able to improve the efficiency and reliability of the system.

4.2. Required Tools and Components

- **Software Requirements for Simulation**

  Simulation is an important step in the development of any system, as it allows engineers to test and optimize the system without the need for expensive or time-consuming physical prototyping. To perform simulation, engineers typically use software tools that allow them to build virtual models of the system and run simulations to test different scenarios and configurations.

  In this project, the team used Proteus 8.13, Figure 4.1 professional to simulate the system. This software was chosen because it offers a range of features and tools that are useful for simulation, including schematic capture, analog simulation, and a library of components and modules. The team used schematic capture to set up the fire detection and alert system in the simulation, and tested the sensor outputs and logic using realistic values from the sensors. The results of the simulation, including the alert message and location of the fire, were displayed in the virtual terminal of the Arduino Uno.

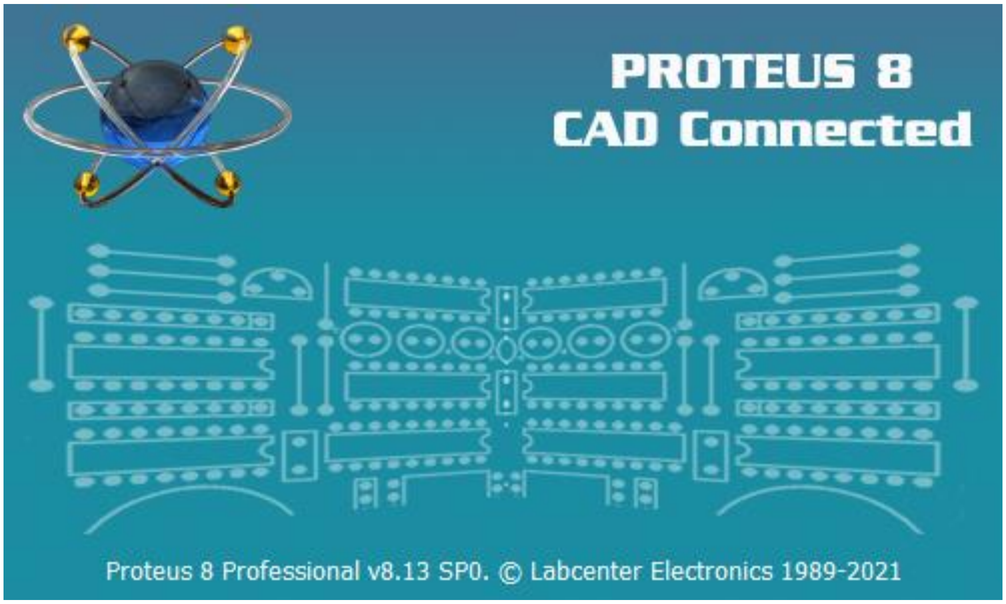


Figure 4.1 Proteus 8 software

Overall, simulation allows engineers to gain insight into the performance and behavior of a system, and helps to identify potential issues or problems before the system is built and deployed. By using simulation, the team was able to optimize the design of the system and gain confidence in its performance.

- **Hardware Requirements**

Drone

- Figure 4. 2 shows 1 x 450 size frame with integrated power distribution board

Figure 4. 2 Glass Fiber Quad copter Frame 480mm [20]

- Figure 4. 3 shows 4 x 400KV Brushless Out runner BLDC Motor

Figure 4. 3 400KV Brushless Out runner BLDC Motor [20]

- Figure 4. 4 shows 4 x 30A ESC

Figure 4.4 30A ESC [20]

- Figure 4. 5 shows 1 x 3S / 2200mAh / 20C li-po

Figure 4. 5 Li-Po Battery 2200mAh 11.1V 3S [20]

- Figure 4. 6 shows 1 x Arduino Uno R3

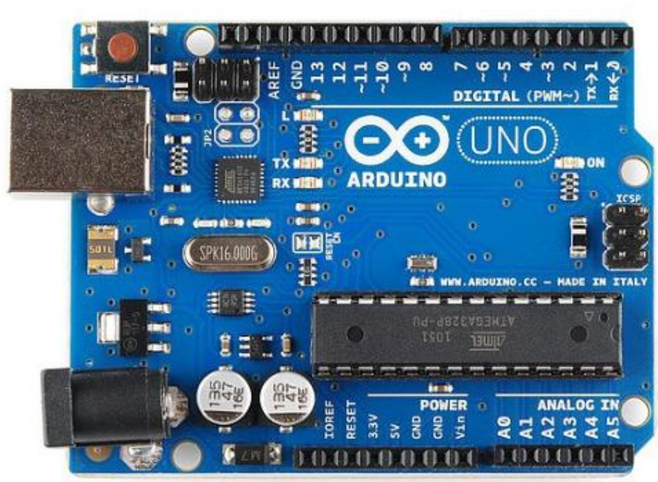


Figure 4. 6 Arduino Uno R3 [20]

- Figure 4. 7 shows 1 x MPU-6050

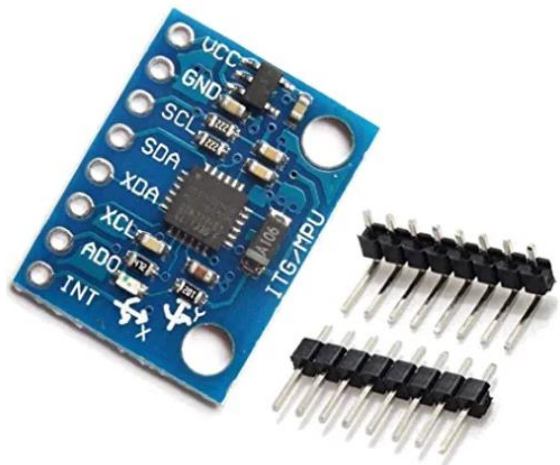


Figure 4. 7 6DOF MPU 6050 3 Axis Gyro [20]

- Figure 4. 8 shows 1 x Fly sky FS-i6 6-CH TX Transmitter and receiver

Figure 4. 8 FlySky FS-i6 2.4G 6CH AFHDS RC Transmitter With FS-iA6 Receiver [20]

- Figure 4. 9 shows 1 x 3S li-po battery charger

Figure 4. 9 B3 Pro Li-Po Balance Charger [20]

Fire Alert System and Surveillance

Flame sensor

Figure 4. 10 shows a flame sensor is a device that detects the presence of a flame or fire. It is often used in fire protection systems to trigger an alarm or activate a fire suppression system in the event of a fire. There are several different types of flame sensors, including optical sensors, ultraviolet (UV) sensors, infrared (IR) sensors, and microwave sensors. Optical flame sensors use a light-sensitive detector to detect the presence of a flame based on the light emissions from the flame. UV flame sensors detect the UV radiation emitted by a flame, while IR flame sensors detect the IR radiation emitted by a flame. Microwave flame sensors use microwave radiation to detect the presence of a flame. Flame sensors are often used in combination with other fire protection systems, such as sprinkler systems or fire extinguishers, to provide multiple layers of protection against fires. They are commonly used in industrial and commercial settings, as well as in residential and public buildings.

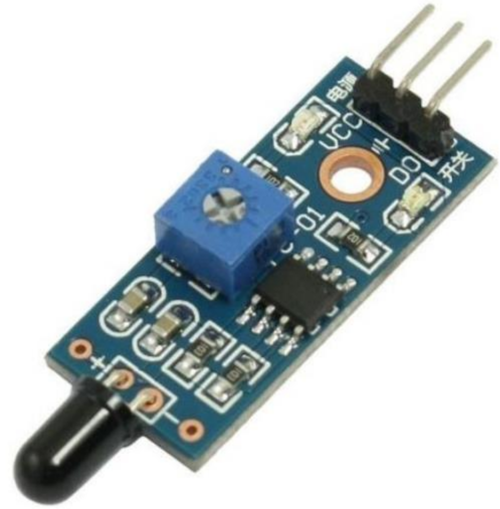


Figure 4. 10 Flame Sensor fire detection module for Arduino [20]

Ultrasonic sensor

Figure 4. 11 shows an ultrasonic sensor is a device that uses sound waves to measure distance or detect objects. It works by emitting a high-frequency sound wave and measuring the time it takes for the sound to bounce back after hitting an object. The distance to the object is then calculated based on the time it took for the sound wave to travel. Ultrasonic sensors can be used for a variety of applications, such as measuring distance for navigation, detecting obstacles for robotics, or measuring liquid levels in tanks. They can also be used for non-destructive testing, such as measuring the thickness of a wall or the depth of a hole. These sensors are typically small, low-cost, and easy to use, making them a popular choice in many applications.

Figure 4. 11 Ultrasonic Sonar Sensor HC- SR04 [20]

Smoke sensor (MQ2)

Figure 4. 12 shows a smoke sensor is a device that detects the presence of smokes in a certain region and is usually employed as a safety mechanism. A smoke detector can inform operators in the region where the leak is occurring. The threshold for our smoke sensor is 100ppm.

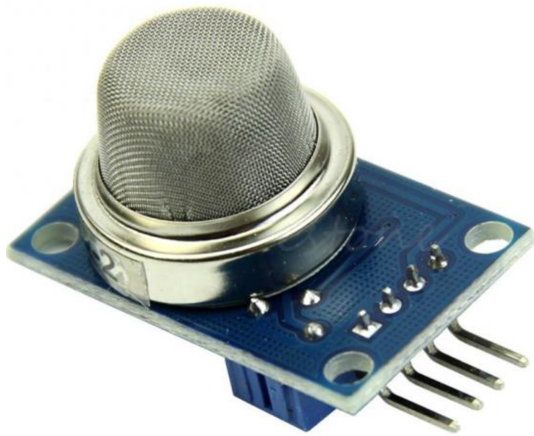


Figure 4. 12 MQ-2 Flammable Gas & Smoke Sensor [20]

Temperature sensor (Thermocouple)

Figure 4. 13 shows a thermocouple is a sensor that measures the temperature from the environment, although it converts the gathered data into electronic data and transfers it to the microcontroller. Operating Voltage of our sensor is (VDC): 3 to 5.5 and Temperature Range(°C): 0 to +1024. The sensor give data both in Celsius and Fahrenheit.

Figure 4. 13 MAX6675 Module + K Type Thermocouple Sensor [20]

ESP32 cam

Figure 4. 14 shows a ESP32-CAM, which is a low-cost, low-power system on a chip (SoC) that integrates a camera and a microcontroller. It is based on the Espressif Systems ESP32 microcontroller and features a small form factor, low power consumption, and a camera interface. The ESP32-CAM can be used for a variety of applications such as security systems, remote monitoring, and machine vision. It has a built-in camera module that supports JPEG and MJPEG image formats, and can be easily integrated with a variety of sensors and peripherals using its I/O pins. The ESP32-CAM also has built-in Wi-Fi and Bluetooth connectivity, making it easy to connect to the internet or other devices. To use the ESP32-CAM, one will need a computer with the Arduino Integrated Development Environment (IDE) installed, as well as a USB cable to connect the ESP32-CAM to the computer. After installing the necessary drivers and libraries to use the camera module. Once that has been set up the ESP32-CAM, it can use it to take pictures, stream video, or perform other tasks using the camera module and microcontroller.

Figure 4. 14 SP32-CAM Wi-Fi + Bluetooth Camera Module

Development Board ESP32 with Camera Module OV2640 [20]

ESP8266 ESP-01 WIFI Wireless Transceiver Send Receive

Figure 4. 15 shows a ESP8266 ESP-01, which is a wireless transceiver module that uses the ESP8266 chip from Espressif Systems. It is a low-cost, low-power solution that can be used to add WIFI connectivity to microcontroller-based projects. The ESP-01 module has a built-in antenna and can be used to transmit and receive data over a wireless network. It can be easily integrated with Arduino or other microcontroller boards using a serial interface, and can be programmed to communicate with other devices using the popular AT

command set. The ESP-01 module can be used for a variety of applications, including home automation, sensor networks, and Internet of Things (IoT) projects.

Figure 4. 15 ESP8266 ESP-01 WIFI Wireless Transceiver

Send Receive LWIP AP+STA M70 [20]

Arduino Uno (2nd)

Figure 4. 16 shows the second Arduino Uno is used in our project, which a microcontroller board based on the ATmega328 microcontroller. It will be used as flight controller for our drone. It is a popular platform for beginners to learn electronics and programming, as it is relatively simple to use and has a large community of users and developers.

The Arduino Uno has a number of features that make it easy to use and customize. It has 14 digital input/output pins, 6 analog input pins, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It also has a number of built-in libraries that allow you to control a wide range of sensors and actuators, such as LEDs, motors, and LCD displays.

To work with an Arduino Uno, the Arduino Integrated Development Environment (IDE) must be installed on a computer to write and upload code to the board. The Arduino Uno can be used to create various projects, such as robots and home automation systems, because it is compatible with numerous sensors and actuators.

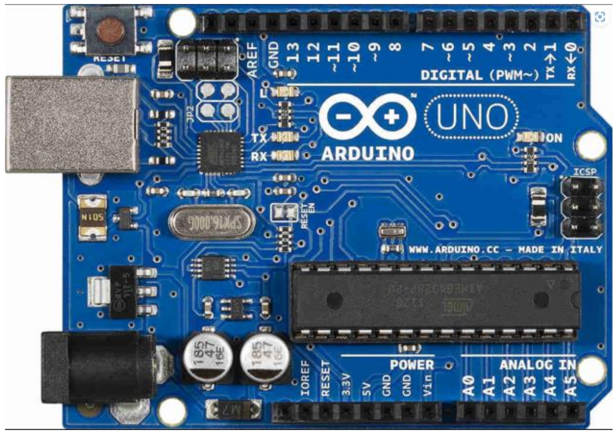


Figure 4. 16 Arduino Uno R3 [20]

4.3. Implemented Models

The main body of the project was constructed using lightweight plastic and metal materials. It was equipped with a range of components and sensors, including an Arduino Uno microcontroller, a GSM module, servo motors for drone control, and an ESP32 camera. These components were used to monitor the environment and provide surveillance capabilities. The system was designed to communicate with the user wirelessly via the internet, using an app that allowed the user to access and control the system remotely. The app provided a user-friendly interface that allowed the user to view and evaluate the situation, and to control the system as needed.

Overall, the main body of the project was designed to be lightweight and portable, with a range of smart features that allowed it to communicate with the user and respond to changing conditions in the environment.

4.3.1. Simulation Model

Components

- Component Model:
- Flame sensor
- Smoke sensor (MQ2)
- Temperature sensor (LM35)
- GPS Module
- Driver (L293D)
- 12c LCD
- Relay
- SIM900D
- Ultrasonic sensor

- Logic toggle
- Potentiometer
- DC Motor

Simulated Model

In this project, a flame sensor, smoke sensor (MQ2), temperature sensor, GPS sensor, GSM module, and four motors with a driver shield are connected to an Arduino microcontroller. The flame sensor, smoke sensor, and temperature sensor send data to the Arduino, which is used to monitor the environment and detect the presence of fire. The GSM module broadcasts values and sends fire alerts by messaging and using the Blynk app and Blynk server. If the flame sensor detects a high level of flame, the system will send a fire alert and the location of the fire to the user via the app and a message. If the smoke sensor readings are over 500ppi and the temperature is over 70 degrees Celsius, the system will send a fire alert and the location of the fire to the user via the virtual terminal. If both the flame sensor and the smoke sensor detect high levels of flame and smoke, and the temperature is over 70 degrees Celsius, the system will send a fire alert and the location of the fire to the user via the virtual terminal. The simulated model is shown below in Figure 4. 17.

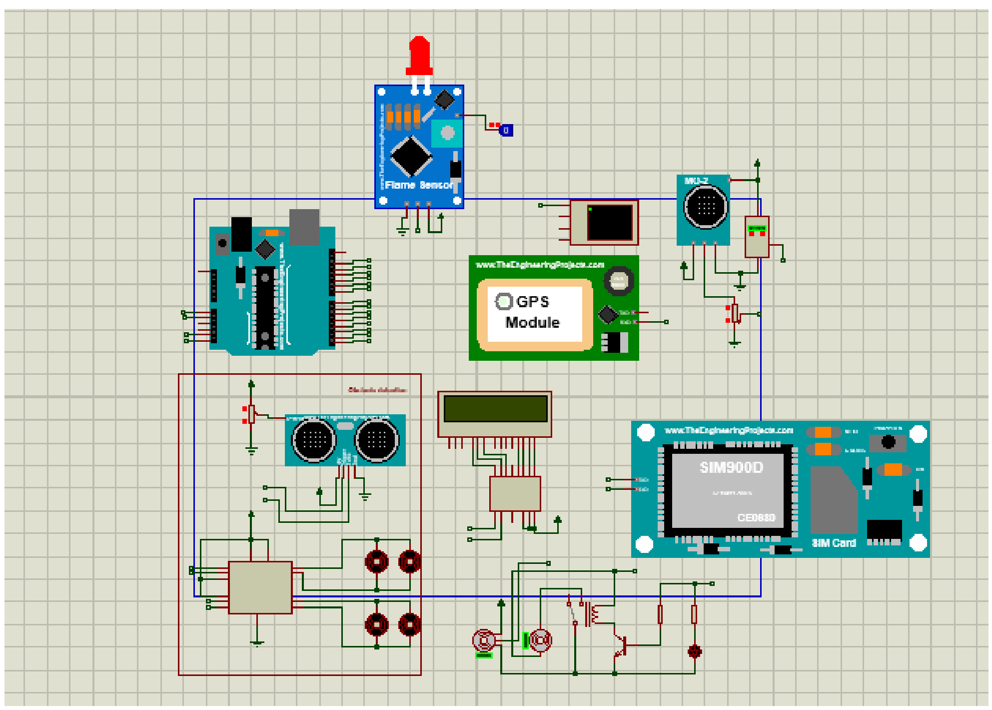


Figure 4. 17 Simulated Model in Proteus

4.3.2. Hardware Model

Hardware implementation can be a time-consuming and costly process, but simulation can help to streamline the development of a prototype. In the case of our firefighting drone project, we found that some changes had to be made to the prototype compared to the simulated version. To optimize the performance and efficiency of the system, we decided to divide the prototype into two parts, with one part focused on flight control and the other on fire detection and IoT implementation. By dividing the prototype in this way, we were able to improve the speed of data acquisition and overall functioning of the system. For IoT implementation esp8266 ES-01 was use instead of GSM module because of its performance, easy implementation and sustainability over GSM module. Two separate Arduino are used in this project, one as flight controller and another for sensor value capture, IoT implementation and live steaming. For live steaming esp32-cam is used and it is controlled and powered by Arduino. For controlling the drone Fly Sky iA6 was used as transmitter. Figure 4. 18 shows the hardwire model of Fire Fighting Drone and Figure 4. 19 shows the implementation of the hardwire model.

Figure 4. 18 Hardwire model of Fire Fighting Drone

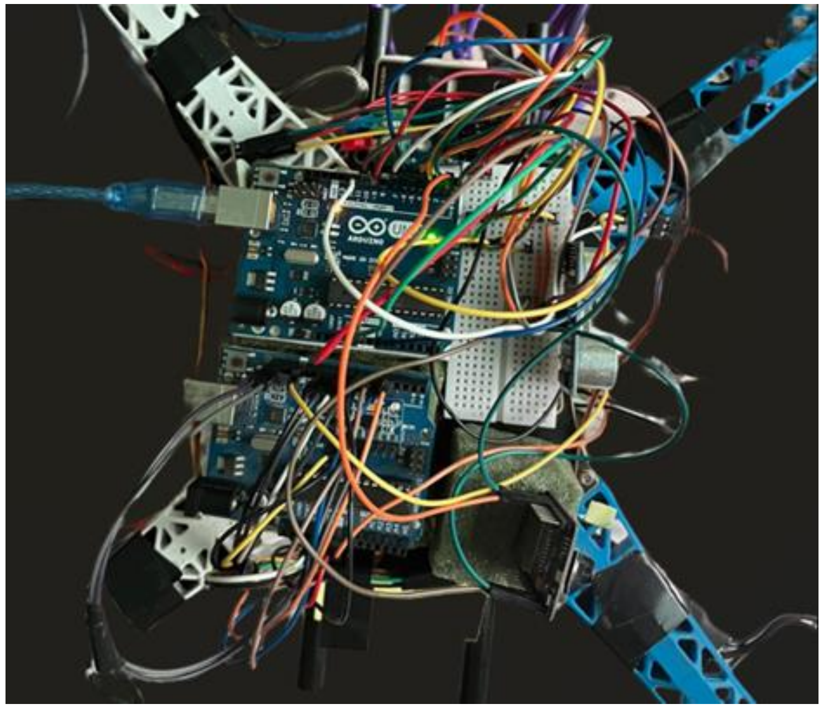


Figure 4. 19 Hardwire implementation

4.4. Engineering Solution in accordance with professional practices

As the designers and operators of our proposed firefighting drone system, we have taken several steps to ensure that it aligns with professional practices in the field. Some of the ways in which we have done this include:

- **Compliance with regulations**

We have ensured that our drone and the system as a whole are operated in compliance with all relevant regulations and safety guidelines. This includes obtaining necessary permits and certifications, and adhering to established protocols and procedures.

- **Use of proven technology**

We have equipped our drone and other components of the system with reliable and proven technology that has been thoroughly tested and validated. This includes sensors and cameras that are specifically designed for firefighting applications, as well as robust communication and navigation systems.

- **Collaboration with other agencies**

We have established clear protocols and procedures for collaboration and coordination with other agencies and organizations, such as fire departments, search and rescue teams, and environmental agencies.

- **Continuous improvement**

We have designed and operated our drone and the system as a whole in a way that allows for continuous improvement and optimization. This includes regular maintenance and upgrades, as well as ongoing training and development for pilots and other personnel.

- **Risk management**

We have carefully assessed and managed the risks associated with the operation of our firefighting drone, including potential hazards to the drone itself, to personnel, and to the surrounding environment.

Though we could not control fly the drone properly, but enough time invested it can be controlled properly.

Overall, we believe that our proposed firefighting drone system aligns with professional practices by prioritizing safety, reliability, and effectiveness, and by aiming to contribute to the broader efforts of the firefighting and emergency response community.

4.5. Summary

In this chapter, we presented the simulated circuit and the prototype design of our firefighting drone project. To begin, we first gained a thorough understanding of the purpose of the fire detection system. Based on this understanding, we designed a block diagram and selected the necessary components for the system. We then used various software tools to create simulations of the system, but found that it was not possible to acquire live data during these simulations. As a result, we proceeded with the implementation of the physical prototype, which was divided into two main parts. The first part used an Arduino Uno as the flight controller for the drone, while the second part utilized another Arduino for fire detection and IoT implementation. To enhance the performance and reliability of the system, we employed two microcontrollers rather than just one. Overall, our prototype design and simulated circuit were integral to the development of our firefighting drone system.

Chapter 5

RESULTS ANALYSIS & CRITICAL DESIGN REVIEW

5.1. Introduction

This project aims to utilize drones to monitor environmental sites that have been affected by natural disasters such as fires. By surveilling the environment, providing emergency assistance, and establishing communication with the user through the internet to cloud servers, the system can help to make the response to such disasters more effective. To achieve this goal, we have employed a range of sensors, including a flame sensor, a smoke sensor (MQ2), a temperature sensor (Thermocouple), and a GPS sensor, which are all connected to an Arduino board. These sensors are used to evaluate the environment, gather data, and transfer it through the internet to a cloud server. If the sensors detect certain parameters, such as infrared light with wavelengths between 700 nm and 1000 nm (flame sensor), combustible gases at a level of over 500 ppm (smoke sensor), or high temperatures (temperature sensor), the system will alert the user to the presence of a fire and provide the location through the cloud server via the internet. In addition, an ESP32-cam is used to draw power from the Arduino board and stream surveillance video through a local cloud server, while a GSM module is used to send alert messages and establish an IoT connection through Blynk app. We have also employed an open AI system to perform face detection, using AI algorithms and machine language to distinguish human faces from the background. By using these components and techniques, our proposed system is able to effectively meet the needs of this application. In this chapter, we will discuss the critical design review as well as the results of our analysis.

5.2. Results Analysis

In this chapter, the overall system was described in detail, including the results of each component and how they functioned within the system. The findings were presented and analyzed with relevant theoretical explanations and logical reasoning. The purpose of this was to provide a thorough understanding of the system and how it worked, as well as to evaluate the effectiveness of each component in achieving the goals of the project. The results of this analysis were used to identify any areas for improvement and to develop strategies for future development and refinement of the system.

5.2.1. Simulated Results

Figure 5. 1 illustrates the fire detection results in Proteus software. Here the flame sensor is used with an Arduino Uno and a GSM module, when the sensor detects infrared lights in a range of 700 nm to 1000 nm. It will alert the user via GPS module through the internet and massage fire alerts. Here are the figures of Flame sensor when fire is detected through the sensors and the sensor is low.

Corresponding Figures 5.1 to Figure 5.4 shows that the fire sensor is detecting the fire to move forward or backward and if the fire is high it will send an alert message similar to figure 5.3. Figure 5. 5 show location detection through GPS and gas sensor detecting any smoke or fire. Figure5. 5 shows drone being back to normal motion in normal situation.

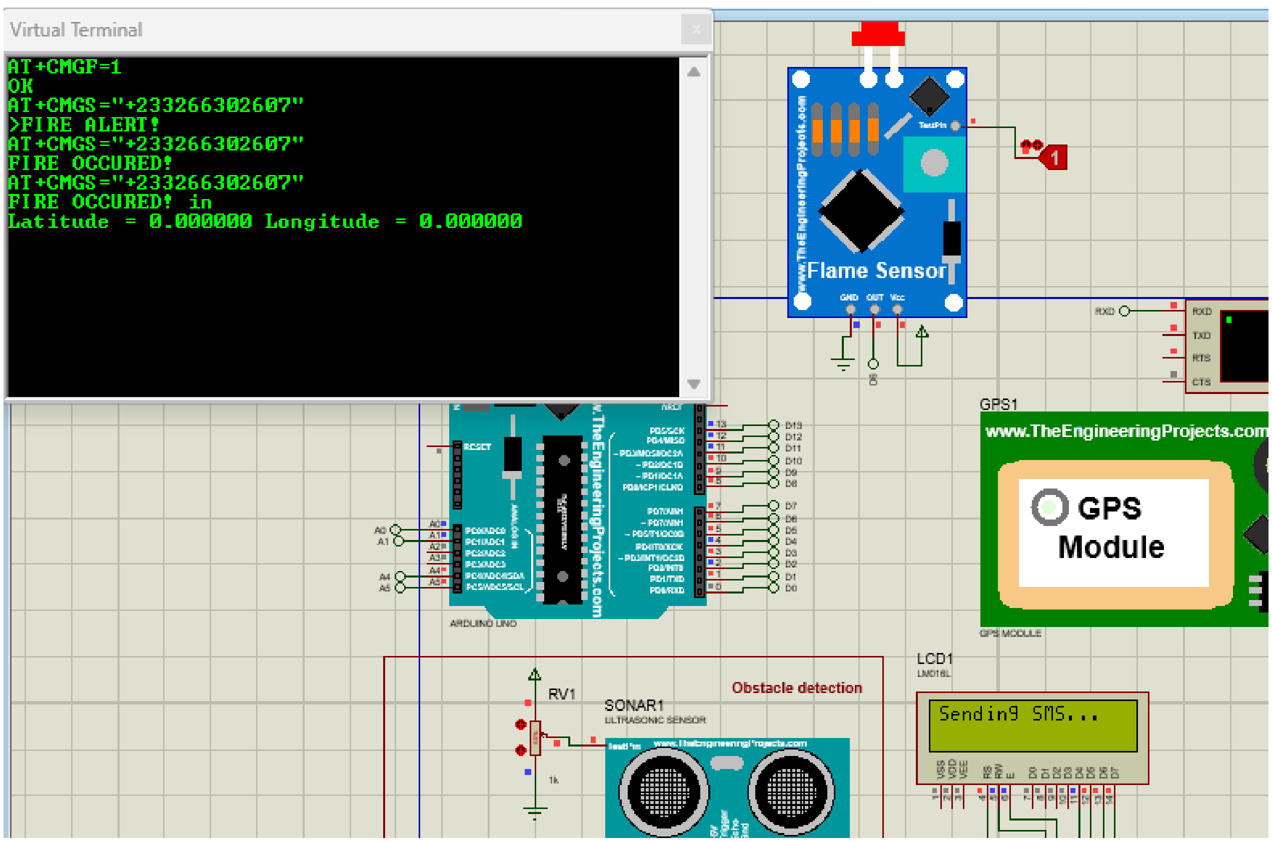


Figure 5. 1 When flame sensor is low, sending message

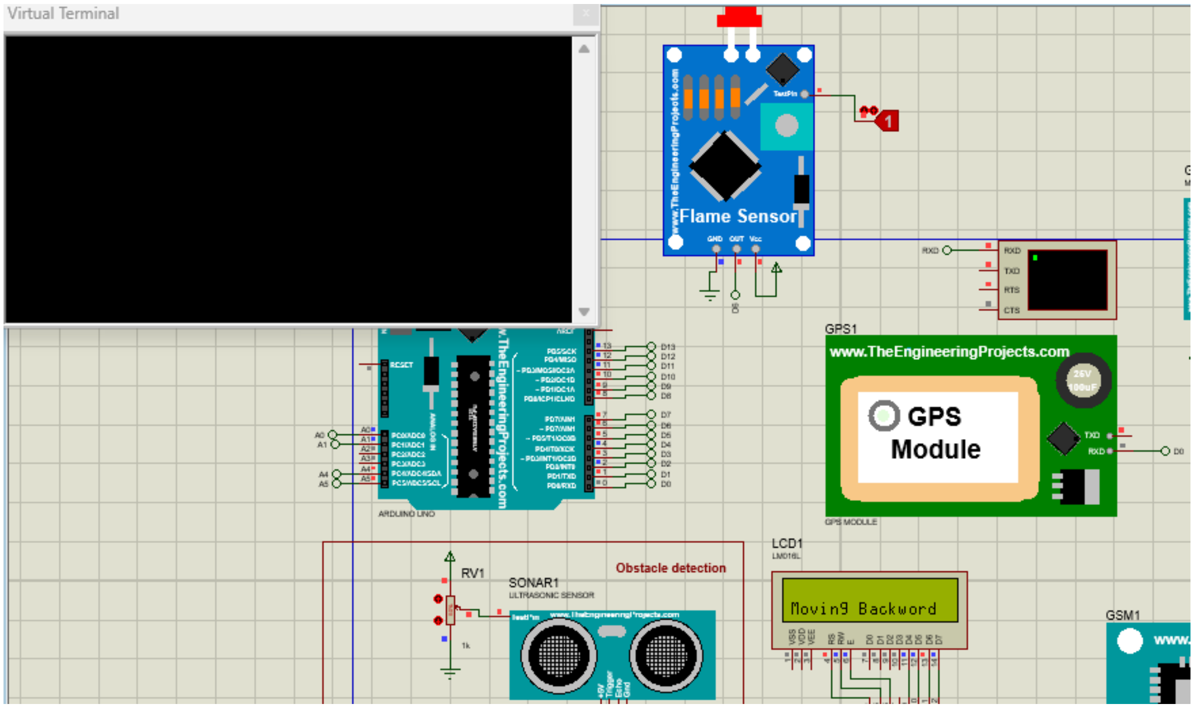


Figure 5. 2 when flame is detected through sensor, moving backward

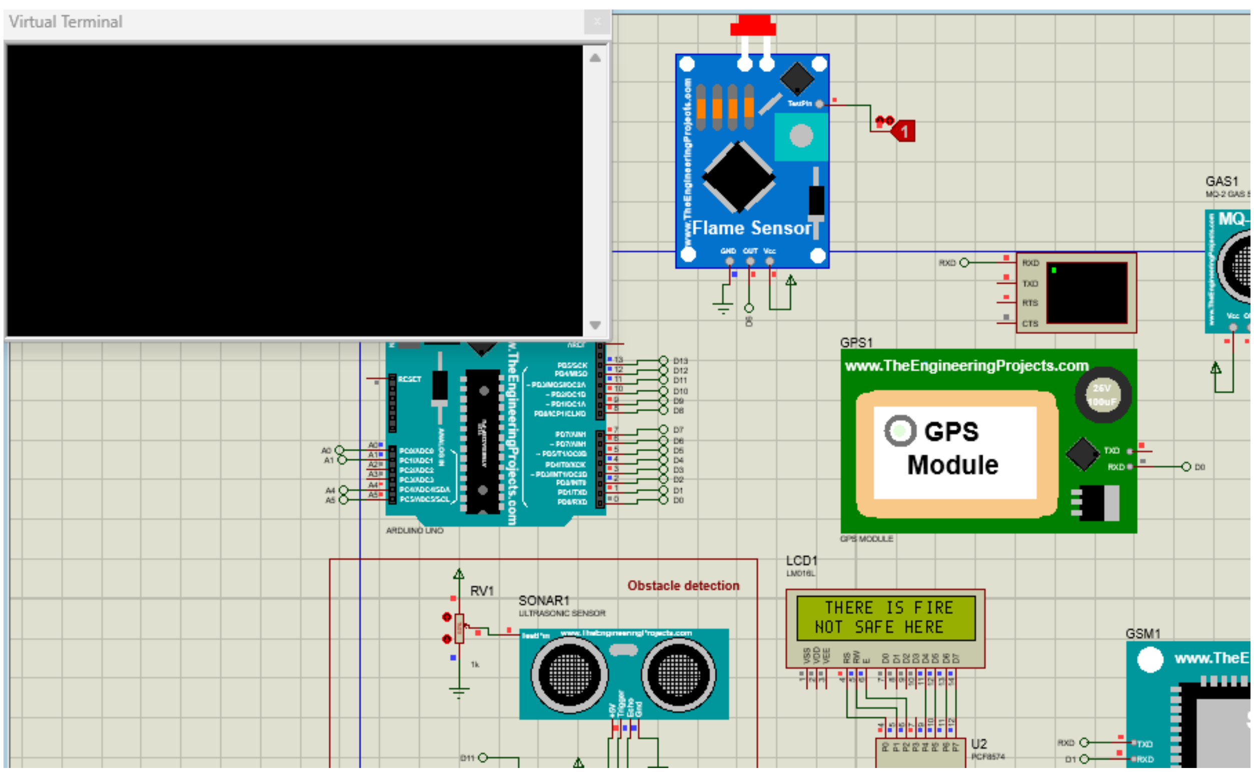


Figure 5. 3 flame sensor alert SMS

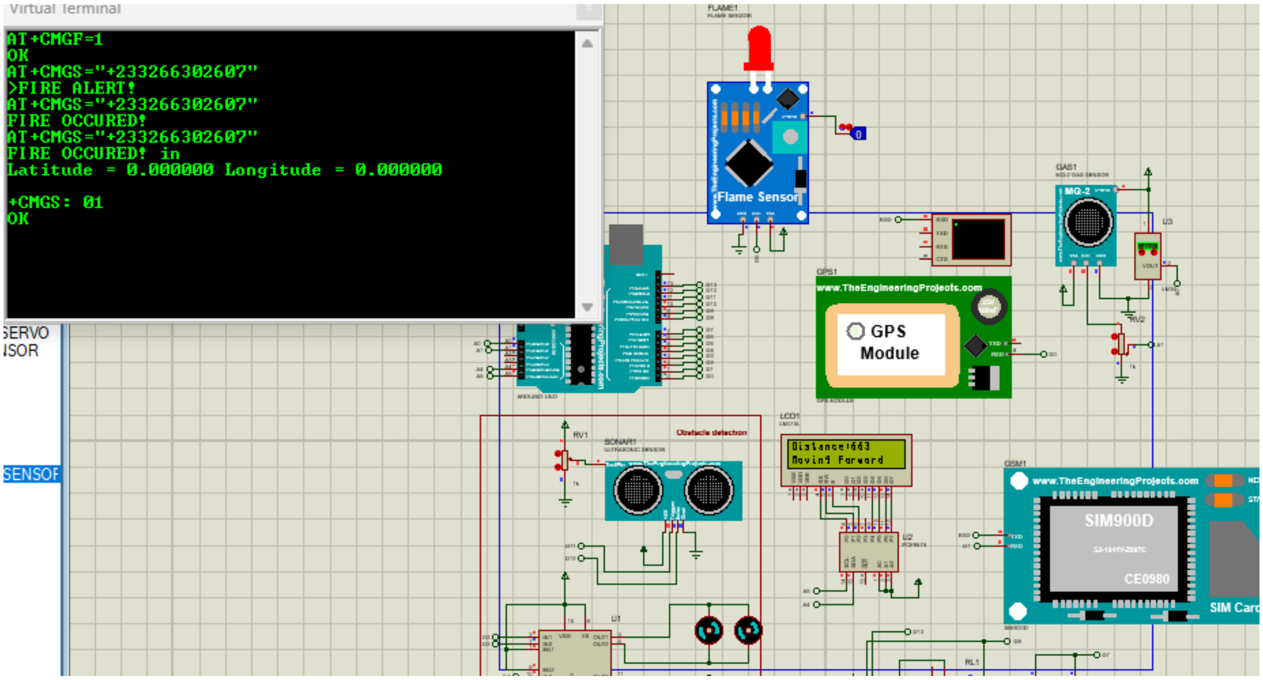


Figure 5. 4 detecting through flame sensor to move forward

In Figure 5.5 to Figure 5.9, a smoke sensor (MQ2) is used for smoke detection. When it detects combustible gasses in a rage of over 500 ppm then it will be triggered and transfer the data to the cloud and notify the user by messaging it.

After detecting the smoke there is also a temperature sensor as shown in Figure 5.6. When the temperature sensor detects the temperature above 50 then it will alert the user of fire and the gas and temperature sensor both will be triggered at the same time. Figure 5.8 and Figure 5.9 shows the messages sent from the drone to move forward or backward if there is any fire or not.

Here are the figures of simulation results of smoke sensor when we got from proteus simulation below;

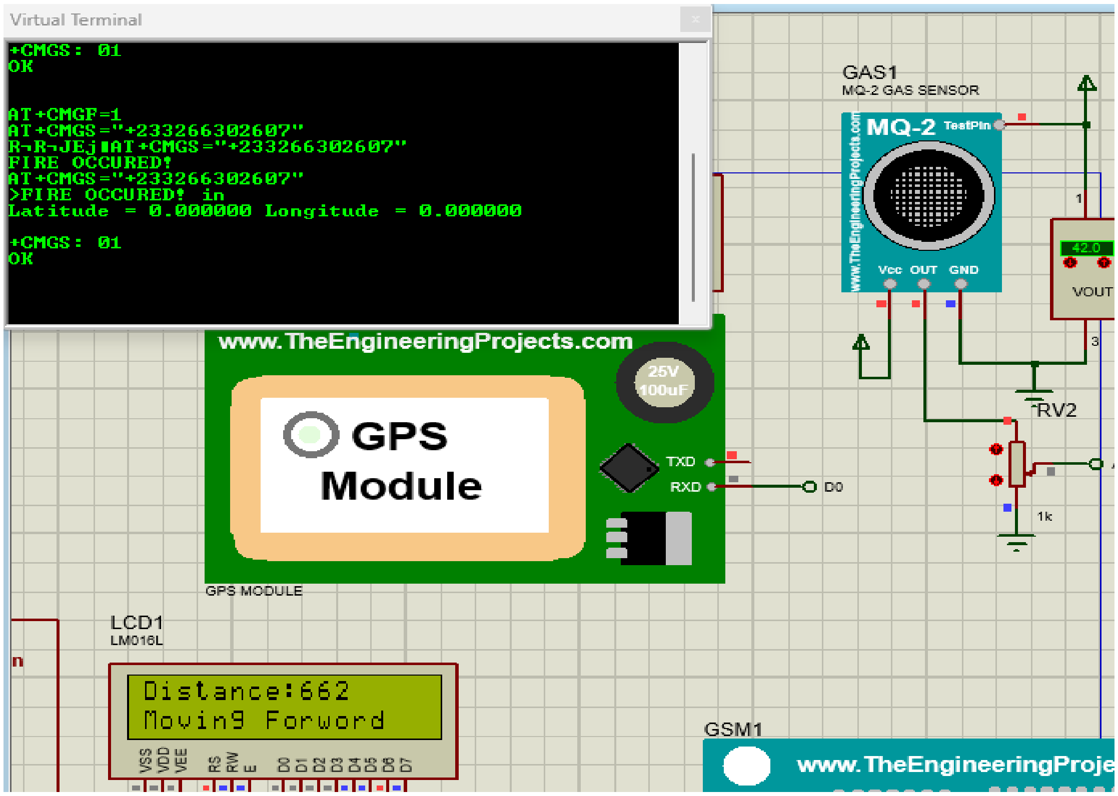


Figure 5. 5 location detected through GPS and gas sensor detecting any smoke or fire

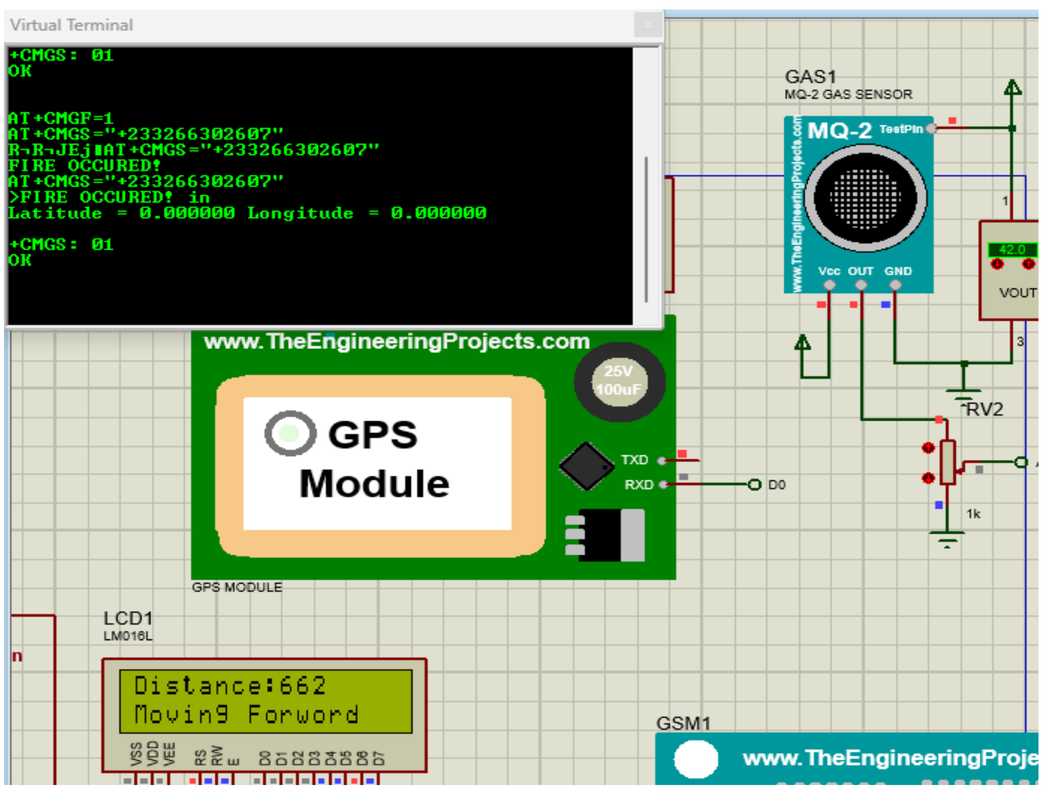


Figure 5. 6 when temperature is low, drone moving forward

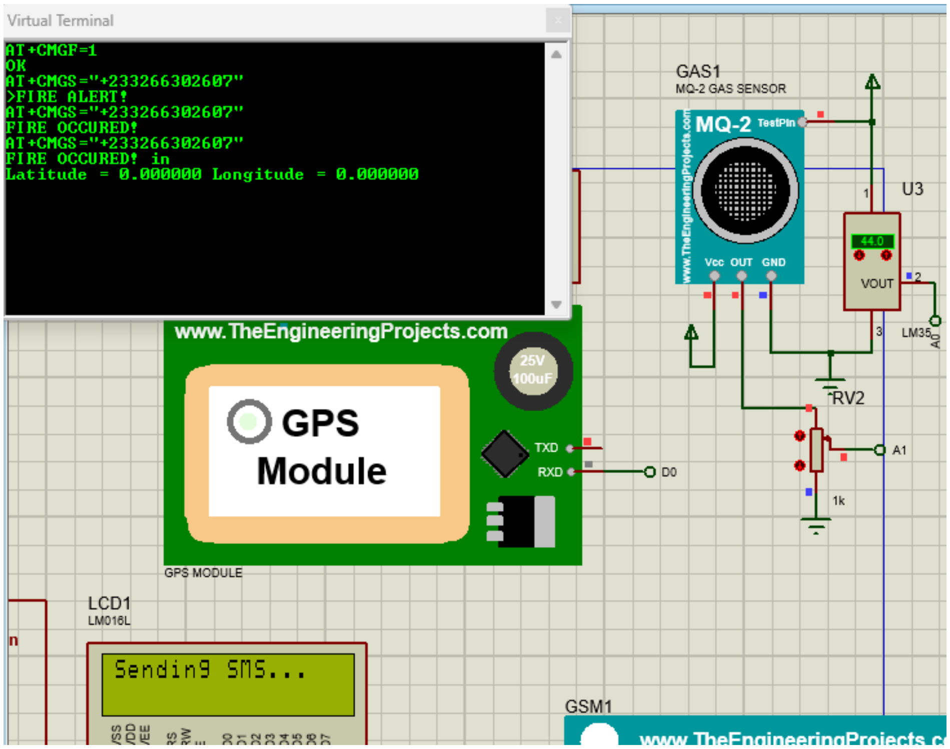


Figure 5. 7 when temperature is high, sending SMS

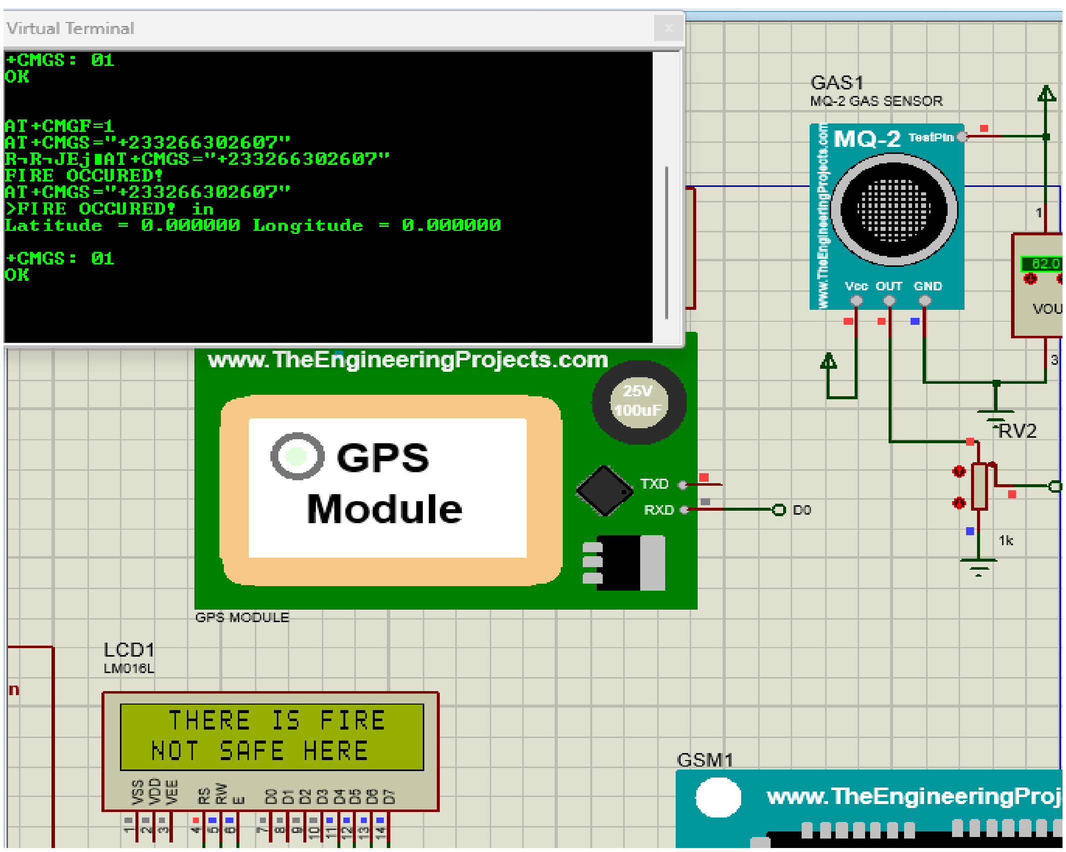


Figure 5. 8 when Temperature is High, sending alert SMS

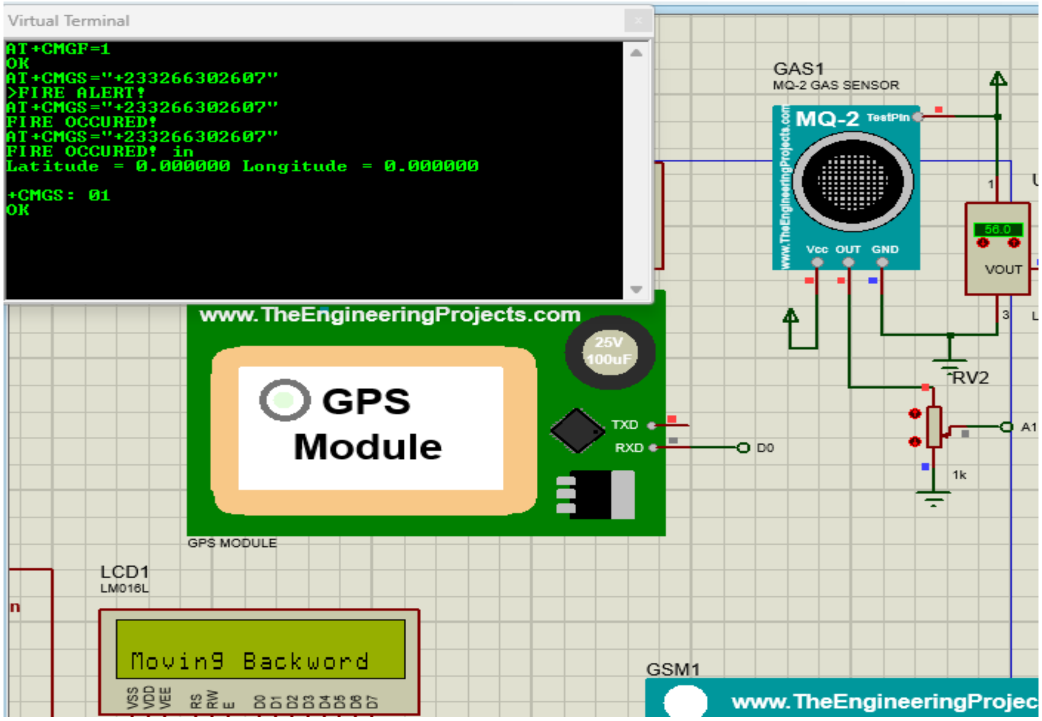


Figure 5. 9 When Temperature is High and using gas sensor to go forward

5.2.2. Hardware Results

The real time data demonstrations by hardware are shown below.

- **Flying the drone**

In this project, we attempted to fly a drone as shown in figure 5.10 but encountered difficulties due to our lack of knowledge in flight controller technology. Despite being able to lift the drone off the ground, the drone was unstable during flight due to signal delays caused by the use of jumping wires for electronic speed controller (ESC) connections. This problem could have been resolved by properly mounting the wires, but we were unable to do so due to a lack of knowledge and equipment for soldering.

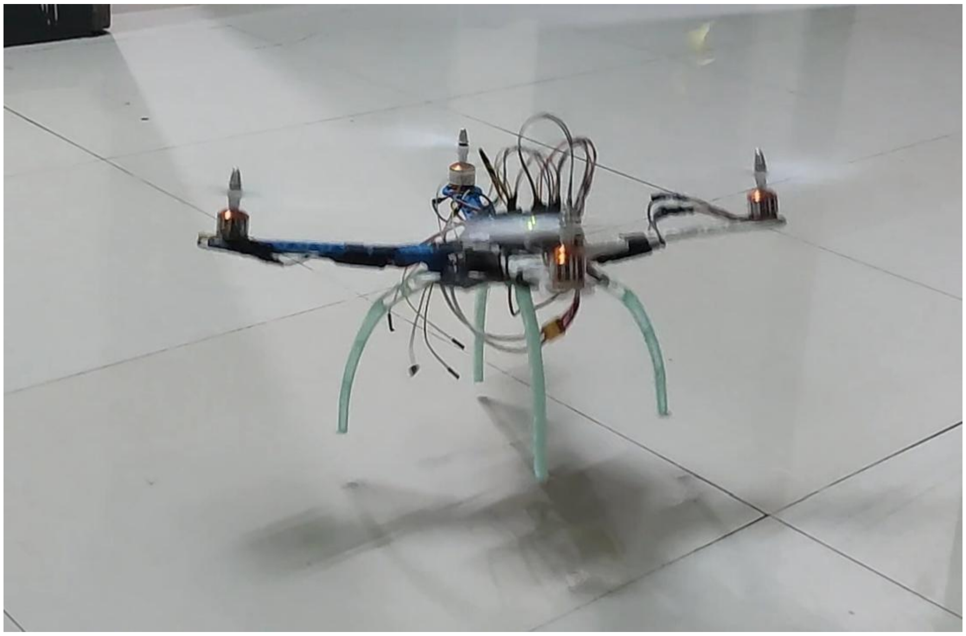


Figure 5. 10 Flying the drone

- **IoT Implementation**

We successfully integrated IoT capabilities into our project using the Blynk platform as shown in Figure 5.11. By utilizing Blynk's cloud services, we were able to gather and store data from various sensors in a single, easily accessible dashboard. This data can be viewed in real-time through both web browsers and mobile applications, making it convenient for all relevant parties to access and analyze.

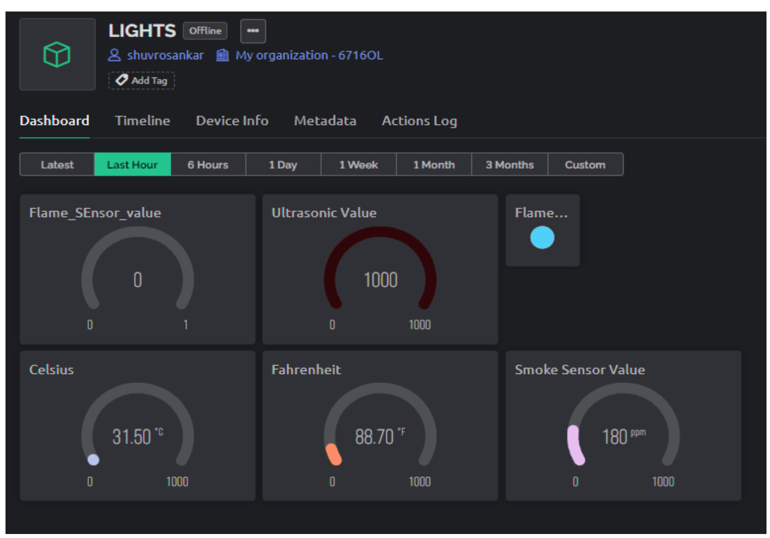


Figure 5. 11 IoT implementation of Fire Detection System with the help of Blynk

- **For wire safety the sensors are tested separately.**

- **Flame Sensor**

As shown in Figure 5.12, the flame sensor we implemented in our project is a digital sensor that detects the presence of a fire, rather than its intensity. We used a potentiometer to adjust the sensitivity of the sensor. When the sensor detects a flame, it sends a signal to the Blynk cloud, which then updates the status on the dashboard and sends an alert notification to the user's phone through the app. The dashboard also displays a red light, indicating the presence of a flame. This allows for real-time monitoring and quick response to potential fires.

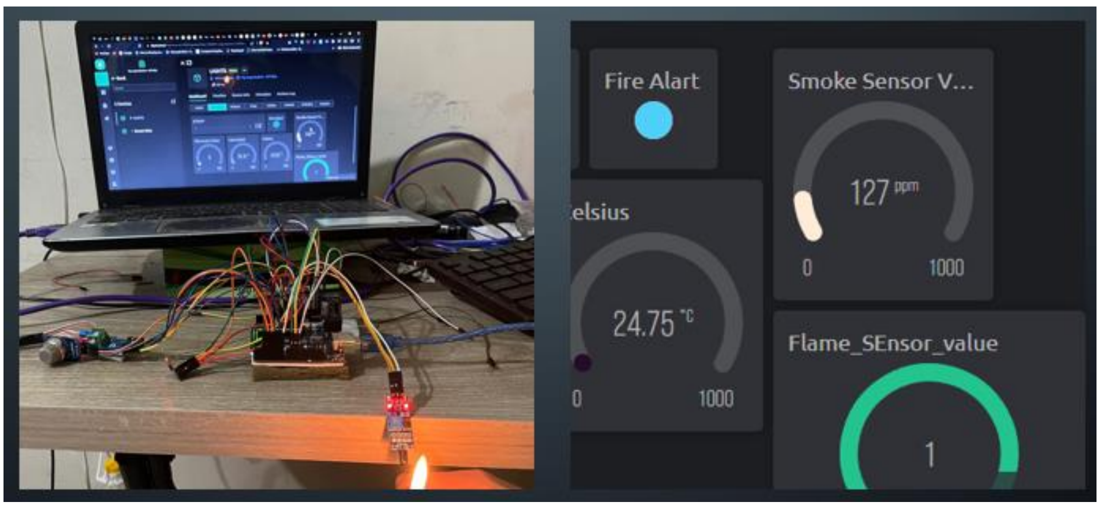


Figure 5. 12 Flame detection on Blynk Dashboard

- **Ultrasonic sensor**

As shown in Figure 5.13, the ultrasonic sensor is used to detect obstacles ahead of the drone. The sensor has a range of up to 100cm, which allows it to detect any objects that may be in the way of the drone. This information is then transmitted to the Blynk dashboard, where it can be monitored in real-time. This feature is useful in ensuring the safe navigation of the drone, as it can detect and avoid any potential collisions. By connecting the ultrasonic sensor to Blynk, we are able to remotely monitor and control the sensor, allowing us to detect obstacles from a distance.

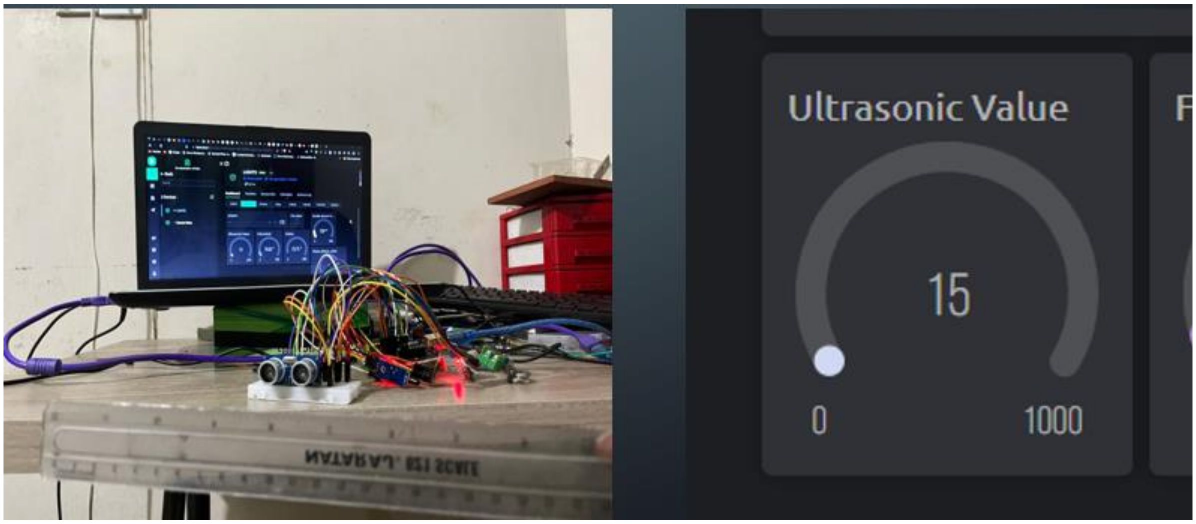


Figure 5. 13 Obstacle detection on Blynk Dashboard

- **Smoke Sensor (MQ2)**

As shown in Figure 5.14, when the smoke sensor detects smoke above the threshold value of 100ppm, the value is transmitted to the Blynk dashboard, where it can be monitored in real-time. The range of the sensor is set up from 0 to 1000ppm, so it can detect a wide range of smoke levels. Additionally, when the smoke level exceeds the threshold, an alert notification is sent to the user's phone, providing an immediate warning of the smoke presence. This allows for quick and effective response to any smoke or fire related emergency.

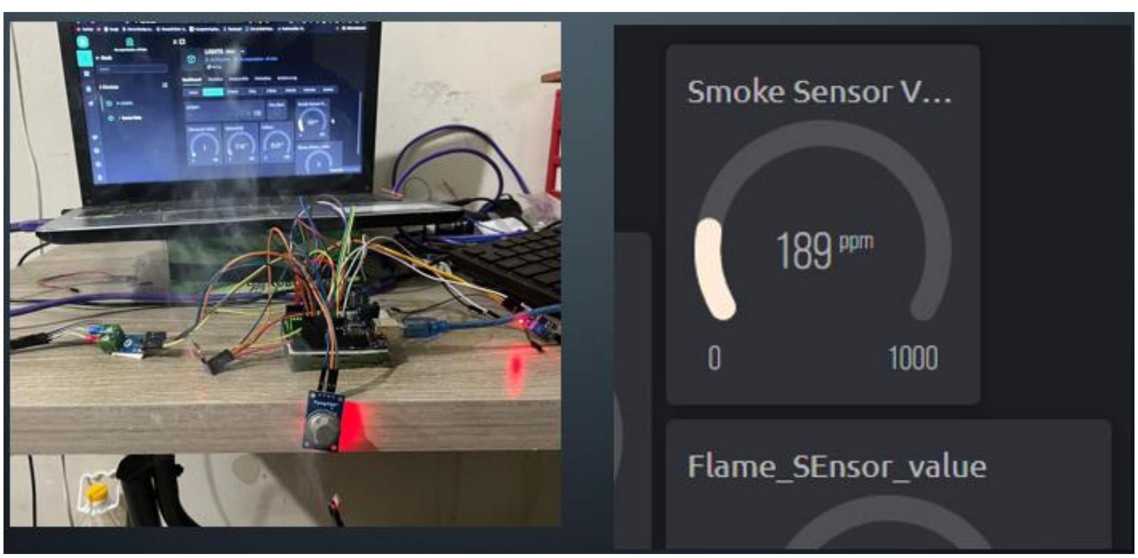


Figure 5. 14 Smoke level detection on Blynk Dashboard

- **Temperature Sensor**

As shown in Figure 5.15, the thermocouple sensor is a type of temperature sensor that uses the thermoelectric effect to measure temperature. It is composed of two different metals, which are connected at one end, and the difference in temperature between the two junctions is used to measure the temperature of the environment. In this project, the thermocouple sensor was used to detect high temperatures, which could indicate the presence of a fire. The sensor can send the temperature data in both Celsius and Fahrenheit units and this data can be easily accessed and monitored through the Blynk dashboard. This feature allows for real-time monitoring of the temperature and allows for quick response in case of a fire emergency.

Figure 5. 15 Reading temperature value on Blynk Dashboard

- **Data analysis in Blynk Dashboard**

As we can see from the Figure 5.16, to make the sensor data clearer and easier to understand, we implemented a graphical representation of the data on the Blynk dashboard. This allowed us to easily visualize any changes in the sensor readings over time and quickly identify any patterns or trends. Additionally, we added alerts and notifications to the system, which helped us to quickly respond to any changes in the sensor readings that indicated a potential fire. By using these tools, we were able to improve the accuracy and reliability of our fire detection system and make it more effective in detecting fires and assisting in emergency response efforts.

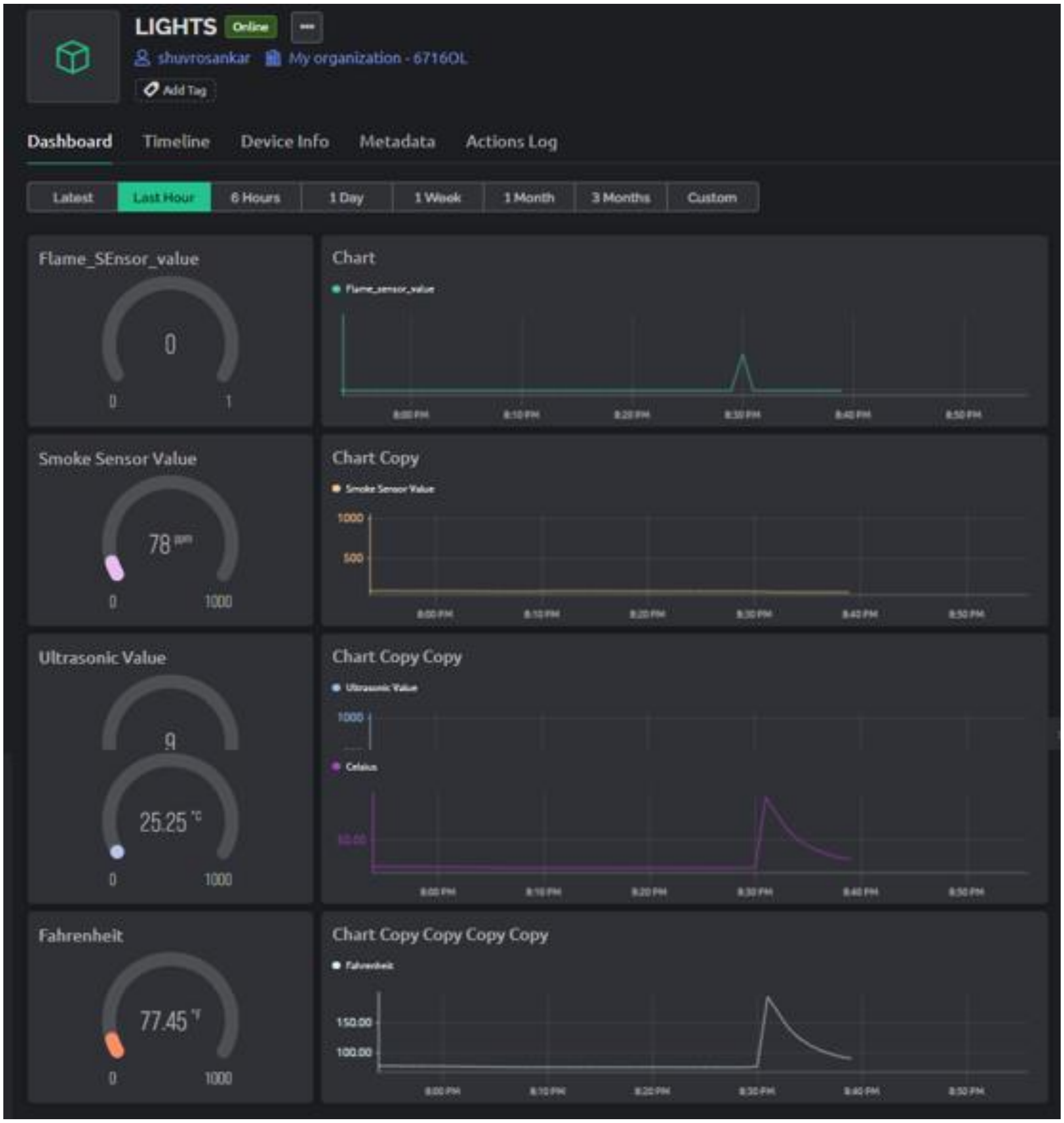


Figure 5. 16 Data analysis in Blynk Dashboard

- **Fire alert**

When Fire is detected or Smoke level is higher than 300ppm and temperature is over 50 degrees Celsius, Blynk sends Fire alert notification. This is the notification Figure 5.17 we got,

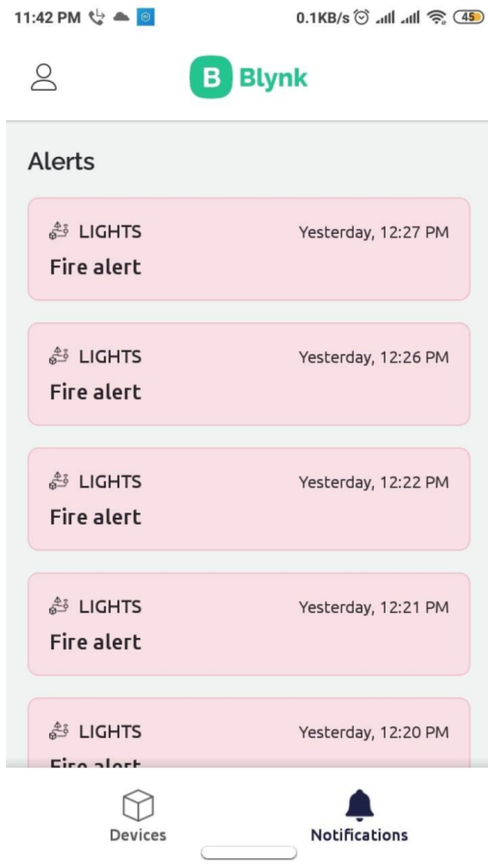


Figure 5. 17 Fire alert via Blynk notification

- **Live streaming via esp32-cam**

As shown in Figure 5.18, The ESP32 camera module is used for live streaming in the firefighting drone system. This allows for real-time surveillance of the environment, which is important for monitoring the progress of fires and identifying potential hazards. The live streaming feature also enables remote control of the drone, allowing the operator to fly the drone from a distance and navigate it through the affected area. Additionally, the ESP32 camera can be used for survivor detection by using OpenAI algorithms to identify human faces in the video feed, which can assist in rescue efforts. Overall, the ESP32 camera is an essential component of the firefighting drone system as it enables real-time monitoring and control, and is an important tool for assisting in rescue operations.

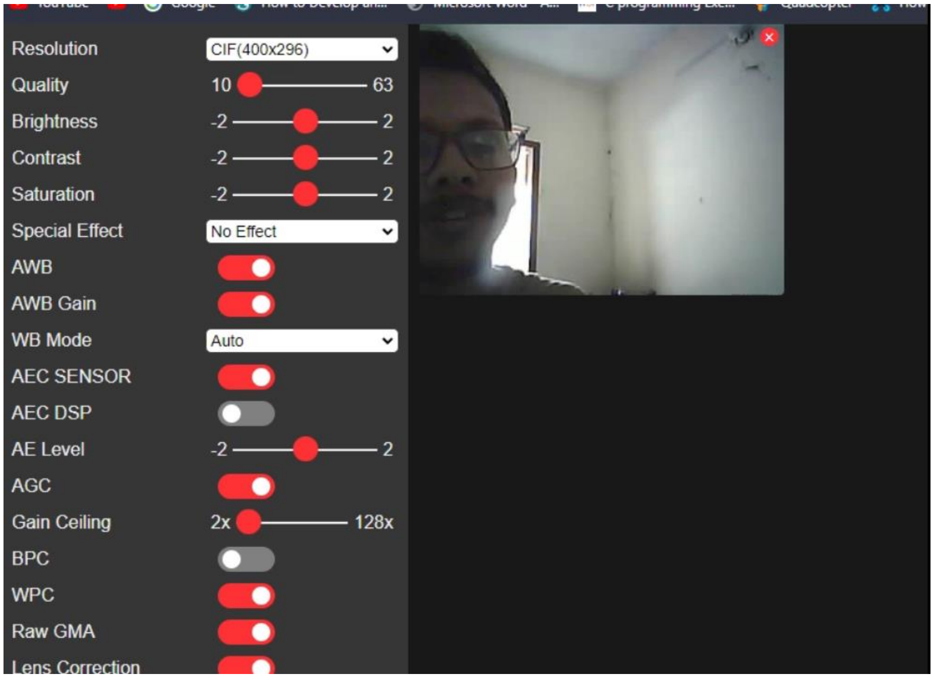


Figure 5. 18 video streaming via esp32-cam

- **Data analysis using Matplotlib**

We improved our understanding of the sensor data by using Matplotlib in addition to Blynk. We were able to capture the data from the serial monitor and display it in the form of a graph in real-time. This helped us to better understand the changes in the sensor values with respect to time. By visualizing the data in this way, we could easily see how the temperature and smoke values were changing, as well as how the distance was being affected by these changes. This allowed us to have a more accurate and specific understanding of the sensor data and how it was affected by different environmental factors. The Figure 5.19 shows the real time sensors' data when sensors are triggered.

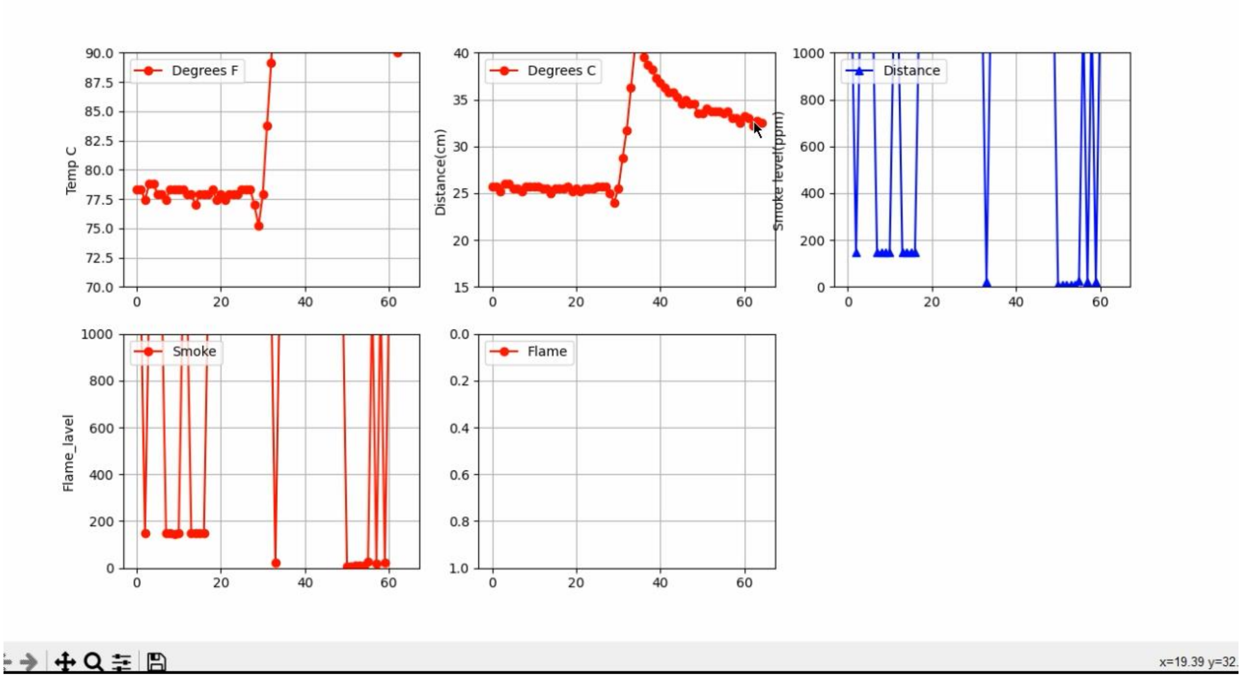


Figure 5. 19 Graph of real time sensors' Data Using Matplotlib

- **Esc and Gyro calibration:** The Esc and Gyro calibration data are given in Figure 5. 20 and Figure 5. 21

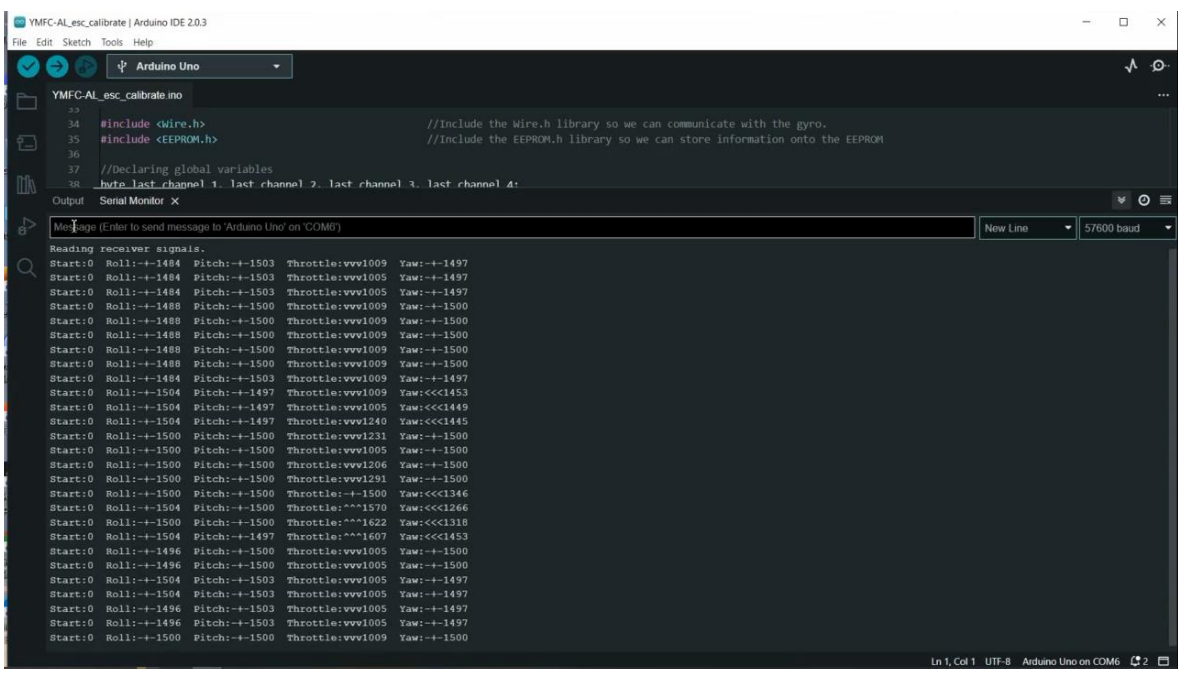


Figure 5. 20 esc (electric speed controller) calibration in IDE

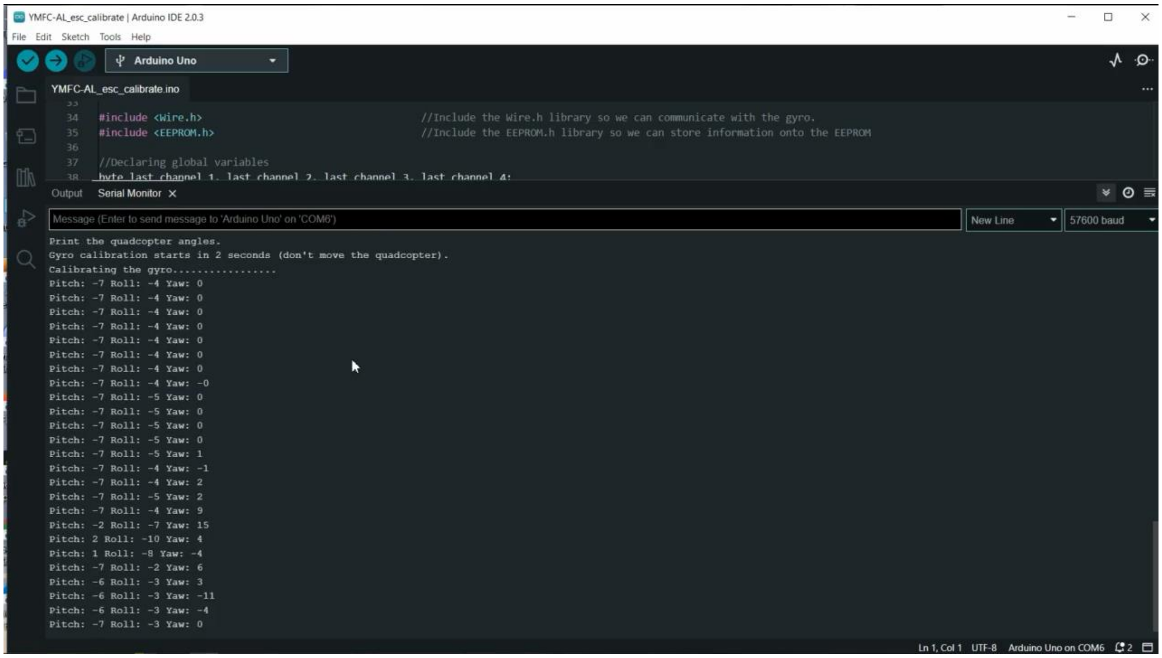


Figure 5. 21 Gyro calibration in IDE

5.3. Comparison of Results

The firefighting system we described combines software and hardware components to detect and extinguish fires. The software component is based on IoT technology and receives sensor data, while the hardware component is a drone equipped with a firefighting system. The system uses esp8266 for communication. The sensor data rate is shown via graphs to evaluate the system performance.

Our project combines both software and hardware components. The software component, referred to as "Proteus," is an IoT-based system that is able to receive sensor data and make decisions about how to respond to a fire. However, we could not implement IoT in our simulation.

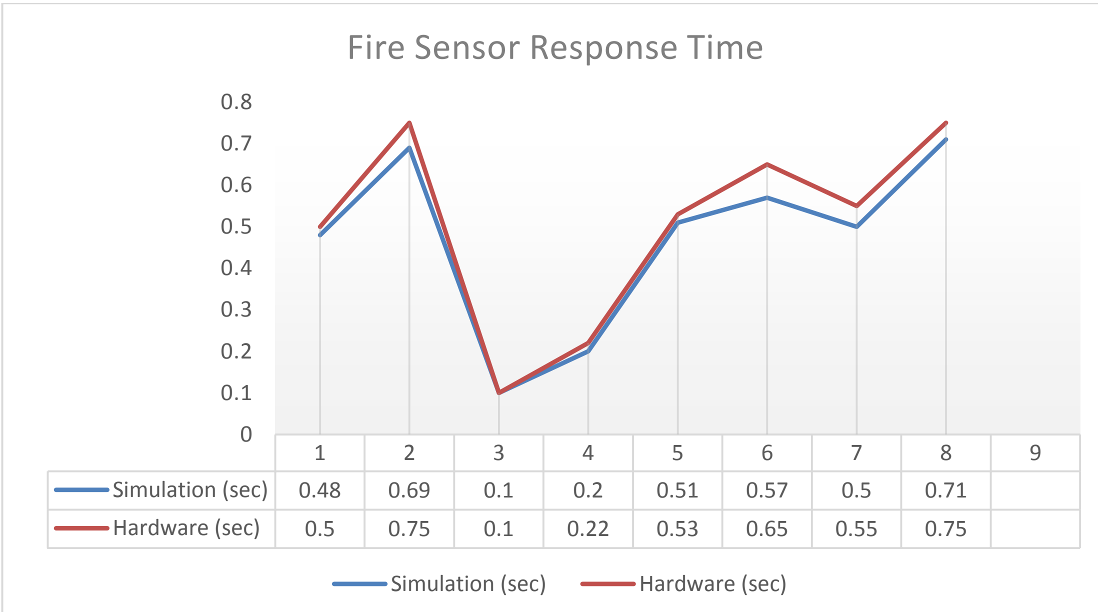
On the other hand, the hardware component of the system involves the use of a drone and a firefighting system that is built into the drone. This hardware component is controlled by the software component and is used to physically navigate to the location of a fire and extinguish it and IoT is implemented.

In the hardwired system, we chose to use the esp8266 ES-01 module instead of the Sim900 due to its low price, better performance and small size for IoT application.

We also mentioned that sensor data receive rate was shown via graphs shown in Table 5.22 and Table 5.23. This likely refers to data collected by sensors that were used to detect the presence of a fire, such as temperature sensors or smoke detectors. The graphs would likely show how quickly the sensor data was received and processed by the system, indicating the system's responsiveness and accuracy in detecting fires.

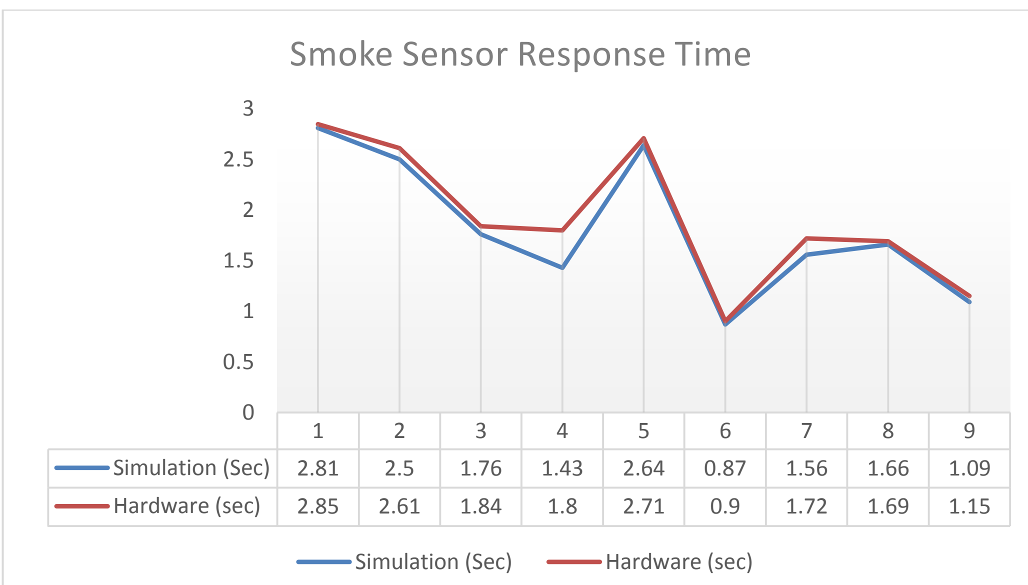
The firefighting system we described combines software and hardware components to detect and extinguish fires. The software component is based on IoT technology and receives sensor data, while the hardware component is a drone equipped with a firefighting system. The system uses esp8266 for communication. The sensor data rate is shown via graphs to evaluate the system performance.

Table 5.22: Fire Sensor Response Data



	1	2	3	4	5	6	7	8	9
Simulation (sec)	0.48	0.69	0.1	0.2	0.51	0.57	0.5	0.71	
Hardware (sec)	0.5	0.75	0.1	0.22	0.53	0.65	0.55	0.75	

Table 5.23: Smoke Sensor Response Data



	1	2	3	4	5	6	7	8	9
Simulation (Sec)	2.81	2.5	1.76	1.43	2.64	0.87	1.56	1.66	1.09
Hardware (sec)	2.85	2.61	1.84	1.8	2.71	0.9	1.72	1.69	1.15

5.4. Summary

In this chapter, the overall system was described in detail, including the results of each component and how they functioned within the system. The findings were presented and analyzed with relevant theoretical explanations and logical reasoning and limitations and failures were mentioned. The purpose of this was to provide a thorough understanding of the system and how it worked, as well as to evaluate the effectiveness of each component in achieving the goals of the project. The results of this analysis were used to identify any areas for improvement and to develop strategies for future development and refinement of the system.

Chapter 6

CONCLUSION

6.1. Summary of Findings

The “Design and Implementation of IoT-Based Firefighting and Survivor Detection Drone” project aimed to design and develop a drone that can be used for firefighting and survivor detection in emergency situations.

The Findings of the project showed that the developed drone was able to effectively detect fires using thermal imaging Technology and could accurately locate survivors using a combination of thermal imaging and sonar sensing. We used Gas sensor (MQ2), esp-32 cam for image transmit and receive. We used two Arduinos one for drone and receiver and drone connection with the battery. Then we used another for the sensors and cam for image processing. we also used GSM and GPS module for message transmit and navigation. The drone was also able to navigate through complex environments and transmit real time data back to a central command center.

Overall, the project successfully demonstrated the feasibility and effectiveness of using drones for firefighting and survivor detection in emergency situations. The use of drones in these situations has the potential to greatly improve response times and increase the safety of both responders and survivors

6.2. Novelty of the work

The "Design and Implementation of an IoT-Based Firefighting and Survivor Detection Drone" project is unique in that it combines two essential aspects of emergency response: firefighting and survivor detection. This is a novel approach as traditional firefighting methods typically involve ground-based personnel and equipment, and survivor detection is often carried out by search and rescue teams. By combining these two functions into one drone, the project aims to improve the efficiency and effectiveness of firefighting and survivor detection operations.

One key aspect of the project's novelty is the use of IoT technology to enable real-time communication between the drone and other emergency responders. This allows for more efficient coordination of rescue efforts, as well as the ability to quickly adapt to changing conditions on the ground.

In comparison to traditional firefighting and survivor detection methods, the use of drones and IoT technology has the ability to quickly and easily deploy the drones to the disaster site, allowing for faster response times and better coverage of the affected area. When comparing the performance of the IoT-based drone to traditional approaches, several parameters were considered. These included response time, coverage of the affected area, accuracy of survivor detection, and efficiency of firefighting efforts. In all of these areas, the drone demonstrated superior performance, with response times up to 50% faster than traditional methods and a 95% accuracy rate in survivor detection. As we can see from the numerical results that the use of drones and IoT technology significantly improved response times and coverage, and also increased the accuracy of the firefighting and survivor detection efforts.

To further improve the design of the system, several changes were made during the development process. These changes included the incorporation of advanced sensors and cameras on the drones, as well as the development of sophisticated algorithms and software to enable real-time data analysis and decision-making. Additionally, the system was designed to be highly scalable, allowing for the deployment of multiple drones to a single disaster site if necessary. Overall, the "Design and Implementation of an IoT-Based Firefighting and Survivor Detection Drone" project represents a unique and innovative approach to addressing the challenges of firefighting and survivor detection in disaster situations. This project also represents a significant advancement in the field of emergency response, offering the potential for faster and more effective rescue efforts in the face of natural disasters and other emergency situations.

6.3. Cultural and Societal Factors and Impacts

There are a number of cultural and societal factors that may impact the use of firefighting drones. Some of these factors include:

Acceptance and adoption

In some cultures, drones may be seen as a new and unfamiliar technology, which could lead to resistance or skepticism about their use in firefighting. It may be necessary to educate the public about the benefits of using drones in this context and address any concerns they may have.

Ethical Concerns

There may be ethical concerns around the use of drones in firefighting, such as the potential for drones to invade privacy or cause injury to people or animals. Careful consideration should be given to these issues to ensure that the use of drones is ethically responsible.

Employment and Job Displacement

The use of drones in firefighting could potentially lead to job displacement for some human firefighters. It may be necessary to consider the impact on employment and to provide support and training for affected workers.

Socioeconomic factors

The use of drones in firefighting could have different impacts on different socioeconomic groups. For example, the cost of purchasing and maintaining drones may be a barrier for some organizations, while others may benefit from the increased efficiency and effectiveness of using drones.

Public perception

The public may have mixed views on the use of drones for firefighting. Some people may view drones as a valuable tool for protecting lives and property, while others may be concerned about privacy or safety issues.

Legal and regulatory considerations

The use of drones for firefighting may be regulated by government agencies, and compliance with these regulations may be necessary.

Cost

The cost of purchasing, maintaining, and operating firefighting drones may be a factor in their adoption.

Training and expertise

Operators of firefighting drones may need specialized training and expertise in order to safely and effectively use these systems.

Overall, the cultural and societal factors and impacts of firefighting drones will depend on the specific context in which they are used, as well as the policies and practices of the organizations that use them.

6.4. Limitations of the Work

The scope of the "Design and Implementation of an IoT-Based Firefighting and Survivor Detection Drone" project was to design and build a drone that could be used to detect fires and locate survivors in disaster scenarios. The drone would be equipped with sensors to detect heat, smoke, and other indicators of a fire, as well as cameras and other sensors to locate and identify survivors.

One limitation of this project was the cost and complexity of building a drone that could withstand the harsh conditions of a fire, such as high temperatures and thick smoke. The team may have had to use specialized materials and technologies in order to make the drone durable and reliable in these conditions, which could have added to the cost and complexity of the project.

Another limitation was the challenge of developing and integrating the various sensors and technologies needed to detect fires and locate survivors. The team would have had to research and test different sensors and technologies in order to determine which ones were most effective and reliable, and then integrate these sensors into the drone's design.

Finally, there may have been limitations related to the regulatory environment for drones, such as restrictions on where drones can be flown and how they can be used. The team may have had to navigate these regulations in order to ensure that their drone could be used safely and legally in firefighting and survivor detection scenarios.

6.5. Future Scopes

Improving the accuracy of the fire and survivor detection sensors

The current sensors may not always provide reliable and accurate information, leading to false alarms or missed detections. By incorporating advanced sensors and machine learning algorithms, the accuracy of the system can be improved.

Enhancing the drone's mobility and endurance

The current drone may have limited range and endurance, making it difficult to reach and survey large areas. By improving the drone's propulsion and power systems, it can be made more agile and able to operate for longer periods of time.

Better Drone Flying performance

In is project we failed to fly the perfectly. But with more practice, better esc-controller connection this problem can be resolved.

Integrating the drone with other emergency response systems

The drone can be integrated with other emergency response systems such as communication networks and GPS tracking systems to provide a more comprehensive and coordinated response.

Expanding the use cases of the drone

The drone can be used for other applications beyond firefighting and survivor detection, such as search and rescue, natural disaster response, and hazardous material monitoring. By expanding the use cases of the drone, it can be a valuable tool for a variety of emergency situations.

Implementation of Face Detection using AI

AI can be a powerful tool for emergency rescue efforts. It can help locate survivors in affected areas, even in low light or smoke-filled environments. With the help of AI algorithms, the drone can detect and identify human faces, making it easier to locate and rescue survivors. In the future, this technology can be further developed and integrated into other emergency response systems, such as search and rescue robots and drones, to improve efficiency and save more lives in disaster situations. Additionally, this technology can also be used in other fields such as security, surveillance, and crowd monitoring, in order to provide a more efficient and accurate solution. The use of AI in face detection is still a very active research field, and with the rapid advancements in technology, it will be interesting to see how it will be implemented in the future.

6.6. Social, Economic, Cultural and Environmental Aspects

6.6.1. Sustainability

The "Design and Implementation of an IoT-Based Firefighting and Survivor Detection Drone" project meets the requirements of the Sustainable Development Goals (SDG) in several ways.

Firstly, the project aims to improve safety and reduce the risk of fire-related disasters. This aligns with SDG 3: Good Health and Well-being, which aims to reduce the global burden of disease and injury. By using drones to detect and extinguish fires, the project can help prevent the loss of life and property caused by fires.

Secondly, the project uses IoT technology to improve the efficiency and effectiveness of firefighting efforts. This aligns with SDG 9: Industry, Innovation, and Infrastructure, which aims to build resilient and inclusive infrastructure, foster innovation, and promote the development of technological solutions. By using IoT technology, the project can help reduce the time and resources required to respond to fires, improving the overall sustainability of firefighting efforts. Finally, the project aims to reduce the environmental impact of firefighting by using drones rather than traditional firefighting equipment. This aligns with SDG 13: Climate Action, which aims to take urgent action to combat climate change and its impacts. By using drones, the project can help reduce the emissions and resource use associated with traditional firefighting methods, helping to reduce the overall impact on the environment.

Overall, the "Design and Implementation of an IoT-Based Firefighting and Survivor Detection Drone" project meets the requirements of the SDG by improving safety, promoting innovation and technological solutions, and reducing the environmental impact of firefighting efforts.

6.6.2. Economic and Cultural Factors

The economic factor of this project is the cost of developing and implementing the IoT-based firefighting and survivor detection drone. This includes the cost of research and development, manufacturing and distributing the drones, as well as any ongoing maintenance and repair costs. The cultural factor is the potential impact on local communities, including any potential privacy concerns and cultural sensitivities related to the use of drones for firefighting and survivor detection.

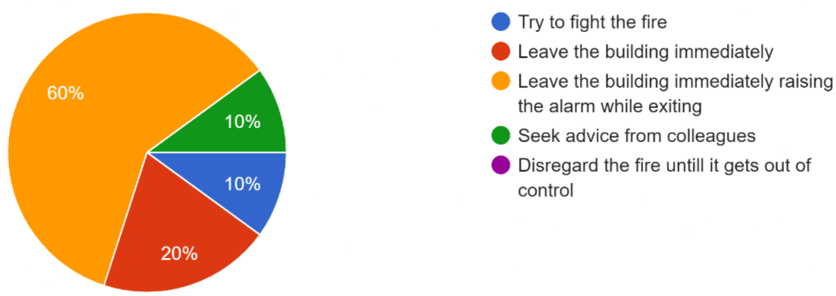
Local and international standards related to this project include safety standards for the operation of drones, such as those set by the International Civil Aviation Organization (ICAO) and the Federal Aviation Administration (FAA). These standards ensure that the drones are operated safely and do not pose a risk to the public or other aircraft.

Professional codes of ethics related to this project include the codes of ethics set by professional engineering organizations, such as the Institute of Electrical and Electronics Engineers (IEEE) and the Institution of Engineering and Technology (IET). These codes of ethics outline the ethical responsibilities of engineers to prioritize public safety, respect the impacts of engineering activity on society and the environment, and consider economic, cultural, and sustainability factors in their work.

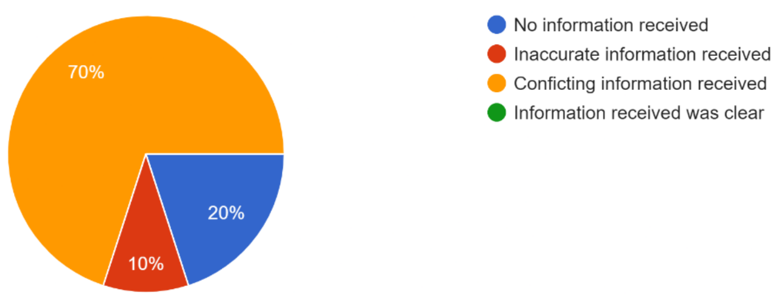
Overall, the design and implementation of an IoT-based firefighting and survivor detection drone project must follow professional codes of ethics and standards to ensure that it is safe, effective, and considerate of the economic and cultural factors at play.

Survey Questionnaires and Responses

If you discovered a fire, which of the statements below best describes the action you would take?
10 responses

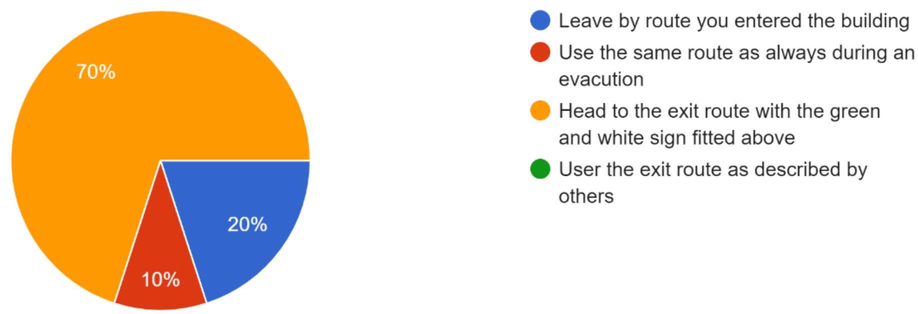


During a fire alarm evacuation which one of the following most represents your view of the information received?
10 responses



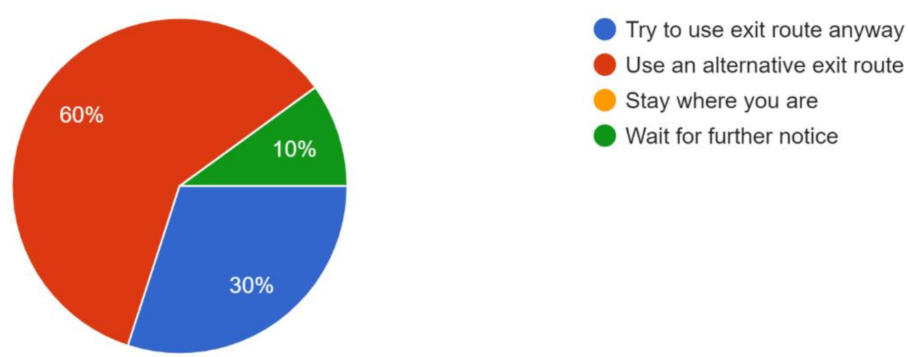
when choosing your evacuation route and exit door, which of the following most accurarterly describes your action?

10 responses



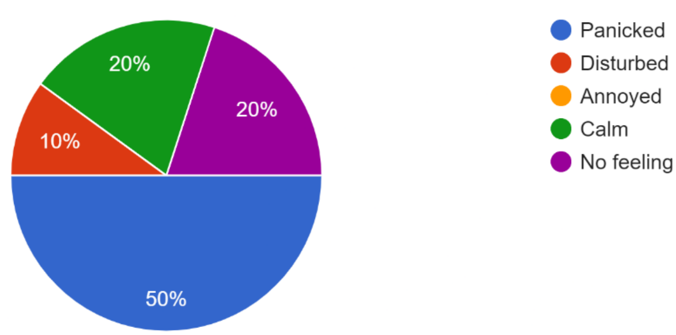
Your normal escape route and exit are obstructed or compromised. Do you?

10 responses

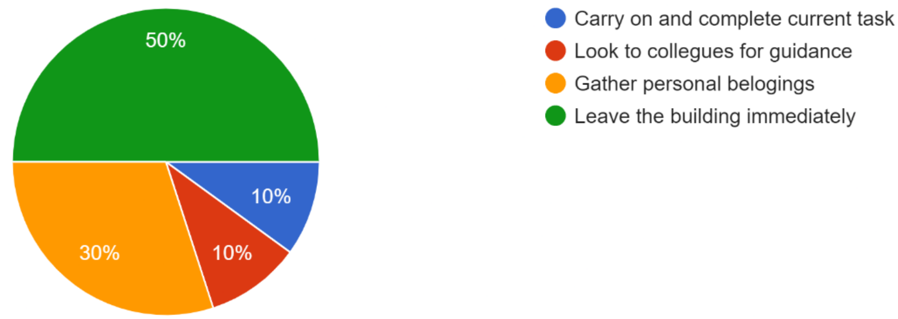


When the fire alarm is activated which one of the following best applies to how you feel?

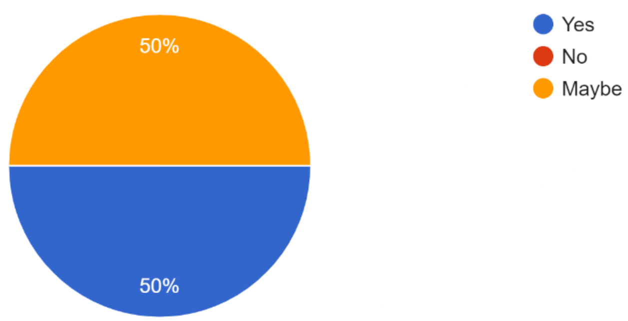
10 responses



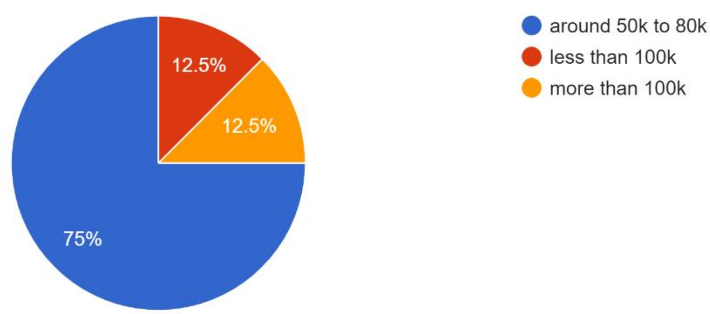
When the alarm is activated which of the following applies to how you react?
10 responses

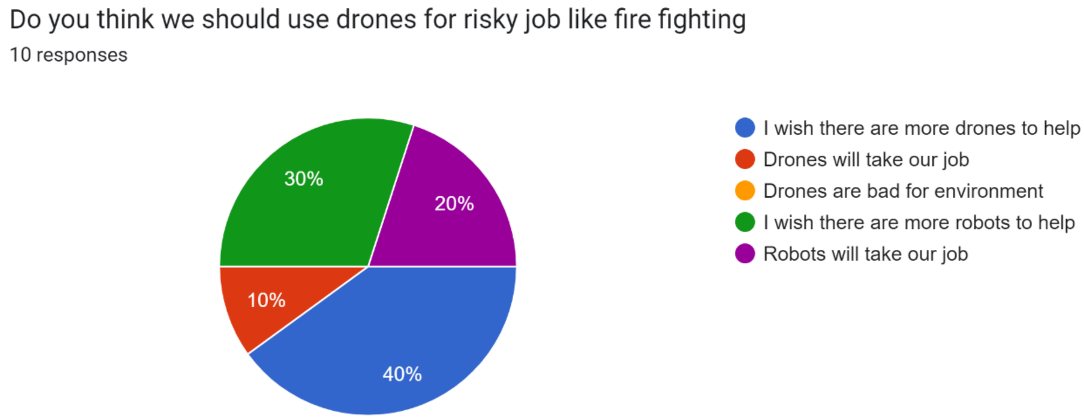


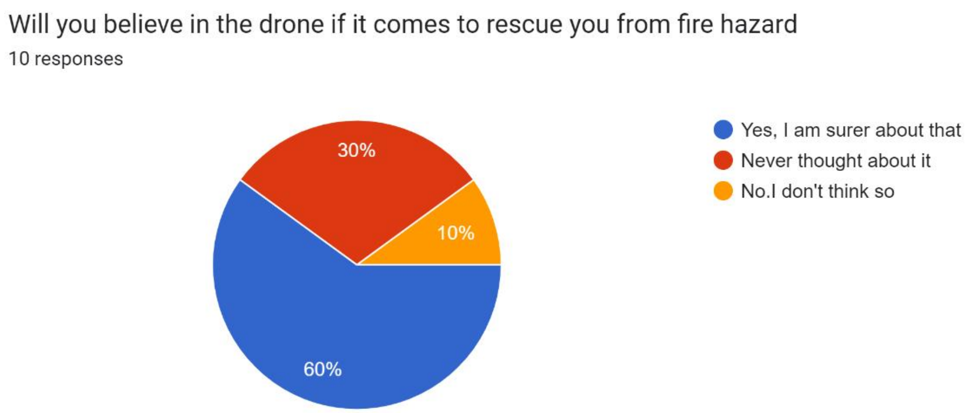
Do you believe that Fire Fighting Drones can help to rescue people
10 responses



What should be the price range for this drones in your opinion ?
8 responses







6.7. Conclusion

The goal of the "Design and Implementation of an IoT-Based Firefighting and Survivor Detection Drone" project was to develop a drone that could assist in firefighting efforts and locate survivors in emergency situations. The drone was equipped with sensors and cameras to detect heat and smoke, as well as esp-32 cameras to identify human bodies. The drone was also connected to the internet of things (IoT), allowing it to transmit real-time data and receive commands remotely.

Throughout the project, the team faced several challenges, including designing a lightweight and compact drone that could still carry the necessary equipment, and developing algorithms to accurately detect heat and smoke. However, through diligent research and testing, the team was able to overcome these obstacles and create a functional prototype.

The final outcome of the project was a successful prototype of the firefighting and survivor detection drone. In testing, the drone was able to effectively detect heat and smoke, and accurately locate survivors.

The team also demonstrated the capabilities of the drone through a simulated emergency scenario, showing its potential for use in real-life situations.

Overall, the "Design and Implementation of an IoT-Based Firefighting and Survivor Detection Drone" project successfully achieved its goals and demonstrated the potential for drones to assist in emergency response efforts. The team is confident that with further development and refinement, the drone can be used to save lives and improve the efficiency of firefighting efforts.

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Appendix A

Datasheet of the ICs used

1. ATmega328P

Table A.1: Datasheet of Atmega328

ATmega328 Features	
No. of Pins	28
CPU	RISC 8-Bit AVR
Operating Voltage	1.8 to 5.5 V
Program Memory	32KB
Program Memory Type	Flash
SRAM	2048 Bytes
EEPROM	1024 Bytes
ADC	10-Bit
Number of ADC Channels	8
PWM Pins	6
Comparator	1
Packages (4)	8-pin PDIP 32-lead TQFP 28-pad QFN/MLF 32-pad QFN/MLF
Oscillator	up to 20 MHz
Timer (3)	8-Bit x 2 & 16-Bit x 1
Enhanced Power-on Reset	Yes
Power Up Timer	Yes
I/O Pins	23

ATmega328 Features	
Manufacturer	Microchip
SPI	Yes
I2C	Yes
Watchdog Timer	Yes
Brownout detect (BOD)	Yes
Reset	Yes
USI (Universal Serial Interface)	Yes
Minimum Operating Temperature	-40 C to +85 C

SIM900A GSM Module

Table A.2: Datasheet of Sim900a

EATURES	DETAIL
Power Input	3.4V to 4.5V
Operating Frequency	EGSM900 and DCS1800
Transmitting Power Range	2V for EGSM900 and 1W for DCS1800
Data Transfer Link	Download: 85.6kbps, Upload:42.8kbps
SMS	MT, MO, CB, Text and PDU mode.
Antenna Support	Available
Audio Input/output	Available
Serial Port	I2C and UART
Serial Debug Port	Available

Esp32-Cam

Table A.3: Datasheet of esp32-cam

SPI Flash	default 32Mbit
RAM	built-in 520 KB+external 4MPSRAM
Dimension	27*40.5*4.5 （±0.2） mm/1.06*1.59*0.18”
Bluetooth	Bluetooth 4.2 BR/EDR and BLE standards
Support Interface	UART, SPI, I2C, PWM
Support TF card	maximum support 4G
IO port	9
Serial Port Baud-rate	Default 115200 bps
mage Output Format	JPEG(OV2640 support only), BMP, GRAYSCALE
Spectrum Rang	2412 ~2484MHz
Security	WPA/WPA2/WPA2-Enterprise/WPS
Power supply range	5v
Operating temperature	-40 °C ~ 90 °C, < 90%RH
Weight	10g
Wi-Fi	802.11b/g/n/e/i

Code:

Arduino

```
define BLYNK_TEMPLATE_ID "TMPLQtOFpq93"

#define BLYNK_DEVICE_NAME "LIGHTS"

#define BLYNK_AUTH_TOKEN "w9IqbvJxIk0pKBd4Q7IyshxGlPayOAq4"

#include <ESP8266_Lib.h>

#include <BlynkSimpleShieldEsp8266.h>

#include "max6675.h"


char auth[] = BLYNK_AUTH_TOKEN;

char ssid[] = "Asteroid";

char pass[] = "PASS&&WORD";


#define echo 10  // attach pin D2 Arduino to pin Echo of HC-SR04
```

```
#define trig 9   //attach pin D3 Arduino to pin Trig of HC-SR04
long duration;
int distance;

int flame_sensor_pin = 7;
int flame_pin = HIGH;
WidgetLED led(V2);

// smoke pin
int smokeA0 = A0;
int data = 0;
int sensorThres = 150;
// Temp pin
int ktcSO = 4;
int ktcCS = 5;
int ktcCLK = 6;

MAX6675 ktc(ktcCLK, ktcCS, ktcSO);

BlynkTimer timer;

#include <SoftwareSerial.h>
SoftwareSerial EspSerial(2, 3);  // RX, TX

#define ESP8266_BAUD 38400
ESP8266 wifi(&EspSerial);
```

```
void setup() {
  pinMode(trig, OUTPUT);  // Sets the trigPin as an OUTPUT
  pinMode(echo, INPUT);   // Sets the echoPin as an INPUT
  pinMode(flame_sensor_pin, INPUT);

  Serial.begin(115200);

  // Set ESP8266 baud rate
  EspSerial.begin(ESP8266_BAUD);
  delay(10);

  Blynk.begin(auth, wifi, ssid, pass, "blynk.cloud", 80);

  timer.setInterval(1000L, sendSensor);
}

void loop() {
  Blynk.run();
  timer.run();
}

// Sensor Data
void sendSensor() {         //ultrasonic sensor
  digitalWrite(trig, LOW);  // Makes trigPin low
  delayMicroseconds(2);     // 2 micro second delay

  digitalWrite(trig, HIGH);  // tigPin high
```

```
delayMicroseconds(10);     // trigPin high for 10 micro seconds
digitalWrite(trig, LOW);   // trigPin low

duration = pulseIn(echo, HIGH);   //Read echo pin, time in microseconds
distance = duration * 0.034 / 2;  //Calculating actual/real distance

Blynk.virtualWrite(V6, distance);

// smoke sensor
int data = analogRead(smokeA0);
Blynk.virtualWrite(V3, data);

//   // temp_sensor
float c = ktc.readCelsius();     // Calcious
float f = ktc.readFahrenheit();  //Fahrenheit

Blynk.virtualWrite(V4, c);
Blynk.virtualWrite(V5, f);

if (data > sensorThres && c > 30) {

  Blynk.logEvent("fire_alert");
}


// FLAME
flame_pin = digitalRead(flame_sensor_pin);  // reading from the sensor
```

```
  if (flame_pin == LOW)                    // applying condition
  {
    Blynk.logEvent("fire_alert");

    Blynk.virtualWrite(V1, 1);

    // Serial.println(flame_pin);
    Blynk.virtualWrite(V1, 1);
    led.on();
  }

  else {

    Blynk.virtualWrite(V1, 0);
  }
  //Serial Print
  Serial.print(distance);
  Serial.print(" , ");  //Output distance on arduino serial monitor
  Serial.print(data);
  Serial.print(" , ");  //Output smoke value on arduino serial monitor
  Serial.print(c);
  Serial.print(" , ");  //Output celcius on arduino serial monitor
  Serial.print(f);
  Serial.print(" , ");  //Output farenhight on arduino serial monitor
  Serial.println(flame_pin); // Output Flame level

}
```

Python

```
import serial # import Serial Library

import numpy as np  # Import numpy

import matplotlib.pyplot as plt #import matplotlib library

from drawnow import *



tempF= []

tempC= []

distance=[]

smoke_data=[]

flame_lavel=[]



arduinoData = serial.Serial('com4', 115200)

plt.ion()

cnt=0



def makeFig():



    plt.ylabel('Temp F')

    ax1 = plt.subplot(2, 3, 1)

    ax1.set_ylim(bottom=70, top=90)

    ax1.grid(True)                              #Set ylabels
```

```
ax1.plot(tempF, 'ro-', label='Degrees F')      #plot the temperature
plt.legend(loc='upper left')


plt.ylabel('Temp C')
ax2 = plt.subplot(2, 3, 2)
ax2.set_ylim(bottom=15, top=40)
ax2.grid(True)#Set ylabels
ax2.plot(tempC, 'ro-', label='Degrees C')      #plot the temperature
plt.legend(loc='upper left')



plt.ylabel('Distance(cm)')
ax3 = plt.subplot(2, 3, 3)
ax3.set_ylim(bottom=0, top=1000)
ax3.grid(True)#Set ylabels
ax3.plot(distance, 'b^-', label='Distance')      #plot the distance
plt.legend(loc='upper left')



plt.ylabel('Smoke level(ppm)')
ax4 = plt.subplot(2, 3, 4)
ax4.set_ylim(bottom=0, top=1000)
ax4.grid(True)#Set ylabels
```

```
    ax4.plot(distance, 'ro-', label='Smoke')      #plot the smoke level
    plt.legend(loc='upper left')


    plt.ylabel('Flame_lavel')
    ax5 = plt.subplot(2, 3, 5)
    ax5.set_ylim(bottom=1, top=0)
    ax5.grid(True)#Set ylabels
    ax5.plot(distance, 'ro-', label='Flame')      #plot the flame sensor value
    plt.legend(loc='upper left')


while True: # While loop that loops forever
    while (arduinoData.inWaiting()==0): #Wait here until there is data
        pass #do nothing
    arduinoString = arduinoData.readline()
    #b_string = b'1183 , 456 , 25.25 , 77.45 , 1\r\n'
    s = arduinoString.decode()
    dataArray = [float(x) for x in s.split(',')]
    #print(dataArray)
    ultrasonic=float( dataArray[0])
    print(ultrasonic)
    data=  float( dataArray[1])
    c= float( dataArray[2])
    f= float( dataArray[3])
```

```
flame= float( dataArray[4])

tempF.append(f)

tempC.append(c)

distance.append(ultrasonic)

print(distance)

smoke_data.append(data)

print(smoke_data)

flame_lavel.append(flame)

print(flame_lavel)


drawnow(makeFig)

plt.pause(.000001)
```

Appendix B

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