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Fire and gas leakage alarming system

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Student Name: Himanshu Pandey

London Met ID: 19031311

College ID: NP01NT4A190131

Internal Supervisor: Aaditya khwakhwali

External Supervisor: Bijay Limbu Senihang

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I confirm that I understand my coursework needs to be submitted online via Google Classroom under the relevant module page before the deadline in order for my assignment to be accepted and marked. I am fully aware that late submissions will be treated as non-submission and a mark of zero will be awarded.

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1. Introduction

Today, our lives are enriched by smartphones, smart devices, and the internet of things because they make our lives more convenient and enjoyable. The IoT has revolutionized everything. As a new generation grows up, anything is just a click away and even the most important job seems "magical" due to the overuse of smart devices. IoT (Internet of Things) is generally defined as any device that connects to the internet and can record specific data and send it to a central location or device for further analysis. The used sensors can record audio, video, temperature, location data, etc. Today, driverless cars and home appliances are the main applications of IoT.

The usage of sensors in buildings could be the most prominent application of IoT in the field of fire safety. The collecting of atmospheric data using sensors could be the foundation for improving human approaches to fire prevention, firefighting, and ultimately lifesaving. Many homes and businesses now have sophisticated fire alarm systems installed. They use a series of sensors and cutting-edge technology to quickly detect fires, and in many cases, they are designed to quickly notify authorities of the presence of a fire. The Fire Alarm System was designed to alert us in the case of a fire in order to protect ourselves, our employees, and the general public. (Dumlao, sep 2016)

1.1. Problem Statements

As one of South Asia's rapidly urbanizing countries, Nepal lacks adequate plans. Cities are being built without regard to disaster protection and risk management. Among disasters that have occurred in the resident area, fires have been recognized as a dangerous catastrophe that could lead to property damage and death. A fire has been

the most common, destructive and most powerful disaster in many disasters. Urban construction has increased the risk of the occurrence of major fires and other special disasters year after year. In Nepal, fire is a frequent danger, one that takes a heavy toll on life and property. When people lose their homes, their primary assets, and their valued assets, they frequently collapse into poverty. In the inner-city areas of growing cities, where houses are old, made of wooden joists, and located in close proximity, fires have a higher risk of becoming dangerous. Fire quickly jumps from house to house, spreads rapidly, and destroys entire settlements in such homes.

Various types of fires are responsible for huge losses and destruction each year. According to Ministry of Home Affairs data from 1971 to 2018, there were 12,694 fire occurrences in the last 50 years, killing 1,755 individuals and injuring 2,176 others, damaging 265,962 households and destroying 90,044 properties.

In the year 2018 alone 87 people were killed and 342 wounded in 2,478 accidents involving fires. In addition, 1,857 houses have been demolished and 291 damaged, resulting in a financial loss of about 3.96 billion. The estimated property losses associated with climate-induced disasters amounted to approximately NPR 6.84 billion, and about 94 per cent of these losses can be attributed to fire events. (Gautam, 2021)

The database produced by the Ministry of Home Affairs for 2017-2018 reveals that flood, fire, lightning and landslides are major disasters in terms of number of disaster records.

Damage and losses of disaster incidents										
S.No.	Incident	No. of Incidents	Dead *			Injured	Affected Family	Houses Destroyed		Estimated Losses (NPR)
			Male	Female	Total			Partial	Complete	
1	Flood	418	128	55	183	61	16196	14424	286	60,944,400
2	Landslide	483	96	65	161	182	1083	149	328	191,662,000
3	Lightning	432	87	72	160	551	618	23	14	14,687,000
4	Fire	3973	74	76	150	557	6027	549	3234	6,422,638,013
5	Cold Wave	48	26	22	48	0	48	0	0	-
6	High Altitude	45	37	4	41	6	46	0	0	-
7	Heavy Rainfall	342	8	22	30	84	538	193	252	89,415,160
8	Animal Terror	141	14	8	22	69	280	136	8	4,390,150
9	Wind storm	254	7	12	19	84	1527	763	301	51,447,998
10	Boat Capsize	10	9	7	16	9	27	0	0	-
11	Epidemic	22	11	4	15	1881	420	0	0	-
12	Snake Bite	18	7	7	14	5	18	0	0	-
13	Snow Storm	2	10	0	10	0	10	0	0	-
14	Avalanche	1	1	0	1	0	1	0	0	-
15	Hailstone	3	0	0	0	0	127	2	0	457,000
16	Other	189	54	45	99	150	289	69	10	3,181,599
		6381	**569**	**399**	**968**	**3639**	**27255**	**16308**	**4433**	**6,838,823,320**

Figure 1 Disaster incidents data from 2017-2018 (Affairs, june 2019)

Figure 2 Estimated economic loss by disaster from 2017-2018 (Affairs, june 2019)

Existing fire alarm systems are costly to maintain and operate because they require skilled personnel. Modern fire alarm systems need a large amount of capital, and most individuals do not want such systems installed in their houses due to their high cost. Traditional fire alarm systems are excellent in preventing fires, but they lack intelligent capability that allows users to be aware of the impacted area without having to physically be present in the building. During a fire, a resident's actual presence in the building is not always required. As a result, a device interference is necessary to detect and inform probable fire failures remotely.

1.2 Project as solution

The research study will identify possible solutions to the problem identified in traditional fire alarm systems. We are designing a system that will use easily accessible and inexpensive devices to provide fire detection and alarm systems that can be easily installed indoors, use minimal energy, and require no special skills to operate. **The Fire and gas leakage alarming system** will be developed using a microcontroller and numerous sensing circuits. The proposed system will alert you about a fire outbreak even if you are not inside the house. It will use a GSM module for remote alerting about fire incidents. For detecting fire and gas, it will also use a flame sensor and MQ2 sensor, in addition to the GSM module. Additionally, MQ2 sensors will help to detect L.P.G gas leakage. A buzzer will be connected to the system to alert people via sound. Arduino will be used as a microcontroller for connecting different sensors. As a result of this fire-alarming prototype, the fire authorities will be notified immediately following the outbreak of a fire, which will reduce the reaction time and errors.

2. Aim and Objectives

2.1. Aim

The main aim of this project is to develop Arduino based fire and gas leakage alarming system using a microcontroller, sensing circuits (Flame sensor, MQ2 sensor), LED light, buzzers, and LCD display which will notify the users by sending alert SMS through GSM Module so that certain appropriate steps could be taken in time to mitigate the fire incident and lessen the loss.

2.2. Objectives

The S.M.A.R.T objectives set for this project are:

- **Specific (S):** The traditional fire alarm system prevents fire outages; however, it does not have the intelligent functionality to remotely monitor the affected area without a physical presence. Therefore, I am trying to develop an automated and IoT-based Fire alarming system that can alert about fire breakouts even if no residents are present. This project will require proper planning, research, designing, and testing to finalize the product in time.
- **Measurable (M):** Developing such an IoT-enabled device in both rural and urban locations will assist to reduce the problem of frequent fires and gas leaks. Components such as Arduino, GSM module, flame sensor, buzzer, MQ2 sensors, and software components such as c/c++, MS word, and draw.io will be required to complete the project/product.
- **Achievable (A):** To achieve the aim of the project, a milestone is created to develop the product with ease and within the desired time period implementing a proper/suitable methodology.
- **Relevant (R):** Another goal of the project is to look at the possibilities of the Internet of Things, home automation, and smart gadgets. It will assist in

understanding how IoT projects and devices can be used in the real world and what benefits they can provide in everyday life**.**

- **Time-bound (T):** The project's ultimate goal is to be completed in a short amount of time. The tasks have been assigned and the time has been set aside. Every phase has been planned to fit inside the time limits. Within a year, the project (component gathering, design, testing, and documentation) must be completed. The previously mentioned WBS and Gantt chart were used to manage time and tasks.

3. Expected Outcomes and Deliverables

- As an outcome, the system should be developed using an Arduino, MQ 2 sensor, Flame sensor, buzzer, LCD, and GSM module.
- The System should be able to detect the fire through flame and gas sensors.
- The System should be able to detect the L.P.G gas leakage.
- The System should be able to send alert notifications to respected personnel.
- The System should be able to alert through Buzzer (Sound producing device).
- The System should be flexible and easily operated.

4. Project risks and contingency plans.

4.1. Risk

- The main concern could be a lack of network and electricity.
- Failure and unavailability of Microcontroller (Arduino) and sensing circuits (Flame sensor, MQ2 sensor).
- Misuse of the system due to lack of proper technical knowledge.
- Physical damage to various hardware components such as sensors, led, and so on.

4.2. Contingency Plans

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• Using the Raspberry Pi while the Arduino Uno is unavailable.

• Using the inverter as a backup power source.

• Instead of using the MQ2 sensor, use the MQ135 or MQ6 gas sensor.

• Defending the system against physical threats such as water or theft.

• Proper research on the implementation of the device for avoiding technical failure.

5. Methodology

The development of software projects is one of the most powerful, crucial, and important issues in the computer world. It's a step in the software development process (SDLC). SDLC is all about minimizing risk and failure while maximizing software product quality. Without a step-by-step process to simplify the software development process and execute the software development life cycle consistently, the software development process is extremely difficult. This is an

approach for developing software processes that is both structural and scientific. The SDLC is a structure that defines a series of actions and tasks that must be completed during the software development process. Different software development life-cycle models exist, each with its own set of benefits and downsides in the software development process. (dubay & kumar, aug 2013)

5.1. Types of Methodologies

5.1.1. The waterfall methodology

This model was created by Rolls-Royce in 1970. This is the standard model for software development. The model is an older one that is still utilized by many large organizations and government projects. A linear or classical sequence model is a term used to describe the model. Requirement analysis, design, implementation, testing, and maintenance are the next steps. The phases cannot be repeated in a systematic way every so often. The waterfall model, as represented in the diagram below, incorporates a number of non-overlapping measures. In this methodology, there is no turning back.

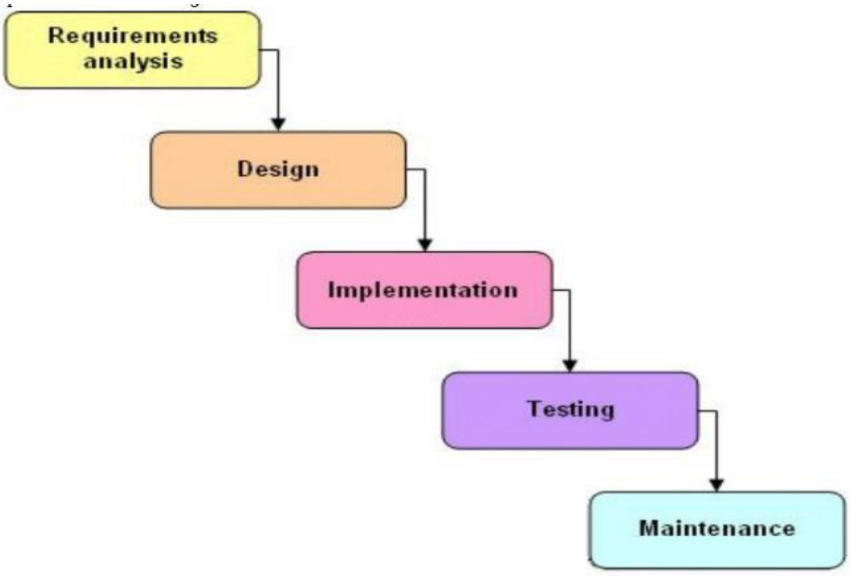


Figure 3 waterfall model (Rather & Bhatnagar, october 2015)

5.1.2. Spiral Methodology

The spiral model, introduced by Barry Boehm, was developed at the end of the 1980s and incorporates risk analysis, which was not included in previous models. Analysis, design, implementation, testing, and deployment are all operations that make up a spiral model. The spiral is applied in a clockwise direction, starting in the middle and working outward, passing through each of the locations listed above.

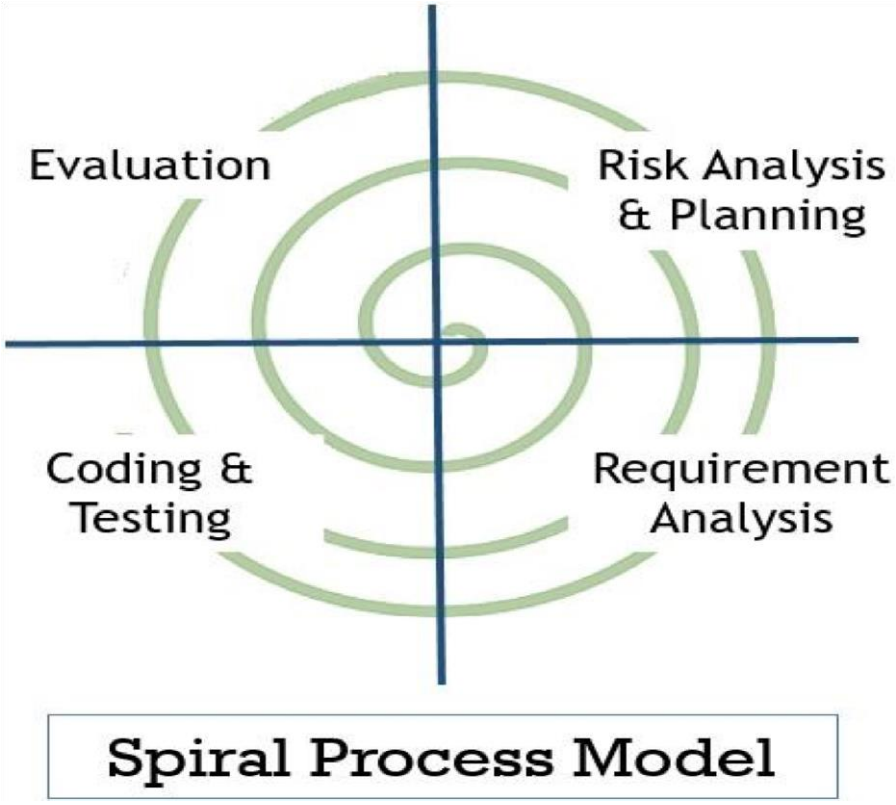


Figure 4 Spiral Model

Draw-backs of Spiral Model:

- May be costly to implement
- Requires a high level of risk analysis skills

- •Not suitable for smaller projects

5.1.3. Agile Model

Agile is a project management methodology that divides a project into multiple phases and requires ongoing communication with stakeholders at all times, as well as continuous development and iteration. Customers describe how to utilize the end product and what problem it will answer as part of the Agile approach. This clarifies the client's requirements to the project team. Once the job begins, teams go through a phase of planning, implementing, and reviewing (HNEIF & HOCK OW, oct, 2009).

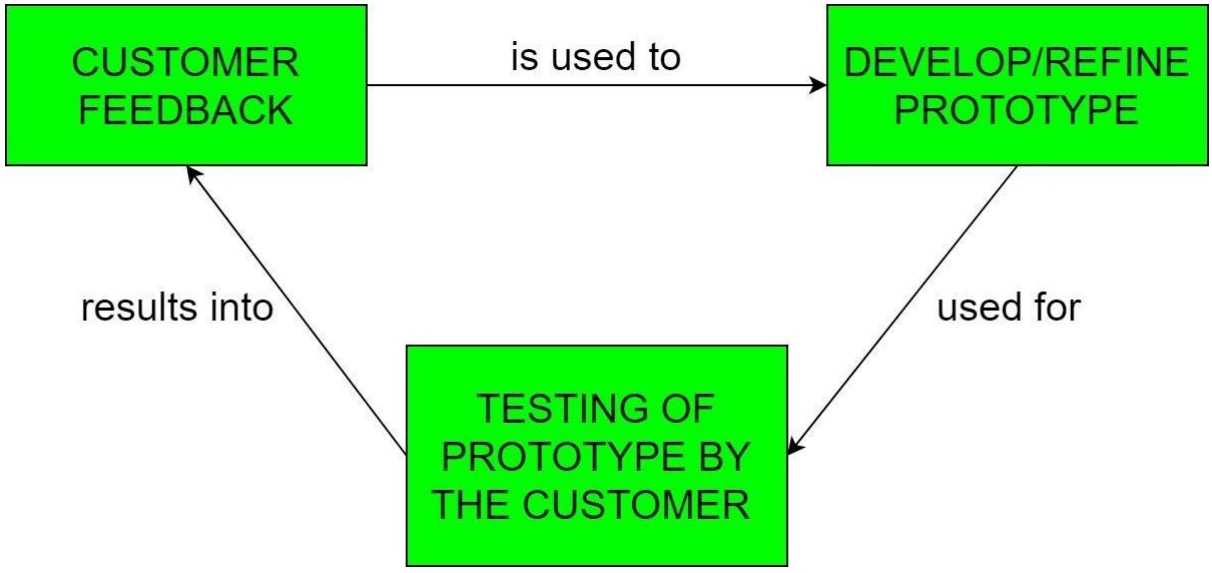
Figure 5 features of agile process

Weakness of agile model:

- There is no preference for thorough documentation, which may cause agile teams to believe that agile does not require documentation;
- The criteria are frequently not crystal clear at the start of projects. Teams may continue to discover that the customer's vision has shifted, in which case they will need to make multiple revisions and will find it difficult to evaluate the end outcome.

5.1.4. Prototyping Methodology

The prototyping model is a software development method in which a prototype is designed, tested, and changed until it is acceptable. It also serves as a foundation for the creation of the final system or program. It's useful in scenarios where the project's specifications aren't fully understood. It is an iterative and trial-and-error process between the developer and the client.



5.2. Selected Methodology

We discussed various software development approaches, including waterfall, spiral, agile, and prototyping. We shall employ the Evolutionary Prototyping Methodology for this project because of its flexibility and advantages. We can't change other software development models if a client or developer wants to change something, but we can adapt the system under the evolutionary prototyping approach based on consumer feedback.

5.2.1. Evolutionary Prototyping

Evolutionary prototyping is a process of software development in which the developer or development team builds a prototype first. After getting early feedback from customers, multiple prototypes are built, each with new features or additions, before the final product is released.

In Evolutionary system architecture is used in the context of a changing environment and dynamic system. First, a prototype with partially known requirements is built. When users interact with the prototype, they have a better understanding of the needs. Then new needs are introduced and implemented. The end result is a system that is always evolving (M.Davis, 1992).

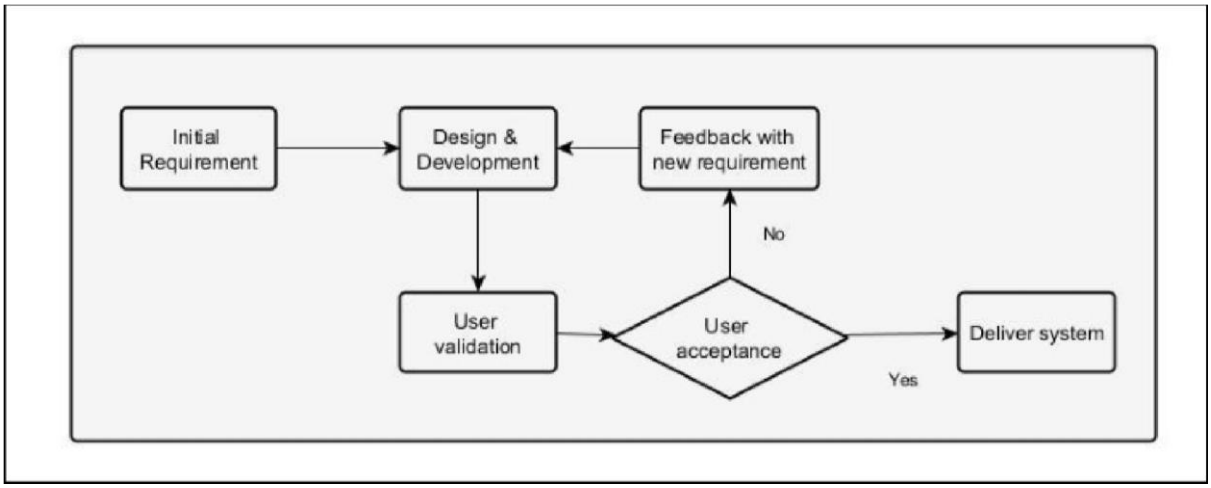


Figure 6 evolutionary prototyping Model

For this project, the Evolutionary Prototyping Model will include the following phases:

- **Identification of initial requirements**: It is the first phase and all the basic needs like hardware are gathered along with the installation of required software. Although we may not be able to know all the requirements because it is a continuous phase, we should be able to identify the basic items that are required for this project to operate.
- **Designing and development of prototype**: An overview design of the project is created in this step to get a quick idea of the project. Additionally. The Development phase is involved with the development of a prototype, which incorporates the system's basic functionality.
- **Prototype verification:** This will be accomplished through surveys and experiments with customers. Customers are the perfect individuals to ask for feedback on whether or not the system is working.
    - **Changes for the prototypes:** When a prototype is found to be adequate or unacceptable, the project team might develop several prototypes until it is improved, based on client feedback.

Changes for the prototypes: When a prototype is found to be adequate or unacceptable, the project team might develop several prototypes until it is improved, based on client feedback.

With this model, processes are created, and customers are continually asked to provide feedback on each of the prototypes they have created throughout the project. This is done to ensure functionality based on the specifications that consumers seek in a product or service.

Advantages of Evolutionary Prototyping methodology are:

- This model is more adaptable than others.
- Errors are easily visible.

- We can easily identify missing features.
- There is opportunity for modification, which means that new requirements can be easily adjusted.
- It can be reused by the developer in the future for more complex projects.
- It ensures a higher level of client satisfaction and comfort.

Disadvantages of Evolutionary Prototyping methodology are:

- It may have poor documentation due to continuously changing customer requirements.
- There may be a massive difference in requirements.
- Sometimes, after seeing an early prototype, customers demand that the final product be delivered as quickly as possible.
- It may be more expensive due to frequent changes and maintenance.

6. Hardware and Software requirements

Different hardware and software are needed for completing this project.

Hardware required

a) Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 pins (6 of which are PWM output), 6 analog inputs, a 16 Mhz crystal quartz, a USB link, a power jack, an ICSP header, and reset buttons. It also has 14 digital output / input pins. It comes with everything you need to assist the microcontroller; simply connect it or power it up with an AC-to-DC adapter or battery to begin working with a device via a USB cable (Joseph, 2021)

Figure 7 Arduino (Joseph, 2021)

It can be programmed using programming languages from Arduino and Arduino Software (IDE). In the project, Arduino acts as the brain, as it will be programmed to track and advise all sensors and analyze the details.

b) Smoke Sensor (MQ2)

The MQ2 gas sensor is an electronic sensor that detects gas concentrations in the air such as LPG, propane, methane, hydrogen, alcohol, smoke, and carbon monoxide. The MQ2 gas sensor is also known as a chemical sensor. It contains a sensing material whose resistance varies as it is exposed to gas. This variation in resistance value will be used to detect gas (ElProCus, 2021).

Figure 8 MQ2 sensor (ElProCus, 2021)

c) Flame Sensor

A flame sensor is a type of detector that detects and responds to the presence of a fire or flame. Otherwise, this sensor detects a flame between 760 nm and 1100 nm from the light source. The sensor's voltage ranges from 3.3 to 5.2 DC volts. In the project, the flame sensor is used to detect a fire breakout.

Figure 9 Flame sensor

d) GSM Module

A GSM modem is a type of modem that accepts a SIM card and, like a mobile phone, operates through a mobile operator subscription. When a GSM modem is connected to a computer, the computer can communicate over the mobile network via the GSM modem. Although these GSM modems are most commonly used to connect to the mobile internet, many of them can also send and receive SMS and MMS messages (nowsms.com, 2021).

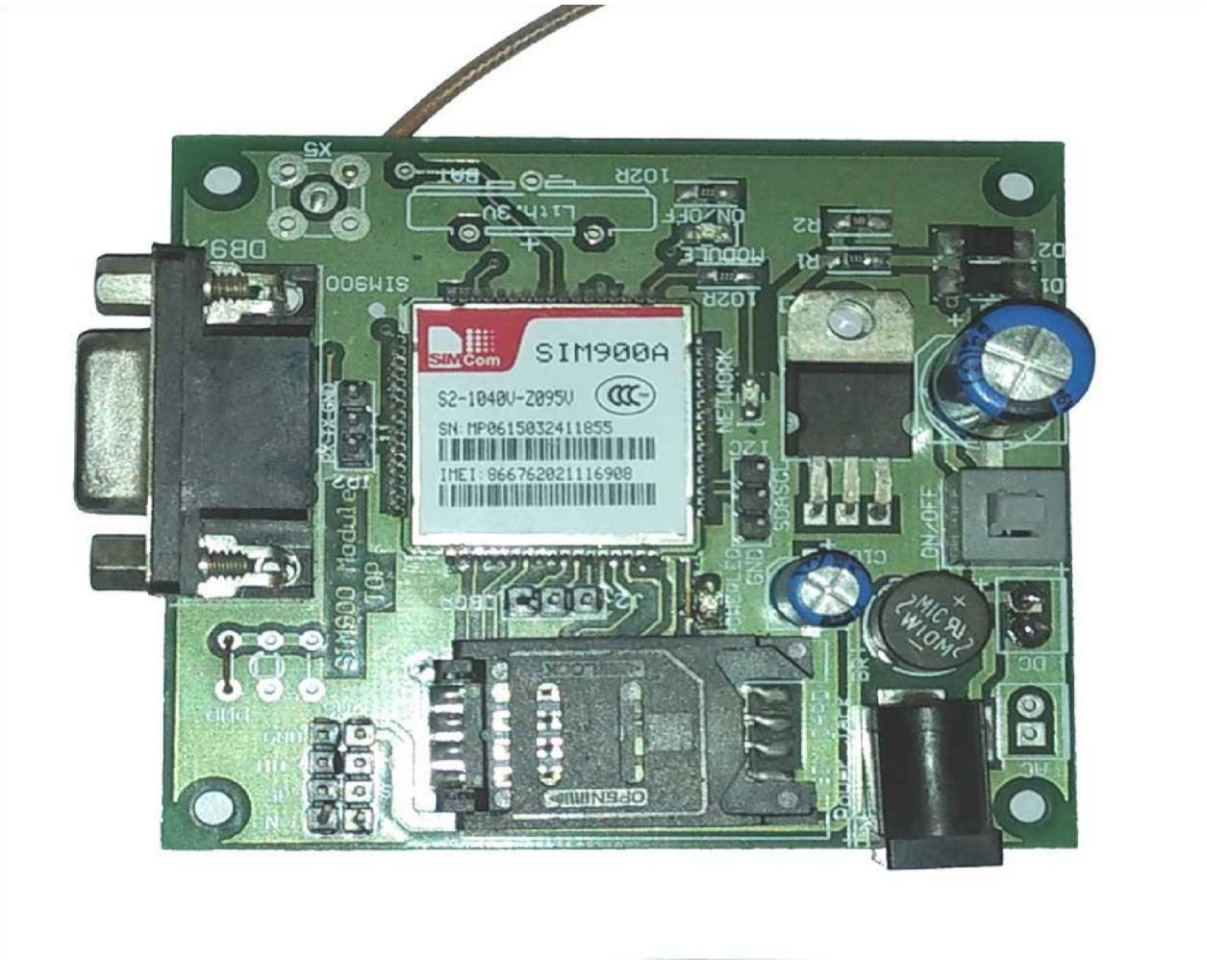


*Figure 10 GSM Module*Figure *(GSM, 2021)*

As the sensor detects the smoke and gas then it activates the pi, which warns the GSM module to send the alert message. To transmit messages, the GSM module uses SIM.

e) LCD Screen

The 14*2 LCD displays will be used in the project to display alert messages in the incident that a fire or smoke break out occurs in the room. The LCD display will be linked to the Arduino.

Figure 11 LCD display

f) Buzzer

The Buzzer is an audio signaling system that can be mechanical, electromechanical, or piezoelectric. The buzzer usually emits sound to alert people to any emergencies. A buzzer is used in this system to alert individuals if the fire and smoke sensor detects fire and gas leakage.

Figure 12 Buzzer (Devices, 2021)

g) LED Light

LEDs are inexpensive, quick, and adaptable, and they produce the best light possible. They can be used for almost any application that requires lighting. The project's lead is used to signal the detection of fire, which is linked to the breadboard. The small prototype is used in the project.

Figure 13 LED Light

h) Breadboard and Jumper wires

Jump wires are electrical wires that connect the breadboard or other test circuit components to the main processing board. The jump wires will be used to connect the sensor to the Arduino and the GSM module in this project. Breadboards are prototyping and electronics construction boards. It acts as a link between the Arduino sensor and the GSM module.

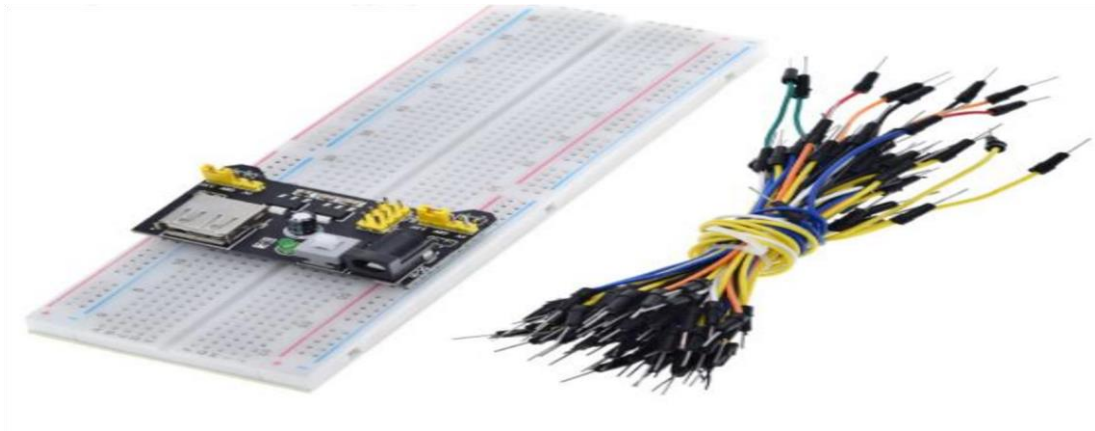


Figure 14 Breadboard

I) Personal Computer

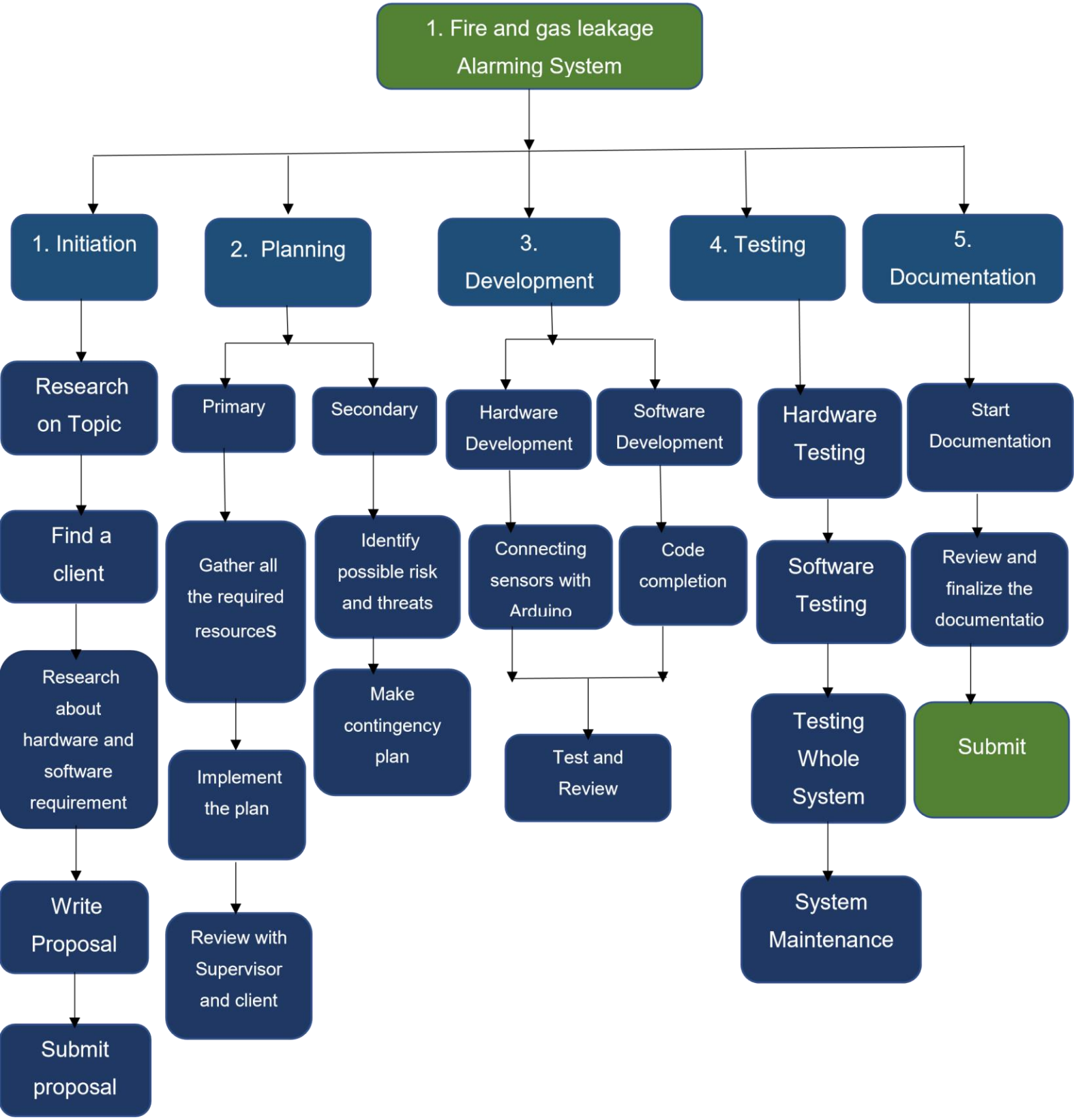
To program the Arduino and for the documentation purpose a desktop computer or Laptop with proper network connection will be required.

Software Required

C++	C++ programming language will be needed to program the proposed system.
Documentation Software	Documentation software like; MS-word, Ms-excel, Draw.io etc. will be required for the documentation process.

7. Work Breakdown Structure

7. Work Breakdown Structure

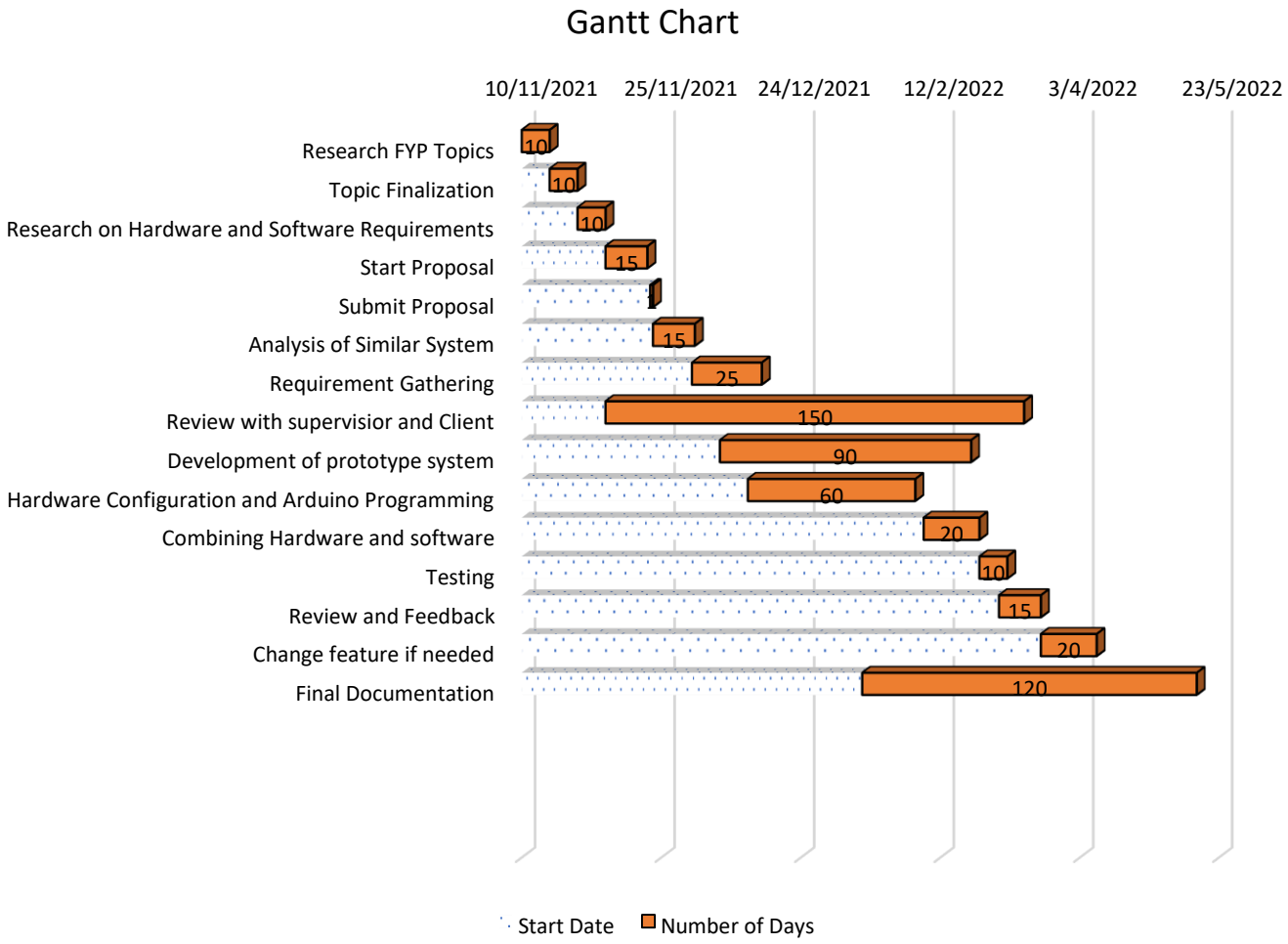


8. Milestones

Milestones	Milestones goals
Research in topic	Completed through research and lessons learned from previous similar projects.
Topic Approval	The main concept and scope of the project were shared with and approved by the supervisor.
Start and Submit Proposal	Project requirement, Previously, similar project problems, goals, and objectives, as well as possible outcomes and data, were illustrated in the proposal.
Requirement Gathering	All of the necessary hardware devices, such as sensors, Arduino, and so on, have been gathered.
Design and development of system	After gathering the required hardware and software, the proposed system is ready for further development.
Combining hardware and software part together	Writing code for various sensors and connecting them to the main microcontroller (Arduino), as well as connecting GSM modules for remote SMS.
Testing	As the System development phase was completed, the system is ready for Testing.

Review	When the testing process is completed successfully, the system is ready for client or supervisor review.
Documentation	Adding extra features and necessary changes have been made as per the recommendation. The Project is ready for documentation.
Submission	The Entire Final report is ready for submission.

9. Gantt Chart



10. Conclusion

Fire outbreak is frequently a relevant threat in residential areas, bringing epidemics and losses that are unexpected and unknown to civilization. This type of life-threatening incident not only destroys physical structures and lives, but it also threatens the social stability of the society. The project was created to provide solutions to the problem of the owner not being present during the fire breakout. Based on the findings of the feasibility study, the fire alarm system is applicable to small-scale housing, industries, and offices where regular fire breakouts occur. The scheme's primary feature is its cost-effectiveness, which can be sold at a low selling price and is intended to provide owners with fire safety. The device can also be used in vehicles, schools, hostels, schools, conference halls, and even industry.

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