PYROSENTRY: ADVANCED IMAGE-BASED FIRE LOCALIZATION & EXTINGUISHING NETWORK

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A Final Year Design Project (FYDP) submitted to the Department of Electrical and Electronics Engineering in partial fulfillment of the requirements for the degree of BSEEE

Electrical and Electronics Engineering
Brac University
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December 2024

Declaration

It is hereby declared that

1. The Final Year Design Project (FYDP) submitted is our own original work while completing degree at Brac University.
2. The Final Year Design Project (FYDP) does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The Final Year Design Project (FYDP) does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. We have acknowledged all main sources of help.

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Approval

The Final Year Design Project (FYDP) titled "PYROSENTRY: ADVANCED IMAGE-BASED FIRE LOCALIZATION & EXTINGUISHING NETWORK" submitted by

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of Fall, 2024 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of BSEE on 09/01/25.

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Ethics Statement

We hereby confirm that this project "Pyrosentry: Advanced Image-Based Fire Localization & Extinguishing Network" has met the requirements of the Final Year Design Project (FYDP). This project has been developed by collective effort of the group members. The supportive materials, literature review and collected data have been cited properly. According to the library of Brac University this report consists of similarity score of 12%. Through proper guidance and support from our supervisors and university we have implemented our project contents.

Abstract/ Executive Summary

With the advancement of technology fire safety is becoming more and more important for the betterment of livelihood. A fire hazard is fatal and dangerous for both household and industrial security. In the case of the detection and mitigation process time is very crucial. Which is why it is important to respond as quickly as possible to reduce the damage and manual functionality to a minimum percentage. In this project we have developed an image-based system that can detect and mitigate fire automatically. An additional feature of this system is that it is practical to implement and can be used in any household or industrial site by slightly modifying existing infrastructure of any fire safety system.

Keywords: Fire Localization, Automatic Fire Detection, Fire Suppression System, Image Processing, Machine Learning, Convolutional Neural Network (CNN), Raspberry Pi, Real-Time Detection, Smart Fire Extinguishing.

Acknowledgement

We would like to express our appreciation for our ATC panel chair — professor Dr. AKM Abdul Malek Azad, who has provided honorable guidance to us. We would also like to thank Md. Rafiqul Islam Rafi, Lecturer, Brac University and Mr. Ihteyaz Aqaeed Avash, Lecturer, Brac University for guiding us to follow various conventions which are making our project better. Finally, we would like to thank Ms. Sabrina Saima also for helping us during initial project phases.

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Chapter 1: Introduction

1.1 Introduction

We are in an era where the rapid advancement in modern technology is changing the ways of how we live. While the achievements in the field of modern technology can push society forward towards greater heights, they fall short when it comes to addressing certain challenges. Among these challenges fire incidents are one of the prominent ones, which not only recurs throughout from time to time, but also imposes a serious threat to human lives, infrastructure, and the environment. Of all these challenges, fire incidents are notably prominent and demand serious attention. They occur repeatedly and are a danger to people's lives, important structures and the ecosystem.

The accomplishments of the technological field often fall short of bringing comprehensive solutions to the light for detecting and mitigating fire hazards effectively. Fires are hazardous, as they can grow at a rapid pace and in just a few seconds it generates significant heat and poisonous smoke. Even with the advancements in the design of fire-resistant buildings and the development of fire prevention strategies, our society is still vulnerable to fire disasters [1].

Therefore, it is an absolute necessity to prioritize the development of a much faster and reliable system which can contain and alleviate fire hazards [2]. These developments are crucial not only for protecting property and lives but also for maintaining the unity, balance, and overall health of our society.

1.1.1 Problem Statement

In recent years many fire incidents have occurred in Bangladesh, which was the cause of ruination of many industries and houses. Dhaka Division witnessed a surge in fire incidents, with 603 occurrences in September 2023. According to the media statement, the Mymensingh Division experienced 63 fire incidents, Chittagong Division 189, Rajshahi Division 225, Khulna Division 132, Sylhet Division 57, Barisal Division 60, and Rangpur Division 248 [3]. The most recent fire accident that occurred was in Dhaka where at least 44 people were killed and 22 critically injured in a fire that broke out at a seven-story commercial building on Bailey Road in Dhaka. Around 75 people, including 42 who were found unconscious, were rescued from Green Cozy Cottage Shopping Mall [4]. If we just analyze this building alone, we can discover how much safety protocol the building lacked. There were no fire exits with fire doors, evacuation paths, fire alarm systems, or fire-fighting systems. The building was said to have very narrow stairways, on top of that according to sources there were large LPG gas cylinders on every landing of the stairs [5]. This is why one of the root causes of these fire incidents is the need for more fire safety measures, suppression methods and specifically designed safety measures for a specific type of building or room. Traditional fire suppression methods may only sometimes be practical or swift enough to prevent extensive damage [6].

The problem this project address is the efficient and timely suppression of fires in residential and commercial buildings. By integrating machine learning-based technology with intelligent fire suppression systems, we aim to enhance the speed and accuracy of fire detection and suppression processes through RGB image processing [7]. A highlight of this project is the availability of the materials and how easily this system is integrated into a household or an industry. This project is relevant to the current and future industry as it addresses the growing need for advanced fire safety measures in densely populated urban areas with prevalent apartment buildings.

1.1.2 Background Study

It is safe to say that fire detectors play a vital role in any kind of fire detection system. Some industries have technologies that may create smokeless flames when faced with an electrical or technical malfunction. Smoke and gas-based fire alarms can give a false alarm if they are not properly calibrated or due to lack of proper system maintenance [8].

A fire detector can be categorized as smoke or gas detector, heat or thermal detectors, flame detectors, semiconductor gas detectors etc. [9]. Among these detectors smoke detectors are the most used detectors because of the variety of their usage. These detectors can have various operational principles, for example optical or photoelectric detectors, ionization detectors, air sampling detectors etc. Another commonly used detector is the heat or thermal type detector. These types of detectors activate whenever the fire or temperature reaches a certain temperature. They are reliable, inexpensive and easy to maintain. However, these types of detectors are a bit slow depending on which version of the detectors and how it is being implemented [10]. To overcome this limitation Flame Type Detectors can be used for newer versions of fire mitigation and detection systems. Flame type detectors generally work with wavelengths shorter than 300 nm. These types of detectors can generally detect fire within 3 to 4 milliseconds from the UV radiation emitted from the fire affected area [11]. Much research has been conducted to improve fire detection and mitigation systems.

For example, W.B. Horn and colleagues introduced a rapid-fire flame detection method employing the HSI color model [12]. This approach references images within a spatial coordinate system to facilitate fire detection. Additionally, it incorporates an alarm unit for timely notifications.

Another paper written by Yoon-Ho Kim presents a solution in which they used a fire detection algorithm which uses video sequences captured by static cameras. The algorithm relates to a wireless sensor network which can detect fire in real time. The detection works by using background and foreground modeling. At first the system creates a model of the background using a statistical method called Mixture of Gaussians (MoG). This is kept as the “normal” background for the system reference. Next the foreground detection is used to capture the scenes, and it is compared with the background model. If the color detected in both background matches, then the system does not detect anything however if the foreground background notices any changes by comparing with the background model it detects it as fire specially if the algorithm detects high pixel red color values afterwards the system performs a blob analysis to check for shapes, size or any changes in the images to make sure if it’s really fire. And finally, if all the criteria are met then the system confirms that the fire is detected. [13].

Fatma M. Talaat and team proposed a detection system which is designed to detect fire using YOLOV8s and IoT. The system aims to enhance the accuracy and the speed of fire detection using smart city frameworks which consist of four-layer applications which are fog, cloud and IoT. They collect the data by gathering a large dataset of fire and non-fire images and videos. Afterwards the images and videos are labeled and split into training and testing sets. The model is trained using the training data sets and then after the testing phase the system can be evaluated using various metrics such as precision, F1 score, recall etc. According to the paper the system can be used to detect fire in real time and it can also be used to detect hazards like gas leaks or flooding. [14]

Even though there are various detection methods available the mitigation methods remain somewhat the same. A paper written by Shikar Baral and team introduced a different approach for fire mitigation which is a comprehensive solution to ensure safety from fire in closed spaces. The system collects data from various sources such as gas, humidity, temperature and flame sensors. When the system detects the type of fire by using these gas and infrared sensors it triggers an evacuation plan by using laser lights and speakers. At the same time the system also notifies the fire department and triggers a ventilation-based sensor threshold which opens doors, windows and activates fire extinguishing process after making sure the place has been evacuated. The fire extinguishing process includes different type of mitigation system based on the type of fire. For example, water is used for fires which is caused by solid combustibles, papers etc. Carbon dioxide is used for fire which is caused by electrical malfunctions etc. [15]

1.1.3 Literature Gap

The background research for this project shows that despite having significant advancements in fire detection and mitigation systems there are some limitations in existing research. For example, many of the existing systems struggle with false positive rates caused by poorly calibrated smoke or gas detectors, environmental noise and maintenance issues.

In addition, most of the work in this field primarily focuses on the detection system. As a result, even though there are various ways to detect fire however the mitigation system remains the same. Even though, there are some mitigation strategies, like the ones proposed by Shikar Baral, which does address a new way of fire mitigation system however, these approaches depend on complex infrastructure making them unsuitable for small scale applications such as houses or small industrial spaces.

Therefore, by combining fire detection with active suppression in a compact and scalable model this project aims to offer a cost-effective solution on both detection and mitigation side by providing a smart fire detection algorithm capable of detecting fire in its early stages and immediately mitigate it using a combination of Raspberry Pi, Arduino and a targeted water-spraying mechanism.

1.1.4 Relevance to current and future Industry

This project has crucial relevance in both current and future industries. It has prominent capabilities to be applied in urban as well as industrial settings, satisfying each of their critical needs. Considering urbanized regions, where highly populated areas exist, it is always an issue how severe fire incidents could occur inside the apartments or any other residential areas. Our advanced fire detection and mitigation system is specifically designed to tackle such challenges. It can be instrumental in saving lives in cities with a dense population.

In addition, many industrial sectors have different ranges of challenges related to fire hazards and mitigation. Many warehouses and facilities store and administer highly flammable materials, while certain factories operate in high temperature conditions, having the risk of fire hazards at any given moment. Our system offers an effective edge in fire detection by identifying potential hazards, including fires that do not emit smoke. This ensures a quicker response, helping to prevent catastrophic disasters and minimize damage in industrial settings.

1.2 Objectives, Requirements, Specification and constant

1.2.1. Objectives

- Develop a fire detection system capable of identifying flames within buildings using image processing algorithms.
- Implement an efficient and low-maintenance fire detection system.
- Implement a fire detection and suppression systems with rapid discharge time enhances system response speed compared to traditional systems.
- Ensure the safety and well-being of occupants by minimizing the spread and impact of flames.

1.2.2 Functional and Nonfunctional Requirements

Functional Requirements:

- High-resolution camera in each room.
- Image processing algorithms for real-time fire detection.
- Nozzles for sprinkling mechanism.
- Main storage tank.
- Stable connection.
- Compliance with safety standards.

Non-Functional requirements:

- Video feed analyzing latency.
- Scalability of the system.
- Video feed and analysis security and encryption.

1.2.2 Specifications

Table 1: Specification of Design Approach 1

Design Approach 1		
Component	**Model**	**Specification**
Camera	Rapoo C260 USB Full HD Webcam	**High-Definition Video:** • 2MP CMOS sensor with 1080p resolution. • Intelligently adjusts frame rate and resolution based on ambient light for clear video even in dim lighting. **Wide-Angle Lens:** • 95° super wide-angle lens for broader image capture. • Field of View: 80°. • 360° horizontal rotation with adjustable upper and lower viewing angles. **Audio Quality:** • Built-in omnidirectional microphone for purer and clearer sound during voice chats.
MCU	Raspberry Pi 5	• **Microcontroller:** Broadcom BCM2712 2.4GHz quad-core 64-bit Arm Cortex-A76 CPU, with Cryptographic Extension, 512KB per-core L2 caches, and a 2MB shared L3 cache • Video Core VII GPU, supporting OpenGL ES 3.1, Vulkan 1.2 • Dual 4Kp60 HDMI® display output with HDR support • 4Kp60 HEVC decoder • LPDDR4X-4267 SDRAM • Dual-band 802.11ac Wi-Fi® • Bluetooth 5.0 / Bluetooth Low Energy (BLE) • microSD card slot, with support for high-speed SDR104 mode • 2 × USB 3.0 ports, supporting simultaneous 5Gbps operation • 2 × USB 2.0 ports • Gigabit Ethernet, with PoE+ support (requires separate PoE+ HAT) • 2 × 4-lane MIPI camera/display transceivers • PCIe 2.0 x1 interface for fast peripherals (requires separate M.2 HAT or another adapter)

		• 5V/5A DC power via USB-C, with Power Delivery support • Raspberry Pi standard 40-pin header • Real-time clock (RTC), powered from external battery • Power button
Sub System Level MCU	Arduino Nano	• **Microcontroller**: ATmega328P (8-bit AVR family microcontroller) • **Operating Voltage**: 5V • **Recommended Input Voltage for Vin Pin**: 7-12V • **Analog Input Pins**: 6 (A0 – A5) • **Digital I/O Pins**: 14 (6 of which provide PWM output) • **DC Current on I/O Pins**: 40 mA • **DC Current on 3.3V Pin**: 50 mA •**Flash Memory**: 32 KB (2 KB used for bootloader) • **SRAM**: 2 KB • **EEPROM**: 1 KB • **Frequency (Clock Speed)**: 16 MHz • **Communication Interfaces**: IIC, SPI, USART
Servo Controller	L293D Shield for Arduino	• **Type**: Dual H-Bridge Motor Driver IC • **Range**: 4.5V to 36V • **Output Current:** Up to 600mA per channel
Alarm	Generic Buzzer	• **Operating Voltage:**5V DC
Servos	SG90 Micro Servo	• **Operating voltage:** 4.8 - 6 V • **Stall torque:** 1.8 kg-cm (0.25 oz-in) • **Speed:** 60 rpm • **Weight:** 9 grams • **Angle of rotation:** 180 degrees

***Table 2**: Specifications of Design Approach 2*

Design Approach 2		
Component	**Model**	**Specification**
Thermal Camera	UNI-T UTi85H+ Infrared Thermal Imaging Camera	• 2.8″ TFT screen • Infrared resolution: 160×120 • Frame frequency: 9Hz • Range of temperature measurement: 30˚C~45˚C • Accuracy: ±0.5˚C • Photographed function and SD card storage • PC software analysis • Point temperature measurement • Type-C USB interface for lithium battery charging
CO_2 Gas cylinder	CO_2 Gas Is: 15222 Carbon Dioxide Cylinder	• **Cylinder Capacity:** 2kg • **Working Pressure:** 55 bar • **Gas Type:** CO_2 gas IS: 15222 • **Color:** Red
MCU	Raspberry Pi 5	• **Microcontroller:** Broadcom BCM2712 2.4GHz quad-core 64-bit Arm Cortex-A76 CPU, with Cryptographic Extension, 512KB per-core L2 caches, and a 2MB shared L3 cache • Video Core VII GPU, supporting OpenGL ES 3.1, Vulkan 1.2 • Dual 4Kp60 HDMI® display output with HDR support • 4Kp60 HEVC decoder • LPDDR4X-4267 SDRAM • Dual-band 802.11ac Wi-Fi® • Bluetooth 5.0 / Bluetooth Low Energy (BLE) • microSD card slot, with support for high-speed SDR104 mode • 2 × USB 3.0 ports, supporting simultaneous 5Gbps operation • 2 × USB 2.0 ports • Gigabit Ethernet, with PoE+ support (requires separate PoE+ HAT) • 2 × 4-lane MIPI camera/display transceivers

		• PCIe 2.0 x1 interface for fast peripherals (requires separate M.2 HAT or another adapter) • 5V/5A DC power via USB-C, with Power Delivery support • Raspberry Pi standard 40-pin header • Real-time clock (RTC), powered from external battery • Power button
Sub-system level MCU	Arduino Nano	• **Microcontroller**: ATmega328P (8-bit AVR family microcontroller) • **Operating Voltage**: 5V • **Recommended Input Voltage for Vin Pin**: 7-12V • **Analog Input Pins**: 6 (A0 – A5) • **Digital I/O Pins**: 14 (6 of which provide PWM output) • **DC Current on I/O Pins**: 40 mA • **DC Current on 3.3V Pin**: 50 mA •**Flash Memory**: 32 KB (2 KB used for bootloader) • **SRAM**: 2 KB • **EEPROM**: 1 KB • **Frequency (Clock Speed)**: 16 MHz **Communication Interfaces**: IIC, SPI, USART
Servo Control	SG90 Micro Servo	• **Operating voltage:** 4.8 - 6 V • **Stall torque:** 1.8 kg-cm (0.25 oz-in) • **Speed:** 60 rpm • **Weight:** 9 grams • **Angle of rotation:** 180 degrees
Alarm	Zeta Conventional Fire Alarm Bell	• **Operating Voltage:**12V DC
Communication	SIM900A GSM/GPRS Module V4.0	• **Two power supply interfaces:** VCC5, 5V DC above 1A. Computer 5V power supply can be early computer USB. DC long data circuit over larger recommended 5V1A. VCC4, 3.5-4.5V power supply, ibid., suitable for a lithium battery. • Control pins all leads. • A TTL level, compatible with 3.3V and 5V. • The two-antenna interface, the default SMA straight head, connector for IPXmini antenna.

System Level Specifications

Table 3: System Specifications of Design Approach 2

Design Approach 1	
Component	**Unit**
Camera	2x
Pipe-50 ft.	1x
Water Nozzle	1x
Alarm	1x
Valve	1x

Table 4: System Specifications of Design Approach 2

Design Approach 2	
Component	**Unit**
Thermal Camera	2x
CO2 Cylinder	1x
Pipe-30 ft.	1x
Water Nozzle	1x
Alarm	1x
Valve	1x

1.2.3 Technical and Non-technical consideration and constraint in design process

Constraints:

- **False alarms:** Image processing algorithms can sometimes give false alarms and be unable to detect fire as these machines are not 100% correct at image detection [11].
- **Data privacy and security:** Data needs to be continuously online and processed, so privacy and security are a concern [12].
- **Technical compatibility:** Integration of the proposed mitigation system with existing mitigation infrastructure can be complex.

Technical Considerations

- Proper dataset with sufficient selection of various fire hazard incident images in various environments should be prepared carefully for model training purposes. Without a balanced or properly selected dataset, the model would either be over-fitted or under-fitted, which are unwanted and can cause false alarms or might not detect fire at all.
- The CNN model should be compact enough for proper integration with the Raspberry Pi. Larger model will hamper the proper optimization with the Raspberry Pi, resulting in increased latency in handling the continuous video feed processing.
- The accuracy of the whole system heavily relies on the proper calibration of the cameras, servo motors and electric valves. Thus, a proper calibration is required for accurate fire response.
- The mobile app alert system depends solely on the central control unit. A proper synchronization is required for timely and accurate warning system.
- Ensuring correct lighting is used in a room, to reduce false alarms.
- The camera placement should allow maximum visibility of the room.
- Properly installing and testing the water nozzle and servo motors withholding surface for a secured connection, which can sustain the force generated from the fire mitigation sub-system.

Non-Technical Considerations

- Getting permission from the authorities and experts for testing and validation purposes.
- Making the companion mobile app suitable for any user for ease of usability.
- Ensuring user privacy by encrypting data transmission between components and not storing unnecessary data from the video feed.
- The water pressure should be maintained properly for effective mitigation process.

Following the system level requirements specified by the stakeholders.

1.2.4 Applicable compliance, standards, and codes

- **IEEE Std 835:** This standard provides a test procedure for determining the ampacity derating factor in the cable installation configurations for Fire-Protected Cable Systems [15].
- **IEC/TC20 Electric Cables IEC 60332:** Specifies the procedure for testing the resistance to vertical flame propagation for a single vertical electrical insulated conductor or cable under fire conditions [16].
- **IEC/TC61 Appliances IEC 60335:** Provides standards for the safety of electrical appliances for household and similar purposes [17].
- **IEC/TC74 IT Equipment IEC 60950:** This standard applies to both mains-powered and battery-powered equipment, including electrical business equipment and associated equipment with a rated voltage not exceeding 600 V [18].
- **IEC/TC89 Fire Hazard IEC 60695:** This is a series of international standards published by IEC/TC89 that specifically deal with fire hazard testing for electrical and electronic equipment [19].
- **IEC/TC92 Audio/Video (TVs) IEC 60065:** This is a series of international standards, published by IEC/TC92, specifically addressing the safety of audio, video, and multimedia equipment [20].
- **ISO 7240-27:2018:** This document specifies requirements, test methods, and performance criteria for multi-sensor point fire detectors that incorporate a smoke sensor, a carbon monoxide (CO) sensor, and, optionally, one or more heat sensors, for use in fire detection and alarm systems installed in buildings [21].
- **NFPA 72:** The National Fire Alarm and Signaling Code offers remote access for system operation and diagnostics in addition to installation, inspection, testing, and maintenance (ITM) of fire alarm systems [22].
- **NFPA 13:** Addresses component selections, system installation techniques, and sprinkler system design ideas to reduce the risk of fire and property loss [23].

1.3 Systematic Overview/summary of the proposed project

This research aims to build a more effective and efficient system for fire detection and extinguishing fire. It's more likely to upgrade and replace the traditional way with an advanced system.

1.3.1 Design Approach 1:

The first design approach for an RGB-based detection system can be divided into two significant parts: detection and extinguishing. In case of detection, feed from CCTV or cameras in the form of RGB images and analyzing those images will be used to detect the fault. Convolutional neural networks (CNN) will work as the base part of machine learning. These image processing will be operated through Raspberry Pi.

For an added layer of functionality and safety, an Infrared (IR) sensor is incorporated into the system to prevent triggering false alarms. The MCU will take feed from the camera and the IR sensor and compare the inputs to omit false positives. If the camera detects a positive feed, it will cross-check the data input from the IR sensor.

Camera functionality is here, so the feed quality is derived from the camera. When a fire is detected, the fire mitigation system is triggered, and the extinguishing system comes into play. The system utilizes a specially designed nozzle/spray system that can move freely in the XY plane. Assisted by a servo mechanism, the system can adequately identify and plot the place of fire and mitigate accordingly. The system uses a pressurized water spraying mechanism for fire mitigation.

The effectiveness of the CNN method mentioned is primarily based on the training data provided. CNN algorithm will be running locally on the Raspberry Pi 4. CNN uses a convolutional layer in general. These are the core building blocks of a traditional CNN model. These are usually the core building blocks of a CNN. They apply filters, which are known as kernels, to slide across the image. These filters detect specific features like edges, lines, and shapes. Each filter eventually learns to identify patterns across the image. These tell the system what to look for in the picture. Finally, the output of said layers and filters creates a feature map that highlights the presence of the item we are looking for. In our case, we will be using this system to detect fire.

1.3.2 Design Approach 2:

For our second design approach, we aim to achieve a fire mitigation system with the help of a thermal image-based camera. Thermal cameras pick up thermal images with their sensors and generate thermal metadata that can be used to identify fires. One of the key advantages of using thermal cameras is that temperatures can rise even before a fire takes place, and thermal cameras can detect such incidents with near-perfect accuracy.in case of implementation, we are replacing the water-based mitigation system with CO2 based system. For functionality, the system uses a thermal camera to obtain temperature data and detect fire. The data is sent to the system's Raspberry Pi 4 or MCU for detection, analysis, and plotting. Upon completion, if the system can detect a fire, the system triggers the servo, controlling the valves of the CO2 extinguishers. A 2-axis servo system is also in the system to precisely cater to the fire-affected area. The MCU drives the servo system, and the trigger mechanisms are controlled by the Arduino Nano modules.

1.4 Conclusion

The PyroSentry project proposes an innovative solution to fire incidents by detecting and extinguishing fire uniquely. If there is a fire outbreak in a densely populated country like Bangladesh the need for an advanced fire safety system that is efficient to apply in most situations is prominent. Integrating machine learning-based technology with a smart fire extinguishing system, PyroSentry aims to make a change in traditional fire detection and extinguishing methods. The use of high-resolution image processing and a point-to-point extinguishing mechanism can make a big impact in the context of a fire extinguishing system. This method will minimize the damage and ensure overall fire safety.

Chapter 2: Project Design Approach [CO5, CO6]

2.1 Introduction

Two different design approaches were developed to compare and analyze which design has the most potential and benefits for the consumers. Both design approaches had some minimal changes in the component level and since the project is based on fire detection some minimal changes to the algorithm have also been made. Furthermore, while comparing the designs some key features were prioritized which are higher accuracy, faster response time and user friendliness as well as ease of maintenance. For both the designs we prioritized having components that are durable and cost effective. Through both designs we successfully achieved our objective to create a reliable, cost-effective and easily adopted by consumers fire detection system.

2.2 Identify multiple design approach

2.2.1 Design Approach 1:

One of the most effective measures that are currently proposed for apartment buildings and commercial structures to reduce fire outbreaks is highly efficient systems, which can easily detect and suppress them in minutes. This system employs CCTV cameras throughout the premises and captures high-resolution RGB images for monitoring. These images are processed by an RGB fire detection system, which alerts the central monitoring unit if any fire signs are detected.

A fire incident confirms the initiation of the suppression process, where the system activates water from a primary storage tank while all other water supplies are shut off. Also, as soon as the trigger signals are sent to sprinkler heads, an automatic 360-degree rotating nozzle mounted on an automated system sprays out enough water to put out the fire and prevent it from further spreading.

Among the vast array of advantages are identifying and reporting fire hazards in their early stages, optimal water consumption rates, and directed application of firefighting resources to areas impacted by fire.

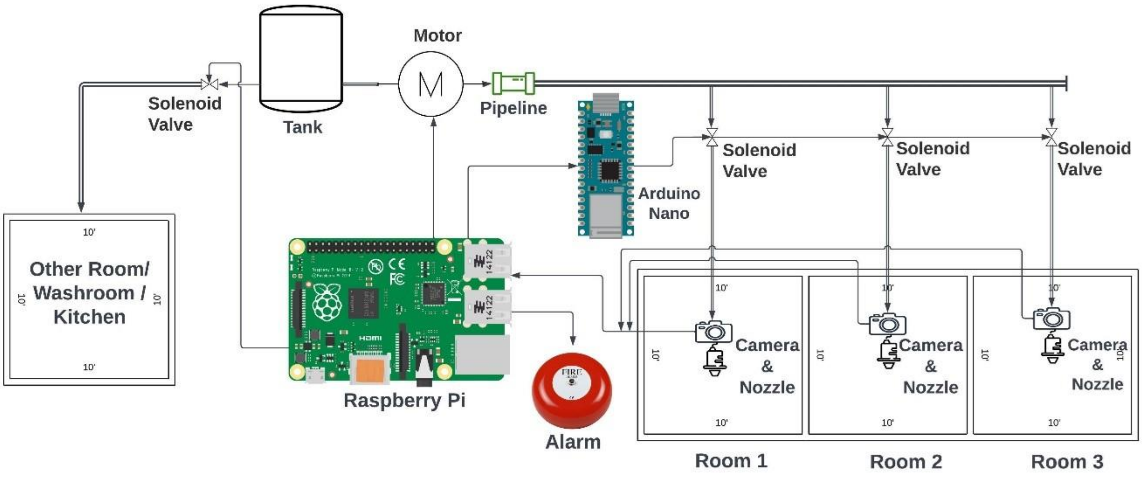

Figure 1: Fire extinguishing system using Water Tank

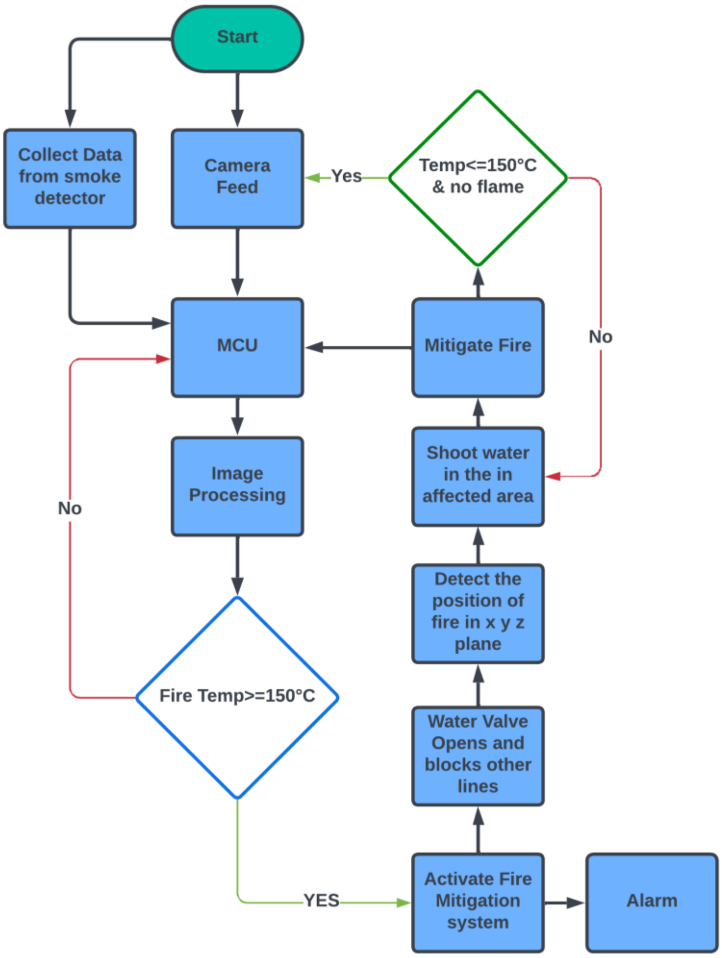

Figure 2: Functional Flowchart of Design Approach 1

The system's flowchart in figure 4 can be explained as follows: The entire process begins with a data collection from the smoke detector whereby it activates the thermal camera feed; this will then be analyzed to find out if the captured image has registered a temperature higher than

150 degrees Celsius threshold value, which is a critical one. If the temperature is still below the 150 degrees, it proceeds to monitoring and processing of the image data. However, when the temperature is beyond 150 degrees, it continues to initiate the fire mitigation process. The whole steps of mitigation mostly featured shooting water inside the concern area, appraising the position of fire from the same thermal camera and opening valves to deny access by other lines. Then, all the activities set are now completed and activate the fire mitigation system, sending out an alarm to notify persons in the area. Hence, the flowchart shows decision points and concomitant actions done by the system to effectively manage and respond to fire-related disasters.

2.2.2 Design Approach 2:

Design Approach 2 uses a different method to identify and put out fires. This system uses a thermal camera placed in every room to check for temperatures suggestive of a fire continuously. The thermal camera instantly notifies the central monitoring station of the presence of a fire and activates local audio sirens to inform residents.

Each room also includes a pre-connected CO2 cylinder with an Arduino Nano micro-controller board. Upon detection of fire, the associated Arduino Nano receives an instant activation signal from the central control unit. The flame is quickly extinguished when the Arduino Nano uses a customized nozzle mechanism to start releasing CO2 right at the source of the fire.

The fire detection system also includes a GSM module to notify building owners or managers via text or phone when an alert is set off, improving emergency response.

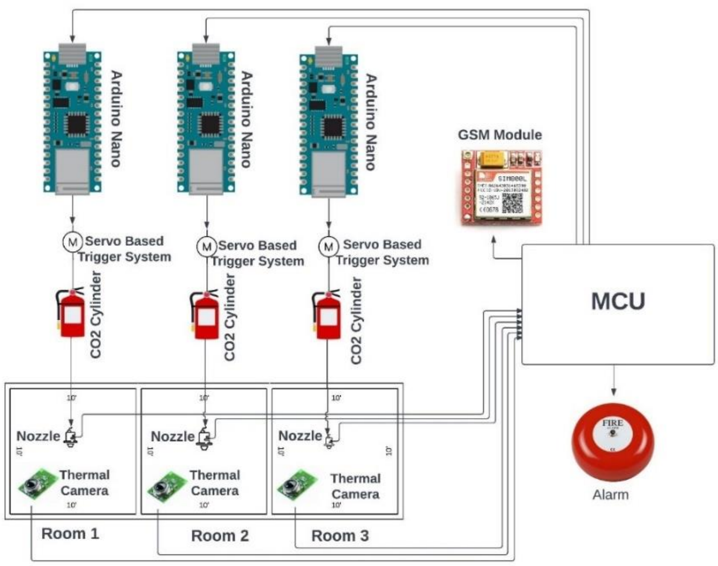

Figure 3: CO2-Based Fire Extinguishing System

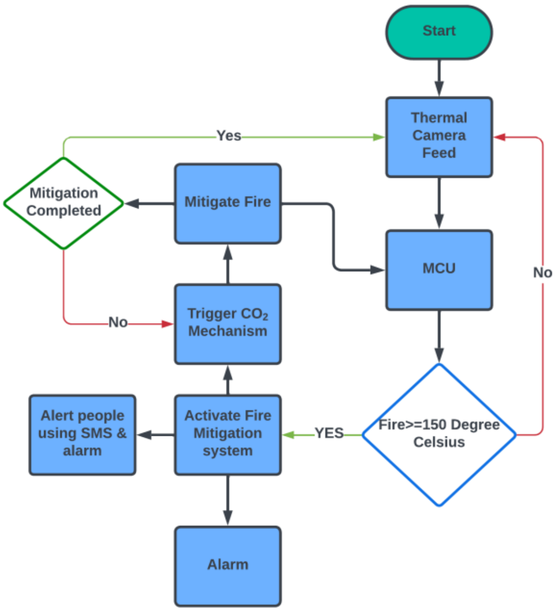

Figure 4: Functional Flowchart of Design Approach 2

The system's flowchart in figure 4 can be explained as follows: The first action displayed in this procedure is putting the area under surveillance via thermal camera feed. Then, in case any fire is detected, following the triggering of a complete fire mitigation system and work of CO2 mechanism, there are other actions added in sequence. This also continuously checks the temperature, and if it goes beyond 150C, an alarm is raised and people notified through SMS and alarm systems. The following process continues until mitigation is complete, at which point it resets to be ready at any time for a new fire incident.

2.3 Describe multiple design approach

2.3.1 Design Approach 1:

The first design approach for an RGB-based detection system can be divided into two significant parts: detection and extinguishing. In case of detection, feed from CCTV or cameras in the form of RGB images and analyzing those images will be used to detect the fault. YOLOV8S will work as the base part of machine learning. This image processing will be operated through Raspberry Pi.

The effectiveness of the YOLOV8S method mentioned is primarily based on the training data provided. YOLOV8S algorithm will be running locally on the Raspberry Pi 5. The model will be trained in a virtual environment such as google collab or python.

When a fire is detected through the camera, the fire mitigation system will be triggered, and the extinguishing system comes into play. The system utilizes a specially designed nozzle system that can move freely in the XYZ plane. Assisted by a servo mechanism, the system can adequately identify and plot the place of fire and mitigate accordingly. The system uses a pressurized water spraying mechanism for fire mitigation.

2.3.2 Design Approach 2:

For our second design approach, we aim to achieve a fire mitigation system with the help of a thermal image-based camera. Thermal cameras pick up thermal images with their sensors and generate thermal metadata that can be used to identify fires. One of the key advantages of using thermal cameras is that temperatures can rise even before a fire takes place, and thermal cameras can detect such incidents with near-perfect accuracy. In case of implementation, we are replacing the water-based mitigation system with a carbon dioxide-based system. For functionality, the system uses a thermal camera to obtain temperature data and detect fire. The data is sent to the system's Raspberry Pi 5 or MCU for detection, analysis, and plotting. Upon completion, if the system can detect a fire, the system triggers the servo, controlling the valves of the carbon dioxide extinguishers. A 2-axis servo system is also in the system to precisely cater to the fire-affected area. The MCU drives the servo system, and the trigger mechanisms are controlled by the Arduino Nano modules.

2.4 Analysis of multiple design approach

Table 5: Comparison table for different approaches.

Criteria	Design Approach 1	Design Approach 2
Suppression System	Uses existing water supply to mitigate fire.	Uses conventional CO2-based extinguishing systems.
Detection Method	RGB Closed circuit camera to feed to incorporate image-based fire detection.	Thermal Camera to directly detect high temperatures.
Efficiency	More efficient with less delay	Less efficient with more delay
Trigger Mechanism	Electromechanical solenoid valves to control flow.	Servo incorporation to control the trigger mechanism of extinguishers.
Complexity	This is due to the added computational infrastructure required to process images of fires.	Less comparatively. Thermal signatures can detect fire with precision.
Cost	Comparatively lower.	Very high.
Dependency	Relies on existing water infrastructure.	Independent of any existing infrastructure.

Water-based mitigation system with RGB camera detection this approach represents a more economical but computationally complex solution. It integrates with existing water infrastructure and uses RGB closed-circuit cameras for fire detection. The system processes visual data to identify fire incidents, triggering electromechanical solenoid valves to control water flow when needed. While it offers high efficiency with minimal delay and lower overall costs, its complexity stems from the sophisticated image processing requirements. The reliance on existing water infrastructure makes it suitable for buildings with established plumbing systems but potentially limiting in other scenarios.

CO2-Based system with thermal detection this design takes a more independent but costly approach, utilizing CO2-based extinguishing systems coupled with thermal camera detection. The system employs servo mechanisms to control the CO2 extinguisher triggers and relies on direct temperature readings for fire detection. While it operates independently of existing infrastructure, making it more versatile in terms of installation locations, it comes with higher costs and slightly longer response times. However, its thermal detection method offers high precision with less computational complexity compared to image-based detection.

2.5 Conclusion

After the analysis of both the designs we can conclude that design approach 1 has more advantages over design approach 2. For example, with design approach 1 we can utilize already existing water infrastructures and CCTV cameras. This can help to make the project more cost effective furthermore by using RGB image processing to detect fire we can get more accuracy than design approach 2. However, design approach 2 also has some advantages such as it is less complex to implement than design approach 2 due to having a simple algorithm which utilizes thermal cameras. Furthermore, it has more precision than the design approach 1. Although, it has lower efficiency because it has longer processed time than design approach 1. From this comparison it can be concluded that design approach 1 is more flexible and feasible when it comes to more practical applications, and it is a cost-effective solution which aligns with our project objectives and consumer needs

Chapter 3: Use of Modern Engineering and IT Tool. [CO9]

3.1 Introduction

To visualize and simulate primary analysis to get to objective different modern engineering and IT tools have been used. Subsystem level circuits were simulated using different tools and integrated according to the prototype requirements.

3.2 Select appropriate engineering and IT tools

Table 6: Engineering and tools table

Engineering and IT Tools	
Hardware Tools	**Software Tools**
Camera	Proteus Design Suite 8.13
Raspberry Pi	Python Language
Arduino	Google Colab
Servo	Open CV
Servo Controller	Arduino IDE
Water Pump	Raspbian
Alarm	Pushbullet
Nozzle	

3.3 Use of modern engineering and IT tools

- ***Python Language*:** The Raspberry Pi is an affordable, compact computer that can be handheld and can be integrated to virtually any IoT projects. It includes essential on-board components such as a processor, memory, and input/output pins, which make it a fully functional computer. It supports various operating systems, with the most popular being Raspbian, a Linux-based distribution designed specifically for this device. Each model of the Raspberry Pi offers different features, such as varying numbers of USB ports, Wi-Fi capabilities, and processing speeds, allowing users to select a model that best suits their needs. The device can be connected to a monitor and keyboard, essentially functioning as a portable and low-cost desktop computer, or it can be integrated into larger projects as a control hub. The Raspberry Pi's GPIO (General Purpose Input/Output) pins are used to connect a wide range of peripherals and components, which increases the device's potential in electronic project creation. From building homemade weather stations, media centers, and game consoles etc. The applications of the Raspberry Pi are vast. We use this essential component to run our fire detection model in the fire mitigation system.

- ***Raspberry Pi*:** The Raspberry Pi is an affordable, compact computer that can be hand held and can be integrated to virtually any IoT projects. It includes essential on-board components such as a processor, memory, and input/output pins, which make it a fully functional computer. It supports various operating systems, with the most popular being Raspbian, a Linux-based distribution designed specifically for this device. Each model of the Raspberry Pi offers different features, such as varying numbers of USB ports, Wi-Fi capabilities, and processing speeds, allowing users to select a model that best suits their needs. The device can be connected to a monitor and keyboard, essentially functioning as a portable and low-cost desktop computer, or it can be integrated into larger projects as a control hub. The Raspberry Pi's GPIO (General Purpose Input/Output) pins are used to connect a wide range of peripherals and components, which increases the device's potential in electronic project creation. From building homemade weather stations, media centers, and game consoles etc. The applications of the Raspberry Pi are vast. We use this essential component to run our fire detection model in the fire mitigation system.

- ***Raspbian****:* Raspbian is a Debian-based Linux operating system customized specifically for Raspberry Pi devices. It is both lightweight and user-friendly, rendering it to be ideal for implementing all types of computational process. It provides various software packages for programming and educational purposes, which come preinstalled. A user-friendly graphical interface called PIXEL is included with the operating system for ease of usability. In addition to its other features, it handles package management through APT and leverages resources efficiently on ARM-based processors. This operating system offers a range of user experiences, from minimal command-line interfaces to full desktop environments, and supports a wide range of applications. With strong community support, regular security updates, and being completely open-source, Raspbian can convert Raspberry Pi from a hardware ideal for IoT projects into a dynamic and convenient computing solution for a wide range of users.

- ***Proteus Software*****:** Proteus is used for designing and simulating electronic circuits. Engineers, designers, and students use it extensively to build, test, and fix electronic circuits. Proteus has two main parts; schematic capture tool and PCB layout tool. Using schematic capture tool, the users can simulate a few electronic circuits using different components such as resistors, capacitors transistors and micro controllers among others. One of the key advantages of Proteus is that it allows simulation of real time circuits which help in identifying any problems with a circuit before one builds an actual hardware for testing. We are going to employ this software in analyzing data from our Raspberry Pi and transmitting it to the next subsystem.

- ***Google Colab*****:** Google Colab is a web-based Python programming collaborative tool which functions on Jupyter notebooks. It is a free computing environment that has various powerful image processing libraries and tools are available to its users, which have made it preferable to many data scientists, researchers and students. With Google Colab one can make new notebooks or upload already existing ones containing texts, codes or visualizations among others. Another thing it does for the users is that it comes with multiple CPUs and GPUs so that they can perform such hazardous tasks with their own capabilities. Moreover, this platform comes along with pre-installed libraries like NumPy, Pandas, TensorFlow and Keras facilitating an easy usage of projects. This is what we are using to write code for my Deep Learning model for fire detection.

3.4 Conclusion

All the modern IT tools used to simulate and process for prototype installation are recommended by the Institute of Electrical and Electronics Engineers (IEEE). The user-friendly interface and high processing capability make this system more optimized. This chapter presents an overview of the modern IT tools we have used during the project timeline.

Chapter 4: Optimization of Multiple Design and Finding the Optimal Solution. [CO7]

4.1 Introduction

Design optimization is a systematic engineering approach to finding the best solution among multiple design alternatives while meeting specific constraints and objectives. The process involves analyzing design variables, objective functions, and constraints through problem definition, design space exploration, rigorous analysis, and optimization techniques. This methodology has become crucial in modern engineering due to increasing system complexity and the need to balance competing factors like cost, performance, and sustainability, ultimately leading to more efficient designs.

4.2 Optimization of multiple design approach

4.2.1 Design Approach 1:

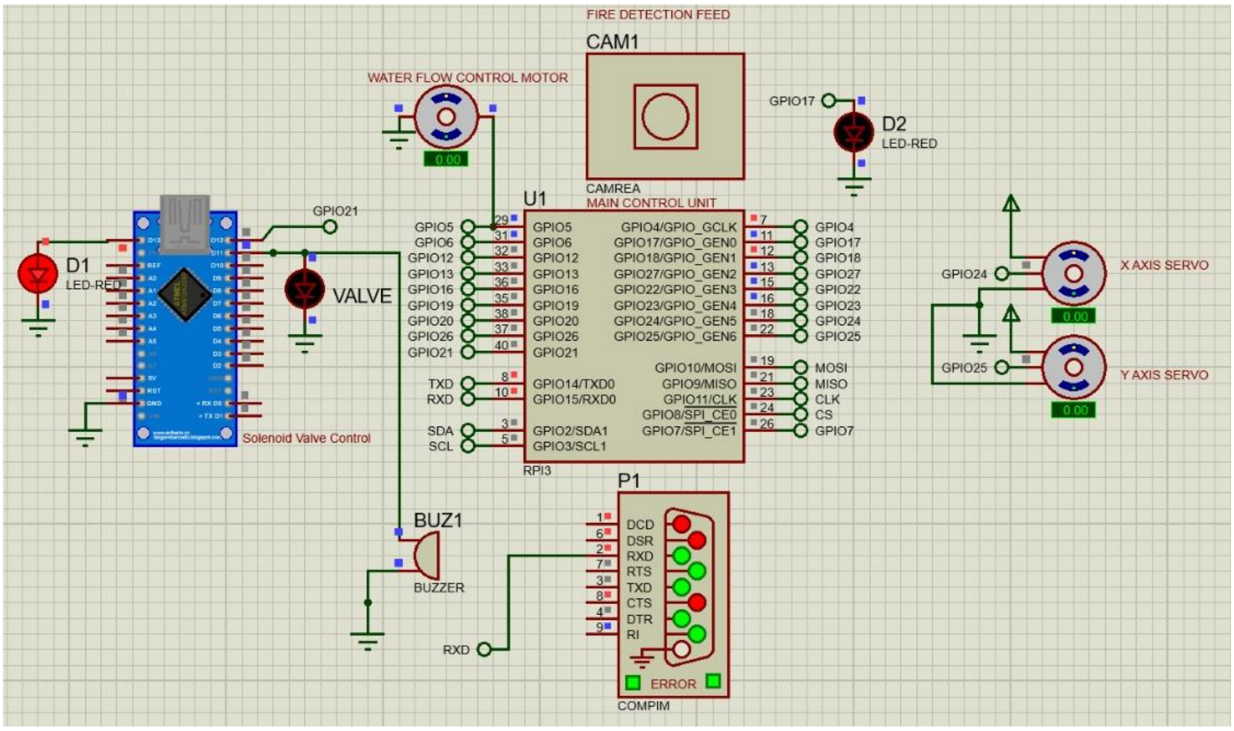

Figure 5: Design Approach 1 In Proteus

Dataset Training:

Batch 1:

Batch 2:

Batch 3:

Figure 6: Dataset

Table 7: Training configuration Data

Training Configuration	
Configuration	**Data**
Epochs	80
Image Size	640x640 pixels
Total Images	2509
Train Image	1004
Test	751
Validation	754
Base Model	YOLOV8S ('YOLOV8S.pt')
Data Configuration	Loaded from 'data.yaml' in the dataset directory

Technical Details:

Hardware:
For our coding, we did not explicitly mention any hardware limitations but YOLOV8S is designed to run on both CPU and GPU. Since we used Colab to train our model, we used the T4 GPU Runtime settings for this training session.

Evaluation:
The 'plots=True' parameter signifies that the performance plots will be generated right after training.

Model Size: In summary, YOLOV8s has approximately 11.2 million parameters in total. Model size on disk: approximately 43 MB.

Layers: The small variant of YOLOV8S usually contains 225 layers.
Detection Heads: Uses three detection heads for detecting objects at various scales.

Loss Function: Utilizes a compound loss function including:
Binary Cross-Entropy BCE - loss for the presence of an object
Class prediction Cross-Entropy (CE) loss
Complete IoU (CIoU) Loss for Bounding Box Regression

Inference Speed: YOLOv8s runs at roughly 170 frames per second at 640x640 resolution on a V100 GPU. With no access to such high-end hardware, we achieved workable frames per second. For our coding, we did not explicitly mention any hardware limitations but YOLOV8S is designed to run on both CPU and GPU. Since we used Google Colab to train our model, we used the T4 GPU Runtime settings for this training session.

Latency Mitigation Procedure:
Previously, our chosen model (YOLOv8s) demonstrated a commendable performance on a windows computer, running on Core i7-8750H and Nvidia 1070 Max-Q. This CPU utilizes x86 architecture. However, Raspberry Pi 5 uses Quad-core ARM Cortex-A76 processor, which is a different architecture compared to x86. When we moved the CNN model to the Raspberry Pi 5, we faced severe latency issues where each Inference Delay was measured up to 380 to 425 milliseconds. For each second, the CNN model was able to process 2.5 frames. Resulting in an FPS count of 2 to 3. This outcome was an obstruction to our claim of real time processing

Although this delay was not a major hinderance for the fire response system, it was a point of concern which was our intent of real time processing and mitigating capabilities. We carried out research to alleviate this problem, and we found an efficient and alternate solution. We opted for a direct conversion approach which uses the NCNN architecture. NCNN stands for Non-Caffe Neural Network. This modification uses a direct translational approach fitted for our model and to finally match that of ARM-based architecture of Raspberry Pi 5. Furthermore, this architecture opts for several optimization factors including onboard hardware acceleration.

This translation is specifically designed to run on edge devices like Raspberry Pi 5, which has limited resources. This “translated” format has dramatically improved the model’s inference performance, making the detection system more efficient. We got around 150-180 millisecond for each inference. Which improves our previous frames per second to a mean of 6. We observed no throttling issues on our Raspberry Pi 5, given an adequate cooling solution has been provided. This solves of the problem we had with processing the video feed in real time.

Translation code:

```
# Load the YOLOv8s model from the .pt file
model = YOLO("/content/best(1).pt")
# Export the model to NCNN format

model.export(format="ncnn", dynamic=True)
```

The code snippet given above incorporates direct translation of our pretrained YOLOv8s model to a more optimized NCNN model.

Training Results:

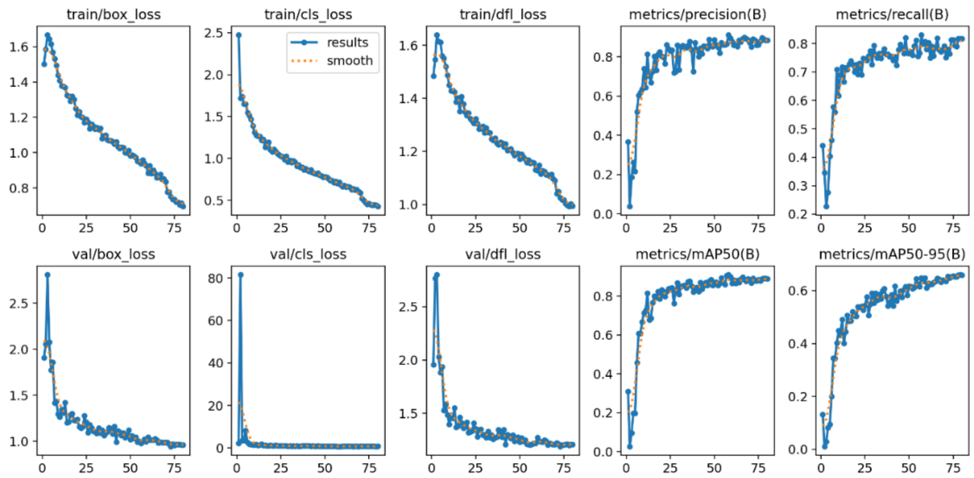

Figure 7: Training result

Figure 7; Training and validation loss curves (box, classification, and distillation loses) over various epochs along with metrics for precision, recall, and mean Average Precision (mAP) at different thresholds (50 and 50-95), showing performance improvement.

The graphs show train/box_loss, train/clss_loss, train/diff_loss, val/box_loss, val/cls_loss and val/diff_loss where decreasing trends indicates better validation performance. In addition, graphs like metrics/precision (B), metrics/recall (B), and metrics/mAP50 (B) shows increasing trends which suggests improved model accuracy over epochs. These graphs help in understanding the model’s performance and convergence during training.

Image of Heatmap, Dense cauterization at the center, Scatter plot of bounding box y vs. x coordinates, and Scatter plot of bounding box height vs. width.

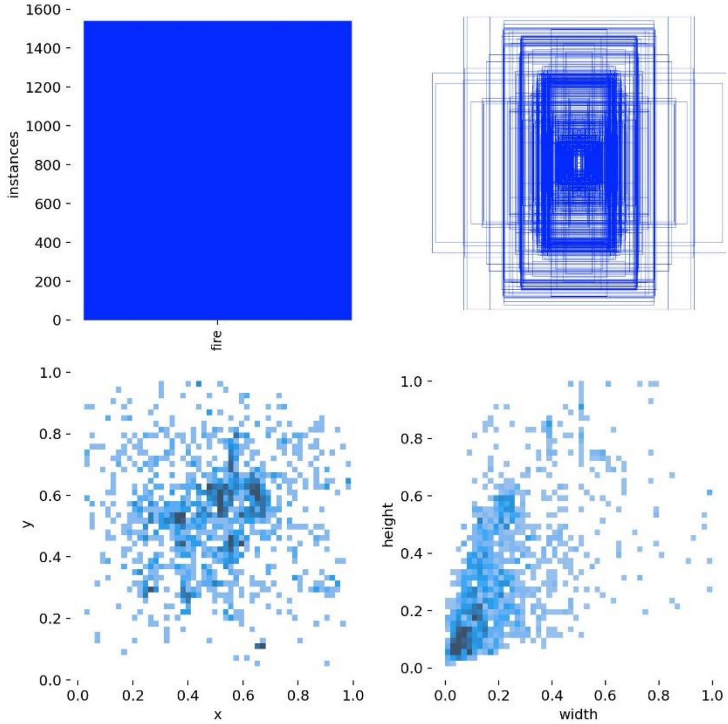

Figure 8: Heat map

Trend: The ‘fire’ line shows a steep decline as confidence increases, indicating recall decreases with higher confidence levels for this class. Helps understand the trade-off between recall (true positive rate) and confidence level, crucial for tasks like machine learning and data analysis.

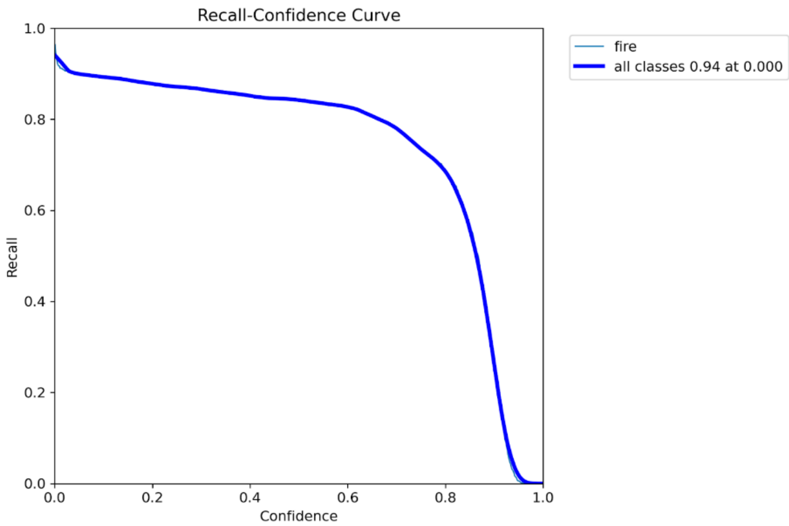

Figure 9: Recall- Confidence Curve

Confusion Matrix			
TARGET / OUTPUT	Positive	Negative	SUM
Positive	435 57.69%	28 3.71%	463 93.95% 6.05%
Negative	26 3.45%	265 35.15%	291 91.07% 8.93%
SUM	461 94.36% 5.64%	293 90.44% 9.56%	700 / 754 92.84% 7.16%

Figure 10: Confusion matrix that shows the performance of the fire detection model

Pair plot displaying relationships between x, y, width, and height while in the diagonal, histograms show individual variable distributions. The scatter plots highlighting pairwise correlations, clustering, and variability in bounding box coordinates and dimensions

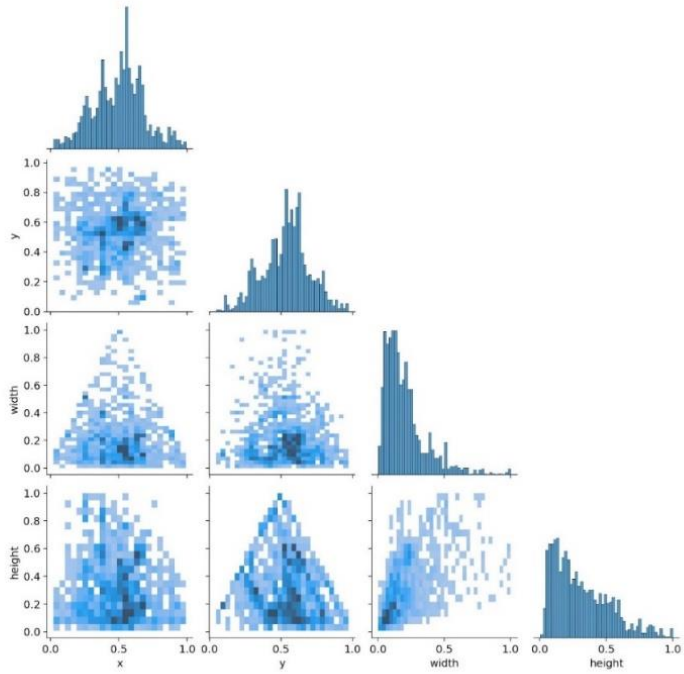

Figure 11: Pair plot displaying relationships

Output:

Test Case 1

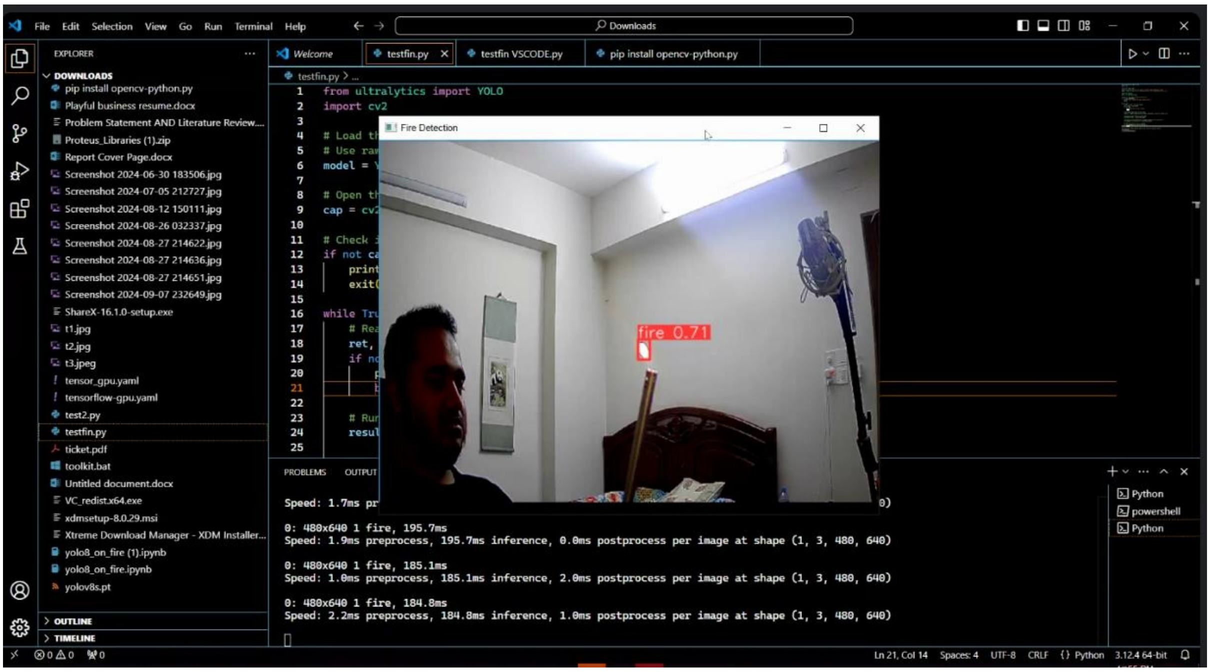

Figure 12: Test 1

Test Case 2:

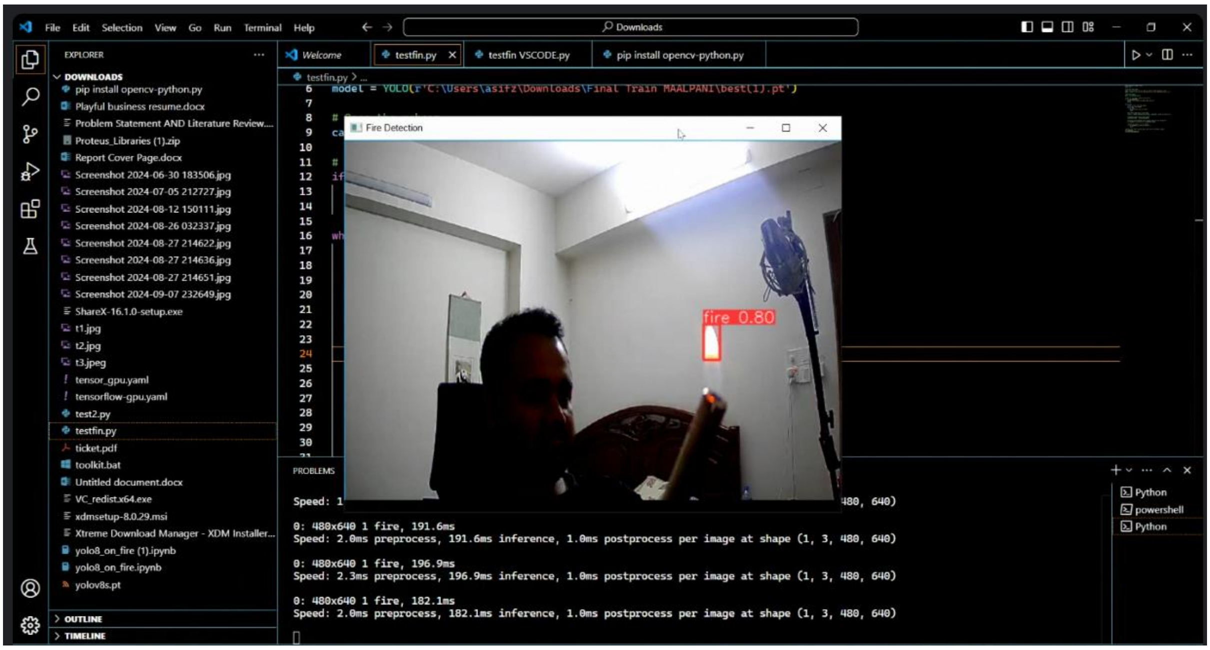

Figure 13: Test 2

We are implementing YOLOV8S for detection of fire. It is training the model for detection of fire. Roboflow has been used, so it's a custom dataset; performance might thus differ from usual benchmarks. 80 epochs is a big training time that allows good convergence on the custom dataset. Here, YOLOV8S strikes a balance between speed and accuracy, hence it will be suitable for real-time applications.

This would be a well-structured way of training a custom object detection model on one of the state-of-the-art architectures. Using a pre-trained model along with transfer learning on a custom dataset should result in a model fine-tuned for the specific task of detecting fire.

4.2.2 Design Approach 2:

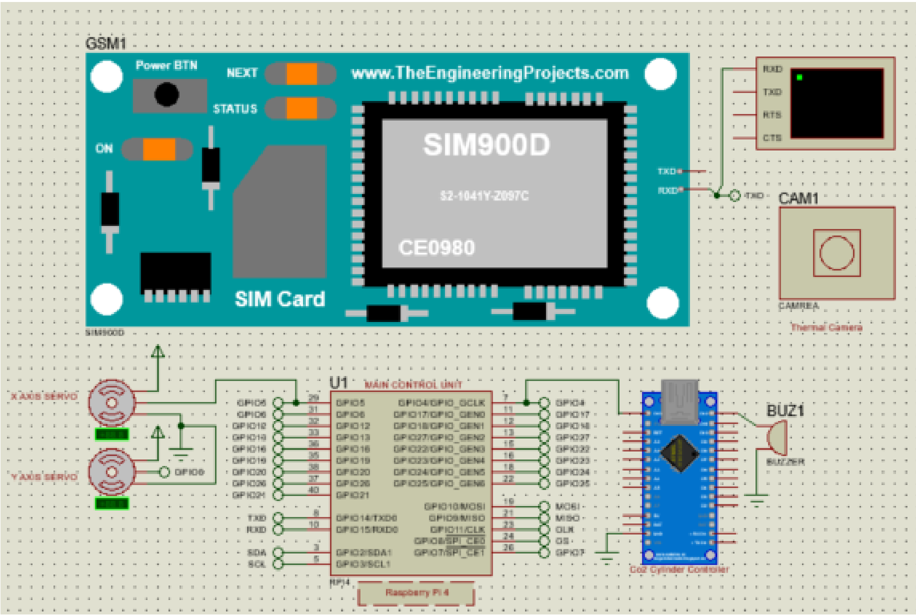

Figure 14: Design Approach 2 in Proteus

Test Case 1:

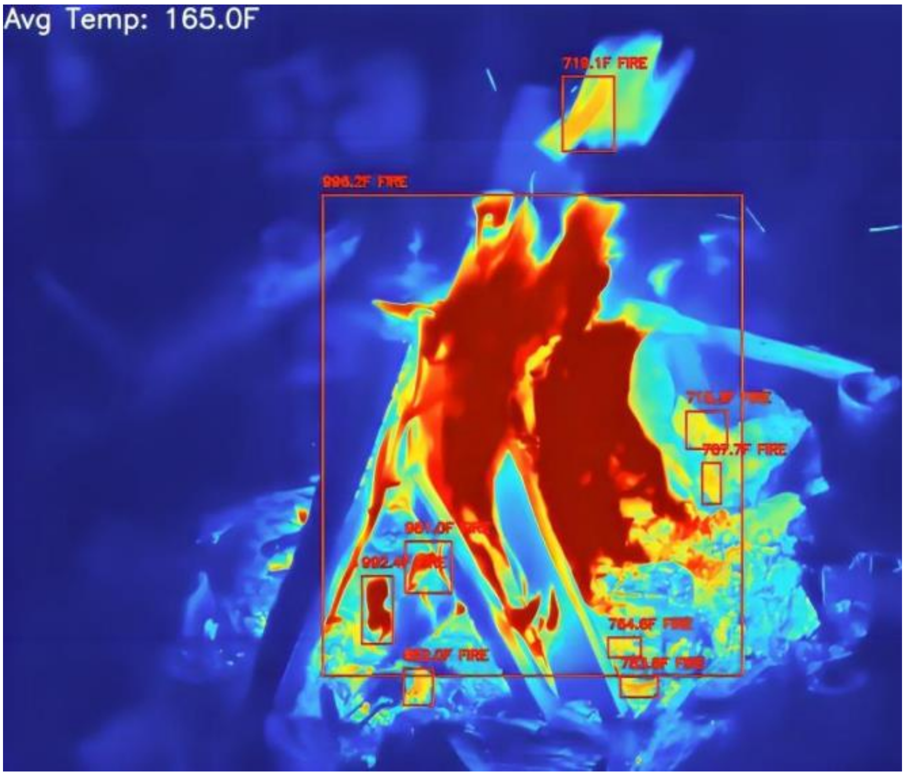

Figure 15: High Temperature detection in Design Approach 2

For the model 2 algorithm we used traditional image processing and computer vision techniques. Firstly, for image preprocessing we used thermal video frames which are converted to grayscale images. Afterwards pixel intensity is converted to correlate with the temperature. Linear mapping is used to convert pixel values from (0-255) to temperature value (32 - 1000F) which allows us to analyze temperature using video footage frames or pictures. Furthermore, to identify hot areas we applied a temperature threshold to the grayscale images which creates a binary image and pixels above the threshold are marked as hot spots. The algorithm also identifies outlines of the hot areas in the binary image to analyze individual hot regions.

To classify fire each hot spot is evaluated based on three criteria which are area, maximum temperature and temperature intensity. In order to detect fire from a single frame at first the hot spot must exceed a minimum size to be considered significant for our code, its 200 pixels. Secondly it must be above the predefined fire temperature threshold value which is 600F and finally the difference between maximum and average temperature within the hotspot must be above a set threshold. This intensity is calculated as (max_temp - avg_temp) / (1000 - 32), and must be greater than 0.1 to be classified as a fire.

Test Case 2:

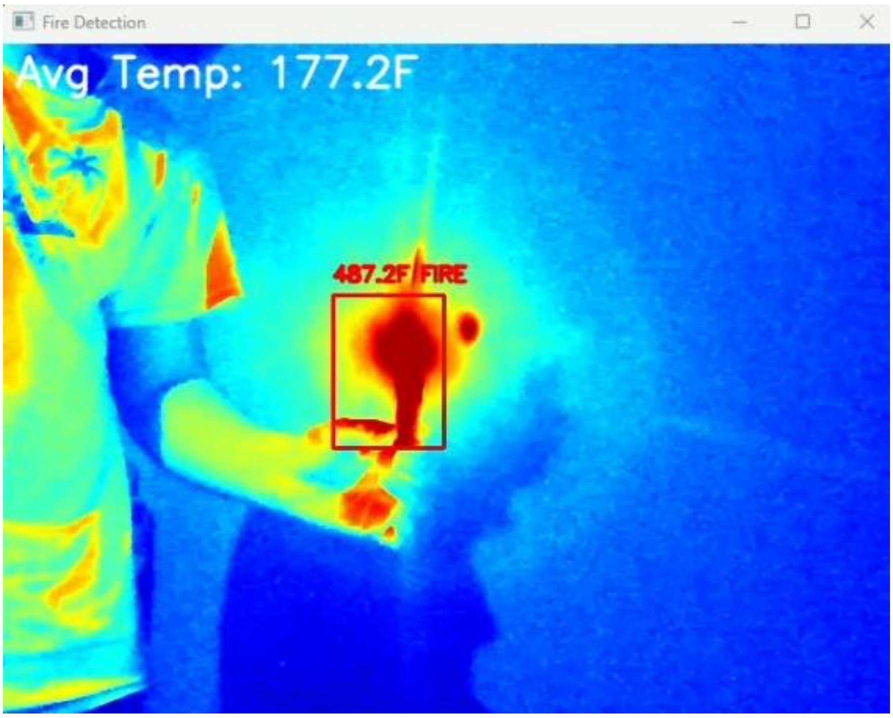

Figure 16: High Temperature detection in Design Approach 2

After detecting the fire the grayscale thermal image is converted into a color heatmap with fire detected regions which are marked on the heatmap using bounding boxes and temperature labels. In addition, for performance evaluation we used the ground truth comparison in which the fire detection results are compared against the ground truth data. For each frame in the video the ground truth function determines if there’s a fire (1) or not (0) afterwards the process frame function of the code makes a prediction if there's a fire (1) or not (0). The values are then stored in the ground truth and prediction lists. Afterwards the processing begins and these two functions are processed using the scikit-learns accuracy score function to calculate the accuracy. For our model 2 algorithm our accuracy is 0.96. Furthermore, we also ran an evaluation for a false positive rate which is 0.00. It means that out of all the frames that don't contain fire the algorithm did not incorrectly identify any of the frames as fire. Our false negative rate was 0.04 which means out of all the frames that do contain fire the algorithm missed 4% of them.

Results:

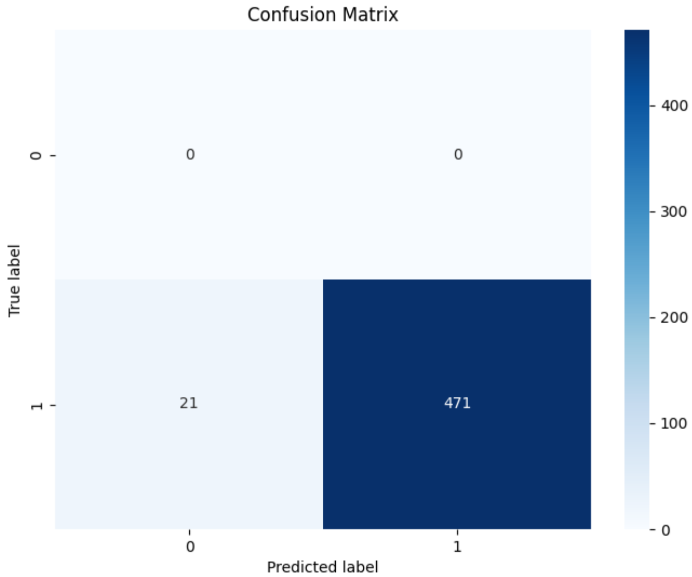

Figure 17: Confusion Matrix

From the confusion matrix of model 2 we get true negative value 0 which means the model correctly detected 0 cases where it could find fire. On the top right side we get 0 which is the false positive rate. It means the model incorrectly predicted 0 cases of fire when there was not any fire present. On the bottom left we got 21 which is the false negatives which means the model failed to detect fire in 21 cases even though the fire was there and finally bottom right we have 471 True positive rate which tells us that the model correctly detected fire in 471 cases. After analyzing this confusion matrix, we can conclude that the model is good enough to detect fire and it has a low false alarm rate. However, it did miss some of the cases where there was fire but it did not detect it.

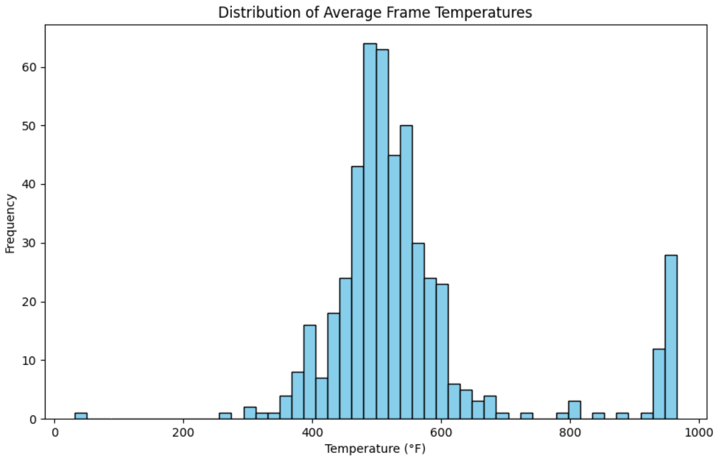

Figure 18: Distribution of Average Frame temperatures.

The graph shows the distribution of average frame temperatures of the video footage which was processed by the algorithm. The graph shows that from 400F to 700F the frequency of the frame increases by a lot which indicates that most of the frames detected fire around 400F to 700F temperature. Few of the frames also detected a temperature of 1000F.

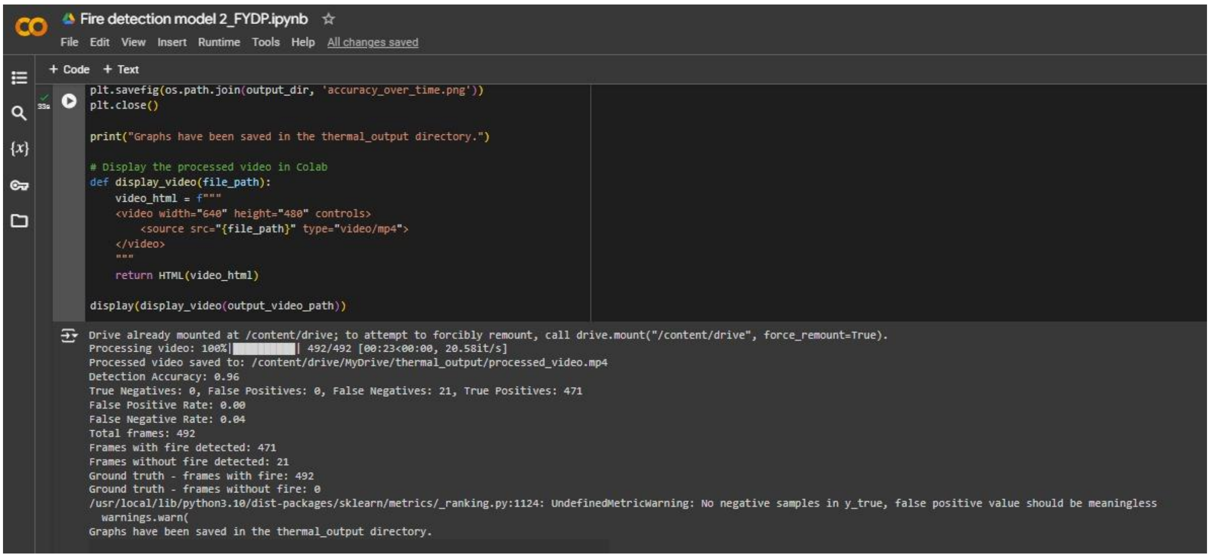

Figure 19: Result of design 2 detection model

We processed video footage which includes fire in it and from this footage we got the detection accuracy of 0.96. For the video footage the false positive rate is 0.00 and false negative rate is 0.04.

4.3 Identify optimal design approach

This report analyses two alternative fire detection and suppression systems designs as part of the PyroSentry project, which seeks to enhance safety in residential and commercial establishments. In design approach 1, RGB cameras and a water-based suppression system are being utilized to detect fire through advanced image processing (YOLOv8s) algorithms. It is low in both cost and maintenance; it is capable of fast action against fire hazards but requires moderate maintenance support. The latter, however, uses thermal cameras and a CO2 placement suppression system which offers a much higher level of accuracy under challenging conditions such as darkness or smoke, counteracting the cooling of the jet to envelope burning objects. However, this comes at the cost of higher expenses, technology and implementation since more advanced equipment is needed. Nevertheless, design approach 1 was eventually adopted since it offered the best compromise between costs of construction and maintenance, effectiveness, ease of scaling and implementation without compromising effectiveness.

A SWOT analysis is also given to measure the sustainability of the project.

SWOT Analysis
Strengths:

1. Less conservation of resources: Conserves resources by utilizing already existing building features and has a low operational footprint.
2. Cost-effectiveness: Easily accessible, the solution can cost less than traditional fire safety systems.
3. Can create new job opportunities for unemployed people

Weakness:

1. Installation cost: The installation cost might cause hesitation for a few building or shop owners as it may be a bit pricey because of the installation process.
2. Maintenance dependencies: Ongoing maintenance is needed for the system for optimal performance, which may displease some of the customer
3. Malfunctions: The system may stop working or short circuit due to various reasons, which may cause a big problem for a given situation

Opportunities:

1. Integration with smart buildings: There are many initiatives for intelligent buildings or smart cities in the future. If this system is integrated into these types of projects, then it can enhance fire safety and perform maintenance automatically through data analysis.
2. Integration with renewable energy sources: Instead of using traditional electricity, if the system is integrated with renewable energy, it can save electricity consumption as well as lower the risk of short circuit damage by a significant amount.
3. Market demand: Due to recent incidents as well as public awareness fire safety measures are being recognized by people. There is rising demand for an accurate fire extinguishing system, making it a good market opportunity.

Threats:

1. Improper disposal of system components: Improper disposal of electronic components when they are damaged or end of their lifespan can cause an e-waste issue.

2. Lack of awareness: Ignorance of the public about the importance of a proper fire suppression system can hamper the project and customers.
3. Competition from existing solutions: Existing fire protection systems or well-developed fire protection companies may bring a competitive concern in the market
4. Data Security and Privacy: Since the system uses a camera that is monitored and processed there are some data security and privacy concerns to be addressed.

4.4 Performance evaluation of developed solution

We ran several test runs of our image processing models and hardware subsystems. As we have primarily trained our model on Wood Fire, Electrical Fire & Chemical Fires. The accuracy of the fire detection, decision model, and servo control were all found out collectively from the successful recognition and mitigation of the fire hazard sources.

Table 8: Accuracy and successful detection of our model based on test dataset.

Objective	Number of tests	False Detection	Mean Accuracy
Wood Fire	27	8	78.93%
Electrical Fire	14	5	67.33%
Chemical Fire	33	3	93.05%

We have also checked if the servo aligns itself properly with the fire hazard or not, before and after optimizing the control of the servo motors. The servo aligns itself from the coordination data that comes from the Raspberry Pi. We have specifically used Chemical Fire for testing the servo alignment. There was a total of 42 test runs made before and after optimization of the servo motors.

Table 9: Servo motor control and fire mitigation, before and after optimization.

Operation	Before Optimization	After Optimization
Fire Missed	6	2
Fire Mitigated	15	19

4.5 Conclusion

After researching, it has been concluded that the first design happens to be the most optimal one based on the analysis provided in the sub-chapter 4.3 concerning cost, precision, adaptability, knowledge representation, real-time Data, requirements, complexity, safety and liability, availability of components, interpretability and explainability, and maintainability. This design approach has further been implemented in a hardware with some general modifications and thus evaluated for performance.

Chapter 5: Completion of Final Design and Validation. [CO8]

5.1 Introduction

The last chapter had a wider comparison concerning putting the multiple proposed designs into practice. The simulation of the entire system was done with the software alone. Various troubleshooting situations have been designed for fine-tuning the system. The final optimal solution was taken up for developing the hardware prototype for further testing. This chapter presents an exhaustive description and analysis of the optimal design shown.

5.2 Completion of final design

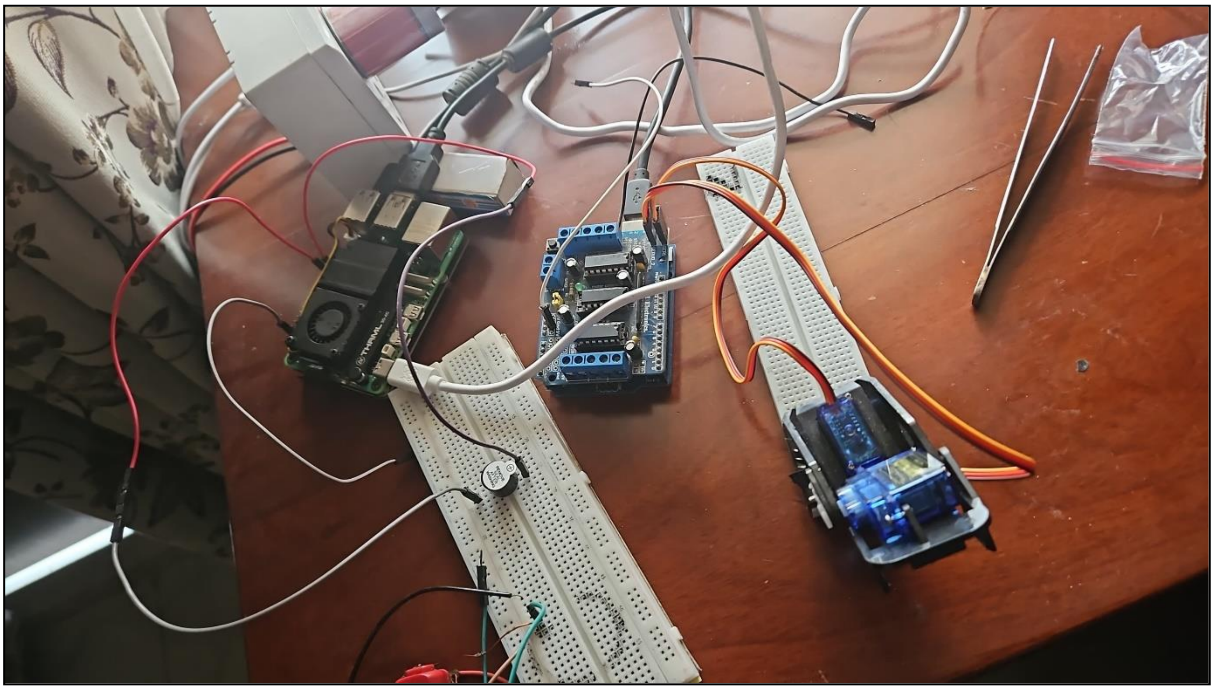

Figure 20: Alarm and Servo mechanism of the mitigation sub-system

In figure 19, we can see a part of the fire mitigation sub-system. The Raspberry Pi is directly connected with the L298N motor driver which is controlling the servo mechanisms which will drive the water nozzle to the fixed coordinate derived by the trained YOLOV8S model. The Buzzer is also connected with the Raspberry Pi as additional alarm mechanism.

In the figure 20 we can see how the two servo motors relate to each other. To move the servo motors, 5 connections were made with them. Two wires were attached with the two motors for power supply, another two were added for moving the servos using PWM signals, and a single connection is made with a servo. The single wire acted as the common ground for both motors. A persisting problem that was hampering our design completion progress was the unwanted shakes or jitters that those servos had when they were receiving a new coordinate from the Raspberry Pi in PWM signal. The problem was mitigated by directly connecting the motor driver with the Raspberry Pi. The jitters were created as the Raspberry Pi would send an addition of PWM signals to the servos alongside with the PWM signals conveying the coordinates of the detected fire.

The figure 21 shows the water nozzle for fire mitigation process which will redirect a pressurized water flow towards the fire source for mitigating the fire.

Figure 21: Water Nozzle and servo motor

In the following figure 22, we can see the 12V DC submersible pump that is being used for pulling and creating the necessary water pressure for the nozzle. The pump works around 8W and pulls about 0.6 amps, suitable for our needs.

Figure 22: 12V DC Submersible Water Pump

Figure 23: Integration of servo and camera mechanism with outer shell.

In this part of project, we tried to design the outer shell of both the servo mechanism and the camera system. The outer shell is made with PVC plastic precisely shaped for our system structure. The camera housing will be mounted at the top using some iron angles and screw. Which will be able to hold our whole system. This cylindrical shape has diameter of 3 centimeter and thickness of 3 mm.

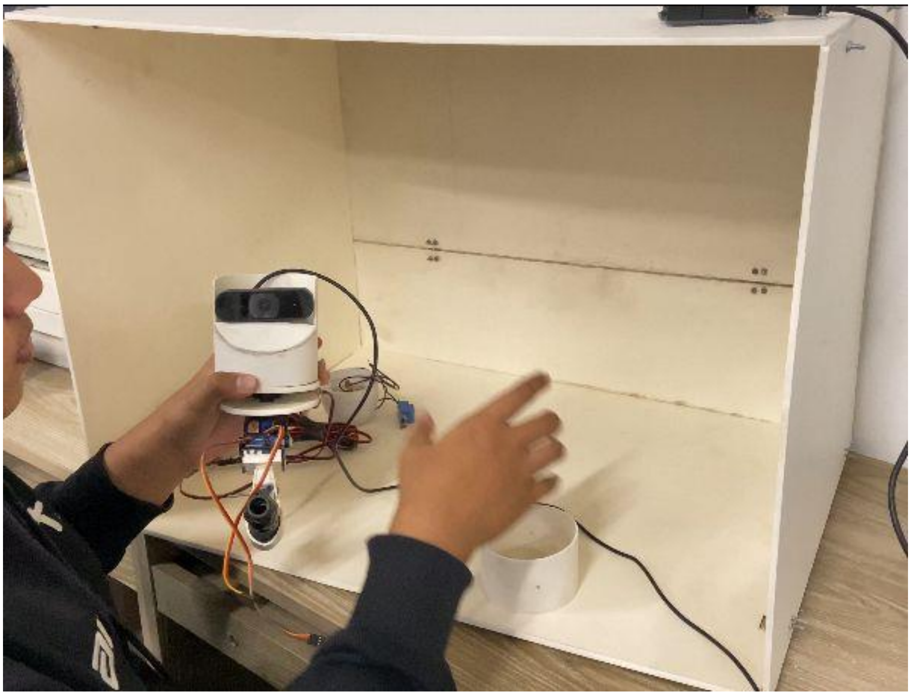

Figure 24: Overall System Outer Layer

The box in figure 24 will be encountered as a room where the module will be mounted. We have used a board which is 5mm thick. Dimensions of the box are: 2ft x 2ft x 1.5ft. We have some iron angles and screw to attach the sheets. To make sure everything to keep in place we used glue as secondary protection. We kept the bottom part a bit slanted to make sure the water has a natural flow path to access the drainage system.

Figure 25: Water drainage system

Our demonstration enclosure is a bit slanted on the side. We opted for this design since we would be using water or our mitigation purposes. The water sprayed from the nozzle gathers on one part of the enclosure since it is slatned. We desinged a drainage system which collects the water. We used a seprate tank to store the waste water that has been used in the mitigation.

Figure 26: Water drainage system and tank

After the water is directed to the side, it is then transferred to a water pump which moves it into the water tank. This serves as our drainage system. By using this drainage system, the prototype can be shown without making any unnecessary mess.

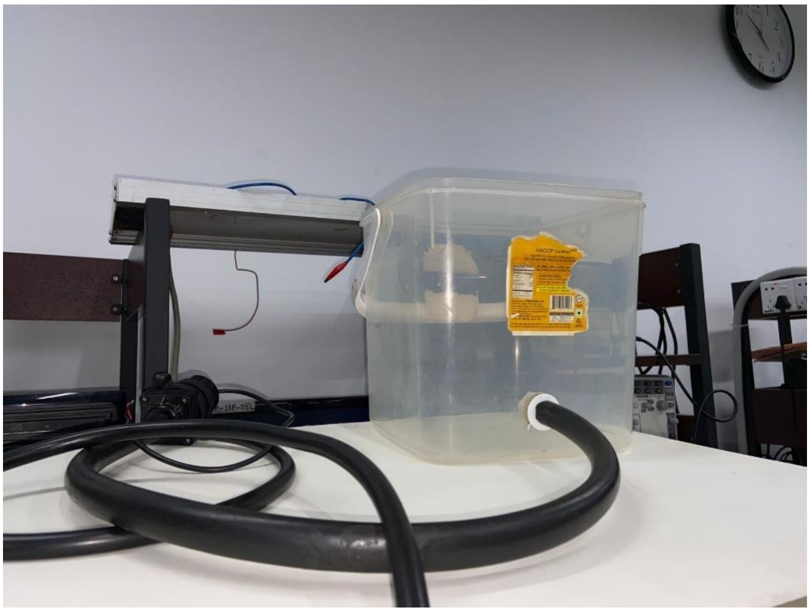

Figure 27: Water reserve tank

We have used a plastic tank to store water for mitigation purposes. This tank could hold approximately 3 liters of water. This pipe will be directly connected to the pump.

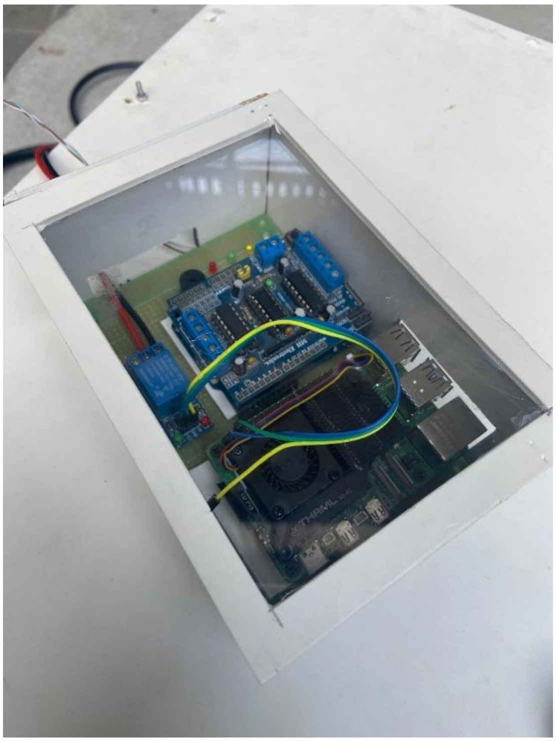

Figure 28: Main control unit

We used all subsystem level control units in a single box here which acts as the main control unit of our system. All the input and output connections are made from this box including the servo control, relay/pump control and all the status indicating LEDs.

Figure 29: Whole integrated System

This enclosure represents our simulated room. The enclosure works as a room in which we implemented the mitigation system and fire simulation. We used PVC boards to make this enclosure with acrylic sheet to prevent water splashing. This also has our mitigation servo system mounted and the pump and water reserve tank as shown in the picture.

PCB Design

We have designed a printed circuit board for sub control system. The JST headers for connection with servo and the relay module are also attached here. The indicator led functionality is also introduced in this design. There is a parallel connection with the module led with PCB led and the buzzer is also attached as requirement of our project.

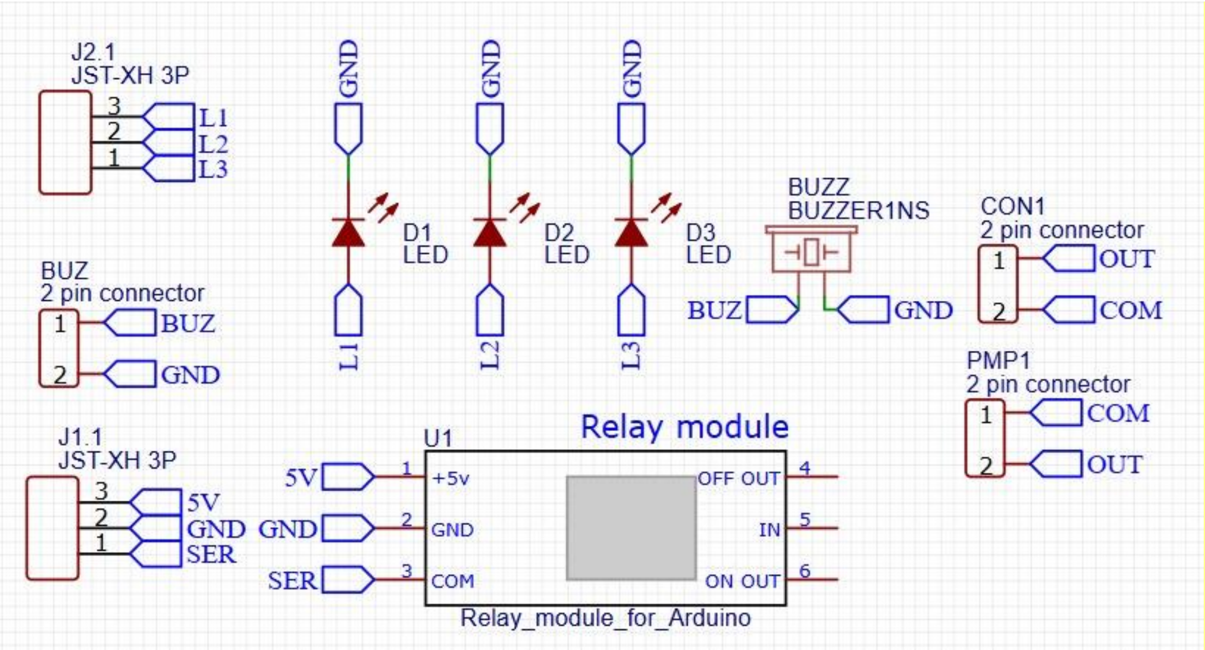

Figure 30: Layout

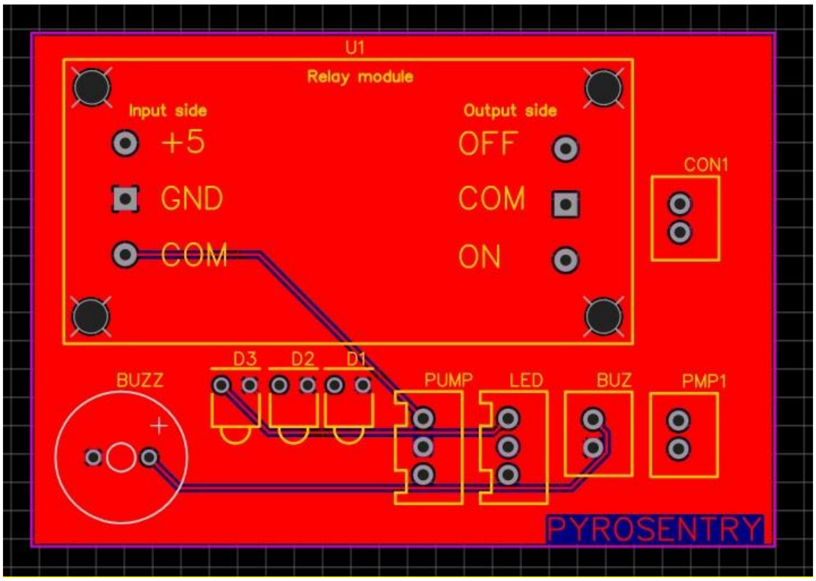

Figure 31: Front part of PCB

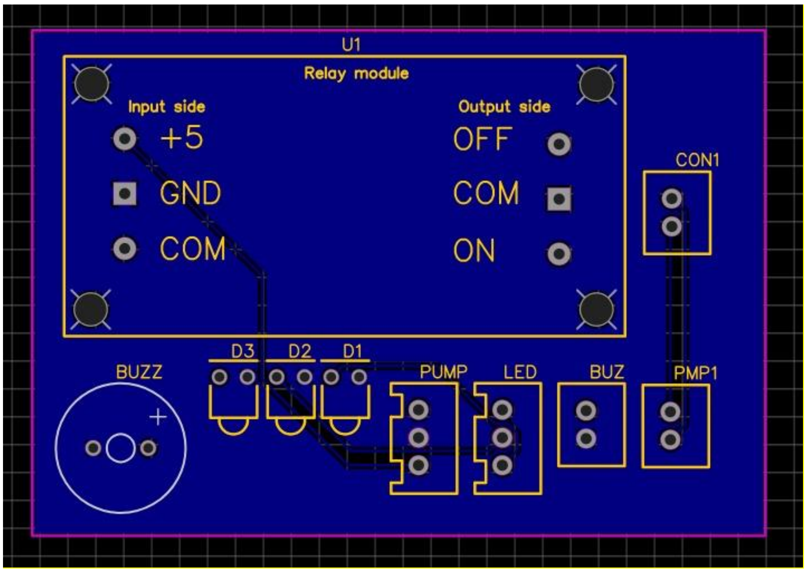

Figure 32: Back part of PCB

This is the PCB for our overall system. The PCB for the project is a double layer PCB with overall length of 45.953mm and a width of 74.803mm. It includes a relay module with pads measuring 2.5mm and hole sizes of 1.1mm. We also attached 3 LEDs to indicate 3 states of the system which includes when the fire is detected, when the system is live and when the system encounters any error. We added 2 JST headers in the PCB one for the LEDs and another to connect the relay module with the pump. We also added two 2 pin connectors parallelly to connect with the output of the relay module. Finally, we added a Buzzer to give us a signal whenever the system detects fire.

System Layout:

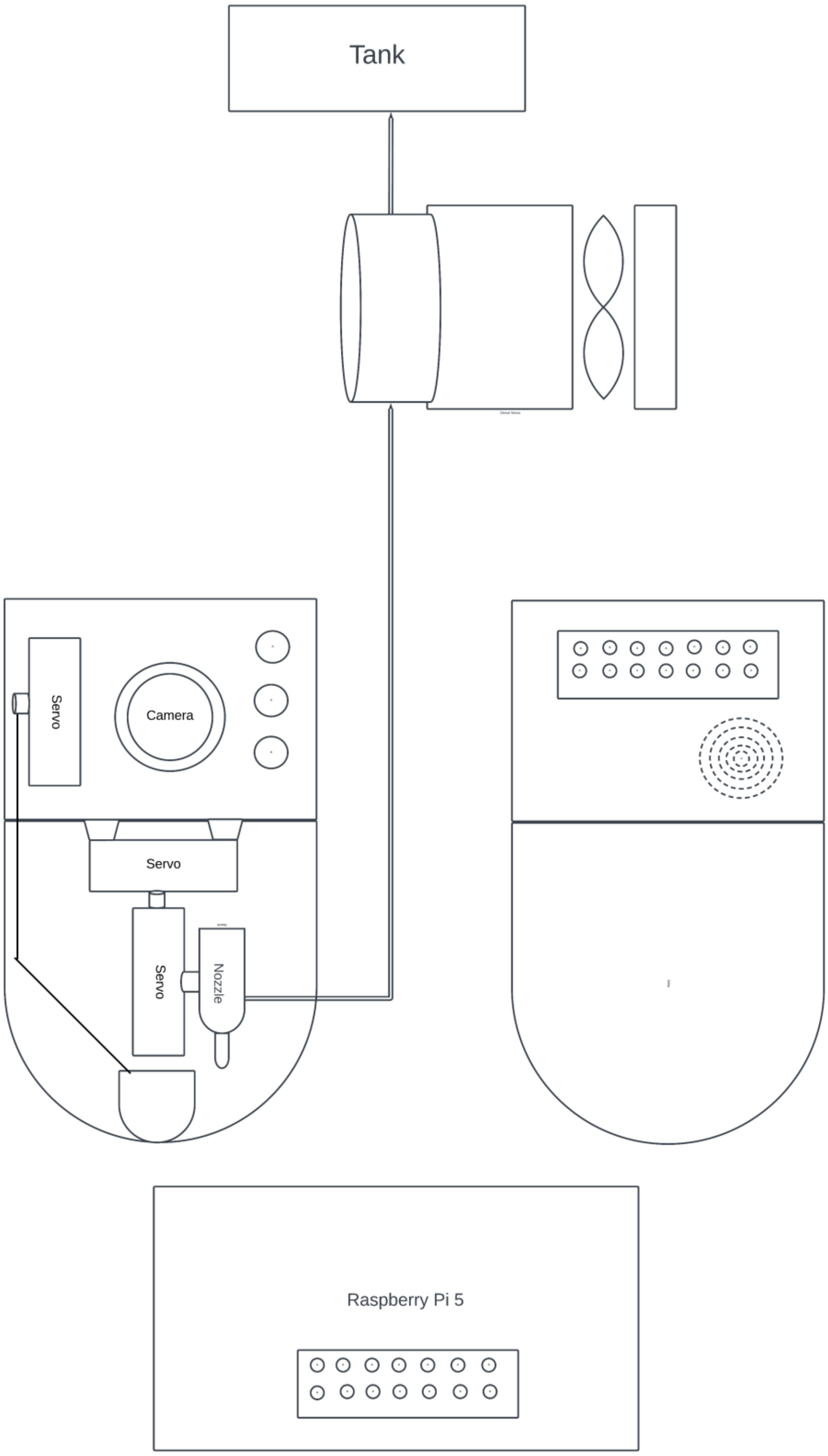

Figure 33: System Layout

5.3 Evaluate the solution to meet desired need

Just as we mentioned before, the accuracy of our model as regards fire detecting reaches the max amount of about 93.07% showing the dependability, robustness with which our model performs well even under most varied conditions. The system has gone through rigorous testing and proved its efficiency in detecting fires from various sources. The testing phase on hardware was done on campus, and we turned the whole exercise to safety and health regulations. All possible safety precautions were taken, including restricting the fire hazard source materials to purely chemical-based simulations. Thus, a controlled environment came to be and yet valuable insights on the performance of the model in fire detection with complex visual features gained. Future tests may include wider applications to validate and optimize the system accuracy and adaptability.

Figure 34: Fire hazard detected by the CNN model.

Coordinate extraction of the fire hazard

Real-time coordinates for fire detection recognition with visual patterns are extracted from a continuous live video feed by the model. The model processes through each frame, making analyses using high-end image processing techniques to discover potential fire hazards that may be originating from anywhere. The moment it recognizes that a frame of data image contains fire above 50% confidence, the model generates a bounding box enclosing the recognized area to highlight the fire region-for future references. This way, the system would be providing online make-up spatial coordinates as to where the fire lies in the video feed for all tangible engagement and dynamic actions of lower-tier components.

Figure 35: Fire hazard coordinate extraction.

Fire mitigation

Once the coordinates of the fire hazard location have been analyzed, the servo motors will then accurately align or control with their real-time nozzles' positions in order to be directed right towards the source of the fire hazard. This will thereby enhance the response time and the mitigation efficiency at its best. After the setup, the Raspberry Pi-circuits signal to activate the motor controlling the water-delivery system. The last will flow in water and be tagged towards the identified fire hazard location.

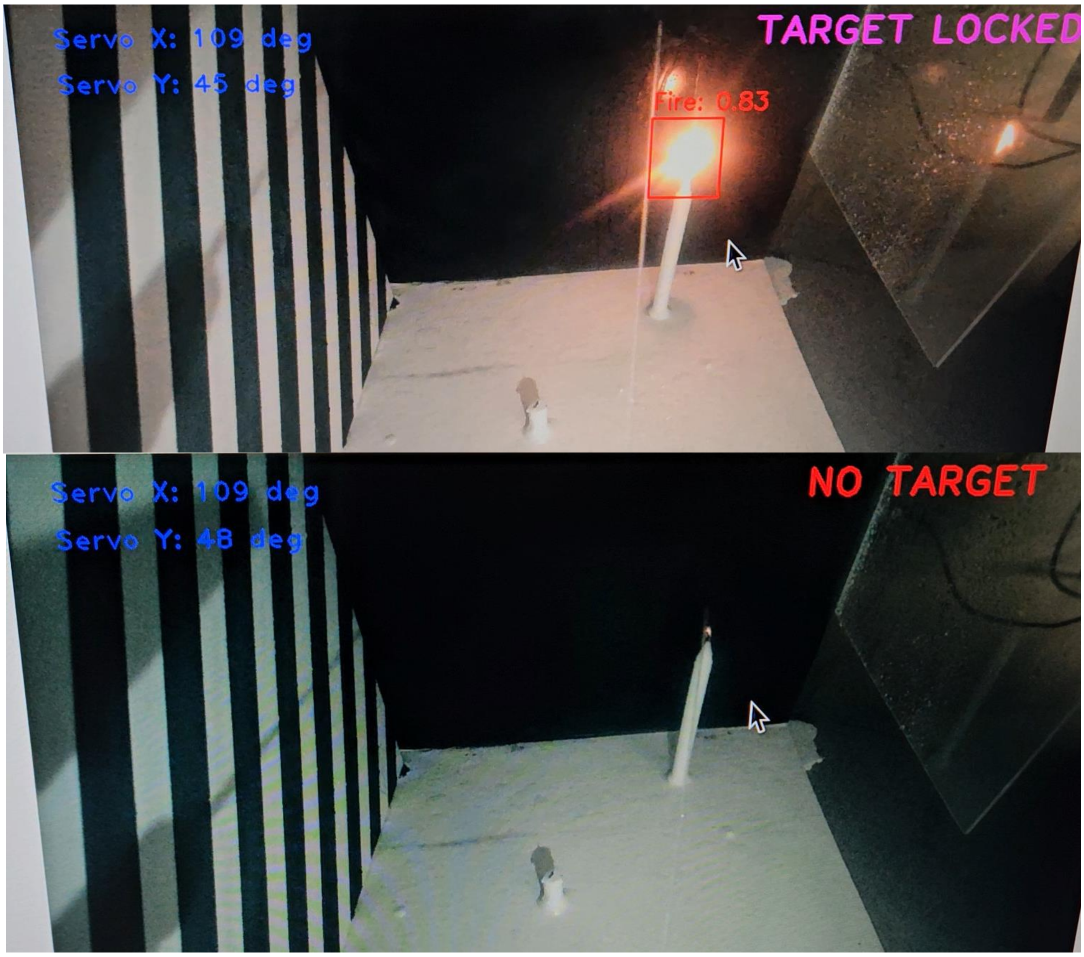

Figure 36: Fire hazard mitigation through running the whole setup.

Alert text system

When the fire detection module detects fire threats through video feed above a confidence level of 50%, the Pi shall send an alarm immediately to alert the owners of the system. This alarm is communicated to them as a detailed text message through the companion app, which is PushBullet, in order for an owner to be made aware without delay about the incident. Included in the alert is important information, such as the confidence level of the detected fire by the CNN model and when the incident happened. By utilizing the services offered by the PushBullet application, therefore, the system provides for real-time and easy communication so that the owners can monitor as well as act on fire threats at any place. Hence, this early warning system improves the safety and reliability of the entire fire response system.

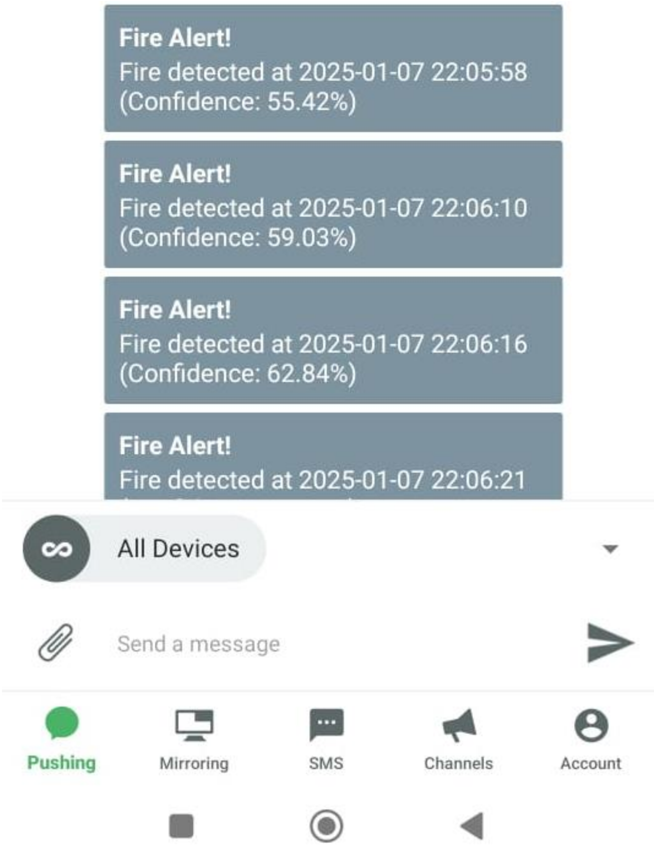

Figure 37: Alert notification sent to the subscribed owner through the PushBullet app.

Here, we face some problems with the servo motor when the fire is at a very narrow angle towards the walls. This is caused by the added weight due to the water supply pipe that is connected to the nozzle from the motor. Also, privacy is a big concern for the customers that will be purchasing this system as a product. A better encryption method is required for making sure that the owners or occupants' personal data is hidden and safe.

5.4 Conclusion

We can conclude that our final design meets all of our objectives and requirements with good accuracy. Our model can detect fire with up to 93% accuracy. Furthermore, the coordination extraction is on par with the fps of the video feed analyzing speed, making the response time fast. The coordinates are accurate as the servos can properly direct towards the fire. So, we can safely say that all of our objectives and project requirements were met successfully.

Chapter 6: Impact Analysis and Project Sustainability. [CO3, CO4]

6.1 Introduction

It is always concerning regarding the recognition of the final product of the project and the gratification of the stakeholders and the broader public, which will come from experiencing it first-hand. Sustainability and the impact that the project will serve will play as an important factor in communicating the design's concept to the stakeholders. An array of opinions were considered for balancing the requirements from the stakeholders with other engineering constraints.

6.2 Assess the impact of solution

- ***Non-stop monitoring for fire hazard detection***

The surveillance camera that is integrated in the system will constantly look for fire hazards, if the video feed is not cut off by any sort of distortions and if there is a power supply available to the core components.

- ***Rapid fire suppression***

The fast and accurate response from the MCU and the electrical valve inside the water nozzle will ensure safe and secure fire mitigation.

- ***Reduced recovery costs***

Fast and effective fire detection will prevent any large-scale damage that may occur from a fire hazard. As a result, repair and replacement expenses will be greatly reduced.

- ***Applicable to various settings***

This fire detection and mitigation system can be applied to various aspects of our current world. From large storage facilities to a regular convenience shop, this project can be implemented anywhere due to its versatility and widely available components that it requires.

- ***Water conservation and reduced emission***

As the project doesn't require additional storage of water and utilizes the existing water supply system of a specified building complex, the project has zero negative impacts over the environment, making it more environmentally sustainable compared to the existing fire mitigation systems available in the market. As an added benefit, this fire detection and mitigation system conserves water by only activating it after detecting the fire. Furthermore, when the fire is no longer detected the water supply to the nozzle is turned off, conserving the precious commodity and minimizing its expenditure.

- ***Increased profit for the stakeholders***

As this project can become a standalone and the most reliable fire hazard and mitigation system, no other systems are going to be required for the safety of an infrastructure. Thus, reducing the cost for maintenance for that specific environment.

- ***Business prospects***

There is an immense possibility for substantial financial growth that can come from this project. As it can be turned into a full-fledged business which can bring profit due to its wide applicability.

6.3 Evaluate the sustainability

This project is designed to be sustainable in environmental, economic, and technological aspects. This project is environmentally sustainable as it uses targeted water spraying which reduces water wastage. Furthermore, due to the design of the project, fire is mitigated much faster, reducing the release of pollutants, smoke, and toxic gases into the environment. Nonetheless, this fire mitigation and detection process requires various electrical components which require continuous power supply. A sudden disruption to this supply can cause the whole system to fail, resulting in a catastrophic disaster in case a fire hazard occurs when the system is down. Additionally, this system is quite cost-effective, as it utilizes the existing components and subsystems of an infrastructure. It reduces the maintenance cost and prevents extensive property damage. Also, this project, being fully automated, reduces the need for continuous human monitoring. However, the initial cost for the installation process of this project is relatively higher than the existing fire mitigation systems that are available in the market. Besides, this project is utilizing Raspberry Pi, Arduino Nano, which are well tested for automation projects such as this one. Also, the trained CNN model ensures accurate and fast fire detection and increased reliability. As a result, creates a new business opportunity as this project can be integrated into any infrastructure. Also, the need for this project will also drive an increase in for the hardware that are utilized in the project.

A practical project has a positive impact both environmentally and economically. The solution of the proposed project is related to the UN's sustainable development goal (SDG) 11, Sustainable Cities and Communities. Which aligns with fire safety in buildings and contributes to a safer environment.

Furthermore, the solution of the proposed project has several implications in terms of environmental, social, and economic aspects.

Environmental Implications:

1. The system is designed in such a way that fire suppression can be possible the moment it is detected, which lowers the emissions of harmful pollutants like carbon monoxide and smoke.
2. By reusing the already existing building features, the system translates to less resource extraction, processing, and waste generation.
3. The system has a low operational footprint, and its energy consumption is expected to be low.

Social Implications:

1. The system can reduce fire damage and injuries and save lives, which gives a greater sense of security and peace of mind for customers, building owners, and residents.

Economic Implications:

1. The project needs maintenance once it is set up, which opens job opportunities for installation, maintenance, and monitoring of the system.
2. By suppressing fire as soon as possible, the project can minimize the property damage from fire saving public institutions, and business which contributes to the economic well-being of communities.
3. Compared to the traditional fire safety systems the project's solution is cost-effective as it is reusing the already existing facilities in the building. Which makes it easily affordable and accessible for a variety of customers.

6.4 Conclusion

Pyrosentry is a revolutionary new step towards the modernization of fire safety systems. It will change the way we perceive and plan any fire mitigation and detection systems. As this project utilizes cutting-edge technologies, many new jobs and business will arise from the implementation of this project, alongside the enhanced protection that it will bring to the daily lives of the general mass. Finally, many lives will be saved from the deadly aftermaths of fire incidents that occur from the scarcity of reliable and effective fire risk management systems.

Chapter 7: Engineering Project Management. [CO11, CO14]

7.1 Introduction

At the earliest stages, it would become important to define project scopes since there would be strict adherence to a predetermined timeframe for advancement on the project. Project Management clarifies how the project objectives are approached and what are the deliverables of the project. Besides project activities, an effective management also deals with consistent communication between project members and all other associated stakeholders. Also, an establishment of contingency protocols should be done for any unwanted emergencies. Employing project management tools automates many functions for ease of monitoring progress and detecting bottlenecks. Also, it should be continuous, so that any team can adjust swiftly to changes. In the end, an effectively managed project ensures its goals are attained and a foundation laid for further successes into the future along with the advancement of the team.

7.2 Define, plan and manage engineering project

EEE499P

Table 10: EEE499P Project Plan

Task	*Start Date*	*End Date*	*Duration*
Topic Selection	*26th January*	*7th February*	*13 Days*
Finding Complex Engineering Problems	26th January	1st February	7 Days
Review of Related Research Papers	2nd February	7th February	6 Days
Selection of Research Topic	4th February	7th February	3 Days
Project Concept Note	*9th February*	*28th February*	*20 Days*
Tentative Objective and Problem Statement	9th February	19th February	11 Days
Multiple Design Approach	9th February	28th February	20 Days
Specification, Requirements, and Constraints	12thFebruary	14th February	3 Days
Comparison Between Design Approaches	16th February	28th February	13 Days
Preparation of Progress Presentation	*1st March*	*7th March*	*7 Days*
FYDP P Progress Presentation	7th March	7th March	*1 Day*
Project Proposal	*21st March*	*18th April*	*29 Days*
Background Research and Methodology	21st March	17th April	21 Days
Project Plan	29th March	17th April	20 Days
Budget and Expected Outcome	29th March	8th April	11 Days
Sustainability, Safety, and Ethical Consideration	21st March	4th April	7 Days
Risk Factor Management	21st March	8th April	11 Days
Final Project Proposal Note	29th March	18th April	22 Days
Preparation of Final Presentation	*15th April*	*24th April*	*10 Days*
Mock Presentation	18th April	18th April	1 Day
Final Presentation	25th April	25th April	1 Day

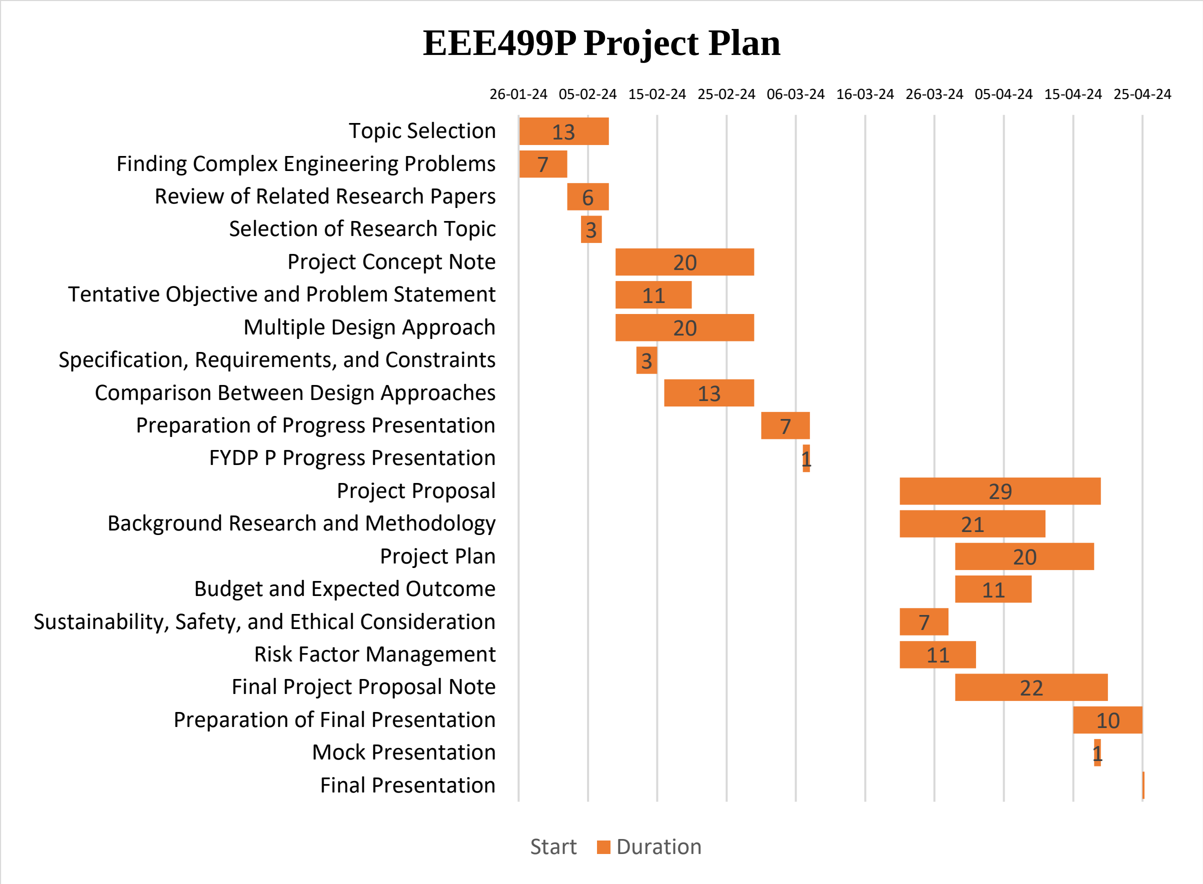

Figure 38: Gantt chart for EEE499P

EEE499D

Table 11: EEE499D Project Plan

Task	*Start Date*	*End Date*	*Duration*
Market Analysis	24-May-24	30-Jun-24	38
Data Collection and Preprocessing	24-Jun-24	31-Jul-24	38
Model Training and Validation	21-Jun-24	15-Jul-24	25
Modification of Design Approach if needed	28-Jun-24	02-Jul-24	5
Software Simulation Setup	28-Jun-24	05-Jul-24	8
Progress Presentation	06-Jul-24	06-Jul-24	1
Algorithm Development and Integration	07-Jul-24	20-Jul-24	14

Simulation of Optimal Approach	07-Jul-24	13-Jul-24	7
Analyzing Optimal Approach	14-Jul-24	20-Jul-24	7
Software Simulation Execution	21-Jul-24	31-Jul-24	11
Simulation of Fire Detection Scenarios	21-Jul-24	25-Jul-24	5
Simulation of Fire Suppression Scenarios	26-Jul-24	31-Jul-24	6
Debug Software Simulated Results	03-Sep-24	07-Sep-24	5
Simulated Result Analysis	02-Sep-24	05-Sep-24	4
Sensitivity Analysis	01-Sep-24	08-Sep-24	3
Performance Evaluation	08-Sep-24	19-Sep-24	12
Project Report Preparation	13-Sep-24	23-Sep-24	11
Presentation Preparation	16-Sep-24	23-Sep-24	8
Mock Presentation	23-Sep-24	23-Sep-24	1
Presentation	26-Sep-24	26-Sep-24	1
Project Report Submission	29-Sep-24	29-Sep-24	1

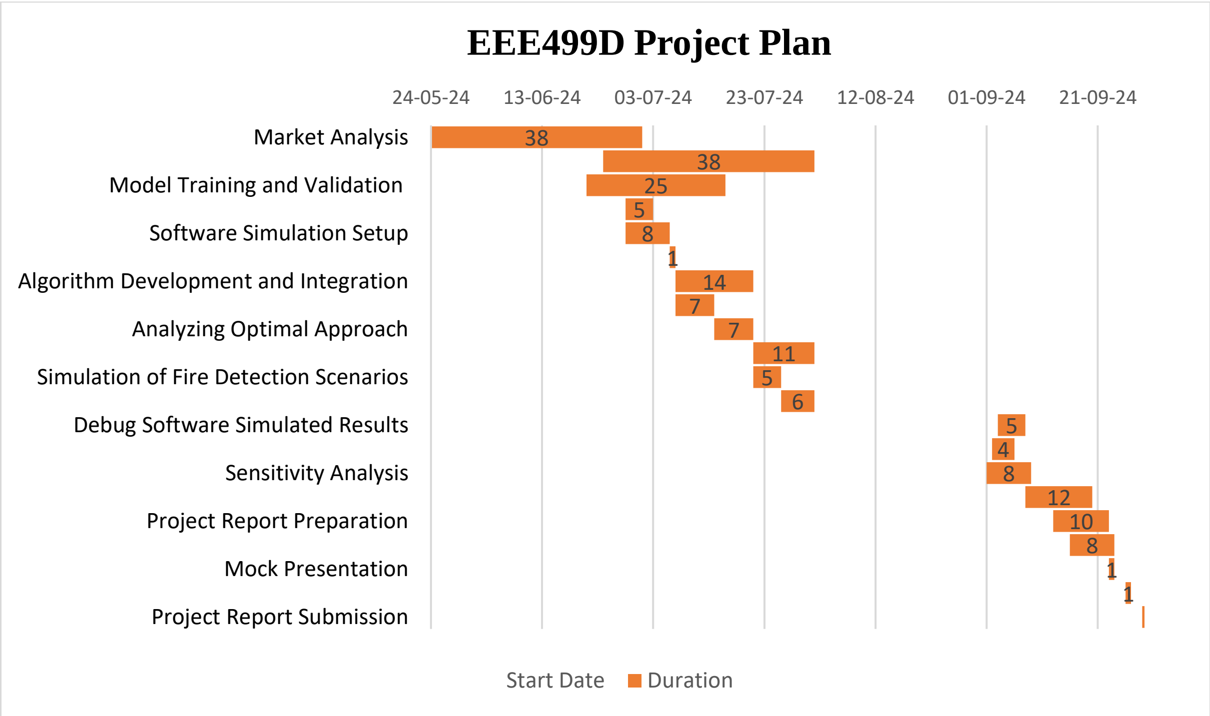

Figure 199: Gantt chart for EEE499D

EEE 499C

***Table 12**: EEE499C Project Plan*

Task	***Start Date***	***End Date***	***Duration***
Prototype Implementation	1st October	*23rd October*	*23 Days*
Components Testing	3st October	16th October	13 Days
Compilation of components	14th October	23rd October	10 Days
Develop the Prototype	*10th November*	*11th December*	*32 Days*
Trial & Error Phase 1	*10th November*	*15th November*	6 Days
Trial and Error Phase 2	15th November	22nd November	8 Days
Trial and Error Phase 3	22nd November	4th December	13 Days
Troubleshooting	20th November	10th December	20 Days
Final Prototype	11th December	11th December	1 Day
Final Prototype Presentation	*14th December*	*4th January, 2025*	*21 Days*
Preparation for Presentation	11th December	21st December	11 Days
Mock Presentation	14th December	14th December	1 Day
Final Presentation	4th January, 2025	4th January, 2025	1 Day
Project Report Submission	21st December	21st December	1 Day

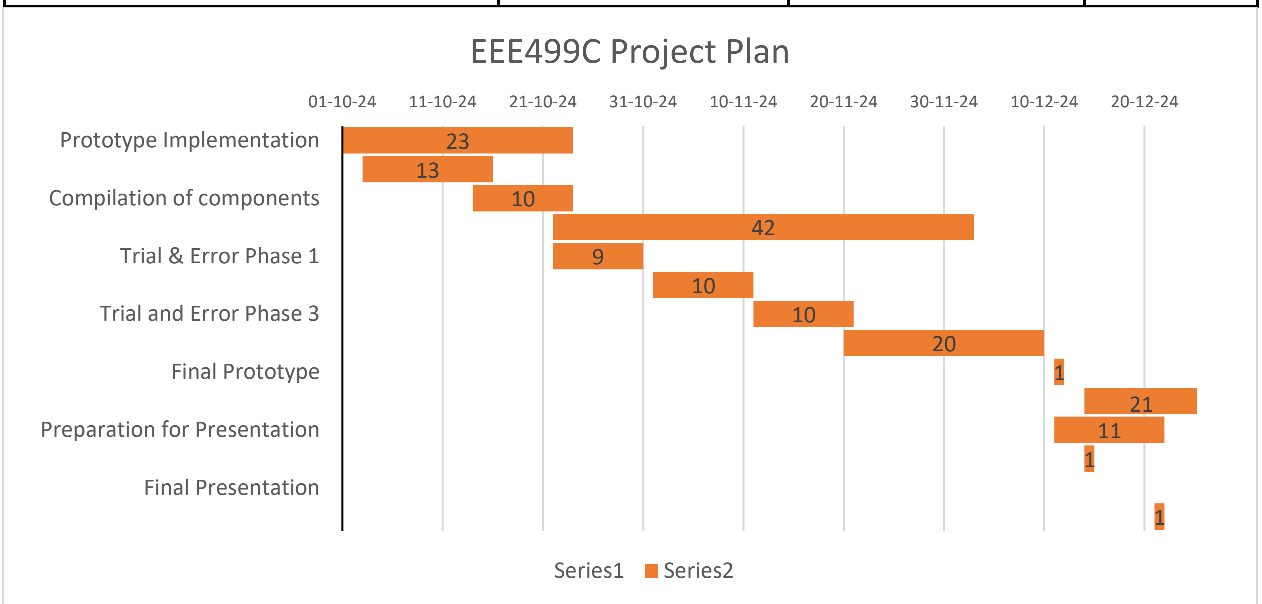

Figure 40: Gantt chart for EEE499C

7.3 Evaluate project progress

Table 31: Risk Management

	Risk Event	Management Procedure	Contingency Plan
1	Hardware component failure	Perform regular testing and inspection of hardware components. Use high-quality, durable components.	Maintain a stock of backup hardware components and have a rapid replacement plan in place.
2	Software bugs in detection algorithm	Continuously test and optimize the fire detection algorithm to handle various fire scenarios. Use version control for software management.	Implement a secondary, simpler detection algorithm as a backup in case of failure or bugs in the primary system.
3	Water leakage or nozzle malfunction	Inspect and maintain the water pump, pipes, and nozzles regularly. Ensure tight, secure connections to prevent leaks.	Install a manual valve that can be controlled in case of a malfunction. Keep spare nozzles and pump components on hand.
4	Ineffective fire detection due to environmental factors	Test the fire detection algorithm under various environmental conditions, including different lighting levels, temperature variations, and types of fire.	Use predefined thresholds or backup detection mechanisms to activate the water mechanism if the algorithm fails.
5	Electrical hazards	Use proper insulation and isolation for all electrical components. Ensure wiring is done according to safety standards.	Implement automatic power shut-off mechanisms in case of electrical shorts or overcurrent situations. Regularly inspect power sources for issues.

Fire mitigation systems which integrate components such as Raspberry Pi, Arduino, servos, and water pumps have several operational and environmental challenges. It has to interact with many mechanical parts and control units where each carries some inherent risks that may affect the performance or safety of the system. These include electrical hazards, mechanical failures, inaccuracies in detection, and changes in environmental conditions such as light and temperature.

Furthermore, there are electrical issues like improper connections which can lead to system failures while mechanical elements in the system may include worn-down or misaligned servos and pumps. Other factors to consider regarding the system include changes in lighting or interference given off by other electronics within the environment that will impact correct fire detection by the system.

Therefore, it is important to implement risk management strategies to ensure that this system performs perfectly in the field, particularly when the environment is critical, like commercial spaces. The following is a risk response matrix giving some of the key risks, management procedures, and contingency plans for such issues

7.4 Conclusion

Project management creates the foundation of all successful projects. Without proper project management and regulations, it is hard to be persistent in executing a project's objectives. Even if management was at its best and adhering to preordained guidelines, there could always be a chance of unwanted risks. So, contingency plans for different probable risks should also be kept. These factors do ensure sufficient delivery of the basic objectives of the project.

Chapter 8: Economical Analysis. [CO12]

8.1 Introduction

Economic analysis for a given research project is vital, since it evaluates the costs incurred and the benefits gained from investing in such a project. The main objectives of economic analysis may vary but among them may include the critical aspect of assessing and predicting different responses towards the product and its impact on the target market, competitors, and overall business strategy. Through economic analysis, businesses are provided with valuable insights on possible costs, revenues, and profitability regarding a product including its production, distribution, and marketing costs on one side and anticipated profitable investments on the other side. All these aspects may be useful in making appropriate strategic decisions such as product development, pricing, marketing, and distribution, as well as identifying possible risks and opportunities.

8.2 Economic analysis

Economic analysis allows any company to reach and achieve effective resources allocation that will generate revenues from the project or product. It helps to perform hard economic evaluations as well as understand what the best resource allocation would be from a trade-off and cost-effectiveness perspective in relation to the performance capabilities. As of now, conventional fire mitigation systems are heavily reliant on smoke detection-based fire safety systems, which necessitate smoke to engulf areas before triggering the mitigation process. This approach is unreliable and error-prone, resulting in disastrous possible consequences. Furthermore, virtually no fire detection systems are commercially available. However, our system not only provides a more cost-effective fire mitigation system than the existing ones, but it also features a sophisticated fire detection mechanism. In this regard, our system is cost-effective, as it uses common and readily available parts that simplifies component replacement. Our system requires negligible maintenance costs, with most costs incurred during initial installation. While our system needs an upfront investment, mass production would greatly reduce costs and enhance the systems overall cost-effectiveness.

8.3 Cost benefit analysis

The feasibility of a project can be determined through the guidance of cost-benefit analysis. Cost-benefit analysis can help to decide the direction for the development of the project by providing detailed information regarding the pros and cons before making a financial investment. Which in terms could help to access if the project's value justifies the expenditure. Although, this does not mean that the project needs to be finished for the lowest cost possible for it to be cost-efficient. The most crucial factor of an engineering project is the effectiveness, the performance and the durability of the components and sensors which are the backbone to its design and operation.

While keeping all these in mind, choosing proper components and sensors for the prototype design was a hardship in itself as the market offered a wide range of options. The chosen components were required to be both economically sustainable and highly effective. However, each of the components and sensors have their own benefits and drawbacks. This governance process is crucial to meet the consumer satisfaction.

In Design Approach 1, Raspberry Pi 5 is utilized for detecting fire by analyzing the video feed. Moreover, Design Approach 2 also requires the same MCU as the computational unit. Although, Design Approach 1 and 2, both utilizes Arduino Nano for the sub-system level mitigation process, Design Approach 1 remains much more cost-effective. As it utilizes a common surveillance camera and takes the video feed from it for the detection process. Whereas, Design Approach 2 requires an expensive Thermal Camera, which significantly increases the overall cost. In addition, Design Approach 1 requires the existing water supply system of a specified building complex for the mitigation process, which adds no extra cost. Unlike Design Approach 1, Design Approach 2 requires a separate batch of CO2 cylinders for the fire mitigation procedure. Finally, for the communication purpose, Design Approach 1 uses no-extra modules. Raspberry Pi 5 can self-host the video from the camera to any Android mobile device. A mobile based application is also created specifically for sending alarm notification to the consumer's smartphone. All of these requires virtually no additional cost. In contrast to Design Approach 1, Design Approach 2 requires a separate GSM module for the communication process. It sends a text or a phone call to the consumer to let them know that a fire hazard has been detected. The GSM module also creates an addition of extra cost, in the design.

The core components required for Design Approach 1 is listed in the table below:

Table 43: Cost benefit analysis design approach 1

Component	Price	Benefits	Drawbacks
Raspberry Pi 5	15550 /=	• Dedicated PMIC for power efficiency and stability. • Can support a wide range of Linux based operating systems. • Faster quad-core CPU and Video Core VII GPU, with a dedicated DDR4 RAM. • Faster networking using Gigabit Ethernet and featuring Wi-Fi 6 and Bluetooth 5.0.	• Requires a 5V/5A adapter for powering the device, which is quite power hungry for an MCU. • Additional accessories like, PCIe adapters, better power supplies etc. requires additional costs. • Requires microSD or external storage, which in result limits speed.
Rapoo C260 USB Full HD Webcam	3000 /=	**High-Definition Video:** • 2MP CMOS sensor with 1080p resolution. • Intelligently adjusts frame rate and resolution based on ambient light for clear video even in dim lighting. **Wide-Angle Lens:** • 95° super wide-angle lens for broader image capture. • Field of View: 80°. • 360° horizontal rotation with adjustable upper and lower viewing angles.	• Does not provide 4K resolution and it cannot be upgraded from 2 MP sensor. • Built-in omnidirectional microphone for purer and clearer sound if required.
Adjustable Direct Water Spray Nozzle	690 /=	• Variable flow control with uniform spraying.	• Spray distance is only up to 10 m.

The core components required for Design Approach 2 is listed in the table below:

Table 54: Cost benefit analysis design approach 1

Component	Price	Benefits	Drawbacks
Raspberry Pi 5	15550 /=	• Dedicated PMIC for power efficiency and stability. • Can support a wide range of Linux based operating systems. • Faster quad-core CPU and Video Core VII GPU, with a dedicated DDR4 RAM. • Faster networking using Gigabit Ethernet and featuring Wi-Fi 6 and Bluetooth 5.0.	• Requires a 5V/5A adapter for powering the device, which is quite power hungry for a MCU. • Additional accessories like, PCIe adapters, better power supplies and etc. requires additional costs. • Requires microSD or external storage, which in result limits speed.
UNI-T UTi85H+ Infrared Thermal Imaging Camera	75000 /=	• Can measure from -20°C to 400°C. • 2.8-inch TFT screen for a clear visualization. • Combines thermal imaging with visible light.	• 400°C benchmark might not be sufficient for a large-scale fire incident. • Considerable amount of installation and maintenance cost.
ABCE Dry Powder 5 Kg Fire Extinguisher	1500 /=	• Effective for multi-class fire hazards. • Ease of use and high affordability	• Non-Eco friendly and can cause respiratory irritations.
SIM900A GSM/GPRS Module V4.0	985 /=	• Operates on GSM 850/900/1800/1900 MHz bands, making suitable for most countries.	• Limited to 2G networks only. • Slow GPRS data

		• Low power consumption and Raspberry Pi friendly. • Supports voice calls, SMS, and GPRS for data transmission.	transmission speed. • Can have poor signal sensitivity in areas with poor GSM coverage.

This contrast between the expenses of the core components of Design Approach 1 and 2, by using a cost-benefit analysis table, gives validation for choosing Design Approach 1 as the most sustainable option, offering the best advantages to stakeholders.

8.4 Evaluate economic and financial aspects

This fire response system project has strong potential economic and financial returns. By eliminating the need to install costly new hardware systems, the project utilizes existing surveillance facilities, minimizing the up-front costs significantly. With this, the project becomes very accessible and scalable to different applications, be it residential, commercial, or industrial. Such a solution is very cost-effective as well as potent but effective in terms of functionality. For example, the nozzle system can deliver a strike or blast of water at an appropriate target. The nozzle optimizes water resources by providing efficient coverage while minimizing consumption. The project shows strong financial prospects as it has been gaining more prominence in the market with increasing global demand for smart safety solutions. As this project significantly reduces fire hazards and thus satisfies a critical safety and financial risk which these people greatly want to minimize, the solution becomes most compelling to insurers, facilities managers, and business owners. That's why the project can be expanded and improved further to better penetrate the marketplace, thereby creating a good economy impact on local and global economies as well. The following budget will be allocated for development and implementation of the prototype.

Table 15: Budget for design approach 1

Design Approach 1			
Elements	**Unit**	**Product Link**	**Price (BDT)**
Raspberry Pi 5	1	https://store.roboticsbd.com/raspberry-pi/2439-raspberry-pi-5-8gb-robotics-bangladesh.html	15,550
Raspberry Pi 5 Charger	1	https://techshopbd.com/detail/4325/Raspberry_Pi_5_Official_27W_Power_Supply_Brand_WaveShare_techshop_bangladesh	3450
Arduino Nano	1	https://store.roboticsbd.com/arduino-bangladesh/32-arduino-nano-robotics-bangladesh.html	590

Servo Motor	1	https://store.roboticsbd.com/robotics-parts/285-abs-material-2-axis-pan-tilt-camera-mount-with-sg90-robotics-bangladesh.html	850
Mini Water Tank	1	https://www.daraz.com.bd/products/mini-water-tank-sera-15-ltr-i212863748.html	620
3/8 Inches Soft & Clear PVC Tubing	2	https://www.daraz.com.bd/products/38-pvc-20-i323697360-s1544028534.html?spm=a2a0e.searchlist.sku.5.3d785eb0iLJx1r&search=1	720
Fire Alarm Bell (AC)	1	https://fireextinguisher.me/product/fire-alarm-bell-price-in-bangladesh/	1,800
Rapoo C260 USB Full HD Webcam	1	https://www.startech.com.bd/rapoo-c260-usb-fhd-webcam?srsltid=AfmBOoqamFcjTU-Zs-DDP8LiHRHlvES6dFgYEW87gzunQjIXCf9KkNRr	3,000
Adjustable Direct Water Spray Nozzle	1	https://www.bdstall.com/details/adjustable-direct-water-spray-nozzle-78453/	360
		Total	**26,940**

Total component Price:	**26,940**
Prototype cost	2,500
Testing Cost	1,000
Delivery Cost	2,000
Unforeseen Emergency	2,000
Total Price	**34,440**

8.5 Conclusion

Future performance and development of the project would have to be inferred or implied from some economic and financial analyses. This is because a sound economic analysis would ensure that the project is still viable to provide for long-term sustainability, while the financial aspect would provide total details for resources required for growth. However, it must be noted that performance and productivity would not, on their own, be sufficient guarantees for the future sustainability of the system. An integrated, holistic view comprising both economic and financial aspects would be needed when it comes to strategic decision making concerning the continuity of the project.

Chapter 9: Ethics and Professional Responsibilities CO13, CO2

9.1 Introduction

Ethical considerations go hand in hand with an engineering project. It takes into account factors such as whether the project is within the prescribed limits of a good moral and socially accepted point of view. Besides ethical considerations, a professional also counts responsibilities toward a project. These factors enable showcasing proper engineering prowess in any project. In the end, both the ethical considerations and professional responsibilities add up to making a project more viable in terms of economic, environmental, and social dimensions.

9.2 Identify ethical issues and professional responsibility

Pyrosentry intends to ensure public safety, coupling the existing CCTV with a validated fire detection mechanism that automatically responds to fire. It's purposely meant to address a key area in public safety and strives to maintain professional and ethical considerations throughout its development and implementation. In the following, some of the key considerations are presented:

A) System Safety and Reliability

Since the project involves risks related to fire hazards, any failure or malfunction of the system will lead to great damage to property and even human life. Addressing the issue necessitates choosing reliable components such as Raspberry Pi, Arduino Nano, and performing many tests to check accurate detection and response of fire. In the same way, the automated water sprinkler system will also be subjected to quality assurance tests to minimize its risks of false activation or failures at emergency times.

B) Responsible Use of Surveillance Data

The project utilizes video feeds residing on existing CCTV cameras and raises some privacy issues. To handle this ethical issue, the system is designed such that it consumes video feeds on local Raspberry Pi edge computing. It ensures that sensitive video data never leave the premises to be transmitted to external servers or unauthorized third parties for upholding data privacy principles.

C) Prevention of Mismanagement and Electrical Hazards

The system involves electrical components, wiring, and actuators, which, if mismanaged, can pose fire or electrical hazards themselves. Extra care has been taken to use certified components maintenance.

D) Accuracy and Avoidance of False Alarms

False alarms in fire detection systems can cause panic, disrupt normal operations, and waste water resources. To address this, the fire detection model has been trained extensively on a large dataset to enhance accuracy and reliability. The system's performance will be monitored and continuously improved to reduce false positives and negatives.

E) Ethical Responsibility Towards Public Safety

As this system is intended to safeguard human lives, the ethical responsibility of ensuring its effectiveness and reliability is paramount. Proper training and guidelines for operators and maintenance personnel will be provided to ensure the system is used responsibly. Additionally, user notifications via the app will offer real-time awareness to prevent delays in emergency responses.

9.3 Apply ethical issues and professional responsibility

The primary aim of the project is to develop and upgrade the fire safety mechanism in a reliable and automated fire detection and preventive measure against fire incidents. This has been achieved through integration of existing infrastructures and advanced technologies so that public safety provisions adhere to the consideration of ethics and professional responsibilities. Following measures have been applied:

A) Use of Consent Forms and Compliance with Privacy Standard

To avoid violating privacy, all owners and other stakeholders will need to clear agreement since the system uses video feeds taken from CCTV cameras. Besides, all consent forms and documents will be prepared to comply with the privacy law. Furthermore, the rights of the individuals whose privacy might be affected will be safeguarded as well.

B) Seek Approval from Relevant Authorities

The project closely adheres to the protocols and guidelines maintained by the fire safety regulators and their corresponding approvals from the fire safety departments. In this regard, the highest possible fire preventive and protective measures have been exhaustively applied at all levels during the course of the work.

C) Integrated Emergency Notification System

The connected mobile application will notify a user about all the fire hazards reported from the system in real-time. Hence, the user can take prompt action, even though the automated sprinkler system may have fired already. This redundancy allows transmission of important events timely to stakeholders.

D) Ensuring Affordability and Accessibility

The project would then make use of the existing CCTVs to further bring costs down for the implementation of the structures. The system can be accessed by a very large section of society including small businesses as well as residential areas, such that fire safety measures can be made inexpensive and available to the public.

9.4 Conclusion

As we worked on building the fire detection and response system, we firmly hold that ethics and professional responsibilities should be given utmost priority so that such a technical solution is not only delivering what is intended but is also socially acceptable and legally and morally responsible. Addressing privacy issues and compliance with all industry regulations while putting in place safety measures assure that this project takes a responsible approach to public safety.

Chapter 10: Conclusion and Future Work.

10.1 Project summary/Conclusion

The project successfully demonstrates an innovative, image-based fire detection and suppression system that is both efficient and reliable. Using advanced video processing algorithms, the system identifies fire hazards in real-time and mitigates them through an automated water-spraying mechanism. The integration of Raspberry Pi and Arduino ensures seamless coordination between detection and suppression components. The project overcomes traditional sensor-based limitations, providing a robust, scalable solution suitable for various residential, commercial, and industrial applications. By leveraging high-resolution image processing and precise mitigation techniques, the system significantly minimizes fire damage risks and ensures optimal safety for occupants. This project represents a meaningful step forward in modern fire safety technology, emphasizing automation, accuracy, and adaptability.

10.2 Future work

Future enhancements to the system could focus on expanding its detection capabilities by integrating more advanced sensors and extending its operational range. Incorporating IoT functionality would allow the system to have more control and enable users to manage and monitor the system from mobile devices or cloud-based platforms. By further upgrading the algorithm the detection system could be improved to distinguish between intentional fire and accidental fire. Furthermore, we plan to minimize false alarms by analyzing sensor data patterns and scale the prototype to handle multiple suppression methods, such as foam or gas-based systems which would make it adaptable to different fire scenarios. Additionally, optimizing the system for larger-scale implementations and exploring renewable energy solutions, such as solar power, could make it more sustainable and applicable in diverse environments. These advancements would enhance the system's scalability and overall effectiveness in mitigating fire hazards.

Chapter 11: Identification of Complex Engineering Problems and Activities.

11.1: Identify the attribute of complex engineering problem (EP)

	Attributes	Put tick (√) as appropriate.
P1	Depth of knowledge required	√
P2	Range of conflicting requirements	
P3	Depth of analysis required	√
P4	Familiarity of issues	
P5	Extent of applicable codes	
P6	Extent of stakeholder involvement and needs	√
P7	Interdependence	√

11.2: Provide reasoning how the project address selected attribute (EP)

P1. Depth of knowledge required: The project requires an understanding of image processing algorithms for fire detection. Knowledge of image processing, computer vision techniques, and feature extraction is required. Furthermore, familiarity with the control system is needed to integrate the mechanical part of the project with the electrical system. Knowledge of how the water system in a building and how the inner structure of a building is built are also required.

P3. Depth of analysis required: Since the system will use RGB image processing to detect fire, it will require analysis beyond basic color segmentation to provide more accurate detection. Understanding fire dynamics, flickering behavior of fire, irregular fire textures, and specific color intensity patterns are all required to analyze the unique characteristics of fire for more accuracy.

P6. Extent of stakeholder involvement and needs: The project relies on several important stakeholders, which include firefighters, Data analysts, Experts on robotics, etc. Firefighters can offer insights into various fire scenarios, which can help improve the algorithms. Engineers who focus on image processing can ensure better performance of the model for better accuracy. By involving the essential stakeholders throughout the project, a proper solution can be made, which can be both reliable and practical.

P7: Interdependence: This project includes various subsystems which are image processing for fire detection, nozzle manipulation, control processing unit, power distribution, sensor integration, communication interface etc. Each subsystem is interdependent on each other for the seamless operation of fire detection and extinguishing.

11.3 Identify the attribute of complex engineering activities (EA)

	Attributes	Put tick (√) as appropriate.
A1	Range of resource	√
A2	Level of interaction	√
A3	Innovation	
A4	Consequences for society and the environment	√
A5	Familiarity	

11.4 Provide reasoning how the project address selected attribute (EA)

A1: Range of Resources: The development and implementation of a smart image-sensing-based fire mitigation system requires a substantial amount of technology. Ranging from using cameras to create data to feed into an image processing algorithm to using thermal data and compilation, real-time fire tracking, sophisticated nozzle mechanisms for quick and effective mitigation, and the infrastructure to incorporate the whole system.

A2: Level of interaction: The project can be integrated with various technologies. For example, it can be combined with fire detection sensors alongside the image processing algorithms for fire detection and mitigation. However, compatibility issues may arise if proper measures are not taken. Furthermore, since the project is an autonomous system, it needs to be reliable and safe. Which involves fail-safe measures, false alarm or false detection, careful extinguishing mechanism etc.

A4: Consequences for society and the environment: The project holds the promise of improved fire safety as well as the potential to reduce water usage for this type of system. However, manufacturing and e-waste disposal of this project may have a negative impact on the environment if not handled properly. Additionally, sustainable practices, careful design choices, and responsible management of the system are needed to create a positive impact on both society and the environment.

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Appendix

Code

```
Code for Servo system driving mechanism simulation and mitiga-
tion block
implementation (Design Approach 1):
import RPi.GPIO as GPIO
import time
# Set up GPIO mode
GPIO.setmode(GPIO.BCM)
# Define GPIO pins
servo1_pin = 24
servo2_pin = 25
gpio21_pin = 21
gpio5_pin = 5
# Set up GPIO pins
GPIO.setup(servo1_pin, GPIO.OUT)
GPIO.setup(servo2_pin, GPIO.OUT)
GPIO.setup(gpio21_pin, GPIO.OUT)
GPIO.setup(gpio5_pin, GPIO.OUT)
# Initialize PWM
pwm1 = GPIO.PWM(servo1_pin, 50) # 50 Hz frequency
pwm2 = GPIO.PWM(servo2_pin, 50) # 50 Hz frequency
# Start PWM with a duty cycle of 0 (servo in neutral position)
pwm1.start(0)
pwm2.start(0)
# Set GPIO5 high
GPIO.output(gpio5_pin, GPIO.HIGH)
# Function to set servo angle
def set_servo_angle(pwm, angle):
duty = (angle + 90) / 18 + 2
pwm.ChangeDutyCycle(duty)
try:
while True:
# Toggle GPIO21
GPIO.output(gpio21_pin, GPIO.HIGH)
# Move both servos to 90 degrees
set_servo_angle(pwm1, 90)
set_servo_angle(pwm2, 90)
time.sleep(1) # Wait for 1 second
# Toggle GPIO21
GPIO.output(gpio21_pin, GPIO.LOW)
# Move both servos to -90 degrees
set_servo_angle(pwm1, -90)
```

```
set_servo_angle(pwm2, -90)
time.sleep(1) # Wait for 1 second
except KeyboardInterrupt:
pass
finally:
# Stop the PWM objects and clean up
pwm1.stop()
pwm2.stop()
GPIO.cleanup()
Python Script RGB-Thermal Conversion for design Approach 2:
import os
import numpy as np
import cv2
# Constants
threshold = 200
area_of_box = 700
min_temp = 102 # in Fahrenheit
font_scale_caution = 1
font_scale_temp = 0.7

def convert_to_temperature(pixel_avg):
return pixel_avg / 2.25

def process_frame(frame):
frame = cv2.cvtColor(frame, cv2.COLOR_BGR2RGB)
heatmap_gray = cv2.cvtColor(frame, cv2.COLOR_RGB2GRAY)
heatmap = cv2.applyColorMap(heatmap_gray, cv2.COLORMAP_HOT)

binary_thresh = cv2.threshold(heatmap_gray, threshold, 255,
cv2.THRESH_BINARY)

kernel = np.ones((3, 3), np.uint8)
image_erosion = cv2.erode(binary_thresh, kernel, iterations=1)
image_opening = cv2.dilate(image_erosion, kernel, iterations=1)

contours, _ = cv2.findContours(image_opening, cv2.RETR_EXTER-
NAL,
cv2.CHAIN_APPROX_SIMPLE)

image_with_rectangles = np.copy(heatmap)

for contour in contours:
x, y, w, h = cv2.boundingRect(contour)
if (w * h) < area_of_box:
continue

mask = np.zeros_like(heatmap_gray)
cv2.drawContours(mask, [contour], -1, 255, -1)
mean = convert_to_temperature(cv2.mean(heatmap_gray,
mask=mask)[0])
```

```
temperature = round(mean, 2)
color = (0, 255, 0) if temperature < min_temp else (255, 255,
127)

if temperature >= min_temp:
cv2.putText(image_with_rectangles, "High temperature detected
!!!", (35, 40),
cv2.FONT_HERSHEY_SIMPLEX, font_scale_caution, color, 2,
cv2.LINE_AA)

cv2.rectangle(image_with_rectangles, (x, y), (x + w, y + h),
color, 2)
cv2.putText(image_with_rectangles, "{} F".format(temperature),
(x, y),
cv2.FONT_HERSHEY_SIMPLEX,    font_scale_temp,    color,    2,
cv2.LINE_AA)

return image_with_rectangles

def process_camera(output_path):
camera = cv2.VideoCapture(0)

if not camera.isOpened():
print("Error: Could not open camera.")
return

video_frames = []
while True:
ret, frame = camera.read()
if not ret:
break

frame = process_frame(frame)
video_frames.append(frame)
cv2.imshow('frame', frame)
if cv2.waitKey(1) & 0xFF == ord('q'):
break

camera.release()
cv2.destroyAllWindows()

if not video_frames:
print("Error: No frames were processed.")
return

height, width, _ = video_frames[0].shape
size = (width, height)
out      =      cv2.VideoWriter(output_path,      cv2.Vide-
oWriter_fourcc(*'MJPG'), 10, size)

for frame in video_frames:
```

```
out.write(frame)
out.release()

def main():
video_output_path = 'output.avi'
process_camera(video_output_path)

if _name_ == "_main_":
main()
Design Approach 1:

Training Code:

!pip install roboflow ultralytics

import os
import time
from roboflow import Roboflow
from ultralytics import YOLO

def print_progress(message):
    print(f"{time.strftime('%H:%M:%S')} - {message}")



api_key = "ygxBtP6wfsCJ9Gsy8SDg"


try:
    print_progress("Initializing Roboflow...")
    rf = Roboflow(api_key=api_key)
    project = rf.workspace("-jwzpw").project("continuous_fire")
    version = project.version(6)

    print_progress("Downloading dataset...")
    dataset = version.download("YOLOv8s")
    dataset_dir = dataset.location
    print_progress(f"Dataset downloaded to: {dataset_dir}")

    print_progress("Contents of the dataset directory:")
    for item in os.listdir(dataset_dir):
        print(f"  {item}")

    print_progress("Preparing for YOLO training...")
    yolo_data_path = os.path.join(dataset_dir, 'data.yaml')
    if not os.path.exists(yolo_data_path):
        raise FileNotFoundError(f"data.yaml not found in {da-
taset_dir}")

    print_progress("Starting YOLO training...")
    model = YOLO('YOLOv8ss.pt')
```

```
    results = model.train(
        data=yolo_data_path,
        epochs=80,
        imgsz=640,
        plots=True
    )
    print_progress("Training completed successfully")

except Exception as e:
    print_progress(f"An error occurred: {str(e)}")

VS code:

from ultralytics import YOLO
import cv2

model     =     YOLO(r'C:\Users\asifz\Downloads\Final     Train
MAALPANI\best(1).pt')


cap = cv2.VideoCapture(0)

if not cap.isOpened():
    print("Error: Could not open video source.")
    exit()

while True:

    ret, frame = cap.read()
    if not ret:
        print("Failed to grab frame")
        break

    results = model.predict(source=frame, imgsz=640, conf=0.6,
show=False)
    annotated_frame = results[0].plot()
    cv2.imshow("Fire Detection", annotated_frame)
    if cv2.waitKey(1) & 0xFF == ord('q'):
        break
cap.release()
cv2.destroyAllWindows()




Design Approach 2:

import numpy as np
import cv2
from google.colab import drive
import os
```

```
from IPython.display import display, HTML
from tqdm import tqdm
from sklearn.metrics import confusion_matrix, accuracy_score,
roc_curve, auc
import matplotlib.pyplot as plt
import seaborn as sns

# Mount Google Drive
drive.mount('/content/drive')

# Set paths
input_path = "/content/drive/MyDrive/fire_detection_pro-
ject/fire vid1.mp4"
output_dir = "/content/drive/MyDrive/thermal_output"
output_video_path = os.path.join(output_dir, 'pro-
cessed_video.mp4')

# Create output directory if it doesn't exist
os.makedirs(output_dir, exist_ok=True)

# Temperature conversion function
def pixel_to_temp(pixel_value):
    return 32 + (pixel_value / 255) * (1000 - 32)

# Ground truth function
def get_ground_truth(frame):
    gray_frame = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
    return 1 if pixel_to_temp(np.max(gray_frame)) > 600 else 0

# Function to process a single frame
def process_frame(frame, fire_threshold=600, min_fire_area=200,
min_fire_intensity=0.1):
    gray_frame = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)

    # Apply threshold to find potential fire areas
    _, hot_areas = cv2.threshold(gray_frame, int((fire_thresh-
old - 32) * 255 / (1000 - 32)), 255, cv2.THRESH_BINARY)

    # Find contours of hot areas
    contours, _ = cv2.findContours(hot_areas, cv2.RETR_EXTER-
NAL, cv2.CHAIN_APPROX_SIMPLE)

    # Create heatmap
    heatmap = cv2.applyColorMap(gray_frame, cv2.COLORMAP_JET)

    # Add text for average temperature
    avg_temp = pixel_to_temp(np.mean(gray_frame))
    cv2.putText(heatmap, f"Avg Temp: {avg_temp:.1f}F", (10,
30), cv2.FONT_HERSHEY_SIMPLEX, 1, (255, 255, 255), 2,
cv2.LINE_AA)
```

```
    fire_detected = False
    # Mark fire detection points
    for contour in contours:
        area = cv2.contourArea(contour)
        if area > min_fire_area:  # Ignore small areas
            x, y, w, h = cv2.boundingRect(contour)
            roi = gray_frame[y:y+h, x:x+w]
            max_temp = pixel_to_temp(np.max(roi))
            avg_temp = pixel_to_temp(np.mean(roi))
            intensity = (max_temp - avg_temp) / (1000 - 32)

            if  max_temp  >=  fire_threshold  and  intensity  >
min_fire_intensity:
                cv2.rectangle(heatmap, (x, y), (x+w, y+h), (0,
0, 255), 2)
                cv2.putText(heatmap,  f"{max_temp:.1f}F  FIRE",
(x,  y-10),  cv2.FONT_HERSHEY_SIMPLEX,  0.5,  (0,  0,  255),  2,
cv2.LINE_AA)
                fire_detected = True

    return heatmap, fire_detected, avg_temp

# Open the video file
cap = cv2.VideoCapture(input_path)
if not cap.isOpened():
    print("Error opening video file")
    exit()

# Get video properties
fps = int(cap.get(cv2.CAP_PROP_FPS))
width = int(cap.get(cv2.CAP_PROP_FRAME_WIDTH))
height = int(cap.get(cv2.CAP_PROP_FRAME_HEIGHT))
total_frames = int(cap.get(cv2.CAP_PROP_FRAME_COUNT))

# Create VideoWriter object
fourcc = cv2.VideoWriter_fourcc(*'mp4v')
out = cv2.VideoWriter(output_video_path, fourcc, fps, (width,
height))

# Lists to store ground truth and predictions
ground_truths = []
predictions = []
avg_temperatures = []

# Process the video
for _ in tqdm(range(total_frames), desc="Processing video"):
    ret, frame = cap.read()
    if not ret:
        break
    processed_frame,    fire_detected,    avg_temp    =    pro-
cess_frame(frame)
```

```
    out.write(processed_frame)

    # Get ground truth and store prediction
    ground_truth = get_ground_truth(frame)
    ground_truths.append(ground_truth)
    predictions.append(1 if fire_detected else 0)
    avg_temperatures.append(avg_temp)

# Release video objects
cap.release()
out.release()

print(f"Processed video saved to: {output_video_path}")

# Calculate metrics
accuracy = accuracy_score(ground_truths, predictions)

# Handle potential 1x1 confusion matrix
cm = confusion_matrix(ground_truths, predictions)
if cm.size == 1:
    if ground_truths[0] == 1:  # If the only prediction is pos-
itive
        tn, fp, fn, tp = 0, 0, 0, cm[0][0]
    else:  # If the only prediction is negative
        tn, fp, fn, tp = cm[0][0], 0, 0, 0
else:
    tn, fp, fn, tp = cm.ravel()

# Avoid division by zero
fpr = fp / (fp + tn) if (fp + tn) > 0 else 0
fnr = fn / (fn + tp) if (fn + tp) > 0 else 0

print(f"Detection Accuracy: {accuracy:.2f}")
print(f"True Negatives: {tn}, False Positives: {fp}, False Neg-
atives: {fn}, True Positives: {tp}")
print(f"False Positive Rate: {fpr:.2f}")
print(f"False Negative Rate: {fnr:.2f}")

# Additional statistics
print(f"Total frames: {len(predictions)}")
print(f"Frames with fire detected: {sum(predictions)}")
print(f"Frames  without  fire  detected:  {len(predictions)  -
sum(predictions)}")
print(f"Ground truth - frames with fire: {sum(ground_truths)}")
print(f"Ground truth - frames without fire: {len(ground_truths)
- sum(ground_truths)}")

# Create graphs
# 1. Confusion Matrix Heatmap
plt.figure(figsize=(8, 6))
sns.heatmap(cm, annot=True, fmt='d', cmap='Blues')
```

```
plt.title('Confusion Matrix')
plt.ylabel('True label')
plt.xlabel('Predicted label')
plt.savefig(os.path.join(output_dir, 'confusion_matrix.png'))
plt.close()

# 2. ROC Curve
fpr, tpr, _ = roc_curve(ground_truths, predictions)
roc_auc = auc(fpr, tpr)

plt.figure(figsize=(8, 6))
plt.plot(fpr, tpr, color='darkorange', lw=2, label=f'ROC curve
(AUC = {roc_auc:.2f})')
plt.plot([0, 1], [0, 1], color='navy', lw=2, linestyle='--')
plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.05])
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver Operating Characteristic (ROC) Curve')
plt.legend(loc="lower right")
plt.savefig(os.path.join(output_dir, 'roc_curve.png'))
plt.close()

# 3. Fire Detection Timeline
plt.figure(figsize=(12, 6))
plt.plot(ground_truths, label='Ground Truth', color='blue')
plt.plot(predictions,  label='Predictions',  color='red',  al-
pha=0.7)
plt.title('Fire Detection Timeline')
plt.xlabel('Frame')
plt.ylabel('Fire Detected (1) / Not Detected (0)')
plt.legend()
plt.savefig(os.path.join(output_dir,     'fire_detection_time-
line.png'))
plt.close()

# 4. Temperature Distribution Histogram
plt.figure(figsize=(10, 6))
plt.hist(avg_temperatures,      bins=50,      color='skyblue',
edgecolor='black')
plt.title('Distribution of Average Frame Temperatures')
plt.xlabel('Temperature (°F)')
plt.ylabel('Frequency')
plt.savefig(os.path.join(output_dir,    'temperature_distribu-
tion.png'))
plt.close()

# 5. Accuracy Over Time
window_size = 100  # Calculate accuracy over every 100 frames
accuracies = []
for i in range(0, len(ground_truths), window_size):
```

```
    window_gt = ground_truths[i:i+window_size]
    window_pred = predictions[i:i+window_size]
    window_accuracy = accuracy_score(window_gt, window_pred)
    accuracies.append(window_accuracy)

plt.figure(figsize=(10, 6))
plt.plot(range(0, len(ground_truths), window_size), accuracies,
marker='o')
plt.title('Accuracy Over Time')
plt.xlabel('Frame')
plt.ylabel('Accuracy')
plt.ylim([0, 1])
plt.savefig(os.path.join(output_dir,                        'accu-
racy_over_time.png'))
plt.close()

print("Graphs have been saved in the thermal_output directory.")

# Display the processed video in Colab
def display_video(file_path):
    video_html = f"""
    <video width="640" height="480" controls>
        <source src="{file_path}" type="video/mp4">
    </video>
    """
    return HTML(video_html)

display(display_video(output_video_path))
```

Design Approach 1 Proteus code:

```
import time
import RPi.GPIO as GPIO
from serial import Serial

GPIO.setmode(GPIO.BCM)

servo1_pin = 24
servo2_pin = 25
gpio21_pin = 21
gpio5_pin = 5
led_pin = 17

GPIO.setup(servo1_pin, GPIO.OUT)
GPIO.setup(servo2_pin, GPIO.OUT)
GPIO.setup(gpio21_pin, GPIO.OUT)
GPIO.setup(gpio5_pin, GPIO.OUT)
GPIO.setup(led_pin, GPIO.OUT)

# Initialize LED to OFF
```

```
GPIO.output(led_pin, GPIO.LOW)
print("LED initialized to OFF")

pwm1 = GPIO.PWM(servo1_pin, 50)
pwm2 = GPIO.PWM(servo2_pin, 50)
pwm1.start(0)
pwm2.start(0)

GPIO.output(gpio5_pin, GPIO.HIGH)

try:
    ser = Serial('/dev/ttyUSB0', 460800, timeout=0.1)  # Increased
timeout to 5 seconds
except Exception as e:
    print(f"Error opening serial port: {e}")
    GPIO.cleanup()
    exit(1)

def set_servo_angle(pwm, angle):
    try:
        duty = angle / 18 + 2.5
        pwm.ChangeDutyCycle(duty)
    except Exception as e:
        print(f"Error setting servo angle: {e}")

last_fire_detection = time.time()
debounce_time = 0.5  # 500ms debounce

try:
    while True:
        try:
            if ser.in_waiting > 0:
                data = ser.read(1)  # Read only 1 byte at a time
                if len(data) == 1:  # Check if the data is valid
                    data = data.decode('utf-8')
                    if data == '1':  # Fire detected
                        print("Fire detected, activating response")
                        GPIO.output(gpio21_pin, GPIO.HIGH)
                        set_servo_angle(pwm1, 90)
                        set_servo_angle(pwm2, 90)
                        GPIO.output(led_pin, GPIO.LOW)  # Turn LED ON
                    elif data == '0':  # No fire detected
                        print("No fire detected, resetting servos")
                        set_servo_angle(pwm1, 0)
                        set_servo_angle(pwm2, 0)
                        GPIO.output(led_pin, GPIO.HIGH)  # Turn LED
OFF
        except Exception as e:
            print(f"Error reading from serial port: {e}")
        time.sleep(0.1)  # Small delay to prevent busy waiting

except KeyboardInterrupt:
    print("Program terminated by user")

finally:
```

```
    pwm1.stop()
    pwm2.stop()
    GPIO.cleanup()
    ser.close()
    print("Cleanup complete")


VSCODE DES1:

from ultralytics import YOLO
import cv2
import os
import serial
import numpy as np
import serial.tools.list_ports
import time

def buffered_write(serial_port, data):
    serial_port.write(data)
    serial_port.flush()

try:
    s = serial.Serial('COM1', 460800)
except serial.SerialException as e:
    print(f"Error opening serial port: {e}")
    exit(1)

# Load the existing model
model = YOLO(r'C:\Users\asifz\Downloads\Final Train
MAALPANI\best(1).pt')

# Initialize video capture (webcam)
cap = cv2.VideoCapture(0)
if not cap.isOpened():
    print("Error: Could not open video source.")
    s.close()
    exit(1)

def detect_fire(frame, model):
    try:
        results = model.predict(source=frame, imgsz=640,
conf=0.6, show=False, verbose=False)

        if results[0].boxes is not None and len(re-
sults[0].boxes) > 0:
            return True, results[0].boxes.xyxy.cpu().numpy()
        return False, None
    except Exception as e:
        print(f"Error in fire detection: {e}")
        return False, None
```

```
last_state_change = time.time()
current_state = False
delay = 0.5  # 500ms delay

try:
    while True:
        ret, frame = cap.read()
        if not ret:
            print("Failed to grab frame")
            break

        fire_detected, boxes = detect_fire(frame, model)

        current_time = time.time()
        if fire_detected != current_state and (current_time -
last_state_change) > delay:
            current_state = fire_detected
            last_state_change = current_time
            if fire_detected:
                buffered_write(s, b'1')
                print("Fire detected - Sending '1' to COM1")
            else:
                buffered_write(s, b'0')
                print("No fire detected - Sending '0' to COM1")

        if fire_detected and boxes is not None:
            for box in boxes:
                x1, y1, x2, y2 = box.astype(int)
                cv2.rectangle(frame, (x1, y1), (x2, y2), (0, 0,
255), 2)
                cv2.putText(frame,  "Fire",  (x1,  y1  -  10),
cv2.FONT_HERSHEY_SIMPLEX, 0.9, (0, 0, 255), 2)

        cv2.imshow("Fire Detection", frame)

        if cv2.waitKey(1) & 0xFF == ord('q'):
            break

except Exception as e:
    print(f"An error occurred: {e}")

finally:
    cap.release()
    cv2.destroyAllWindows()
    s.close()
    print("Cleanup complete")

PROTEUS DES2
# Clean up GPIO
GPIO.cleanup()
```

```
# Close serial connection
ser.close()

# Print statistics
print(f"Total frames processed: {len(predictions)}")
print(f"Frames with fire detected: {sum(predictions)}")
print(f"Frames without fire detected: {len(predictions) - sum(predictions)}")

# Create and save temperature distribution histogram
plt.figure(figsize=(10, 6))
plt.hist(avg_temperatures, bins=50, color='skyblue', edgecolor='black')
plt.title('Distribution of Average Frame Temperatures')
plt.xlabel('Temperature (°F)')
plt.ylabel('Frequency')
plt.savefig(os.path.join(output_dir, 'temperature_distribution.png'))
plt.close()

print("Temperature distribution graph has been saved in the output directory.")



VSCODE DES2

import numpy as np
import cv2
import os
from sklearn.metrics import confusion_matrix, accuracy_score, roc_curve, auc
import matplotlib.pyplot as plt
import seaborn as sns
import serial


# Set paths
output_dir = "output"
os.makedirs(output_dir, exist_ok=True)


# Temperature conversion function
def pixel_to_temp(pixel_value):
    return 32 + (pixel_value / 255) * (500 - 32)


# Function to process a single frame
def process_frame(frame, fire_threshold=400, min_fire_area=200, min_fire_intensity=0.1):
    gray_frame = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
```

```
    # Apply threshold to find potential fire areas
    _, hot_areas = cv2.threshold(gray_frame, int((fire_thresh-
old - 32) * 255 / (500 - 32)), 255, cv2.THRESH_BINARY)


    # Find contours of hot areas
    contours, _ = cv2.findContours(hot_areas, cv2.RETR_EXTER-
NAL, cv2.CHAIN_APPROX_SIMPLE)


    # Create heatmap
    heatmap = cv2.applyColorMap(gray_frame, cv2.COLORMAP_JET)


    # Add text for average temperature
    avg_temp = pixel_to_temp(np.mean(gray_frame))
    cv2.putText(heatmap, f"Avg Temp: {avg_temp:.1f}F", (10,
30), cv2.FONT_HERSHEY_SIMPLEX, 1, (255, 255, 255), 2,
cv2.LINE_AA)


    fire_detected = False
    fire_temp = 0


    # Mark fire detection points
    for contour in contours:
        area = cv2.contourArea(contour)
        if area > min_fire_area:  # Ignore small areas
            x, y, w, h = cv2.boundingRect(contour)
            roi = gray_frame[y:y+h, x:x+w]
            max_temp = pixel_to_temp(np.max(roi))
            avg_temp = pixel_to_temp(np.mean(roi))
            intensity = (max_temp - avg_temp) / (1000 - 32)
            if max_temp >= fire_threshold and intensity >
min_fire_intensity:
                cv2.rectangle(heatmap, (x, y), (x+w, y+h), (0,
0, 255), 2)
                cv2.putText(heatmap, f"{max_temp:.1f}F FIRE",
(x, y-10), cv2.FONT_HERSHEY_SIMPLEX, 0.5, (0, 0, 255), 2,
cv2.LINE_AA)
                fire_detected = True
                fire_temp = max_temp


    return heatmap, fire_detected, avg_temp, fire_temp


# Open the webcam
```

```
cap = cv2.VideoCapture(0)  # Use 0 for default webcam, or change
if you have multiple cameras


if not cap.isOpened():
    print("Error opening webcam")
    exit()


# Set up serial connection
ser = serial.Serial('COM1', 9600, timeout=1)


# Lists to store predictions and temperatures
predictions = []
avg_temperatures = []


try:
    while True:
        ret, frame = cap.read()
        if not ret:
            print("Failed to grab frame")
            break


        processed_frame, fire_detected, avg_temp, fire_temp =
process_frame(frame)


        # Store prediction and temperature
        predictions.append(1 if fire_detected else 0)
        avg_temperatures.append(avg_temp)


        # Send output to COM1 port
        if fire_temp > 400:
            print("Fire is detected")
            ser.write(b'1')
        else:
            ser.write(b'0')


        # Display the resulting frame
        cv2.imshow('Fire Detection', processed_frame)


        # Break the loop on 'q' key press
        if cv2.waitKey(1) & 0xFF == ord('q'):
            break
```

```
finally:
    # Release the capture and close windows
    cap.release()
    cv2.destroyAllWindows()
    ser.close()  # Close the serial connection


    # Print statistics
    print(f"Total frames processed: {len(predictions)}")
    print(f"Frames with fire detected: {sum(predictions)}")
    print(f"Frames without fire detected: {len(predictions) -
sum(predictions)}")


    # Create and save temperature distribution histogram
    plt.figure(figsize=(10, 6))
    plt.hist(avg_temperatures,    bins=50,    color='skyblue',
edgecolor='black')
    plt.title('Distribution of Average Frame Temperatures')
    plt.xlabel('Temperature (°F)')
    plt.ylabel('Frequency')
    plt.savefig(os.path.join(output_dir,   'temperature_distri-
bution.png'))
    plt.close()


    print("Temperature distribution graph has been saved in the
output directory.")
```

FYDP (P) Spring 2024 Summary of Team Log Book/ Journal

Title: PyroSentry
Advanced RGB Image-Based Fire Localization and Extinguishing Network

Group 3

Final Year Design Project (P) Spring 2024				
Student Details	**NAME**	**ID**	**EMAIL ADDRESS**	**PHONE**
Member 1	Md.Tanveer Anjum	20121048	md.tanveer.anjum@g.bracu.ac.bd	01982599577
Member 2	Asif Abdullah Zamee	20321032	asif.abdullah.zamee@g.bracu.ac.bd	01641640716
Member 3	Md.Toushifur Rahman	20321031	md.toushifur.rahman@g.bracu.ac.bd	01943376994
Member 4	Bishwajit Chandra Mozumder	20321017	bishwajit.chandra.mozumder@g.bracu.ac.bd	01591132927

ATC Details		
ATC 3		
ATC	**Name and Designation**	**Email Address**
Chair	Dr. AKM Abdul Malek Azad Professor, Department of EEE Brac University	a.azad@bracu.ac.bd
Member 1	Ms. Sabrina Saima Lecturer, Department of EEE, Brac University	sabrina.saima@bracu.ac.bd
Member 2	Md. Rafiqul Islam Rafi Lecturer, Department of EEE, Brac University	rafiqul.rafi@bracu.ac.bd

General Notes:

1. In addition to detail journal/logbook fill out the summary/key steps and progress of your work
2. Reflect planning assignments, who has what responsibilities.
3. The logbook should contain all activities performed by the team members (Individual and team activities).

FYDP (P) Spring 2024 Summary of Team Log Book/ Journal

Date/Time/ Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
25.01.2024 **FYDP Class 1** (In person)	**FacultyMember** Mohaimenul Islam **Students** 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	1. Introduction to overall FYDP projects 2. Overview of complex engineering projects and how to find them.		
31.01.2024 **ATC** Meeting 1 (Online)	**ATC Members:** 1. Prof. Dr. AKM Abdul Malek Azad 2. Md.Rafiqul Islam Rafi 3. Ms. Sabrina Saima **Students** 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	1. Five project ideas were demonstrated by the students to the ATC panel. 2. Project ideas were selected to research further and demonstrate in the next ATC meeting with evidence that it can be simulated on software		1. The ATC meeting will be held every Wednesday at 9 PM. 2. Find if the software simulation is possible for the project ideas that were discussed in the ATC meeting with enough evidence.
01.02.2024 **FYDP Class 2** (In person)	**Faculty Member** Prof. Dr. Md. Mosaddequr Rahman **Students** 1. Asif Abdullah Zamee 2. Md.Toushifur Rahman 3. Md.Tanveer Anjum 4. Bishwajit Chandra Mozumder (Absent)	1. Discussion on engineering design processes 2. Overview of the steps to complete a project		
03.02.2024 **Group Meeting 1** (Online)	**Students** 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	**Task 1:** Research on advanced fire detection and extinguishing simulation **Task 2:** Research on Sign language interpreter simulation	**Task 1:** Everyone **Task 2:** Everyone Progress: **Task 1**: Completed **Task 2**: Completed	
05.02.2024	**Students**	**Task 1:** Advance fire detection and	**Task 1:** Md.Toushifur	

Group Meeting 2 (Online)	1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	extinguisher block diagram and simulation parameters **Task 2:** Discussion on different approaches to fire detection system	Rahman, Asif Abdullah Zamee **Task 2:** Everyone Progress: **Task 1**: Completed **Task 2**: Completed	
07.02.2024 **ATC Meeting 2** (Online)	**ATC Members:** 1. Prof. Dr. AKM Abdul Malek Azad 2. Md.Rafiqul Islam Rafi 3. Ms. Sabrina Saima (Absent) **Students** 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	1. The project idea was presented by group 3 and approved by the ATC panel. 2. Design approaches for the project advance fire detection and extinguisher were demonstrated by group 3 3. Relevant research papers on the project topic were displayed		1. Find different research papers related to the project proposal. 2. Start preparing a log book and concept note.
08.02.2024 **FYDP Class 3** (In person)	**Faculty Member** Prof.Dr. Arshadur Rahman **Students** 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	1. Understanding the Objectives, and figuring out an existing Complex Engineering problem. 2. Completion Guidelines of the BSEEE Curriculum's Final Year Design Project		
08.02.2024 **Group Meeting 3** (In person)	**Students** 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	**Task 1:** Look through different research papers related to project proposals. **Task 2:** Start of log book preparation.	**Task 1:** Everyone **Task 2:** Everyone Progress: **Task 1:** Completed **Task 2:** Completed	
13.02.2024	**Students**	**Task 1:** Start of Concept note preparation.	**Task 1:** Everyone	

FYDP (P) Spring 2024 Summary of Team Log Book/ Journal

Group Meeting 4 (Online)	1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum		Progress: **Task 1:** Completed	
14.02.2024 **ATC Meeting 3** (Online)	**ATC Members:** 1. Prof. Dr. AKM Abdul Malek Azad 2. Md.Rafiqul Islam Rafi 3. Ms. Sabrina Saima (Absent) **Students** 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	1. Review of group 3 logbook. 2. Review of group 3 concept notebook.		1. Correct the errors in the log book according to the instructions. 2. Correct the errors in the concept notebook according to the instructions. 3. Re-design the 2nd design approach.
15.02.2024 **FYDP Class 4** (In person)	**Faculty Member** Dr. Abu S.M Mohsin **Students** 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	1. Guidelines on how to identify complex engineering problems. 2. Discussion on project titles and objectives, specifications, etc.		
16.02.2024 **Group Meeting 5** (Online)	**Students** 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	**Task 1:** Formatting the concept notebook. **Task 2:** Re-design the first design approach.	**Task 1:** Everyone **Task 2:** Md.Toushifur Rahman Progress: **Task 1:** Completed **Task 2:** Completed	
20.02.2024 **Group Meeting 6** (Online)	**Students** 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	**Task 1:** Research on 2nd design approach and re-design. **Task 2:** Research on Applicable Standards and codes.	**Task 1:** Everyone Progress: **Task 1:** In progress **Task 2:** Completed	

22.022024 **FYDP** **Class 5** (In person)	**Faculty Member:** Abdullah Hill Kafi **Students:** 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee (absent) (Out of Dhaka) 3. Md.Toushifur Rahman (absent) (Sick) Fever 4. Md.Tanveer Anjum	1.Overview of project safety, sustainability and green system designs. 2. Environmental impact in engineering design.		
24.02.2024 **Group** **Meeting 7** (Online)	**Students** 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	**Task 1:** Update specifications.	**Task 1:** Everyone **Task 1:** Completed	
28.02.2024 **ATC** **Meeting 4** (Online)	**ATC Members:** 1. Prof. Dr. AKM Abdul Malek Azad 2. Md.Rafiqul Islam Rafi 3. Ms. Sabrina Saima (Absent) **Students** 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	1. Review of group 3 logbook. 2. Review of group 3 concept note.		1. Start preparing presentation slides.
29.02.2024 **FYDP** **Class 6** (In person)	**Faculty Member:** Abdullah Hill Kafi **Students:** 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	1. Review of engineering ethical practices. 2. Codes and standards for engineering projects.		
02.03.2024 **Group** **Meeting 8** (Online)	**Students** 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	**Task 1:** update specifications for project. **Task 2:** Presentation slides preparation.	**Task 1:** Everyone **Task 2:** Everyone Progress: **Task 1:** Completed	

			Task 2: Completed	
06.03.2024 **Group Meeting 9** (Online)	**Students** 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	**Task 1:** Budget planning.	**Task 1:** Everyone Progress: **Task 1:** Completed	
18.03.2024 **Group Meeting 10** (Online)	**Students** 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	**Task 1:** Project Proposal Discussion and Preparation.	**Task 1:** Everyone Progress: **Task 1:** Completed	
21.03.2024 **FYDP Class 7** (In person)	**Faculty Member:** Mohaimenul Islam **Students:** 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum (Absent due to fever)	1. Review of Project Proposal Preparation.		
21.03.2024 **ATC Meeting 5** (Online)	**ATC Members:** 1. Prof. Dr. AKM Abdul Malek Azad 2. Md.Rafiqul Islam Rafi 3. Ms. Sabrina Saima **Students** 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	1. Overview of project proposal contents.		1. Start preparation of project proposal. 2. Gather information on the system. specifications of the project. 3. Gather information on stakeholders.
24.03.2024 **Group Meeting 11** (In person)	**Students** 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	**Task 1:** Ethical Considerations **Task 2:** Budget **Task 3:** Expected Outcome **Task 4:** Sustainability	**Task 1:** Bishwajit Chandra Mozumder **Task 2:** Asif Abdullah Zamee	

			Task 3: Md.Toushifur Rahman **Task 4:** Md.Tanveer Anjum Progress: **Task 1:** Completed **Task 2:** Completed **Task 3:** Completed **Task 4:** Completed	
27.03.2024 **Group Meeting 12** (Online)	**Students** 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	**Task 1:** Writing of Methodology **Task 2:** Writing of Project Plan **Task 3:** Writing of risk Management & Analysis **Task 4:** Writing of impact	**Task 1:** Asif Abdullah Zamee, Md.Toushifur Rahman **Task 2:** Bishwajit Chandra Mozumder, Md.Toushifur Rahman **Task 3:** Md.Tanveer Anjum **Task 4:** Asif Abdullah Zamee Progress: **Task 1:** Completed **Task 2:** In progress **Task 3:** Completed **Task 4:** Completed	
28.03.2024 **FYDP Class 8** (In person)	**Faculty Member:** Mohaimenul Islam **Students:** 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman (Absent due sickness) 4. Md.Tanveer Anjum	1. Overview on Writing and presentation techniques.		
28.03.2024 **ATC Meeting 6** (Online)	**ATC Members:** 1. Prof. Dr. AKM Abdul Malek Azad 2. Md.Rafiqul Islam Rafi 3. Ms. Sabrina Saima	1. Review of project proposal. 2. Review of log book.		1. Correct the errors in the log book.

FYDP (P) Spring 2024 Summary of Team Log Book/ Journal

	Students 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum			2. Remove any extra block diagrams which are not needed. 3. Rewrite reference in IEEE format. 4. Fix paper formatting.
01.04.2024 **Group Meeting 13** (In person)	**Students** 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	**Task 1:** Update the safety consideration. **Task 2:** Update the methodology. **Task 3:** Update the attributes of Complex Engineering Problems. **Task 4:** Update the Project plan.	**Task 1:** Asif Abdullah Zamee **Task 2:** Md.Toushifur Rahman **Task 3:** Md.Tanveer Anjum **Task 4:** Bishwajit Chandra Mozumder Progress: **Task 1:** Completed **Task 2:** In progress **Task 3:** Completed **Task 4:** Completed	
03.04.2024 **Group Meeting 14** (Online)	**Students** 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	**Task 1:** Rewrite reference in IEEE format. **Task 2:** Fix paper formatting. **Task 3:** Update the attributes of Complex Engineering Activities.	**Task 1:** Md.Toushifur Rahman **Task 2:** Md.Toushifur Rahman, Asif Abdullah Zamee **Task 3:** Md.Tanveer Anjum Progress: **Task 1:** Completed **Task 2:** In progress **Task 3:** Completed	
04.04.2024 **ATC Meeting 7** (Online)	**ATC Members:** 1. Prof. Dr. AKM Abdul Malek Azad 2. Md.Rafiqul Islam Rafi 3. Ms. Sabrina Saima	1. Review of project proposal. 2. Review of log book.		1. Rephrase the mentioned incorrect sentences in the paper.

	Students 1. Bishwajit Chandra Mo-zumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum			2. Fix the figure number accord-ingly. 3. Adjust the font size, make it constant. 4. Fix the deci-sion box of the flowchart ac-cording to in-struction. 5. Add a gantt chart for the pro-ject.
16.04.2024 **Group Meeting 15** (Online)	**Students** 1. Bishwajit Chandra Mo-zumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	**Task 1:** Update of the Problem Statement and background re-search. **Task 2:** Update of the project plan. **Task 3:** Fix paper formatting. **Task 4:** Update of the risk management with proper reference.	**Task 1:** Bishwajit Chandra Mo-zumder **Task 2:** Bishwajit Chandra Mo-zumder **Task 3:** Md.Toushifur Rah-man, Asif Abdul-lah Zamee **Task 4:** Md.Tan-veer Anjum Progress: **Task 1:** Completed **Task 2:** Completed **Task 3:** Completed **Task 4:** Completed	
17.04.2024 **ATC Meeting 8** (Online)	**ATC Members:** 1. Prof. Dr. AKM Abdul Malek Azad 2. Md.Rafiqul Islam Rafi 3. Ms. Sabrina Saima (Absent) **Students**	1. Review of project proposal. 2. Review of log book.		1.Prepare for the mock presenta-tion. 2. Prepare slides for the final presentation.

	1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum			3. Fix grammatical errors in the project proposal. 4. Fix references in the project proposal.
21.04.2024 **Group Meeting 16** (Online)	**Students** 1. Bishwajit Chandra Mozumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	**Task 1:** Start preparation of slides. **Task 2:** Update of the budget.	**Task 1:** Everyone **Task 2:** Asif Abdullah Zamee Progress: **Task 1:** Completed **Task 2:** Completed	
23.04.2024 **Group Meeting 17** (Online)	**Students** 1. Bishwajit Chandra Mozumder (Absent due to unforeseen circumstances) 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	**Task 1:** Addition of risk management in the slide **Task 2:** Update of the diagram. **Task 3:** Addition of system level specification. **Task 4:** Formatting the slides.	**Task 1:** Md.Tanveer Anjum **Task 2:** Md.Toushifur Rahman **Task 3:** Md.Toushifur Rahman, Md.Tanveer Anjum, Asif Abdullah Zamee **Task 4:** Md.Toushifur Rahman, Md.Tanveer, Asif Abdullah Zamee Progress: **Task 1:** Completed **Task 2:** Completed **Task 3:** Completed **Task 4:** Completed	
24.04.2024 **ATC Meeting 9** (Online)	**ATC Members:** 1. Prof. Dr. AKM Abdul Malek Azad 2. Md.Rafiqul Islam Rafi 3. Ms. Sabrina Saima	1. Mock Presentation to the ATC panel		

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	Students 1. Bishwajit Chandra Mo-zumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum			
27.04.2024 **Group Meeting 18** (Online)	**Students** 1. Bishwajit Chandra Mo-zumder 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	**Task 1:** Update of the System specification **Task 2:** Update of the Budget	**Task 1:** Md.Toushifur Rah-man, Md.Tanveer Anjum **Task 2:** Asif Ab-dullah Zamee Progress: **Task 1:** Completed **Task 2:** Completed	
01.05.2024 **Group Meeting 19** (Online)	**Students** 1. Bishwajit Chandra Mo-zumder (Absent due to un-foreseen circumstances) 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Md.Tanveer Anjum	**Task 1:** Update of the problem statement and background re-search **Task 2:** Correction of the references **Task 3:** Correction of the paper formatting, grammatical errors.	**Task 1:** Md.Tan-veer Anjum **Task 2:** Md.Toushifur Rah-man **Task 3:** Asif Ab-dullah Zamee, Md.Toushifur Rah-man Progress: **Task 1:** Completed **Task 2:** Completed **Task 3:** Completed	

FYDP (D) Summer 2024 Summary of Team Log Book/ Journal

Title: PyroSentry
Advanced RGB Image-Based Fire Localization and Extinguishing Network

Group 3

Final Year Design Project (D) Summer 2024				
Student Details	**NAME**	**ID**	**EMAIL ADDRESS**	**PHONE**
Member 1	Md.Tanveer Anjum	20121048	md.tanveer.anjum@g.bracu.ac.bd	01982599577
Member 2	Asif Abdullah Zamee	20321032	asif.abdullah.zamee@g.bracu.ac.bd	01641640716
Member 3	Md.Toushifur Rahman	20321031	md.toushifur.rahman@g.bracu.ac.bd	01943376994
Member 4	Bishwajit Chandra Mozumder	20321017	bishwajit.chandra.mozumder@g.bracu.ac.bd	01591132927

ATC Details		
ATC 3		
ATC	**Name and Designation**	**Email Address**
Chair	Dr. AKM Abdul Malek Azad Professor, Department of EEE Brac University	a.azad@bracu.ac.bd
Member 1	Ms. Sabrina Saima Lecturer, Department of EEE, Brac University	sabrina.saima@bracu.ac.bd
Member 2	Md. Rafiqul Islam Rafi Lecturer, Department of EEE, Brac University	rafiqul.rafi@bracu.ac.bd

General Notes:

1. In addition to detail journal/logbook fill out the summary/key steps and progress of your work
2. Reflect planning assignments, who has what responsibilities.
3. The logbook should contain all activities performed by the team members (Individual and team activities).

FYDP (D) Summer 2024 Summary of Team Log Book/ Journal

Date/Time/ Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
30.05.2024 **FYDP Class 1** (In Person)	**Faculty Member** Tashfin Mahmud **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Introduction to overall FYDP-D project methods. 2. General guidelines on how to develop and design simulations. 3. Brief on tentative time schedules on FYDP-D and design report writing		
10.06.2024 ATC Meeting 1A (Online)	**ATC Members:** 1. Prof. Dr. AKM Abdul Malek Azad **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Brief on how the FYDP-D curriculum will be held. 2. General guidelines on design report writing 3. Briefing on simulation for 2 design approaches.		1. Categorize all FYDP-D tasks and update gantt chart 2. Start working on the design report.
10.06.2024 ATC Meeting 1B (In Person)	**ATC Members:** 1. Ms. Sabrina Saima **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman(Absent, Unforeseen circumstances) 4. Bishwajit Chandra Mozumder (Absent,Unforeseen circumstances)	1. Fire Detection algorithm demo demonstration 2. Discussion on various approaches on fire detection algorithms.		1. Prepare a fire detection algorithm for design approach 1
13.06.2024 ATC Meeting 1C (In Person)	**ATC Members:** 1. Md.Rafiqul Islam Rafi **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Discussion on project plan. 2. Brief on various fire detection algorithms.		1. Prepare an algorithm for design approach 1
15.06.2024 Group	**Students** 1. Md.Tanveer Anjum	1. Design approach 1 research on algorithms.	**Task 1:** Asif, Bishwajit	

Meeting 1 (Online)	2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	2. Design approach 2 research on algorithms. 3. Gantt chart listing	**Task 2:** Tanveer, Tousif **Task 3:** Bishwajit **Progress:** **Task 1:**In progress **Task 2:**In progress **Task 3:**Completed	
20.06.2024 Group Meeting 2 (Online)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Design approach 1 algorithm coding and training using gray scaling method. 2. Design approach 1 algorithm coding and training using calorimetric method. 3. Design approach 2 coding and training for thermal cameras. 4. Preparation of Gantt chart	**Task 1:** Asif, **Task 2:** Bishwajit **Task 3:** Toushif, Tanveer **Task 4:** Toushif **Progress:** **Task 1:**In progress (lack of datasets) **Task 2:**In progress (Algorithm error) **Task 3:**In progress (Uploaded normal video footage due to lack of thermal camera) **Task 4:** Complete	
21.06.2024 Group Meeting 3 (Online)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Design approach 1 algorithm coding and training using gray scaling method 2. Design approach 1 algorithm coding and training using the calorimetric method. 3. Design approach 2 coding and training for thermal cameras.	**Task 1:** Asif, Toushif, Tanveer, **Task 2:** Bishwajit **Progress:** **Task 1:**In progress (training and finalizing simulation parameters) **Task 2:**In progress (Lack of HRR datasets) **Task 3:**In progress (Uploaded thermal image footage and got around 40% accuracy)	

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22.06.2024 Group Meeting 4 (Online)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Design approach 1 algorithm coding and training using gray scaling method. 2. Design approach 1 algorithm coding and training using the calorimetric method. 3. Design approach 2 coding and training for thermal cameras. 4. Start writing a draft Design report	**Task 1:** Asif **Task 2:** Bishwajit **Task 3:** Toushif, Tanveer **Task 4:** Toushif **Progress:** **Task 1**:In progress (Working on improving accuracy) **Task 2**:In progress (Complicated algorithm structure for detection) **Task 3:**In progress (Uploaded thermal video footage and got around 40% accuracy) **Task 4:** Complete	
24.06.2024 ATC Meeting 2A (Online)	**ATC Members:** 1. Prof. Dr. AKM Abdul Malek Azad **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Review of the logbook 2. Review of design report and gantt chart. 3. Discussions on design approach 1 simulation. 4. Discussion on design approach 2 simulation		1. Update the design report. 2. Include all the research papers in IEEE format. 3. Work on the design approach 1 simulation. 4. Make preparation for the mock presentation.

24.06.2024 ATC Meeting 2B (Online)	**ATC Members:** 1. Ms. Sabrina Saima **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Discussion on design approach 1 gray scale method algorithm and datasets. 2. Discussion on design approach 2 algorithm with thermal camera, accuracy improvements. 3. Guidelines on how to get datasets for the simulation programs.		1. Find datasets for both design approaches. 2. Prepare simulations for both design approaches.
26.06.2024 Group Meeting 5 (In Person)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Design approach 1 algorithm coding and training using gray scaling method. 2. Implementation of design approach 1 in Proteus simulation. 3. Collecting dataset sample from kaggle and roboflow platform 4. Reaching out to authors for dataset access for design approach 1	**Task 1:** Asif **Task 2:** Asif, Toushif **Task 3:** Tanveer **Task 4:** Tousif **Progress:** **Task 1:**In progress **Task 2:**In progress **Task 3:** Complete **Task 4:** Complete	
27.06.2024 ATC Meeting 2C **(**In Person)	**ATC Members:** 1. Md.Rafiqul Islam Rafi **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Discussion on design approach 1 gray scaling method algorithm improvements.		1. Prepare simulation for both design approaches. 2. Start preparing presentation slides for the progress presentation.

FYDP (D) Summer 2024 Summary of Team Log Book/ Journal

30.06.2024 Group Meeting 6 (Online)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Preparation of slides for progress presentations. 2. Making sure that all the PO's are met for the presentation slides 3. Updating design report (Background research, objectives) 4. Update Logbook	**Task 1:** Tanveer, Toushif, Asif **Task 2:** Tanveer **Task 3:** Bishwajit **Task 4:** Tanveer **Progress:** **Task 1:**In progress **Task 2:** Complete **Task 3:** Complete **Task 4:** Complete	
01.07.2024 ATC Meeting 3A (Online)	**ATC Members:** 1. Prof. Dr. AKM Abdul Malek Azad **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Review of design report and the mistakes that can be fixed. 2. Review of logbook. 3. Review of presentation slides and discussion on progress presentation.		1. Highlight the changes made in the design report. 2. Fix the mistakes in the presentation slides addressed in the meeting. 3. Write down all the tasks done by every groupmate 4. Add a screen record of the working design in the presentation slides. 5. Add reference for data privacy.

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01.07.2024 ATC Meeting 3B (In Person)	**ATC Members:** 1. Ms. Sabrina Saima **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Discussion on design approach 1 algorithm progression. 2. Review of presentation slides.		1. Fix the mistakes addressed in the meeting 2. Add more information like video footage of the detection algorithm in the presentation slides. 3. Add a screen record of the working design. 4. Start working on the design approach 2 proteus simulation.
02.07.2024 Group Meeting 7 (Online)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Update presentation slides (Background research,Specification, Design 1 simulation) 2. Redesign proteus simulation for design approach 1. 3. Practice giving the presentation within 8 minutes. 4. Addition of pump motor in the proteus simulation for design approach 1. 5. Screen recording design approach 1 proteus simulation. 6. Screen recording design approach 2 output video footage.	**Task 1:** Bishwajit, Toushif, Tanveer **Task 2:** Asif **Task 3:** Everyone **Task 4:** Toushif **Task 5:** Asif **Task 6:** Toushif **Progress:** **Task 1:** Complete **Task 2:** Complete **Task 3:** Complete **Task 4:** Complete **Task 5:** Complete **Task 6:** Complete	

04.07.2024 FYDP Committee Progress presentation (In Person)	**Faculty member:** 1. Tashfin Mahmud 2. Md. Ehsanul Karim 3. Bristi Das 4. Md. Mahmudul Islam **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Suggested to recheck one of the functional and non-functional requirements. 2. Asked about the purpose of the coordinates aspect of the servo motors. 3. Questioned how was the loss function calculated for the design approach 1 4. How will the object detection procedure work.		
04.06.2024 ATC Meeting 3C (In Person)	**ATC Members:** 1. Md.Rafiqul Islam Rafi **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Discussion on design approach 1 proteus simulation and its working.		1. Start building design approach 2 simulation in proteus. 2. Research how to control servo motors using coordinate systems in proteus simulation.

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<table>
<tr>
<td>07.07.2024
Group
Meeting 8
(Online)</td>
<td>Students
1. Md.Tanveer Anjum
2. Asif Abdullah Zamee
3. Md.Toushifur Rahman
4. Bishwajit Chandra Mo-zumder</td>
<td>1. Design report update (Background Research and Survey, Objectives, alignment changes)

2. Add both design ap-proach simulation re-sults.

3. Research on ethical considerations, safety considerations, and up-dates in the design re-port.

4. Added appropriate references for data pro-tection.

5. Added code for both systems in the appen-dix.

6. Fixing formatting and margin for report.

7. Added selection of modern IT tools.

8. Updated, added and edited table of contents.</td>
<td>Task 1: Bishwajit
Task 2: Asif
Task 3: Tanveer
Task 4: Tanveer
Task 5: Toushif
Task 6: Asif
Task 7: Bishwajit
Task 8: Asif

Progress:

Task 1: Complete
Task 2: Complete
Task 3: Complete
Task 4: Complete
Task 5: Complete
Task 6: Complete
Task 7: Complete
Task 8: Complete</td>
<td></td>
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<tr>
<td>01.09.2024
Group
Meeting 9
(In Person)</td>
<td>Students
1. Md.Tanveer Anjum
2. Asif Abdullah Zamee
3. Md.Toushifur Rahman
4. Bishwajit Chandra Mo-zumder</td>
<td>1. Discuss among team how to restart again.

2. Review our model.</td>
<td>Task: Everyone</td>
<td></td>
</tr>
</table>

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02.09.2024 ATC Meeting 4A (In Person)	**ATC Members:** 1. Prof. Dr. AKM Abdul Malek Azad **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Brief about the future of the project and the scope of improvement.		1. Q1 journal research. 2. Training progress demonstration of both design approaches
04.09.2024 Group Meeting 10 (In Person)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Attain new and improved datasets for design approach 1. 2. Attain new and improved datasets for design approach 2.	**Task 1:** Bishwajit, Asif **Task 2:** Toushif, Tanveer	**Task 1:** In-Progress **Task 2:** In-Progress
05.09.2024 ATC Meeting 4C (In Person)	**ATC Members:** 1. Md.Rafiqul Islam Rafi **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Progress report on the project. 2. Current plan and upcoming plan. 3. Updates on the dataset and training algorithm.		
07.09.2024 Group Meeting 11 (Online)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Train with new datasets for design approach 1. 2. Accuracy improvement of the design approach 2 model. 3. Obtain Q1 Journal Paper.	**Task 1:** Asif **Task 2:** Toushif, Tanveer **Task 3:** Toushif, Bishwajit	**Task 1:** In-Progress **Task 2:** In-Progress **Task 3:** In-Progress

09.09.2024 ATC Meeting 5A (Online)	**ATC Members:** 1. Prof. Dr. AKM Abdul Malek Azad **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. ATC members asked for the report but could not show any update. 2. Discussion on project report, software simulation, and system algorithm.		1. Finish working on both of the design approach algorithms. 2. Update the design reports 3. Fix the mistakes shown in the meeting.
09.09.2024 ATC Meeting 5B	**Discontinuation of ATC member**			
11.09.2024 Group Meeting 10 (In Person)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Design approach 1 training and try to improve accuracy. 2. Design approach 2 tried to integrate gray scaling with thermal feed 3. Update the report with some corrections and new data including: Functional Verification of Multiple Design Solutions, Analyze the Multiple Design Solutions to Find the Optimal Solution	**Task 1:** Asif, **Task 2:** Tanveer, Toushif **Task 3:** Toushif	**Task 1:** In-Progress **Task 2:** In-Progress **Task 3:** In-Progress
12.09.2024 ATC Meeting 5C (In Person)	**ATC Members:** 1. Md.Rafiqul Islam Rafi **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Progress update on design algorithm, codes. 2. Updates on simulation parameters.		1. Start working on proteus design. 2. Update the design report.

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16.09.2024 Group Meeting 11 (Online)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Design approach 1 detection algorithm finalization. 2. Yolov8 architecture training, data collection 3. Design approach 1 model testing. 4. Design approach 2 image processing algorithm finalization. 5. Report updates on cost, efficiency, manufacturing, Impact, sustainability, and maintainability 6. Report update on design approach 2 functional verification of multiple design solutions, graph explanation. 7. Report update on functional verification of multiple design solutions for design approach 1. 8. Gantt chart Update. 9. New component update and camera model correction. 10. Full report update and formatting	**Task 1:** Asif **Task 2:** Asif **Task 3:** Asif **Task 4:** Tanveer, Toushif **Task 5:** Tanveer, Asif, Toushif **Task 6:** Tanveer, Toushif **Task 7:** Zamee **Task 8:** Tanveer, Tousif **Task 9:** Toushif **Task 10:** Toushif **Progress:** **Task 1:**Complete **Task 2:**Complete **Task 3:**Complete **Task 4:**Complete **Task 5:**Complete **Task 6:**Complete **Task 7:**Complete **Task 8:**Complete **Task 9:**Complete **Task 10:**Complete	

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18.09.2024 Group Meeting 12 (In person)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Design approach 1 proteus simulation file update. 2.Design approach 2 proteus simulation file update. 3.Simulation file module download and extraction for both design approach 1 and 2. 4. Design approach 1 proteus circuit design research on components and codes. 5.Design approach 2 proteus simulation components research and codes	**Task 1:** Asif, Bishwajit **Task 2:** Tanveer, Toushif **Task 3:** Asif,Tanveer, Toushif, **Task 4:** Asif, Bishwajit **Task 5:** Tanveer, Toushif **Progress:** **Task 1:** Complete **Task 2:** Complete **Task 3:** Complete **Task 4:** Complete **Task 5:** Complete	
19.09.2024 ATC Meeting 6C (In Person)	**ATC Members:** 1. Md.Rafiqul Islam Rafi **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Discussion on how to add camera module and GSM module with raspberry pi in proteus simulation.		**1.** Update Proteus circuit design figures in design report. 2. Fix servo motor coordination code for the system
22.09.2024 Group Meeting 13 (In person)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1.Design approach 2 algorithm update to run in VS code using webcam. 2.Proteus circuit design for design approach 1 3.Proteus circuit design for design approach design 2. 4.Update slides for presentation. 5.Design report update.	**Task 1:** Tanveer, Toushif **Task 2:** Asif **Task 3**: Toushif, Tanveer **Task 4:** Toushif **Task 5:** Toushif **Task 6:** Bishwajit **Progress:** **Task 1:** Complete **Task 2:** In progress (Error running servo motors)	

		6.Optimal design selection using weights and bias.	**Task 3:**In progress (Fatal simulation encountered while running the proteus file) Error running servo motors) **Task 4:**Complete **Task 5:**Complete **Task 6:**Complete	
23.09.2024 ATC Meeting 6A **(**Online)	**ATC Members:** 1. Prof. Dr. AKM Abdul Malek Azad **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1.Mock presentation of the group 3. 2. Review of the final presentation slides. 3. Review and discussion on the design report.		**1.** Improve the presentation slides formatting. 2. Fix the mistake found in the dataset slide. 3. Finish the presentation in 8 minutes. 4.Fix design report writing mistakes which were pointed out.
24.09.2024 Group Meeting 24 (Online)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1.Update presentation slides. 2. Design approach 2 proteus circuit update. 3. Addition of weights and bias for design approach comparison. 4. Design report format update 5. Report update on modern engineering tools. 6. Report update on new graphs and codes for design approach 1.	**Task 1:** Toushif, Tanveer, Bishwajit **Task 2:** Toushif, Tanveer **Task 3**: Toushif, Asif, Tanveer **Task 4:** Toushif **Task 5:** Asif **Task 6:** Asif, Toushif **Task 7:** Toushif, Tanveer **Task 8:** Tanveer **Progress:** **Task 1:** Complete **Task 2:** Complete **Task 3:** Complete **Task 4:** Complete **Task 5:** Complete	

		7. Report update on design approach 2 result analysis. 8. Final logbook update		
25.09.2024 ATC Meeting 7C (Online)	**ATC Members:** 1. Md.Rafiqul Islam Rafi **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Review of Final presentation slides.		1. Be prepared for all kinds of questions for the presentation. 2.Add a little description under the images of software icons.
26.09.2024 FYDP Committee Progress presentation (In Person)	**Faculty member:** 1. Tashfin Mahmud 2. Md. Ehsanul Karim 3. Bristi Das 4. Md. Mahmudul Islam **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1.Suggested to explain about the project with a more technical approach and more details. 2. For the design approach 1 faculty suggested using more epochs for better accuracy. 3.For detection part faculty suggested adding various fire mitigation methods to make sure fire mitigation is done properly in various situations.		

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Title: PyroSentry
Advanced RGB Image-Based Fire Localization and Extinguishing Network
Group 3

Final Year Design Project (C) Summer 2024				
Student Details	**NAME**	**ID**	**EMAIL ADDRESS**	**PHONE**
Member 1	Md.Tanveer Anjum	20121048	md.tanveer.anjum@g.bracu.ac.bd	01982599577
Member 2	Asif Abdullah Zamee	20321032	asif.abdullah.zamee@g.bracu.ac.bd	01641640716
Member 3	Md.Toushifur Rahman	20321031	md.toushifur.rahman@g.bracu.ac.bd	01943376994
Member 4	Bishwajit Chandra Mozumder	20321017	bishwajit.chandra.mozumder@g.bracu.ac.bd	01591132927

ATC Details		
ATC 3		
ATC	**Name and Designation**	**Email Address**
Chair	Dr. AKM Abdul Malek Azad Professor, Department of EEE, Brac University	a.azad@bracu.ac.bd
Member 1	Md. Rafiqul Islam Rafi Lecturer, Department of EEE, Brac University	rafiqul.rafi@bracu.ac.bd
Member 2	Ihteyaz Aqaeed Avash Lecturer, Department of EEE, Brac University	ihteyaz.avash@bracu.ac.bd

General Notes:

1. In addition to detail journal/logbook fill out the summary/key steps and progress of your work
2. Reflect planning assignments, who has what responsibilities.
3. The logbook should contain all activities performed by the team members (Individual and team activities).

FYDP (C) Summer 2024 Summary of Team Log Book/ Journal

Date/Time/ Place	**Attendee**	**Summary of Meeting Minutes**	**Responsible**	**Comment by ATC**
23.10.2024 **Group** **Meeting 1** (Online)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Purchase of equipment for the FYDP-C project. 2. Discussion onthe FYDP-C project plan. 3. Finalizing decision for Raspberry Pi for storage solution. 4. Start of equipment integration.	**Task 1:** Asif **Task 2:** Asif, Toushif, Tanveer, Bishwajit **Task 3:** Asif, Toushif, Tanveer, Bishwajit **Task 4:** Asif **Progress:** **Task 1:**In progress **Task 2:**Complete **Task 3:** Complete **Task 4:** Complete	
29.10.2024 **Group** **Meeting 2** (In Person)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Lab slot book for the project. 2. Discuss various parameters for the project station with the lab assistant.	**Task 1:** Asif, Toushif, Tanveer **Task 2:** Asif, Bishwajit, Toushif, Tanveer. **Progress:** **Task 1:**Complete **Task 2:** Complete	

FYDP (C) Summer 2024 Summary of Team Log Book/ Journal

03.11.2024 **Group** **Meeting 3** (Online)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Start writing the logbook for FYDP-C. 2. Start writing the FYDP report. 3. Research on web app development. 4. AL293D and Arduino integration.	**Task 1:**Tanveer **Task 2:** Toushif, Bishwajit **Task 3:** Asif, Bishwajit **Task 4:** Asif **Progress:** **Task 1:** Complete **Task 2:** Complete **Task 3:** Complete **Task 4:** Complete	
07.11.2024 **FYDP** **Class 1** (In Person)	**FacultyMember** 1. Abu S.M. Mohsin, PhD **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Introduction to overall FYDP-C project methods. 2. General guidelines on how to develop the project according to the suggestions of stakeholders. 3. Discussion on the project showcase and presentation procedure. 4. Brief on how to write the FYDP-C report. 5. Discuss how to maintain the COs and POs for the project.		

		6. Guidelines on Submission format for the FYDP-C report and the plagiarism rate (which should be under 35%).		
10.11.2024 **ATC** **Meeting 1C** (In Person)	**ATC Members:** 1. Ihteyaz Aqaeed Avash **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Brief on how the FYDP-P and FYDP-D curriculum were held.		1. Upload a drive folder containing FYDP-P, FYDP-D documents and research files
11.11.2024 **ATC** **Meeting 1A** (Online)	**ATC Members:** 1. Prof. Dr. AKM Abdul Malek Azad **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Brief on how the FYDP-C curriculum will be held. 2. General guidelines on FYDP-C Final report writing.		1. Fix the logbook error mentioned in the meeting. 2. Order all the components needed for the project. 3. Take a video of hardware work for evidence 4. Start preparing slides for the mock presentation.

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13.11.2024 **Group** **Meeting 4** (In Person)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Report writing on introduction, relevance to current and future industry. 2. Review of journals and articles, finding new relevant papers. 3. Background research on detection and mitigation systems. 4. Report writing on problem statements, background study, and literature gap. 5. Report writing on objectives, requirements, specifications, and constant, systematic overview for design approaches 1, 2, ethics statement, conclusion 6. Report writing on use of modern engineering and IT tools. 7. Developing code for object tracking	**Task 1**: Bishwajit **Task 2:** Bishwajit **Task 3:** Tanveer **Task 4:** Tanveer **Task 5:** Toushif **Task 6:** Asif **Task 7:** Asif **Task 8:** Asif **Progress:** **Task 1:** Complete **Task 2:** Complete **Task 3:** Complete **Task 4:** Complete **Task 5:** Complete **Task 6:** Complete **Task 7:** Complete **Task 8:** Complete	

		8. Building object tracking using webcam 8. Building object tracking using webcam		
14.11.2024 **ATC** **Meeting 1B** (In Person)	**ATC Members:** 1. Md.Rafiqul Islam Rafi **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Discussion on FYDP-C final report writing. 2. Brief on how to make the slides for the presentation. 3. Suggestion on how to manage the rotation of the servo mechanism by shifting coordinates.		1. Start preparing slides for the presentation. 2. Keep working on the servo mechanism according to the suggestion.
16.11.2024 **Group** **Meeting 5** (Online)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Report writing on project design approach, introduction , identify multiple design approaches design approach 1, design approach 2, conclusion. 2. Attach analysis of multiple design approaches, optimization of multiple designs, and finding the optimal solution topics from the previous report.	**Task 1**: Tanveer **Task 2:** Tanveer **Task 3:** Toushif **Task 4:** Toushif **Task 5:** Toushif **Task 6:** Asif **Task 7:** Asif **Task 8:** Toushif, Bishwajit, Tanveer **Progress:** **Task 1:** Complete **Task 2:** Complete **Task 3:** Complete	

		3. Attach impact analysis and project sustainability topics from the previous report. 4. Attach engineering project management topics, updated graphical aspect of Gantt chart graph for FYDP-C 5. Update budget for design approach 1 6. Initiate a trial run on servo control systems. 7. Hardware implementation of servo and MCU with power supply. 8. Add 5 new sources and update the references accordingly.	**Task 4:** Complete **Task 5:** Complete **Task 6:** Complete **Task 7:** Complete **Task 8:** Complete	
17.11.2024 **ATC Meeting 2C** (In Person)	**ATC Members:** 1. Ihteyaz Aqaeed Avash **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman	1. Discussion on FYDP progress presentation slides, and how to improve some of the parts in slides.		1. Try and find out what is the reason behind the servo jitter. 2. Improve the slides according to instructions

	4. Bishwajit Chandra Mozumder	2. Discussion on how to stabilize the servo jitter.		
18.11.2024 **ATC** **Meeting 2A** (Online)	**ATC Members:** 1. Prof. Dr. AKM Abdul Malek Azad **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Review of FYDP progress presentation slides. 2. Review and discussion on the FYDP report. 3. Progress showcase via recorded video how the servo is working.		1. Fix the grammatical mistakes mentioned in the logbook. 2. Write some description under the pictures in the slides. 3. Properly label all the components within the pictures in the slides. 4. Add video evidence of the progress and include it in the slides. 5. Find out why the servo jitters so much and fix it 6. Add the conclusion and future work to the slides. 7. Start setting up the water mitigation mechanism.

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20.11.2024 **Group Meeting 6** (Online)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Add video progress to the slides. 2. Add a description under the pictures. 3. Add picture labels for all the pictures. 4. Add the conclusion and future work in the slides. 5. Update slide structure. 6. Add a risk management matrix. 7. Update system-level configuration.	**Task 1**: Asif **Task 2:** Toushif **Task 3:** Toushif **Task 4:** Tanveer **Task 5:** Asif, Bishwajit, Toushif, Tanveer **Task 6:** Bishwajit **Task 7:** Toushif, Tanveer **Progress:** **Task 1:** Complete **Task 2:** Complete **Task 3:** Complete **Task 4:** Complete **Task 5:** Complete **Task 6:** Complete **Task 7:** Complete	
21.11.2024 **FYDP Committee Progress presentation** (In Person)	**Faculty member:** 1. Abu S.M. Mohsin 2. Ihteyaz Aqaeed Avash 3. Bristi Das 4. Nahid Akhter Jahan 5. Mohammed Thushar Imran. **Students**	1. FYDP committee suggested to mention that the project is for commercial space. 2. Ensure that the fire detection algorithm is capable of accurately detecting fire under		

	1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	various lighting conditions. 3. Add a more diverse dataset that includes various fire environments to improve the algorithm's ability to detect fire accurately. 4. Questioned if the algorithm can distinguish between intentional fire and accidental fire.		
21.11.2024 **ATC** **Meeting 2B** (In Person)	**ATC Members:** 1. Md.Rafiqul Islam Rafi **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Discussion on how the overall FYDP progress presentation went.		1. Begin working on the PCB design for the project
01.12.2024 **ATC** **Meeting 3C** (In Person)	**ATC Members:** 1. Ihteyaz Aqaeed Avash **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee (Absent due to sickness) 3. Md.Toushifur Rahman	1. Discussion on the overall progress of the FYDP. 2. Review of a solution to resolve the jitter problem affecting the servo.		2. Start setting up the water mechanism to mitigate fire.

	4. Bishwajit Chandra Mozumder (Absent due to sickness)			
01.12.2024 **Group** **Meeting 7** (Online)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Report writing on assessing the impact of the solution. 2. Report writing on evaluating the sustainability, conclusion 3. Report formatting 4. Fix the jitter problem by implementing a dedicated servo driver. 5. Report writing on evaluating project progress, conclusion 6. Report writing on cost-benefit analysis 7. Report writing on technical and non-technical considerations and	**Task 1:** Toushif **Task 2:** Tanveer **Task 3:** Toushif **Task 4:** Asif **Task 5:** Tanveer, Asif **Task 6:** Bishwajit **Task 7:** Bishwajit **Task 8:** Asif **Task 9:** Bishwajit **Task 10:** Tanveer **Progress:** **Task 1:** Complete **Task 2:** Complete **Task 3:** Complete **Task 4:** Complete **Task 5:** Complete **Task 6:** Complete **Task 7:** Complete **Task 8:** Complete **Task 9:** Complete	

		constraints in the design process. 8. Change the method of servo handling by enabling proper serial communication. 9. Research on mobile app development for streaming and alert texting. 10. Logbook update	**Task 10:** Complete	
02.12.2024 **ATC** **Meeting 3A** (Online)	**ATC Members:** 1. Prof. Dr. AKM Abdul Malek Azad **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Review and discussion on the FYDP report. 2. Review of the logbook.		1.Highlight all the new points written in the report and logbook. 2. Write a description for the figure 2,4. 3. Show project progress to ATC members in the FYDP lab if available. 4. Start working on the PCB design for the project

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04.12.2024 **Group** **Meeting 8** (In person)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Purchase a pump and other necessary components for the mitigation subsystem. 2. Resolution factor re-calibration for reduced delay. 3. Perform a trial test of the servo subsystem for the mitigation system. 4. Test the pump's performance for the mitigation subsystem	**Task 1:** Toushif, Tanveer, Bishwajit, Asif **Task 2:** Bishwajit, Asif **Task 3:** Toushif, Asif, Tanveer **Task 4:** Toushif, Tanveer, Bishwajit, Asif **Progress:** **Task 1:** Complete **Task 2:** Complete **Task 3:** Complete **Task 4:** Complete	
05.12.2024 **ATC** **Meeting 3B** (In Person)	**ATC Members:** 1. Md.Rafiqul Islam Rafi **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Discussion on how the water pressure is being controlled. 2. Discussion on the specification of the pump..		1. Adjust the water pressure according to the specification.

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08.12.2024 **ATC** **Meeting 4C** (In Person)	**ATC Members:** 1. Ihteyaz Aqaeed Avash **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman (Absent due to injury) 4. Bishwajit Chandra Mozumder	1. Update on the overall progress of the project so far.		1. Integrate all subsystems and complete the prototype before the next meeting.
08.12.2024 **Group** **Meeting 9** (Online)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Shifting MCU from micro SD to SSD. 2. Mitigation system trial and error. 3. Code fine-tuning for the mitigation algorithm. 4. Report writing on Economic Analysis 5. Start drafting on completion of final design and validation. 6. Layout design for the final prototype. 7. Update the logbook	**Task 1:** Asif **Task 2:** Toushif, Tanveer, Bishwajit, Asif **Task 3:** Asif **Task 4:** Toushif, Tanveer, **Task 5:** Toushif, Bishwajit **Task 6:** Toushif **Task 7:** Toushif, Tanveer, Bishwajit **Progress:** **Task 1:** Complete **Task 2:** Complete **Task 3:** Complete **Task 4:** Complete **Task 5:** Complete **Task 6:** Complete **Task 7:** Complete	

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09.12.2024 **ATC** **Meeting 4A** (Online)	**ATC Members:** 1. Prof. Dr. AKM Abdul Malek Azad **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Review and discussion on the FYDP report. 2. Review of the logbook.		**1.** Make the PCB design for the circuit. 2. Highlight the updated written part and keep the previous updated highlight.
11.12.2024 **Group** **Meeting 10** (In person)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Faced serial monitor data read error after simulating the YOLOv8s model in SSD. 2. Mount the servo on the top surface. 3. Report writing on engineering project management (introduction, conclusion). 4. Report writing on ethics and professional responsibilities (introduction, identify ethical issues and professional responsibility).	**Task 1:** Asif **Task 2:** Toushif, Asif **Task 3:** Toushif, Bishwajit **Task 4:** Toushif, Tanveer, **Progress:** **Task 1:** Complete **Task 2:** Complete **Task 3:** Complete **Task 4:** Complete	

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12.12.2024 **ATC** **Meeting 4B** (In Person)	**ATC Members:** 1. Md.Rafiqul Islam Rafi **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Update on the overall progress of the project.		1. Latency problem of the system is not a major issue and keep building the subsystems along with the pcb.
15.12.2024 **ATC** **Meeting 5C** (In Person)	**ATC Members:** 1. Ihteyaz Aqaeed Avash **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Update on the overall progress of the project. 2. Discussion on PCB printing		1. If the latency of the system can not be fixed then use the older approach using the SD card.
15.12.2024 **Group** **Meeting 11** (Online)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Update report on completion of final design. 2. Format the report according to instructions. 3. Include additional code to run the servo in the report. 4. Research on PCB design for the system layout.	**Task 1:** Toushif, Bishwajit **Task 2:** Toushif **Task 3:** Bishwajit **Task 4:** Tanveer, Asif **Task 5:** Tanveer, Asif **Task 6:** Bishwajit, Toushif, Tanveer **Progress:**	

		5. PCB design and gerber file creation for the system. 6. Update the logbook	**Task 1:** Complete **Task 2:** Complete **Task 3:** Complete **Task 4:** Complete **Task 5:** Complete **Task 6:** Complete	
16.12.2024 **ATC** **Meeting 5A** (Online)	**ATC Members:** 1. Prof. Dr. AKM Abdul Malek Azad **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Review and discussion on the FYDP report. 2. Review of the logbook.		1. Fix the spelling mistake in the logbook 2. Fix the keywords in the report. 3. Fix the figure numbers and report format 4. Change the introduction in 7.1 5. Add a description in the 2.4 table 6. Try to reduce subsystem latency.
17.12.2024 **Group** **Meeting 12** (Online)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Updated 2.4 table descriptions for design approaches 1 and 2. 2. Updated the keywords in the report.	**Task 1:** Toushif **Task 2:** Tanveer **Task 3:** Bishwajit **Task 4:** Asif, Tanveer **Task 5:** Asif **Progress:**	

		3. Report writing on chapter 9 (apply ethical issues and professional responsibility, conclusion) 4. Updated the technical details under chapter 4 and introduction under chapter 5 5. Fixed latency issue of the system using NCNN architecture.	**Task 1:** Complete **Task 2:** Complete **Task 3:** Complete **Task 4:** Complete **Task 5:** Complete	
18.12.2024 **Group** **Meeting 13** (In person)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Purchased a PVC board to construct the base structure of the project. 2. Measured the PVC board to accurately construct the outer layout. 3. Purchased necessary tools to build the structure. 4. Constructed the outer framework of the project.	**Task 1:** Toushif, Tanveer, Asif, Bishwajit **Task 2:** Toushif, Asif **Task 3:** Bishwajit, Asif, Toushif, Tanveer **Task 4:** Asif, Toushif, Bishwajit, Tanveer **Progress:** **Task 1:** Complete **Task 2:** Complete **Task 3:** Complete **Task 4:** Complete	

19.12.2024 **ATC** **Meeting 5B** (In Person)	**ATC Members:** 1. Md.Rafiqul Islam Rafi **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Discussion on the overall project progress.		1. Make sure the camera is positioned for optimal coverage. 2. Ensure that no components are damaged during the fire ignition process
22.12.2024 **Group** **Meeting 14** (In person)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Designed and built the mounting mechanism for the camera. 2. Constructed a mechanism to securely mount the servo. 3. Positioned and adjusted the servo and camera within the structure layout. 4. Revised the PCB design file and placed the order. 5. Developed a mobile notification system using Pushbullet for real-time alerts.	**Task 1:** Toushif, Tanveer **Task 2:** Asif, Toushif **Task 3:** Bishwajit, Asif **Task 4:** Toushif, Tanveer **Task 5:** Asif, Bishwajit **Progress:** **Task 1:** Complete **Task 2:** Complete **Task 3:** Complete **Task 4:** Complete **Task 5:** Complete	

FYDP (C) Summer 2024 Summary of Team Log Book/ Journal

22.12.2024 ATC Meeting 6C (In Person)	**ATC Members:** 1. Ihteyaz Aqaeed Avash **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahmpan 4. Bishwajit Chandra Mozumder	1. Demonstration of the overall project progress to the ATC panel.		1. Implement the water drainage system by next week 2. Integrate the water tank into the overall project structure. 3. Assemble the mounting mechanism in the overall structure.
23.12.2024 ATC Mee-ing 6A	**ATC Members:** **1.** Prof. Dr. AKM Abdul Malek Azad **Students** **1.** Md.Tanveer Anjum **2.** Asif Abdullah Zamee **3.** Md.Toushifur Rahman **4.** Bishwajit Chandra Mozumder	1. Review and discussion on the FYDP report. 2. Review of the logbook.		1. Improve the key-word of the report 2. On page 17 re-move design 1 and design 2 subtitles. 3. Address the er-rors mentioned in the discussion within the report. 4. Build the drain-age system and the water tank system by next week.
24.12.2024 Group Meeting 15 (Online)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Update Ethics and Professional Responsibilities. 2. Add PCB de-scription under the PCB design sec-tion. 3. Update tech-nical details (la-tency mitigation procedure) 4. Update the completion of the	**Task 1:** Bishwajit **Task 2:** Tanveer **Task 3:** Asif **Task 4:** Toushif **Task 5:** Tanveer **Task 6:** Asif **Task 7:** Toushif **Progress:**	

		final design section of the report. 5. Update keywords in the report 6. Add water drainage system description. 7. Add water reserve tank description.	**Task 1:** Complete **Task 2:** Complete **Task 3:** Complete **Task 4:** Complete **Task 5:** Complete **Task 6:** Complete **Task 7:** Complete	
29.12.2024 Group Meeting 16 (In person)	**Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Modeling and implementation of the water reserve tank. 2. Installation of the camera and the servo motors 3. Adjusting camera angle for proper viewing coverage. 4. Redesigning the surface into a slanted slope to make water disposal easier.	**Task 1:** Tanveer, Asif **Task 2:** Toushif, Bishwajit **Task 3:** Bishwajit, Asif **Task 4:** Toushif, Tanveer **Progress:** **Task 1:** Complete **Task 2:** Complete **Task 3:** Complete **Task 4:** Complete	
29.12.2024 ATC Meeting 7C (In Person)	**ATC Members:** 1. Ihteyaz Aqaeed Avash **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Review of the overall progress of the project.		1. Conduct a primary test of the whole system within next week.

30.12.2024 ATC Meeting 7A (Online)	**ATC Members:** 1. Prof. Dr. AKM Abdul Malek Azad **Students** 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Review and discussion on the FYDP report. 2. Review of the logbook. 3. Discussion on how to prepare the poster for the final demonstration		1. Start writing the poster. 2. Prepare the prototype by 6th January 3. Fix the description for the PCB design 4 . Complete the report and do a similarity check after the demonstration 5. Make a video of the prototype and keep it running in a loop format in the final demonstration. 6. Make the figures in the report more clear. 7. Fix the errors made in the report mentioned in the meeting. 8. Send the final report to the ATC for final feedback 9. Send the final report to the library for a similarity check.
2.1.2025 Group Meeting 17 (In person)	**Students** **1. Md.Tanveer Anjum** **2. Asif Abdullah Zamee** **3. Md.Toushifur Rahman**	1. Start writing the poster 2. Connect the servo mechanism with the pump subsystem	**Task 1:** Tanveer, Bishwajit **Task 2:** Asif, Bishwajit **Task 3:** Toushif, Tanveer	

	4. Bishwajit Chandra Mozumder	3. Finish preparing the enclosure for the whole system.	**Progress:** **Task 1:** Complete **Task 2:** Complete **Task 3:** Complete	
4.1.2025 Group Meeting 18 (In person)	Students 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Connect the main control unit and check the whole connection. 2. Paint the enclosure alongside other components. 3. Make a small enclosure to put the main control unit in it 4. Perform a trial run of the whole system.	**Task 1:** Tanveer, Asif **Task 2:** Toushif, Bishwajit **Task 3:** Toushif **Task 4:** Asif. Toushif, Tanveer, Bishwajit **Progress:** **Task 1:** Complete **Task 2:** Complete **Task 3:** Complete **Task 4:** Complete	
6.1.2025 **Group** **Meeting 18** (Online)	Students 1. Md.Tanveer Anjum 2. Asif Abdullah Zamee 3. Md.Toushifur Rahman 4. Bishwajit Chandra Mozumder	1. Make a website for the project to show details about the project with a QR code. 2. Take a picture of the project components and make a video of the whole project.	**Task 1**: Toushif, Asif **Task 2**: Asif, Bishwajit **Task 3**: Bishwajit, Toushif **Task 4:** Toushif, Tanveer **Task 5:** Tanveer	

		3. Complete writing chapter 4.5 (performance evaluation of developed solution) and chapter 4 conclusion. 4. Complete writing chapter 5.3 (Evaluate the solution to meet desired need) 5. Update the PCB description 6. Make 1 hard copy of the book to show during the project showcase. 7. Make extra copies of the poster using A4 paper to distribute while the project is shown.	**Task 6**: Bishwajit, Toushif **Task 7:** Bishwajit, Toushif Progress: **Task 1**: Complete **Task 2**: Complete **Task 3**: Complete **Task 4**: Complete **Task 5**: Complete **Task 6:** Complete **Task 7**: Complete	