IOT BASED INDUSTRIAL LOAD CONTROL AND SAFETY MANAGEMENT

By

Md. Mehedi Hasan
16321131
Shah Rukh Islam
16321133
Yousuf Mohammad
16310002

A project submitted to the Department of Electrical and Electronic Engineering in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering

Department of Electrical and Electronic Engineering
Brac University

January 2022

Declaration

It is hereby declared that

1. The project report submitted is our own original work while completing degree at BracUniversity.
2. The report 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 report does not contain material which has been accepted, or submitted, for anyother degree or diploma at a university or other institution.
4. We have acknowledged all main sources of help.

Student's Full Name & Signature*:*

_____
Md. Mehedi Hasan
16321131

_____
Shah Rukh Islam
16321133

_____
Yousuf Mohammad
16310002

Approval

The project titled "IOT based industrial Load Control and Safety Management"
submitted by

1. Md. Mehedi Hasan (16321131)
2. Shah Rukh Islam (16321133)
3. Yousuf Mohammad (16310002)

of Fall, 2021 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Science in Electrical and Electronic Engineering on 6th January, 2022.

Examining Committee:

Academic Technical Committee: (Chair)

_____
Farzana Shabnam
Senior Lecturer, Department of Electrical and Electronic Engineering
Brac University

Coordination Committee: (Chair)

_____
Abu S. M. Mohsin, PhD
Assistant Professor, Department of Electrical and Electronic Engineering
Brac University

Department Chair: (Chair)

_____
Md. Mosaddequr Rahman, PhD
Professor and Chairperson, Department of Electrical and Electronic Engineering
Brac University

Ethics Statement

We confirm that this project on “IOT based industrial Load Control and Safety Management” has met the project criteria of graduation and this project is absolutely the result of our own efforts instead of any kind of plagiarism. Along with the support of our supervisor and the EEE department, we’ve accomplished the entire project on our own where we have collected some data from other sources which have been properly referenced

Acknowledgement

We would like to extend our sincere gratitude to our ATC Farzana Shabnam, Senior Lecturer, Department of Electrical and Electronics Engineering and Rakibul Hasan, Lecturer, Department of Electrical and Electronics Engineering, BRAC University whose guidance, supervision, excellence and perfection helped us a lot throughout the entire process. Also, we are grateful to BRAC University for giving us the opportunity and all the supportive materials required for the fruitful completion of the project.

Table of Contents

Chapter 1: Introduction

Introduction

The Internet of Things (IoT) is an advanced technology in the IT sector. It provides interworking for numerous devices, such as sensors, actuators, and other electronic embedded smart devices and controls, and various software, and provides network configuration and system connectivity so that communication between many of these devices can exchange information. The IoT is currently characterized by remotely connected sensor devices discovering more functions, providing efficiencies, and structured systems or infrastructure. As IoT enables real-time interconnection between various sensors, PLCs, and other intelligent devices, this technology will, with significant advances, be used in more advanced cyber systems., “such as smart grid, smart vehicle systems, smart medical systems, smart cities, and others smart systems. [1]. IoT technology provides more efficiency in control and monitoring systems in industrial automation. These technologies enable the user to control the devices from remote locations over the internet, cloud, or local area network. Monitoring environmental parameters, such as temperature, humidity and the concentration of toxic gases, in the industrial medium is of great importance for keeping the employees safe and comfortable. Many previously conducted kinds of research have been focusing on developing different hardware and software configurations for industrial environment monitoring and control. For instance, researchers have developed a wireless sensor network (WSN) system for environmental monitoring in an instant coffee factory. [2]. In this paper, we are introducing a project that will provide industrial load control facilities and safety monitoring of industrial areas using sensors and actuators and built a communication medium that will remotely control and monitor the whole project from any place in the world.

Problem statement

Automation is one of the growing needs in industries as well as household applications. This reduces human effort by replacing them with autonomous systems. The Internet is a medium of development of an automation platform where new advancements allow users to monitor as well as control systems using Internet settings. As more people use the Internet, the system becomes secure and functional can monitor data by IoT. Recently, today's industries have demanded equipment to monitor and control environmental risk parameters in risk areas. Mankind Safety and material loss are essential to maintain a balance between industry and the industrial environment. According to the investigation, these four basic factors are the source of an accident: low light, gas leak, sudden temperature rise, and explosion. Accidents in the workplace often occur individually for the above-mentioned people. factors or their combined effects. Therefore, it is very important to establish a system that can control the workload of the industry and achieve risk management.

Background study and literature Gap

Previously Bluetooth and RF (radio frequency) technologies were used to control and monitor Industrial mechanical applications but were limited to short distances. The operator has to be in the range of the Bluetooth connectivity in the RF area [3]. The solution to short-distance communication is the IoT-based industrial load control and safety management Where we can control as well as monitor industrial applications from anywhere in the world. The main concept of a network of smart devices was used as early as 1982 with a modified Coca-Cola vending machine and the term IoT was coined by Kevin Astone (Director of auto ID-Labs) in 1999. The first stable project of an industry based on IoT was introduced in 2016. Now in many universities, IoT-based project researches are undergoing & developing step by step. [4]. SCADA (Supervisory control and data acquisition) systems are nearly universal in today‟s manufacturing as well as utility sectors where they are used to monitor and optimize the performance of industrial processes but IOTs advancement leads more efficient to transfer data to plan floor to the computers of the central control unit. Key features of IoT over SCADA are the wireless connection to a database via the internet and it has a cloud-based connection. on the other hand, SCADA has a wired connection on PLC (programmable logic Controller) and works on-premises [5] [6]. So, in industrial automation, The Internet of Things (IoT) plays a crucial part as it is starting to explore IoT concepts and technology. It is clear that with the help of IoT technology remote monitoring and control of any machine or device will be easier for a user as the user can have full access to perform the allocated task from any place with convenience.

Objective, Specifications, Requirements, and constant:

Objective: The main motivation behind this design effort is to create a system that is cost-effective and easy to assemble. Monitor your industrial environment with a user-friendly interface that alerts your employees. In industry, even if there is a small chance of an accident due to a small fire or gas leak, sudden temperature change, or loss of light, these systems are designed to help industrial workers prevent these minor factors before they lead to serious accidents.

Key objective:

- Monitoring industrial workplace risky situations. Such as gas leakage detection, fire detection temperature rises Etc.
- Control the indusial appliances from remote distance places when they need to be controlled. In risky situations industry may need to switch off heavy loads associated with many pieces of machinery.

- Providing an auto alert system in the workplace so that any abnormal situation occurs, workers in the area will be alerted by an alarming buzzer till the situation get normal.

Functional and non-functional requirements: Requirements are qualities or qualifications that one must possess to be able to do something or be fit for something. As we are building up an industrial load control and risk management project the core requirements are those defined to reduce risk and control load as required. Like any other requirement, it can initially be defined at a high level, such as simply the need to mitigate a given risk.

I. Functional Requirements

- **Sensor:** when gas leakage, a fire occurs or temperature increases, the sensors need to send a signal to the microcontroller to alert users.
- **Internet connection:** This system must have an internet connection for communication purposes. So, it requires a WIFI connection.
- **Data cloud:** ThingSpeak data cloud storage will store data continuously from the microcontroller to see a constant update.
- **Secondary communication system**: In case of Internet failure it must have a second communication medium to communicate with the microcontroller from a remote place.
- **Power**: A supply of constant 5v has to be connected with the controller to power up the device
- **Alarm system**: An alarm system needs to be there so that microcontroller can raise an alarm if the temperature increases to a certain level and also fire or gas leakage occurs. Thus, it can give precaution.

II. Non- Functional Requirement

- This project should have a simple design that allows users to replace any component if malfunctioned.
- Uninterrupted Internet connection should ensure to get maximum outcome from the project.
- Uninterrupted power should be supplied to the system to ensure safety and to get a constant update of the projected area environment. our microcontroller needs to have a backup battery supply for the continuous running process
- There should be a contact number of the nearest fire-service station in the GSM module directory to inform fire-service in case of an accident. Ensuring this will minimize the damage of properties (if taken place)

Specifications:

NO.	Unit	Components
1	Sensor	**MQ-2 Gas sensor:** The Grove Gas Sensor (MQ2) module helps detect gas leaks (domestic and industrial). Suitable for detecting H2, LPG, CH4, CO, alcohol, smoke, or propane. Sensitivity and fast response times allow you to make measurements as quickly as possible. The sensitivity of the sensor can be adjusted using a potentiometer. i. Operating Voltage is +5V ii. Analog output voltage: 0V to 5V iii. Digital Output Voltage: 0V or 5V (TTL Logic) iv. Preheat duration 20 seconds v. Can be used as a digital or analog sensor **Flame sensor:** IR detected Flame sensor which is interfaced to Arduino to detect Flame. i. LM393 comparator chip ii. Detection Range: 760 nm to 1100 nm iii. Operating Voltage: 3.3 V to 5 V iv. Maximum Output Current: 15 mA v. Digital Outputs: 0 and 1 vi. Detection Angle: about 60 degrees **DHT11 temperature sensor:** The DHT11 is a temperature measuring device with an analog output voltage proportional to the temperature. Provides output voltage in Celsius (Celsius). No external calibration circuit is required. i. Calibrated directly in Degree Celsius ii. Linear + 10.0 mV/˚C scale factor iii. 1˚C accuracy guarantee-able (at +25˚C) iv. Rated for full 0 to +50˚C range v. Operates from 4 to 30 volts vi. Less than 60 μA current drain vii. Low self-heating, 0.08˚C in still air
2	Actuator	**Servo motor:** (Model-Towerpro SG-90) Operating Voltage is +5V..TypicallyTorque:2.5kg/cm. Operating speed is 0.1s/60°.Gear Type: Plastic. Rotation: 0°-180°Weight of motor: 9gmPackage includes gear horns and screws **Buzzer:** Rated Voltage: 6V DC Operating Voltage: 4-8V DC. Rated current: <30mA…Sound Type: Continuous Beep Resonant Frequency: ~2300 Hz. Small and neat sealed package. Breadboard and Perf board friendly
3	Datastore cloud	**Thing speak:** Thing Speak is an open data platform for the Internet of Things. device or application can communicate with Thing

		Speak using API, we can either keep data private or make it public. In addition, use Thing Speak to analyze and act on given data.
4	Communication	**GSM Module:** Single supply voltage: 3.4V – 4.5V • frequency bands: SIM900A Dual-band: EGSM900, DCS1800. The SIM900A can search the two frequency bands automatically. The frequency bands also can be set by AT command. • Supports CSD, USSD, SMS, FAX. Supports MIC and Audio Input. Speaker Input • Supports single SIM card • Communication by using AT commands • Features Real-Time Clock **Internet:** internet broadband connection, portable internet connection.
5	Control system	**ESP32 Microcontroller:** • Support 802.11 b/g/n WIFI where 802.11 n (2.4 GHz), up to 150 Mbps • TX/RX A-MPDU, RX A-MSDU • 4 × virtual Wi-Fi interfaces • 448 KB ROM • 520 KB SRAM • Multi-connections in Classic BT and BLE • Simultaneous advertising and scanning • Xtensa® single-/dual-core 32-bit LX6 microprocessor(s), upto 600 MIPS • High-speed UART HCI, up to 4 Mbps • Bluetooth 4.2 BR/EDR BLE dual-mode controller • +12 dBm transmitting power **Arduino Uno** • Operation voltage 5v. • Recommended input voltage 7-12v, input voltage limit 6-20V, • Digital i/o pins – 14 out of which 6 provided PWM output • DC i/o pins 40mA • Dc current 3.3v pin 50mA • Frequency (clock speed) 16MHz

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

Technical consideration & constraints

- Constant power supply needs for wi-fi router to get an uninterrupted internet connection to run the whole system.
- Testing system functionality, constant checking whether all sensors are properly working or not.
- In this project we are not using our own website for checking sensors parameter value and real-time updates, so we need to rely on a third-party monitoring site to get constant updates.
- If the internet connection gets lost in the control area, action needs to be taken immediately to get it fixed otherwise interruption in the control system may lead to damage. For this purpose, our secondary communication medium (GSM network) will notify shortly to the user.
- If the GSM module (secondary communication system) gets a low network connection, then the system may not give a proper response to the user when internet disconnection happens.

Non-Technical consideration & constraints

- When maintenance needs to be performed by supporting parties that will need access to stalk holders‟ IoT devices and their information, data, and security contact requirements.
- This system needs to have continuous checking so proper monitoring is a must to avoid system failure.
- Due to digitization and automation in the industry some employee may lose their job as our system offers safe monitoring of the working environment without physical monitoring for safety management.
- As our system consists of electrical components so it may get damaged which can interrupt the connection of transferring and receiving data from sensors and actuators to the control unit
- This project has no interoperability or intelligent network system to work itself on when industrial appliances need to control in a risky situation so needs to operate by the user end.

1.2.4 Application Standards code:

Our proposed system follows ISO/IEC TR 30166:2020 (E) standards which describe the following:

• General IoT (IoT) systems and industrial landscape describe the characteristics, technical aspects, and functional and non-functional elements of IoT structure and list of standards organizations, consortiums, and open source communities working on all aspects of IoT;

• Consider the prospects of IoT standardization, including risk analysis, new technologies, and identified collaborations. [7]

- **WIFI Module**: ESP32 ESP-32S Node MCU Development Board Wireless WIFI: IEEE 802.11 standard security features all supported, including WPA, WPA2, WPA3, and WAPI. [8]
- **Sensors:** ISO/IEC TR 30148:2019 std code describes the structure of wireless gas sensing network and the application protocol of the wireless gas network system. we are following this std code implementing gas sensors for our project.

  Temperature and flame sensors follow the std code of IEEE 1451.7 which specifies communication methods also does command set, data formats, and Transducer Electronic Data Sheet (TEDS) for sensors working method in cooperation with Radio Frequency Identification (RFID) systems.

- **Control board:** We are using the Arduino UNO development board as our main control board. which follows Std 1855 standard and codes to operate functionality. IEEE Std 1855 enables the design of the project fully interoperable fashion. [10]
- **Secondary communication network:** GSM 900 mainly operates in 2G network system. GSM operates on the mobile communication bands between 900 MHz and 1800 MHz in most parts of the world. GSM module includes the ability to transmit audio data in real-time, which is done at a rate of 13 kbps. Apart from This involves sending and receiving short text messages over the mobile network itself, without the need of being connected to the internet. GSM networks follow IEEE 802.11 std and codes protocol.

Summary of the proposed project

This proposed project comprises integrating multiple sensors and micro-controller to control industrial parameters and load control of industrial appliances. Arduino Uno MCU which is the slave controller of our project which will take analog input from the sensors and generate those inputs into real-time data to the cloud and the users using the concept of IoT through the connected wi-fi module and the help of Blynk android applications. This system will include multiple boards and sensors integration to cover industrial parameter monitoring including temperature humidity flame detection to the projected area.

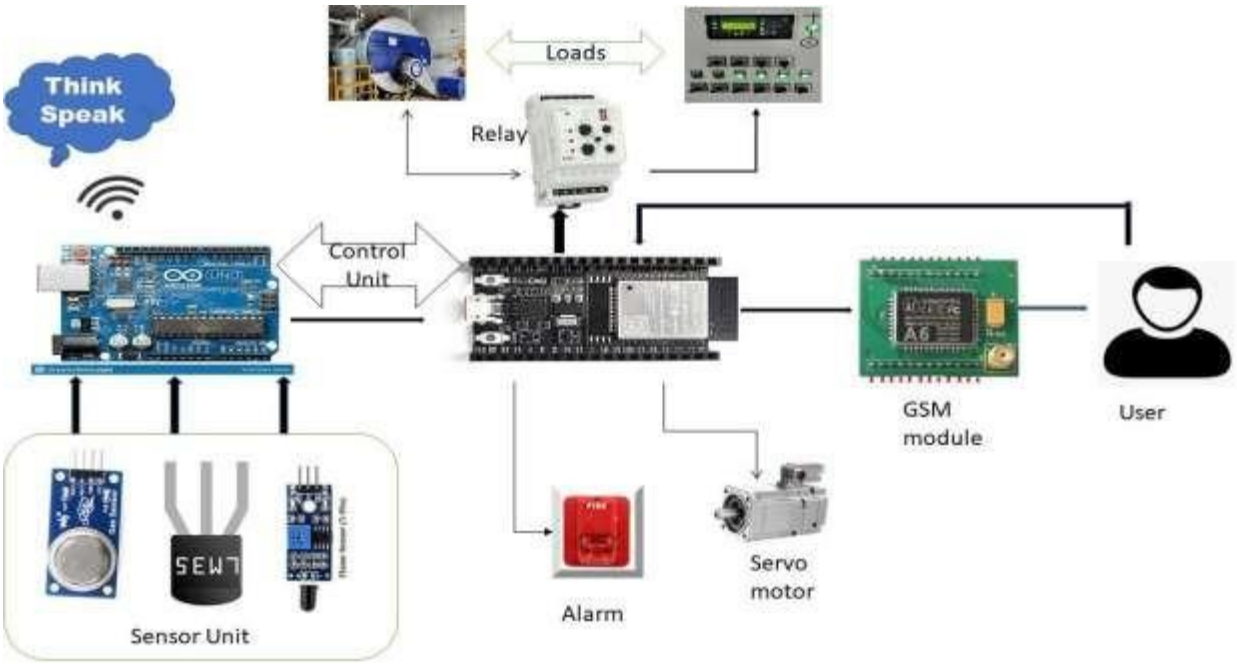

Fig1.3: Project Diagram

Chapter 2 Project Design Approach

Identifying multiple design approaches: Design thinking can help to create the right environment for a realistic and broad understanding of the consumer's voice. A problem-solving process that puts consumer needs first. With regards to as many solutions as possible, various designs were tried to find the optimal solution. We tried 5 solutions with different approaches. We can divide them into two important parts.

I. **Network-Based:** In this part, we tried 3 types of possible solutions.

i. Bluetooth Connection: In this system, we have designed this project based on Bluetooth module HC-05. In absence of an internet connection, the controller device like a mobile phone or pc will be connected with the microcontroller via Bluetooth. This system will run in the short-range & this is just an optional solution that we tried just for testing the scenario. Mainly our project is based on internet connection

ii. Internet Connection: In this system, our full project will be connected through the internet. The controller device such as a mobile phone or PC should have an internet connection with a microcontroller. In this design, the full setup is depending on the internet. In case internet connection interrupt micro-controller will be failed to send data or any kind of notification to the controlling device

iii. Internet + GSM module Connection: After two different approaches in the network process we have tried to design our project with an uninterrupted connection. In this case, we have connected our system through an internet connection adding a GSM module for any emergency contact. If internet connection become fail somehow and the sensor can detect any violence then the micro-controller will send data to the subscriber via the GSM module

II. **Platform Based:** As we have a simulation procedure in our project so, we have to choose a platform to compile the simulation. We have tried two different platforms in this project.

i. Blynk: This is the open-source platform that can be hosted on-premise on local servers, through cloud environments such as AWS, or hosted by Blynk. We tried Blynk to develop our project because of its advanced feature and we successfully simulated our project [11].

ii. Arduino IOT Cloud: To simulate with Arduino UNO we tried a platform named Arduino IoT. This platform program has subsections and converted into one operational .hex file but the code had been programmed successfully.

iii. ThingSpeak: ThingSpeak is a cloud-based Internet of Things (IoT) analytics platform designed to enable organizations in a variety of industries to evaluate data in real-time. The output of sensors can be stored on this platform for monitoring purposes and real-time data display.

Multiple design approaches

There are many ways to achieve the goals we have chosen for our project. We tried to figure out which one worked well by finding and simulating various possible solutions. Since this is a simulation, there are some limitations when doing IoT projects.

Case1- Simulation using Bluetooth and Arduino UNO: We are simulating a project using Bluetooth as a communication medium and Arduino Uno as MCU. The Blynk IoT platform has the versatility to use Bluetooth as a communication medium. Blynk's library makes the task fairly easy. We simulate proteus, and the connection diagram is given below:

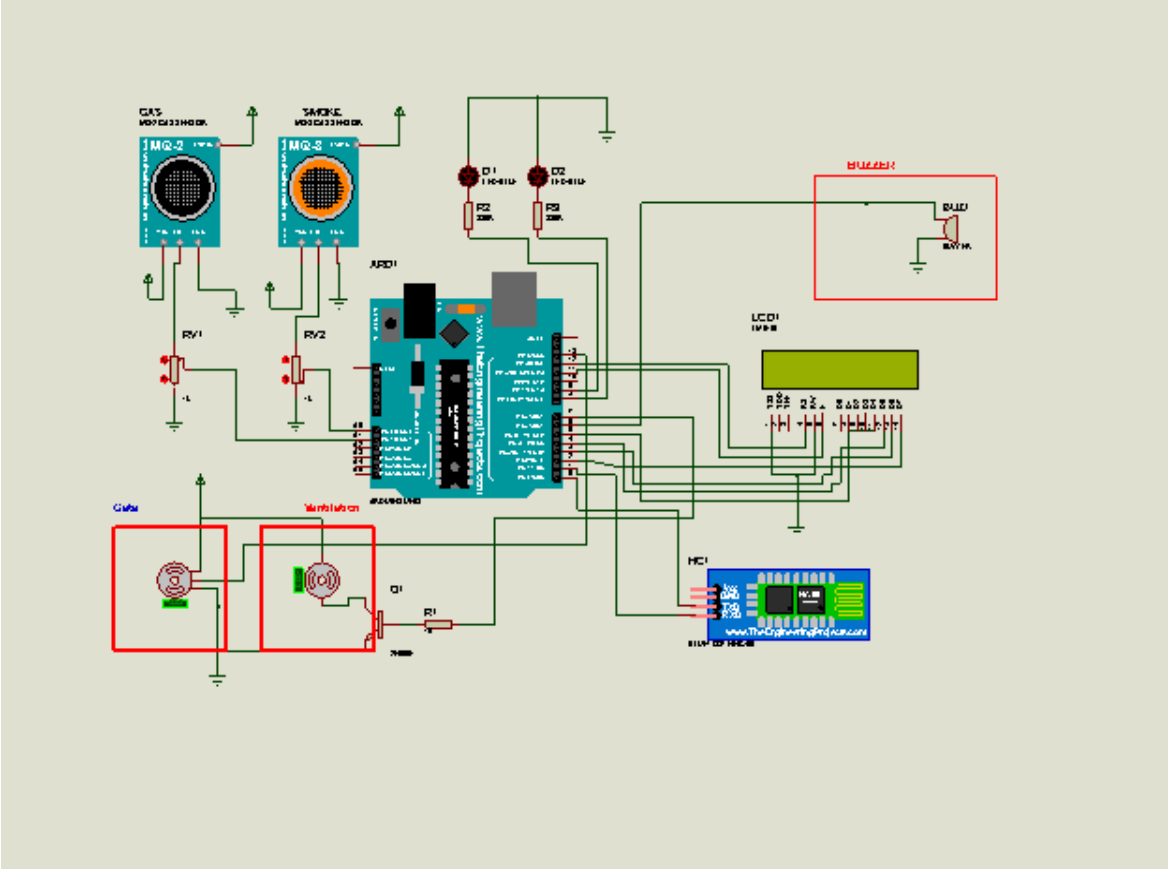

Figure:2.2.1: simulation using Bluetooth

Case2 -Simulation using WIFI and Arduino UNO: It uses WIFI internet as the default communication medium to avoid blue band problems. The Blynk IOT Platform Library supports Internet over WIFI, so programming MCU is almost identical to Bluetooth, except that it contains the router SSID and password as a character array and takes the built-in Blynk function as parameters. This simulated in the Proteus Design Suite using the connection below

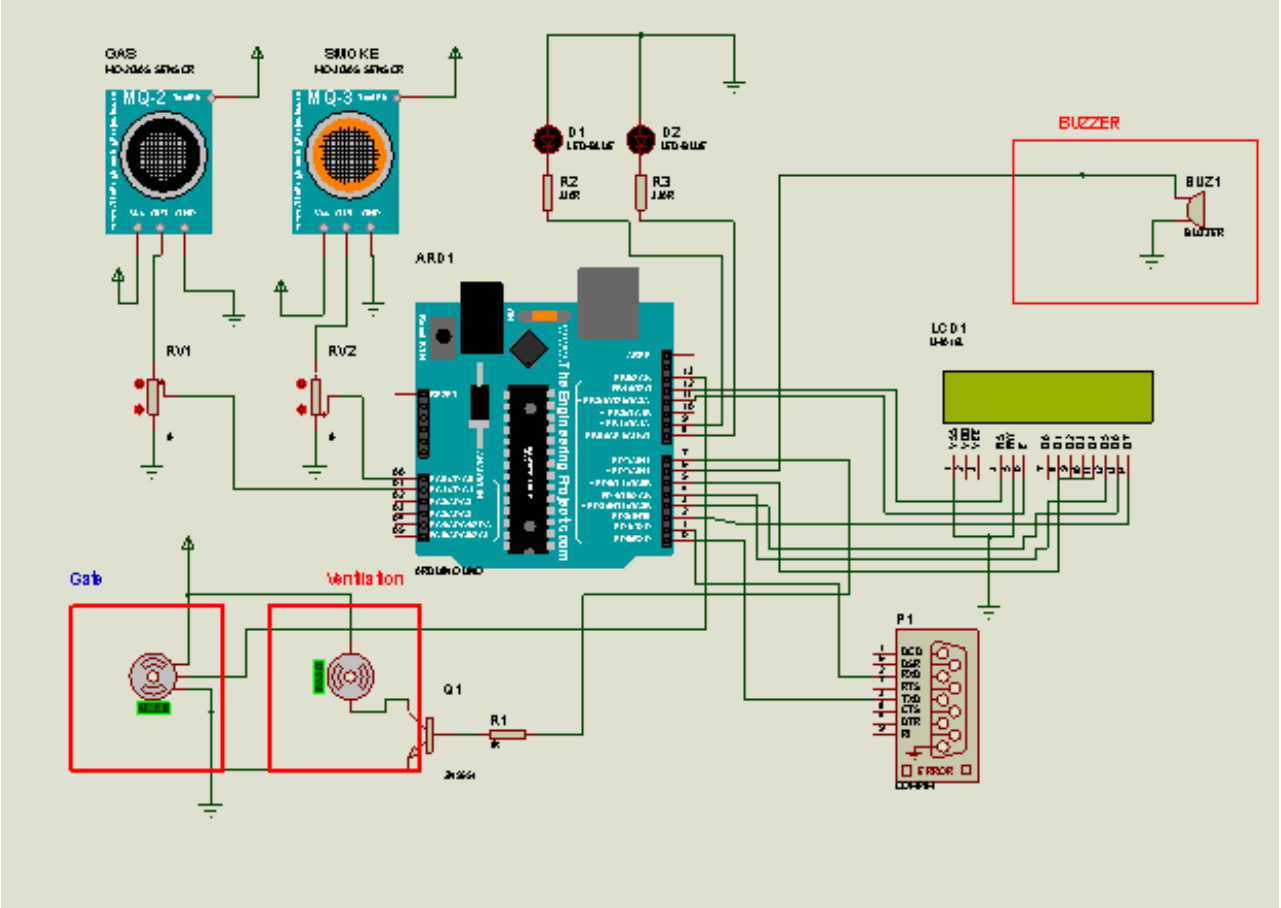

Figure:2.2.2: simulation using WIFI and Arduino Uno

Case3-Simulation using WIFI +GSM and Arduino UNO: We will need to maintain a backup connection as you will not be able to get a continuous internet connection over Wi-Fi due to many issues such as ISP, router, channel duplication, etc. We solved this problem by using a GSM communication system with the internet via WIFI. The system provides the user with data on anomalies detected by the sensor via SMS. The Blynk IOT platform acts as a load controller over the internet and can also collect data from sensors. The GSM module works as a warning system in the event of an emergency. The simulation is done with circuits below:

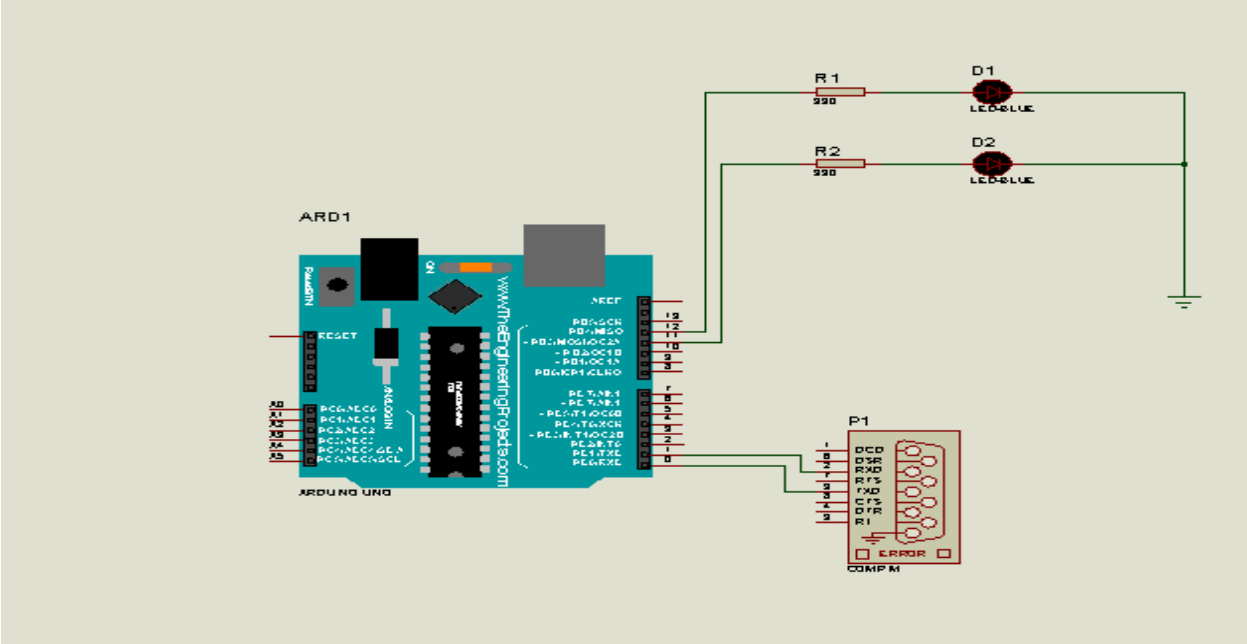

Figure:2.2.3a: simulation for WIFI with GSM

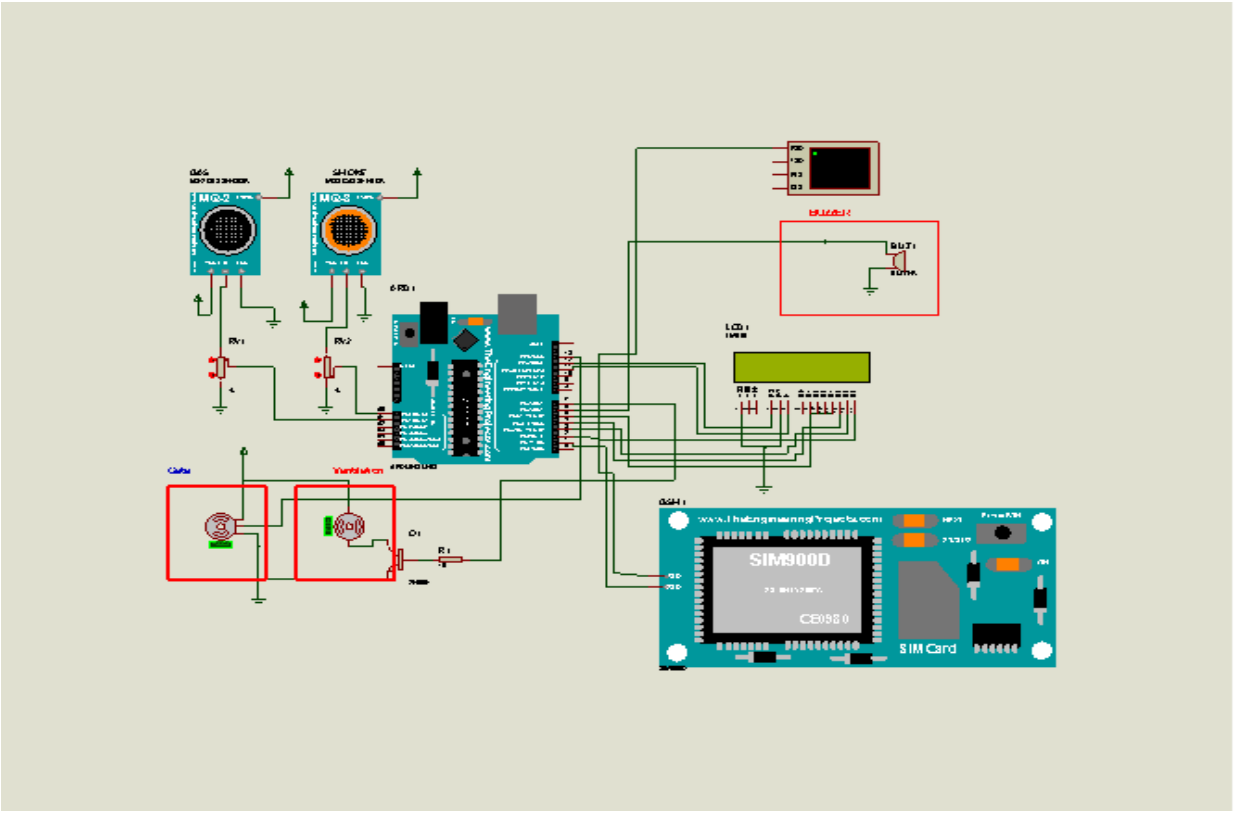

Figure:2.2.3b: simulation for WIFI with GSM

Case4-Simulation using WIFI +GSM and Arduino Mega:

Our honorable ATC panel suggested we use Arduino Mega to solve the problem with Tx/Rx pin shortage. We have implemented Our project in Arduino mega but by this Blynk has decided to upgrade their platform‟s version, new version has some bugs and will be fixed by the developer of the Blynk IoT platform. As an alternative, we have switched to the Arduino IoT platform.

The problem with Arduino IoT is, it is not as versatile as Blynk. Arduino IOT cloud‟s program is in the OOP system that caused a problem in generating a .hex file to run simulations. Our code for the code is compiled but simulation is not operating due .hex files problem. The circuit implementation of Arduino Mega in Proteus is given below:

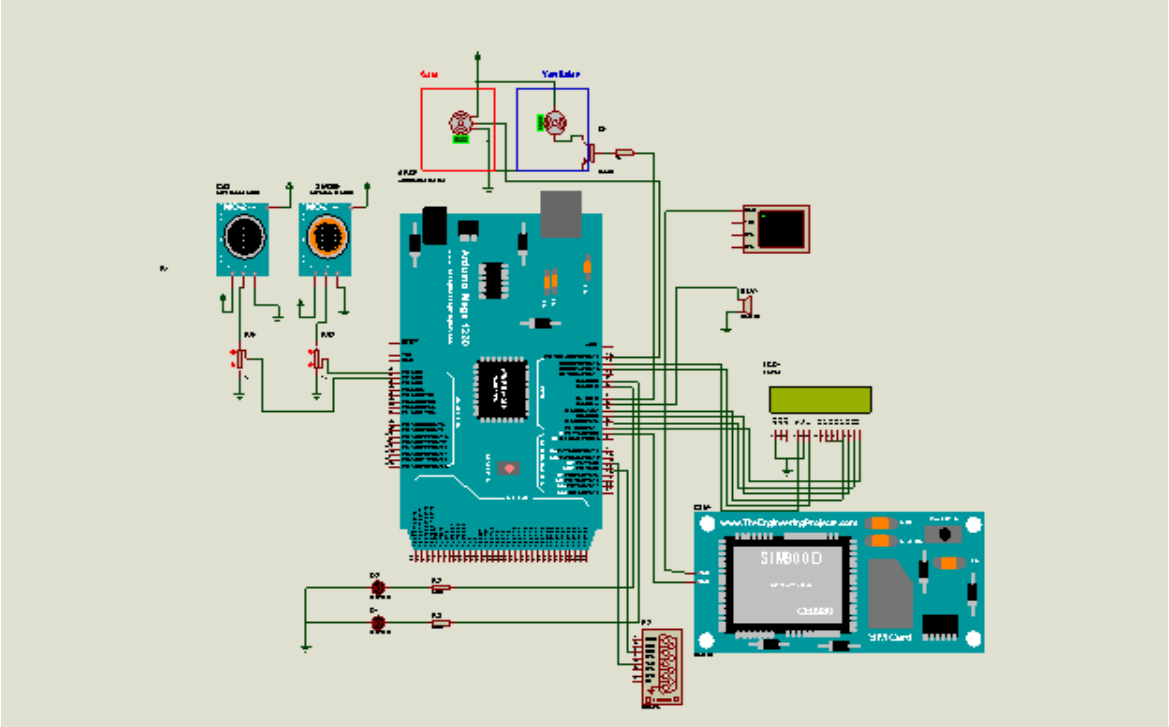

Figure:2.2.4: simulation using Arduino mega

Case-5: Simulation using WIFI +GSM and two Arduino UNO: To meet all the requirements we need more input pins to collect data. For this, we used two Arduino Uno, but on the hardware, we have used one ESP32 for parental control and one Arduino Uno for child control. This is because Esp32 does not have a suitable library for simulation. One Arduino board collects all data from the sensors and another Arduino Uno board connects to the GSM module, buzzer, and communication section to respond according to the first board. The circuit implementation is given below:

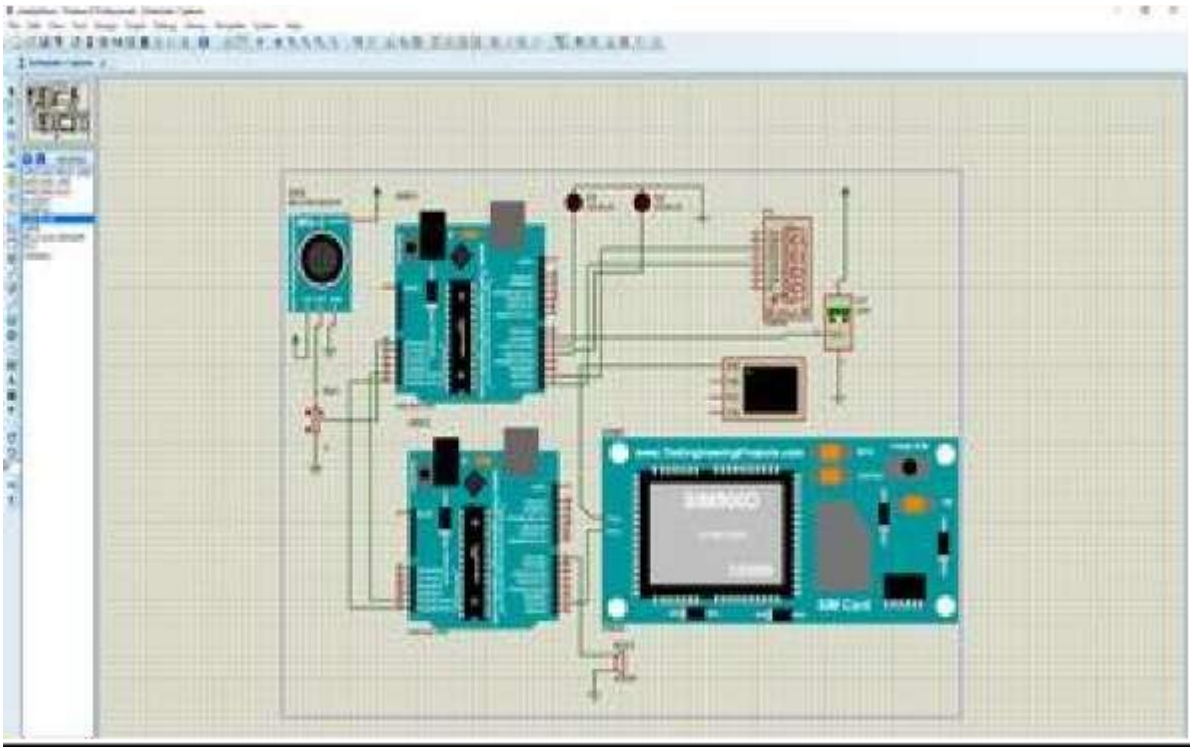

Figure:2.2.5: simulation using two Arduino Uno

Decision: In our simulation 2unit Arduino Uno works almost perfectly. Our primary plan was to use ESP32 as our MCU as this board has onboard WIFI and also Tx/Rx pins for these reasons it could be the most suitable board for our project. But we could not find any programmable library for ESP32 in proteus. We have run our code for ESP32, code is compiled successfully and uploaded in a physical board of ESP32. Our ESP32 board is running a small-scale load controlling implementation successfully.

Analysing of Multiple design approaches

We've outlined the different solutions for our project. Now we need to analyze one by one to match with our desired objective considering cost, efficiency, usability, manufacturability, impact, sustainability, maintainability, etc.

- Case1- Simulation using Bluetooth and Arduino UNO: This case has run smoothly but it does not serve our purpose because of the range of Bluetooth. It can only perform the task when in the Range of the Bluetooth module. Moreover, our project is based on IoT because of its advanced feature and flexibility. Using Bluetooth is not effective and also, it‟s not sustainable as well.
- Case2 -Simulation using WIFI and Arduino UNO: This test runs fine but the problem with this solution is its dependency on only WIFI. As we know sometimes WIFI fails to provide uninterrupted internet communication. Since this project‟s primary objective was to ensure safety and avoid accidents, the Interruption of the internet can be disastrous for the project. So, this method is also less effective and there remains some risk as well due to interruption of communication.

- Case3-Simulation using WIFI +GSM and Arduino UNO: This simulation works perfectly and meets the requirements of our project. But due to lack of Tx/Rx pins, we have to use 2 MCU units. Here we can easily use the GSM module with the extra pin MCU. But we need the different controllers for individual MCU. So, this method will not be cost-effective and also high maintenance.
- Case4-Simulation using WIFI +GSM and Arduino Mega: This simulation is not operational because of .hex files‟ unavailability. Since the code is Compiled, it should run on a physical board when uploaded. Problems with Tx/Rx pin are solved but Arduino Mega is much costlier than using 2 units of Arduino Uno. So, this method is not cost-effective and also less efficient.
- Case-5: Simulation using WIFI +GSM and two Arduino UNO: This simulation has run perfectly with two Arduino Uno. All requirements have been fulfilled successfully. Calibration of two MCU makes this method effective to obtain the object. We can use multiple sensors easily and also can add various accessories for a complete project which will make the user frankly and impactful.

Chapter 3 Use of modern Engineering & IT tools

Introduction

There are many Engineering and IT tools available to complete complex engineering projects. Finding the appropriate tools and media as per the project is one of the crucial steps.
Firstly, we sorted out the tools and platforms for our project, shortlisted some by discussing them among the group mates. Finally, present them to the ATC panel and approve the appropriate tools and platforms.

Selection of Modern Engineering and IT Tools:

Our project is an IoT-based automation project for Industrial load and safety. These projects have multilayers of engineering designs and works that result in vast options for modern engineering tools to pick on.

i. **IoT Platform:** Since this is an IoT-Project, we had to choose an appropriate IoT platform. There are many open-source platforms for IoT projects like Blynk, Arduino IoT, ThingSpeak, Firebase ETC. Apart from these platforms, the MQQT protocol with Node-Red can build a system to work similarly.

   Among all these options for IoT platforms, we shortlisted Blynk and Arduino IoT as they are much simpler and user-friendly to work with and have their mobile apps and web-based platform.

   Arduino IoT has much more advantages over Blynk since Blynk offers limited access for free users, whereas Arduino has more access for free users. But Blynk‟s system is much more stable than Arduino IoT. Arduino IoT does not produce a single. hex to check the outcome virtually but, Blynk simulates perfectly.

ii. **Microcontroller Unit:** As the controller unit of the project, we have to choose an appropriate MCU from various collections of MCUs. Among these MCUs, we choose ESP32 as our core component of the project. Since it has built-in Wi-Fi and Bluetooth it will be easier to integrate with an IoT project.

   Firstly, we plan to use only an ESP32 to run the whole project but then realize this will limit the possibility of using numerous sensors if needed. We solve this by using Arduino UNO as slave and ESP32 as master MCU.

iii. **Code Compiler:** The Options for code editor and compilers are endless. Code editors like Sublime Text, VS Code, Atom, Arduino IDE, Code vision AVR ETC are vastly used in the current engineering industry.

   Arduino IDE has libraries of various MCU and Sensors. This compiler has a built-in uploader. For these reasons, Arduino IDE is the ideal compiler for our project.

iv. **Sensors & Actuators:** In terms of choosing Sensors and actuators, we had much fewer options than others. Because of its availability in the domestic market.
As gas sensors we have MQ2, MQ5, MQ6 is available in the market. We have tested both MQ2 and MQ5 and decided to go with MQ2. Because of its range of flammable gas detection ability. We choose IR flame sensors as there is no other option available in the current market.

We choose 5v Relay because we don't have access to any industry to run the test on a higher load. But there are relays that can handle higher loads like an industrial machine.

v. **Simulator:** Before implementing the project physically we simulate the whole project. Simulating the project allows us to find out technical flaws and solve them before implementing them.

We have used Proteus Design Suite to simulate the project, although there were some problems like the unavailability of the ESP32 board library.

vi. **Data Cloud:** ThingSpeak is open-source software written in Ruby which allows users to communicate with internet-enabled devices. It facilitates data access, retrieval, and logging of data by providing an API to both the devices and social network websites.

We use ThingSpeak to store numerical data of DHT senor and show them as a graph against time. This will allow us to check the temperature to find out any abnormality if happens.

Use of Modern Engineering and IT Tool:

After Selecting the Appropriate Engineering & IT tools, we implement our project using them. Some of these tools were new to us and leads us to learn a few new things to use them properly. We write our code in Arduino IDE compile it there, then store code in GitHub for future use and check by our supervisor. Use PDS (Proteus Design Suite) to simulate the project by compiled code. These simulations give us a fine overview of what could be done and go wrong with our project without wasting any resources. As an IoT platform, we use Blynk, since we are the free user we have limited access to its full potential. If funded in the future, we will buy or build a similar platform. Configuring ThingSpeak was one of the most challenging tasks. We have used their documentation to solve the problems we faced. We use multiple libraries to solve our problems like Blynk, MQ, ThingSpeak, ESP32 ETC. These libraries were collected from their official GitHub and websites. We use a WIFI module with each Arduino IDE to send collected data by the sensors to ThingSpeak.

Conclusion:

Designing and implementing a complex Engineering project for FYDP allow us to explore Modern IT and Engineering tools. This is a great opportunity to learn and implement a lot of new technologies for using these modern tools.

Chapter 4: Optimization of Multiple Design and Finding the Optimal Solution

Introduction: The task of optimal solution engineering design problem is considered as a decision-making requirement processes of which real-life industrial problems often have to consider out of very different views. In this context, the most logical approach to achieving the best solution, in the presence of several design criteria and many design variables, is the task of performing science optimization to produce potential solutions for standard decision-making. The result is multiple criteria optimal decisions approach techniques design problems, through the effective use, cost optimization, global and multi-objective optimized algorithms, yielded a significant and competitive advantage with optimized design. [12]

Identifying optimal design approach: We've outlined the different solutions for our project, so we need to choose the one that works best for this project and is right for us. We should look at a few objectives to get the best results. Which is very necessary for any project to maintain the quality and user‟s demand.

I. Cost Efficiency: Adding multiple objects using a microcontroller requires enough TX/RX pins that the Arduino Uno doesn't have. So, we tried the Arduino Mega for this simulation, which has enough Tx/Rx pins to add multiple objects. However, using the Arduino Mega is very expensive and inefficient. So, we decided to use two collaborated MCU boards that are cheaper than Arduino Mega.

II. Effectiveness: Effectiveness is the ability to achieve the desired result or achieve the desired output in the simplest way. In this project, in addition to choosing the communication system, we chose the internet with a GSM module from several solutions. We can use these two connections to create an uninterrupted connection to the microcontroller. This is a more effective method than other processes.

III. Availability: Esp32 is another micro-controller which we planned to use at the beginning but to simulate with node MCU we didn't get any programable library online. Where Esp32 is the most effective considering all microcontrollers for our project. So, instead of using Esp32, we have to use Arduino Uno which is also available in the market. The library for Uno proteus simulation is also available and easily accessible.

IV. Usability: We can develop this project with atmega32 or any other micro-controller or we can use one single Arduino Uno for this project but to ensure the best use of this project we had approaches 2 Arduino Uno at the same time from multiple object connections in one project. Collaborating two MCUs in one control panel has made this project easily usable.

V. Sustainability: Sustainable engineering is the process of designing or operating systems so that they use energy and resources in a sustainable way or are able to meet the needs of future generations. As this project is IoT based and we are using the internet with the GSM module as our communication system & updated IT tools for programming or design. So, we can say that this method will sustain longer.

Performance of Evaluation and Developed solutions: We can evaluate your work based on the above criteria, requirements, and goals. With all these facts in mind, the final design should be verified to obtain an optimized solution. The design can be divided into four parts.

i. Control Unit: We have used two MCU boards to control our basic project that could be scaled up as needed. To control the full unit, we have used two separate boards to avoid the collision. Since there are multiple sensors and additional actuators so, using multiple boards should be considered as the key idea to meet the final solution. As a result, there are enough TX/RX and I/O pins are available as well which increases the effectiveness and cost-efficiency of the project design.

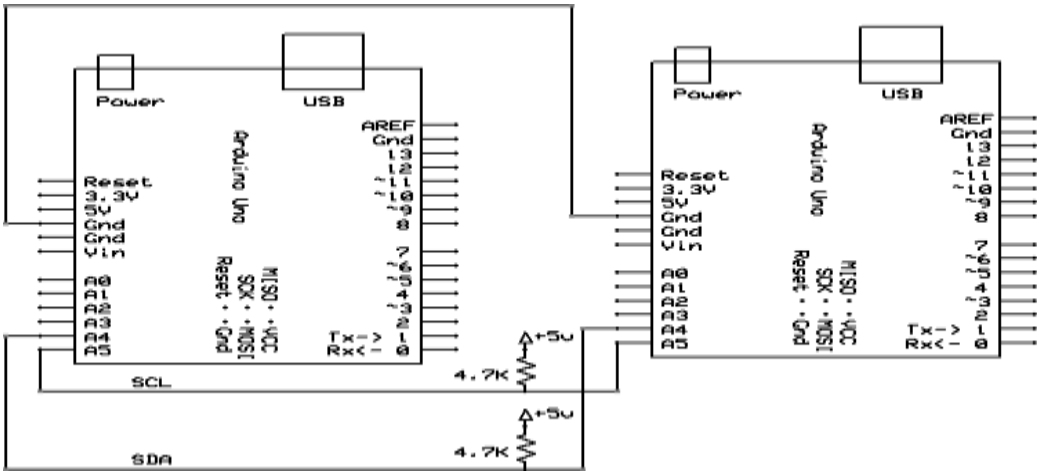

Figure 4.3.1: Two MCU board interfacing.

ii. Communication Unit: Instead of using a single communication system to create the network in this design, we used the Internet with GSM modules. In case of any emergency due to a loss of internet connection, users will be immediately notified via Global System for Mobile Communications (GSM) in the event of an accident. So, our design project is able to provide uninterrupted service. [13]

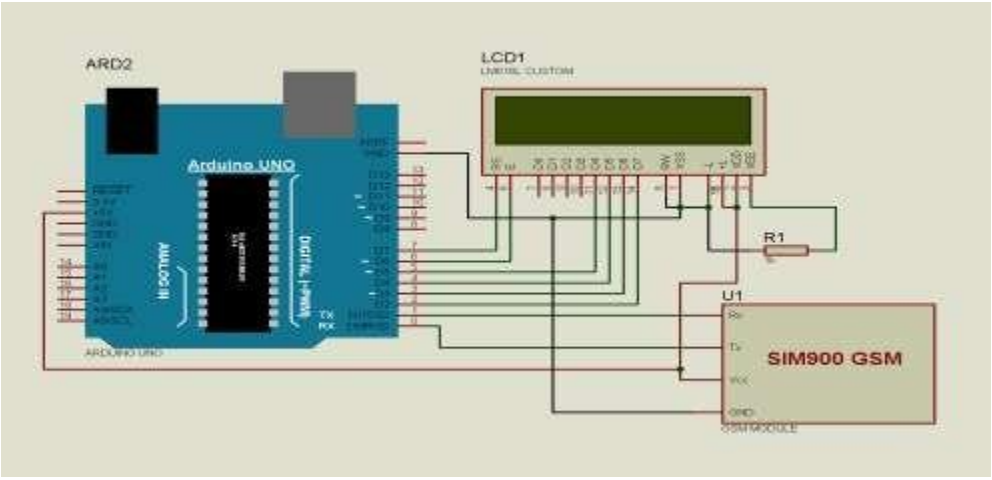

Figure 4.3.2: GSM connection with Arduino Uno.

iii. Sensor Unit: We need multiple sensors to detect any problem related to gas leakage & fire detection purposes. There are many kinds of sensors for this project in the market. Among them, we have chosen some most effective sensors.

- Gas Sensor: There are many gas detection sensors. MQ2 & MQ3 are the most popular sensor. In our project design, we have used an mq2 sensor for its better experience.

Model	MQ2	MQ3
Range	200ppm – 10000 ppm	25ppm – 500 ppm
Gas detection	Methane, Butane, LPG, Smoke, Alcohol	Alcohol, Ethanol, Smoke
Voltage	5Vdc	5Vdc

Table4.3.1: Gas sensor selection

So, for better output and maximum detection capacity, we have chosen the MQ2 sensor. Moreover, the MQ2 sensor is available & cheaper than the MQ3 sensor. As a result, it will be cost-efficient, most effective, and higher manufacturability as well for detecting gas. [14]

Temperature Sensor: To detect the overheating issue of the environment which indicates any risk we have used DH11 instead of LM35. These two are the most popular temperature sensor in the market. [14]

Model	LM35	DHT11
Accuracy	± 0.5° c	± 1.0° c
Sensing capacity	Temperature	Temperature & Humidity
Temperature range	-55° to +150° c	0° to 50° c

Table4.3.2: Temperature sensor selection

Though LM35 has a higher range than DHT11 and also has higher accuracy power. It only detects the temperature but it can"t detect humidity. Moreover, our objective of this project can be fulfilled by this range of DHT11, and also there is a high fluctuation in LM35 output reading. So, considering the problem using DHT11 is a better choice in our design project.

To sum up multiple design optimization we can conclude with our most specified and suitable design. From the above discussion we can that the approach of optimization technique design is discussed with More emphasis on the challenges related to complex engineering, analytical skills, and nature according to some criteria of practical engineering design problems. As the only option is to consider challenges, achieving an optimized approach in the framework of an integrated design environment is considered for the key success to win the industry. The design is given below:

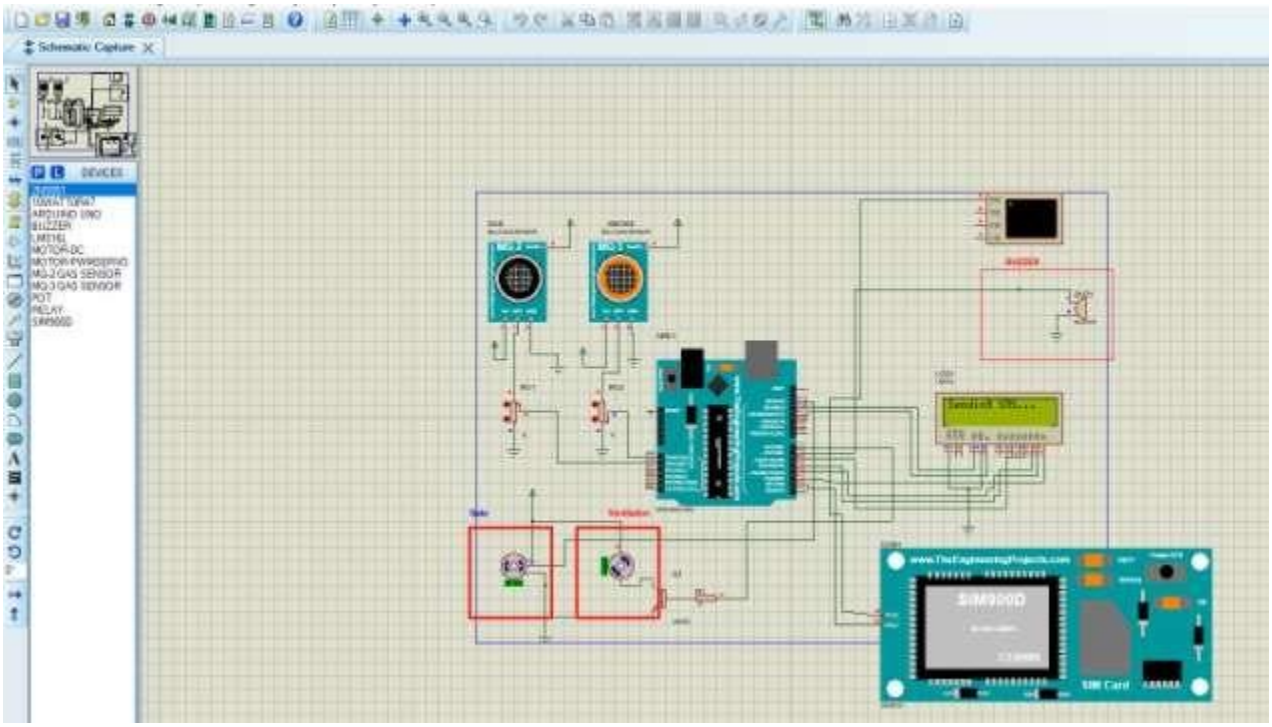

Figure 4.3.2(a): Final optimized design for sensors & actuators

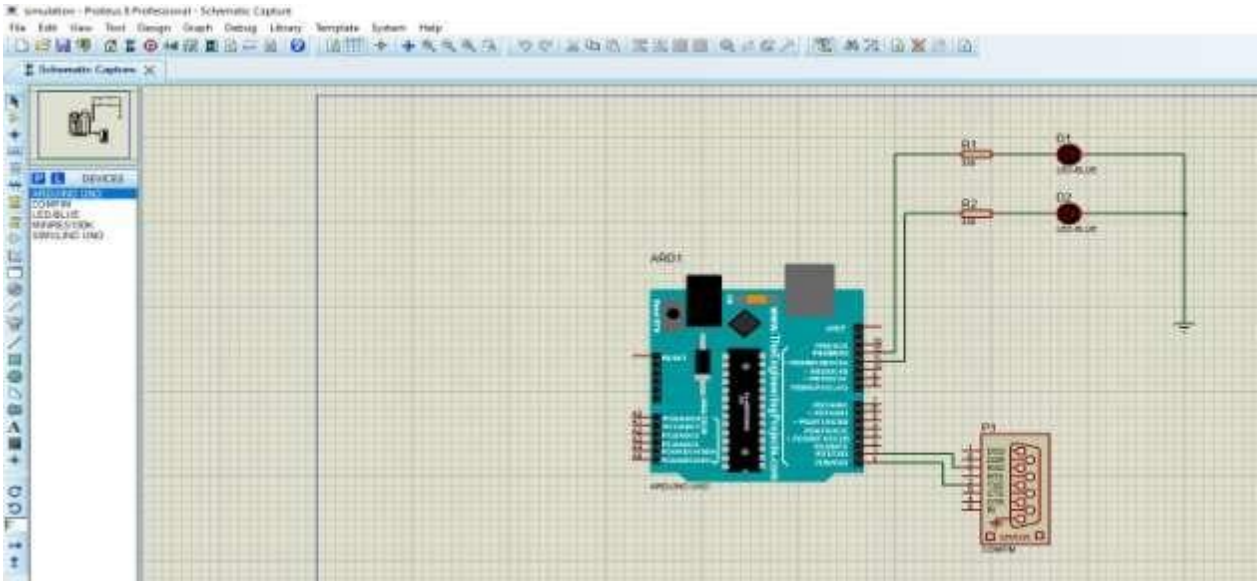

Figure 4.3.2(b): Final optimized design for load control.

Chapter 5: Completion of Final Design & Validation

Introduction:

After Selecting appropriate modern IT & Engineering tools and running a few simulations, we focus on implementing the project physically. It is our very first experience implementing a complex engineering project. It was challenging to implement the project since there is some difference between simulations and physical implementation.

Completion of the final design:

We have divided our projects into chunks of works to make the task easier and trackable. After completing all of them successfully, we combine them all.

- **Blynk and Load Control:** First of all, we implemented the IoT part since establishing the communication was one of the most challenging parts of the project.
  5v Relay module is connected with the ESP32 MCU to control the load of 220v. We open a Blynk Channel to operate through the Blynk IoT Platform. We Program the board and give necessary info like channel link of Blynk, WIFI Id, and password to connect with ETC.

  The code of this part of the task is in this link: " https://github.com/Yousuf-Mohammad/Automation_project/blob/main/FYDP_trail_1_jul7a/trail_One.ino "

- **Sensor and Actuator:** There are three types of sensors in this project Gas, Flame and DHT. And as the actuators, we have a buzzer and servo motor.
  If the gas sensor senses any flammable gas, the buzzer will give an alert & the servo motor will open the gate and ventilations. The flame sensor will alert if it detects flame on the premises. The DHT sensors will give us the numeric value of Humidity and Temperature of the Premises.

  We program ESP32 and Connect sensors to the MCU. The code of this part of the task is in this link: " https://github.com/Yousuf-Mohammad/Automation_project/blob/main/gas_and_smoke_detector/gas_and_smoke_detector.ino"

- **ThingSpeak:** ThingSpeak is open-source software written in Ruby which allows users to communicate with internet-enabled devices. Use ThingSpeak to store the numeric data on the ThingSpeak cloud. This data can be retrieved as a graph against time.

  We send the numeric value of humidity and Temperature to ThingSpeak. A Graphical View of the data is available at this link: "https://thingspeak.com/channels/1604462"

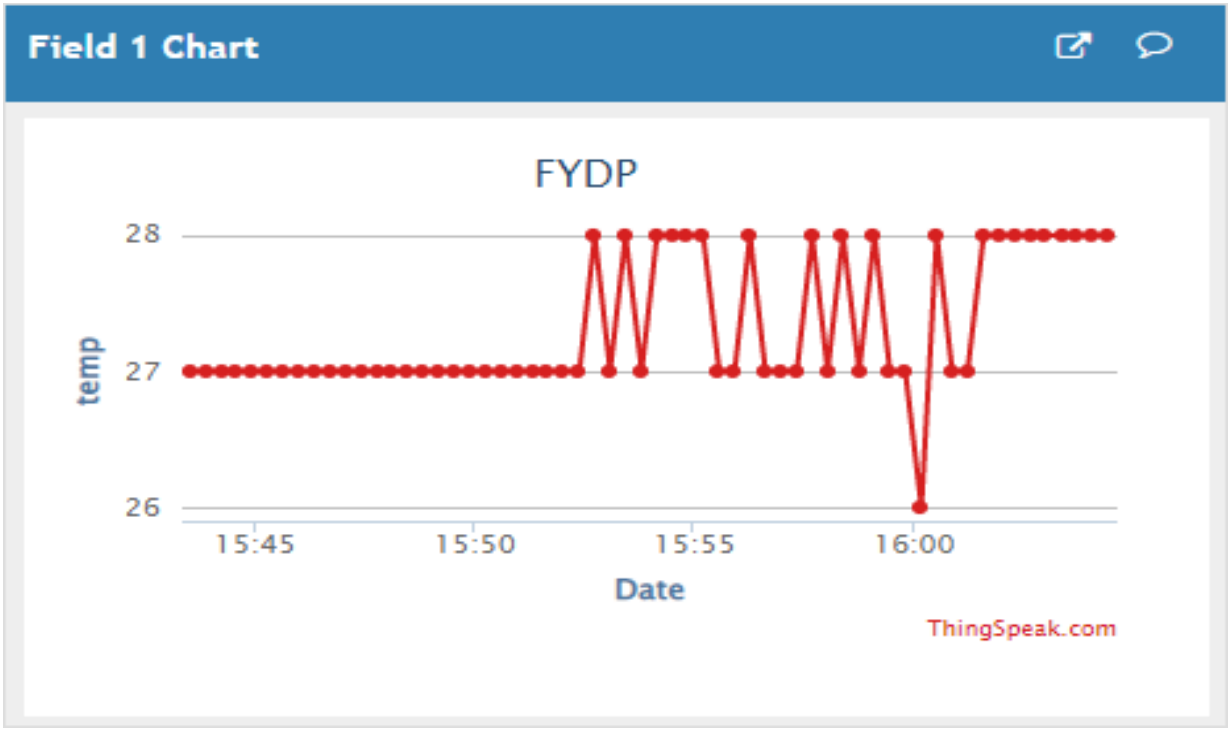

Chart5.2.1: reading Temperature

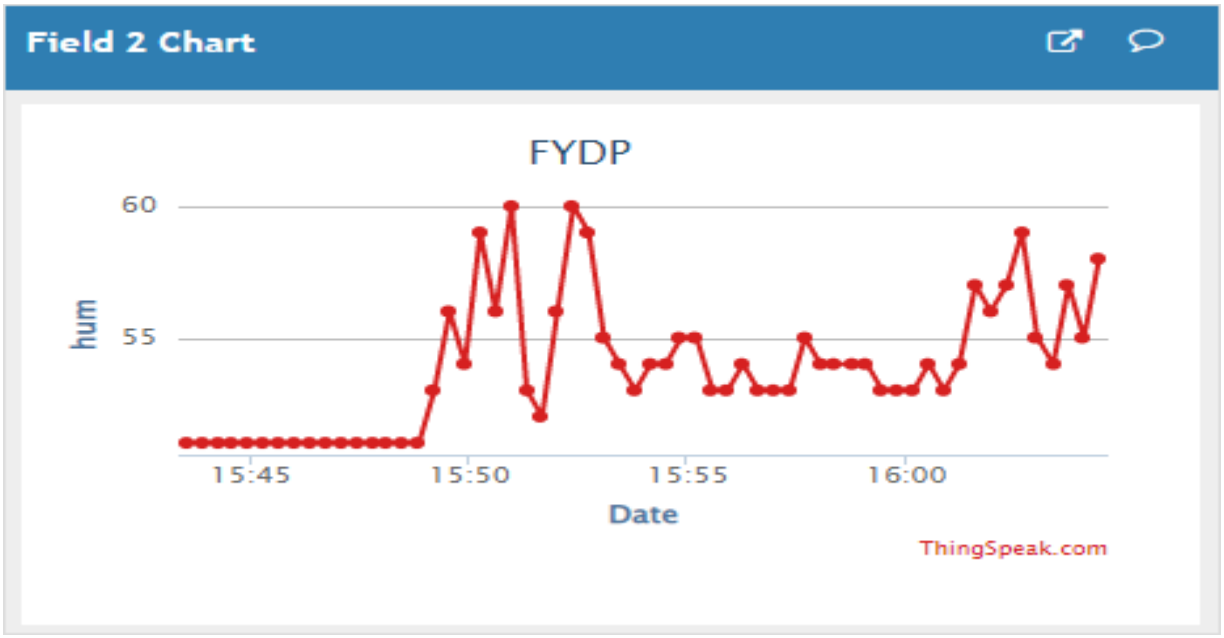

Chart 5.2.2: Reading humidity

The Code of this part of the task is in this link: " https://github.com/Yousuf-Mohammad/Automation_project/tree/main/master_slave/dht_thingSpeak"

- **Master-Slave ESP32 and Arduino:** Finally, we combine all the parts to complete the project. We used Arduino as Slave MCU to collect data from the sensors, send DHT values to ThingSpeak. ESP32 Master MCU gets alerts from the Slave MCUs data and alerts users & takes necessary steps.

  The Code of this part of the task is in this link: " https://github.com/Yousuf-Mohammad/Automation_project/tree/main/master_slave/blynk_master_ESP32"

- **GSM module:** GSM was our secondary communication medium for this project. Although, we have integrated GSM in our simulation perfectly. But the GSM module we have that has failed to connect with the SIM we currently have. According to our research and the opinion of some senior engineers, the GSM module operates in the 900MHz frequency range, this should support up to 3G SIMS. Our Code for this part runs perfectly in the simulation.

  The Code of this part of the task is in this link: "https://github.com/Yousuf-Mohammad/Automation_project/tree/main/gas_and_smoke_detector "

Evaluation of the solution to meet the desired need:

Evaluating the outputs from the implemented project is a necessary part of the completion of the project. We divide the evaluation into two different stages.

- **Sensors Output:** Firstly, we check the sensor's output with the environment. We have three types of sensors

  1. MQ2 gas Sensor: We test this sensor using various flammable gas in a safe environment. We check the alcoholic gas used in the gaslight and gas used in the kitchens. The result of both outputs is satisfying. The sensor can detect any flammable gas immediately it reaches a specific point density.

  2. Flame Sensor: We have used IR based Flame detecting sensor in this project. This sensor can detect flame in its range and line of sight only. The range is not satisfying but we do not have any other option available in the current market.
  Inside the range, the flame sensor detects any fire in splits of seconds.

  3. DHT Sensor: DHT Sensor provides us the numerical value of Humidity and Temperature. These values are tested against the Air conditioner's built-in sensor's value. Also, we check the temperature rising using a flame. The Humidity data matched with online sources with slight variation.

- **Checking the IoT Connection:** The Controlling range of the project should be unlimited if there is an internet connection. To put our claim to test, we connect our mobile device with the data connection of the sim and tried to control the load. This test validates our claim of unlimited range if there is an internet connection.
  After running all the evaluation tests, we ensure that the project runs perfectly. We hope that this project will be able to make the life of every Industrial worker safer.

Chapter 6: Impact analysis and project sustainability

Introduction: In an age of globalized markets and workforces, engineers need a solid understanding of the impact of their projects locally and globally. The rapid development and implementation of intelligent technologies and technologies based on the Internet of Things (IoT) are opening up various opportunities for technological development in various areas of life. The main goal of IoT technology is to simplify processes in various fields, increase the efficiency of systems (technology or specific processes), and finally improve the quality of life. Sustainability has emerged as a key issue for the population where the dynamic advancement of IoT technologies brings various benefits, but these rapid developments must be carefully monitored and evaluated from an environmental point of view to limit the existence of harmful impacts and ensure wise use. What our proposed project brings societal, health safety, and impact in terms of engineering responsibility is given below

Impact of the solution:

- ✓ **Societal impact**

  IoT devices have a significant impact on society. Smart homes and offices can reduce energy costs by controlling appliances when away from home or work. In industrial perspective, reducing manpower in terms of remote control of the industrial application is a commercially effective process. Even they can provide better security through continuous monitoring and taking measures. proactively in the event of a security breach. This project offers low-cost control and monitoring system that offers economic benefits.

- ✓ **Health impact**

  The world's growing population and rising expectations for the security of life in the workplace are placing increasing pressures on healthcare. So, health care continues to be one of the world's most important social and economic challenges.

- ✓ **Safety impact**

  Human safety is a very important term in any industry. With this application, people can control different risky loads remotely. On the other hand, in this pandemic situation, people are very much aware of maintaining distance and the government is inspiring them to work from home. As this project is an IoT-based project, many staff can do their job from home using this application which will maintain social distances and safety. due to having an Alarming system in this project, will give rise to safety issues for the workers who are working in heavy load area where gas or fire explosion can take place. Also, this proposed project offers no harm to the industry and the working environment as the component we are using don‟t have any explosive material. [15]

✓ Legal impact

If we talk about the legal issue, this initiative will not be carried out in a way that is illegal. Every instrument and equipment we mentioned to apply is legal in our country. As many research papers have already used this component for different purposes for their research. Globally these components are available in the marketplace and usable for all. are We as a team had planned and proposed that it will not cause any damage to our environment, rather it will be helpful to our society.

Evaluation of sustainability: Sustainability refers to a society's ability to improve the quality of life while maintaining the availability and quality of natural resources. Simply put, it means building a project in a way that does not have a negative impact on the environment or that minimizes or compensates for our impact on the environment. As our project is IoT-based, there are different aspects of developing a sustainable project that needs to be considered while addressing a sustainable plan.

- ✓ **Social and economic considerations**: The rise of IoT technologies is currently intense and according to projections for the next 10 years, over $125 \cdot 10^9$ IoT devices are expected to be connected. [16] This IoT technology could have a social impact due to the reduced necessity for labor, as our project is about monitoring industrial appliances and the environment from a remote place, the industry may need less stuff to monitor industrial applications. Hence, quality employees are hard to find in the labor industry, so monitoring through remote places needs less eligible manpower for the purpose of quality control. Therefore, recruiting fewer employees can bring economic sustainability to the industry.
- ✓ **Environmental consideration:** Environmental consideration may bring waste of electrical material that use to run a big project, as wastage of material may bring harm to the environment. hence, we are using components that are more sustained and long-term useable and sometimes reusable as well. Furthermore, to have a network-based system, it has no harmful effect on the environment as it doesn‟t emit any toxic elements or something from that or from its wastage environment got threatened.
- ✓ **Air Quality Monitoring**: A sustainable project needs to offer a positive impact on the working environment and on the workers. As the development in industrialization, effective management and safety consideration of workers are related directly with safe environment. Hence, the quality of air inside the industry is one of the crucial aspects of workplace security. This project system can read temperature and flammable gas from the air and update it on the thingspeak website which will give a constant update to the stakeholder to ensure workplace safety monitoring and to maintain good health.

conclusion: Sustainable engineering refers to an engineering approach that takes into consideration the sustainable solutions to the problem of sustainable development. To conclude with this, in this proposed project sustainable solutions in terms of societal, economical, and environmental considerations have been addressed. To meet the goal toward industrial success we can say this engineering solution will meet sustainability in project management and in sustainable development.

Chapter 7: Engineering project management

Introduction: Engineering project management is a type of project management that focuses solely on engineering projects. For a successful project, the following project management principles are essential assets to chart the way forward**.** In this final year design project, we have managed our project and validated the whole project as teamwork. since multiple designs were evaluated to get the optimal solution, we had done so many experiments. From the beginning of the final year design project, we had to finalize our project and was evaluated by the supervisor and discussed among ourselves by constant weekly meetings and thorough checklist (logbook), we had to mark our work progress.

Management of Engineering project

- ✓ **Initiating:** Having done several types of research on industrial automation, we had approached this project. In industrial, IoT has brought a new revolution in industrial automation and brought a huge change in the way of industrial development. As our interest was IoT-based, so we decided to work in this area to contribute our work in this field. As per our supervisor guideline, we were guided to find our desired topic selection and were guided throughout the whole project and monitored by continuous weekly meetings and through a checklist what we had done was listed in it from the beginning.

- ✓ **Planning:** Our contribution to the work equally participates in what we have done so far. To come up with the final solution we have conducted several experiments. IT can be divided into several parts
  - **Project structure:** A project structure can often be successfully created by looking at project goal, project timeline, and order, project milestone. In order to accomplish our project, we have a clear structure of our project that defines how our project is actually working.

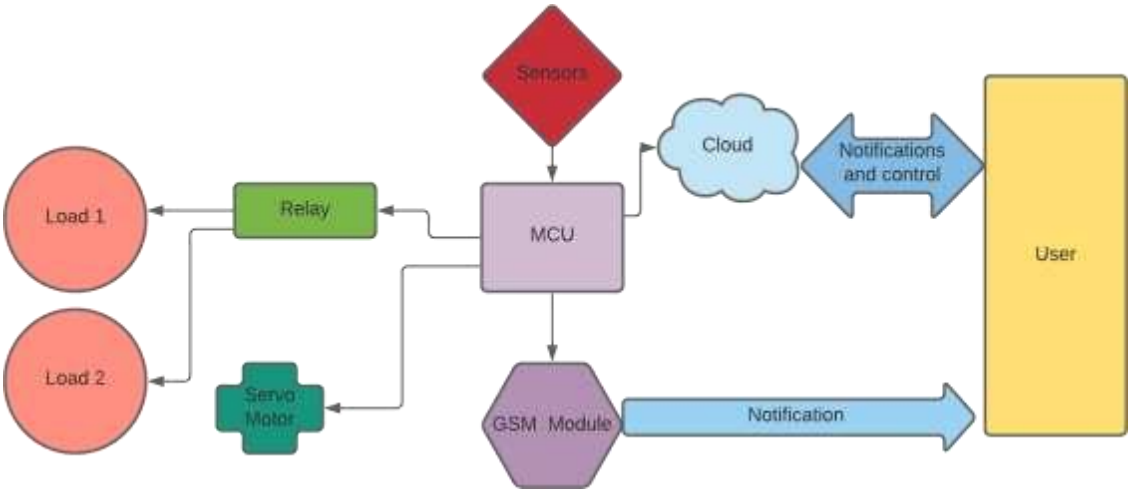

Fig 7.2.1: project structure overview

- **Clear goal:** As engineering students and to work on final year design project we must have our clear goal and vision in order to get the achievement from the project .. our goal is to give a safety control and monitoring system in the factory or industrial area where fire and gas parameter being used as commercial purpose. we structured a control system to see those parameters are working in normal conditions or not.
- **Transparency of project status**: We are using components that are available in the marketplace and also authorized. Even our project management and ideas are also valid as our reference research papers are taken from renowned sources. our project workflow was also monitored through the supervisor panel. As we are integrating sensors in our project can also monitor the environment through Thingspeak third party data storage and display in real-time on their website as it considers public access it is easy to monitor
- **Risk recognition &Managing project disturbance:** It‟s our duty to evaluate risks regularly in our project. we should consider that every project may come with a variety of risks. As our project is based on the IoT platform, we may face default internet connectivity issues. Internet breakdown may cause severe damage in the application area so we consider a second communication medium. Even the power supply to the control unit needs to back up so we add a backup power supply to the project.

✓ **Execution:** Our project was divided into three-part among ourselves .. one is a deep literature review about relevant projects and experiments to gather deep knowledge to maintain the standard of the project. another part is the technical part which consists of software integration and hardware implementation and another part is project management. we divided work according to the constant meeting among ourselves and with our mentors. Our contribution has taken into every part of our project. Each update of any part of the project has been approved by the supervisor and listed In the LOGBOOK of the project.

Evaluation of project progress: The total time span for the project work has been upheld in the Gantt chart. The project progress has been evaluated according to plan.

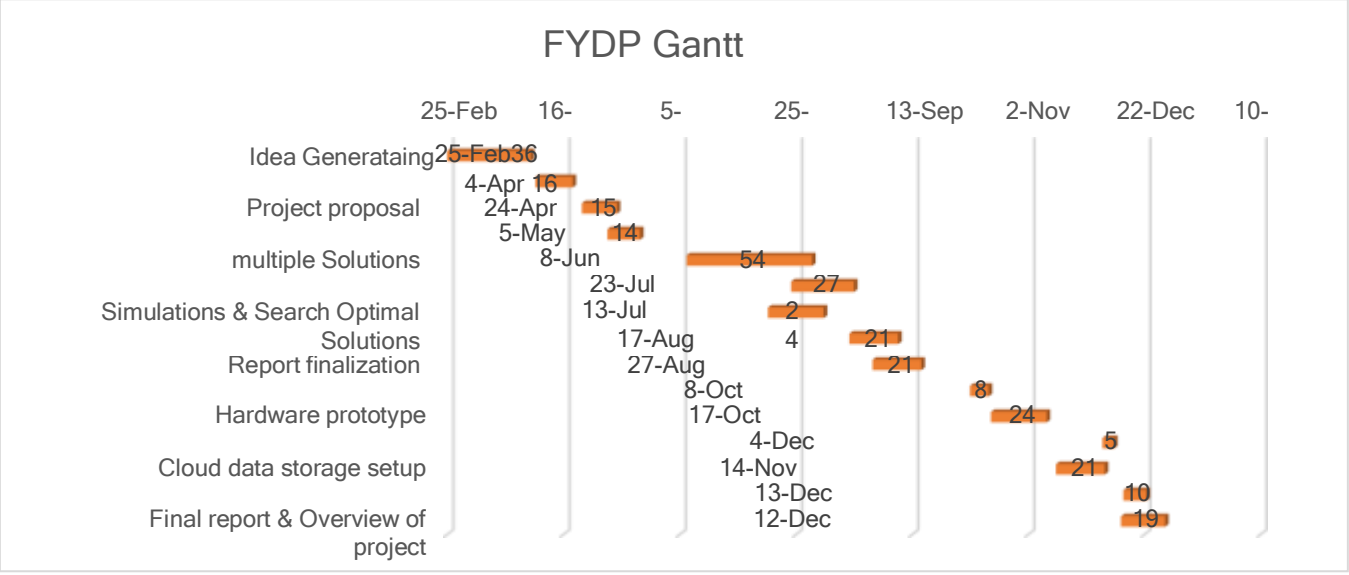

Chart 7.3.1: Final Project Gantt Chart

Our final year design project was evaluated through three steps throughout the year. From the beginning of the final year design project, we were planned how to successfully complete a project. According to our FYDP time frame, we first submit draft prosomal, and later we submit our final proposal to our supervisor panel in FYDP-(c). After approving our project proposal, we started doing multiple solutions and finding optimal solutions and validation were the main focus of the FYDP-D design semester. Our supervisor panel approved our progress throughout the semester and suggested us work on it according to the problem that we faced during finding multiple solutions. We approach different ways to find the optimal solution and validate our final solution considering the problem we faced and suitable solution for our project. In the FYDP-P final semester, we worked on a hardware prototype, find suitable components for our project considering cost efficiency and quality product available in the market. we use these components according to our required specifications. Finally, we demonstrate our final project prototype and approved it by the supervisor panel. We visited the industry to collect data and made a chart of how we can validate our project according to our industrial project perspective. A Gantt chart is shown bottom to see how we evaluate our project management throughout the final year design project.

Chapter 8: Economic Analysis

Introduction: Good management of project design consists mainly of making smart decisions. A wise decision involves choosing between alternatives. Economic considerations of an engineering design determine the feasibility of a project and represent an alternative method of implementing the project. Economic considerations also determine the desirability of a project and how it will be implemented. Economic and Financial Analysis for Design and Project Management is intended to analyze the financial and economic impact of manufacturing and supporting capital projects. Economic analysis inherently involves the assessment of costs and benefits.

Cost-benefit and economic analysis: We designed an industrial load control and safety management project to reduce accident compensation and ensure a safe workplace. Accidents due to gas leaks and fires have now become a common occurrence in our district. But we must ensure that the accident rate is minimal or the loss of life is minimized at all costs.

We have implemented a small-scale prototype for industrial load control and safety management. If we assume a 1200 square ft room for our project implementation then the estimation will be like this:

Components	Quantity	Price (BDT)/Unit	Cost (BDT)
ESP32 ESP-32S Node MCU Development Board	1	750	750
Arduino Uno	3	620	1860
A6 Pro Serial GPRS GSM Module Core Development Board	1	1400	1400
ONESTO MRV3X industrial relay	1	1700	1700
DHT11-2 Gas Sensor	4	160	640
DHT11 Sensor	6	200	1200
Flame Sensor	24	100	2400
Peripherals			2500

Total			**12250**

Here,

Room length 40 ft or 12m

Room width 30 ft or 9m

So, we have to use a 6*4 =24 piece of the flame sensor as we know the range of the flame sensor is 1.1-meter square. For the temperature sensor, we have to use 6 pieces of DHT11. For the MQ2 gas sensor, it can detect any gas that range is 200ppm to 10000ppm. For safety, we have used 4 pieces of MQ2.

Using these products is more effective and less costly according to the latest market. Using Arduino Uno and ESP32 module at a time instead of using Arduino mega is most efficient for our project. Moreover, this project is a basic need of an industry that can save many costs and increase the effectiveness of management as well.

Evaluation of economic and financial aspects: The Internet of Things will ultimately provide control systems with low-cost, high-resolution data about the real world. It can be a tool to develop an entire field of organization and complex systems management, with all its unique strengths and weaknesses. To evaluate our economic and financial aspect we have considered the following objectives:

- The time value for money: Time value of money (TVM) is the concept that an amount of money today is worth more than a similar amount at a future date because of its earning potential. From an industry management perspective, IoT-based projects are more sustainable, efficient & cost-effective systems than people-based projects. The Internet of Things enables continuous monitoring and control of industrial environments that can deliver valuable results.
- Saving labor cost & uninterrupted service: This project can provide continuous monitoring of the industry. An ideal industry must meet several basic criteria, and a safe workplace is a top priority for all employees. Delivering these capabilities requires a full-time workforce across all industries. However, the implementation of this project can reduce these labor costs and provide continuous service. The energy required to complete this project is very low, which is negligible compared to the labor cost and high efficiency.
- Reducing demurrage and accidental issues: Accidents caused by gas leaks and plant fires can cause death and enormous economic loss. To avoid this downtime, this project helps stem holders. Our project can reduce accidents and save many lives by detecting flammable gases, fire, and heat with sensors. [17]

Chapter 9 Ethics and Professional Responsibilities

Introduction: Ethical considerations can be cited as one of the most important parts of research. Society gives engineers certain benefits, including the ability to use their training for meaningful and respected work. The purpose of Ethics is to provide a code of ethics and conduct that helps people decide what is wrong, how to behave, and how to behave when developing engineering projects. The Internet of Things (IoT) encompasses numerous things and people that are connected via the Internet „when" and „where" to provide homogeneous communication and contextual services. It thus creates a new social, ecological and ethical environment that requires new and improved legal and ethical measures for the protection of privacy, data security, protection of property rights, improved trust & the development of appropriate standards. [18]

Ethical issues and professional responsibility: Projects must maintain several ethical rules and conditions while developing and describing final work. In addition, responsibilities in professional life must be exercised for the wellbeing of the environment, society & the country. Some key issues and responsibilities include:

- If a project draft decision is invalidated in a life or property-threatening situation, the stick owner or customer and other appropriate authorities should be notified.
- Facts, data or information may not be disclosed without the prior consent of the customer or tracking owner unless permitted or required by standard code. The design of the project must be true in any professional report, statement, or testimony, including any relevant information pertaining to the report, statement, or testimony.
- Before a project can be published anywhere that requires proof of copyright or a patent, a positive agreement of ownership is required. Project designs, data, records, and all content must refer solely to the original work.

Applying of ethical issues and professional responsibility: Through the code of ethics, professional engineers have a clearly defined duty to the public welfare as paramount. Following the discussion above, there are several issues to consider when developing the project. All considerations are broken down into environmental, legal, liability, and safety aspects.

Safety issue: In our project, we are working as professional Engineers to construct this project according to the working plan and maintain the proper safety of the employers. As our project undeviatingly deals with risk aspects of employers, ethical considerations are the epitome of the things that are needed to be

acknowledged. Identifying fire or gas and also remote-control load management can reduce accident rate & risk as well in a factory. Because of using IoT-based load control, staff doesn‟t have to work in the high radiational area, and also, they don‟t need to switch off appliances in hazardous situations.

Accountability: Proper measurements will have to be maintained so that a constant check is there for various types of defective parts. As this is an IOT based project, we are remotely controlling industrial load from any distance. All employers who will be working in the industry will be alarmed if any accident is going to happen. Due to the continuation of checking and monitoring safety conditions through our sensors and our cloud module, employers will get a precaution and will be informed accordingly. All these system data will be stored as proof of any scenario which will make sure of accountability of a company.

Legal Issues: In this project, hardware components we are using are easily available in the marketplace such as Esp32 Development board, Gas detection sensors, GSM Module, DHT11 temperature sensor, etc. As they are legally sold in the marketplace, it is highly possible to find faults. We will make sure every sensor and component is tested and analyzed properly so that our work can make industries easily accessible and uphold their benefit and safety and the project‟s result, consideration, and constraints are very much transparent to the users

Environmental Ethics: This project will not bring any harmful impact on our environment. As we are working for controlling industrial load for giving safety management, our IOT based project design has no direct issues with environmental pollution. Rather, our project will be working to reduce gas leakage and fire occurring which may reduce environmental pollution. On the other hand, we have used quality full components to avoid wastage of projects which can also reduce environmental pollution.

Lastly, the proposed project will have to be implemented and made available at an affordable cost. So that institutions and organizations of any scale can use this system for their betterment. We are pledged to uphold the highest ethical and professional standards and acknowledge responsibility for making decisions that affect public safety, health, and wellbeing according to the code of ethics

Chapter 10: Conclusion & Future work

Conclusion This project describes an IOT based industrial security system developed with Arduino and ESP32. The system can collect sensor data and respond intelligently to specific situations and can control load remotely according to necessary. It has been developed based on wireless communication applications. It is well suited to the efficient real-time requirements of high-speed data acquisition systems in IoT environments. ARDUINO UNO integrated with ESP32 greatly simplifies peripheral circuit design and makes the entire system more flexible and scalable. Different types of sensors are available when connected to a system with additional load control functions. This paper describes a basic design method for a reconfigurable smart touch interface. Finally, taking industrial security parameter monitoring in the IoT environment as an example, we were convinced that the system would give good results in practical application. Nevertheless, there are many interesting methods for further research in this area.

: Future work: There is a lot of potentials to develop an environment that can be automatically controlled based on monitoring system alerts. The system is already connected to a GSM module in the simulation design that can notify the user of an emergency via text message as a precaution. But for some network connectivity issues, there is an error to get the proper output in hardware setup which can be developed in the future. The system can also be designed to take reasonable precautions to prevent industrial damage, such as turning on a blower fan when a gas leak is detected or turning on an industrial fire suppression system when a large flame is detected in a factory. Based on temperature and flame sensor readings. Moreover, adding a camera feature with this project in the future will make this design more effective in a monitoring perspective.

.

Chapter 11: Identification of complex Engineering problems and activities

: Identifying the attribute of complex engineering problems:

Attribution of Complex Engineering Problems

	Attributes	**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	√

: Reasoning how the project address selected attribute

This project requires a depth of knowledge of IoT-based automation which is now a rapidly increasing sector that is contributing to the industrial economy. There is no conflict between the key requirements of our proposed system Dept of analysis must require as we analyze multiple ways to come up with the final solution for this project. Many projects have been done related to the project so there are available similarities that can be found in many articles. we follow IEEE and IEC/Iso standards for this project and the components we use follow the same way which is already discussed in the applicable standard and codes section.

Attribution of Complex Engineering Activities

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

Reasoning how the project address selected attribute

We have considered a lot of resources like research papers, industrial data, hardware components to establish this project. We have to interact deeply to make this project output more appropriate. Though interacting in lockdown was very hard but we managed it in the google meet to meet our desired output. If we talk about innovation there is no further new task in this project. We had just intergraded some problem solutions into one design and tried to develop it. Moreover, this project has direct consequences on society and the environment. Applying this project to an industry can reduce industrial demurrage and also environmental pollution as well. This project isn‟t very innovative and unfamiliar in our society but by intergrading some extra features in is project had made this design more effective.

Reference

[1]. A. Shahzad, Y. Kim and A. Elgamoudi, "Secure IoT Platform for Industrial Control Systems," 2017 International Conference on Platform Technology and Service (PlatCon), 2017, pp. 1-6, doi: 10.1109/PlatCon.2017.7883726.

[2] J. Valverde, V. Rosello, G. Mujica, J. Portilla, A. Uriarte, and T. Riesgo, "Wireless Sensor Network for Environmental Monitoring: Application in a Coffee Factory," *International Journal of Distributed Sensor Networks*, vol. 8, pp. 638067, 2011.

[3] Jayasri, R & Raghavendran, R.Vidya & Rex, J Antony Daniel. (2018). A SURVEY ON INDUSTRIAL AUTOMATION BASED ON IOT WITH ARDUINO MICROCONTROLLER.

[4] Keith,D. Foote, "Brief History Of The Internet Of Things", DATAVERSITY, 16 August,2016. https://www.dataversity.net/brief-history-internet-things/

[5] *IoT vs. SCADA. What's the Difference?*, 2020, www.3agsystems.com/blog/iot-vs-scada.

[6] Hwaiyu Geng, "IoT REVOLUTION IN OIL AND GAS INDUSTRY," in Internet of Things and Data Analytics Handbook , Wiley, 2017, pp.513-520, doi: 10.1002/9781119173601.ch31.

[7] "ISO/IEC TR 30166:2020." *ISO*, 30 Apr. 2020, www.iso.org/standard/53286.html.

[8] G. R. Hiertz, D. Denteneer, L. Stibor, Y. Zang, X. P. Costa and B. Walke, "The IEEE 802.11 universe," in IEEE Communications Magazine, vol. 48, no. 1, pp. 62-70, January 2010, doi: 10.1109/MCOM.2010.5394032

[9] "Technical Requirements and Application of Sensor Network for Wireless Gas Meters." *Technical Requirements and Application of Sensor Network for Wireless Gas Meters | StandICT.eu 2023*, 1 Oct. 2018, www.standict.eu/standards-repository/standard/technical-requirements-and-application-sensor-network-wireless-gas.

[10] G. Acampora and A. Vitiello, "Extending IEEE Std 1855 for designing Arduino™-based fuzzy systems," 2017 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE), 2017, pp. 1-6, doi: 10.1109/FUZZ-IEEE.2017.8015755.

[11] *Blynk Pricing, Features, Reviews & Alternatives | Getapp*. www.getapp.com/emerging-technology-software/a/blynk/.

[12] A. Mosavi, "Application of multi-objective optimization packages in the design of an evaporator coil," World Academy of Science, Engineering and Technology, Vol. 61, No. 37, pp. 25-29, 2010.

[13] [Mahzan, N.N., Enzai, N.M., Zin, N.M. and Noh, K.S.S.K.M., 2018, June. Design of an Arduino-based home fire alarm system with GSM module. In *Journal of Physics: Conference Series* (Vol. 1019, No. 1, p. 012079). IOP Publishing.]

[14] "Electronic Components Pinouts, Details & Datasheets." *Components101*, components101.com/.

[15] Aris, I.B., Sahbusdin, R.K.Z. and Amin, A.F.M., 2015, May. Impacts of IoT and big data to automotive industry. In 2015 10th Asian Control Conference (ASCC) (pp. 1-5). IEEE.

[16] Nižetić, Sandro, et al. "Internet of Things (IOT): Opportunities, Issues and Challenges towards a Smart and Sustainable Future." *Journal of Cleaner Production*, Elsevier, 20 Nov. 2020,

[17] Fleisch, Elgar. "What is the internet of things? An economic perspective." *Economics, Management, and Financial Markets* 5.2 (2010): 125-157.

[18] Tzafestas, Spyros G. "Ethics and law in the internet of things world." *Smart cities* 1.1 (2018): 98-120.

Appendix

1. FYDP(C) LOGBOOK

Date/Time /Place	Attendance	Summary of Meeting Minutes	Responsible	Comment by ATC
Date: 14.10.2021 Time: 11.00pm Place: google meet	1. Shah Rukh Islam 2.Mehedi Hasan 3.Yousuf Mohammad	Discussion about implementation of prototype	yousuf-design mehedi-prototype Shahrukh-software integration	.
Date: 21.10.2021 Time: 2.00pm Place: Google meet	1. Shah Rukh Islam 2. Mehedi Hasan 3. Yousuf Mohammad	ATC meeting Progress flow... Prototype implementation	Yousuf-working with Esp32 Multiple testing - shahrukh and mehedi	sensor integration in industrial perspective
Date: 28.10.2021	1. Shah Rukh Islam 2. Mehedi Hasan 3.Yousuf Mohammad	ATC meeting Problem finds out regarding sensor integration	Mehedi – Arduino code generation Shahrukh-blynk operation Yousuf- Gsm module	Find out appropriate background and literature review with reference
Date: 01.11.2021	1.Shah Rukh Islam 2. Mehedi Hasan	Real-time sensor calculation, data analysis from an online source		

	3.Yousuf Mohammad			
Date: 04.11.2021 Time: 12.30pm-1.20pm	1. Shah Rukh Islam 2. Mehedi Hasan	ATC meeting Build prototype, sensors implementation. (Temperature, flame sensor, Gas sensor)	Yousuf- prototype Shahrukh- GSM module 2g Mehedi-GSM module	Evaluate sensor output according to industry

Place: google meet	3. Yousuf Mohammad	2. facing problem implementing GSM module.		
Date 11.11.2021 TIME: 12.00PM-1.00PM PLACE: Google meet	1. Shah Rukh Islam 2. Mehedi Hasan 3. Yousuf Mohammad	ATC meeting 1. need to collect industrial data 2. need to work with thingspeak 3. GSM problem discussed and asked to be solved	Mehedi-industrial data Shahrukh-thingspeak Yousuf-GSM	Work with the given task individually.
Date 16.11.2021 TIME: 12.00PM-1.00PM	1. Shah Rukh Islam 2. Mehedi Hasan 3. Yousuf Mohammad	1. Problem facing with thingspeak. AT command Error, 2. Gsm module compile error		
18.11.2021	1.Shah Rukh Islam 2. Mehedi Hasan 3.Yousuf Mohammad	ATC Meeting 1. Industrial data analysis 2. implemented solution testing 2. progress presentation.	Industrial data analysis-mehedi Finalize sensor implementation-Yousuf and Shahrukh	1. Prepare slide for presentation 2. Analyze industrial data according to project
22.11.2021	1.Shah Rukh Islam 2. Mehedi Hasan	ATC meeting 1. slide modification Discus C09, CO10 to evaluate the progress.	Prepare for presentation.	1. need to submit progress slide within 24th 3 pm.

	3.Yousuf Mohammad			
25.11.2021		Progress presentation.		
06.12.2021	1.Shah Rukh Islam	ATC Meeting 1. report progress	Yusuf-MCU board integration	1. use multiple MCU board

	2. Mehedi Hasan 3.Yousuf Mohammad	2. multiple sensor integration processes according to an industrial floor.	Shahrukh, Mehedi - C013 assessment	Evaluate C013 for ethical consideration.
13.12.2021	1. Shah Rukh Islam 2. Mehedi Hasan 3. Yousuf Mohammad	ATC Meeting 1. finalize thingspeak problem and update the website. 2. Update final report	Shahrukh- thingspeak Yusuf- multiple MCU Mehedi- MCU code generation, Arduino IDE	Submit a Draft report of final project report within 18th December
20.12.2021	1. Shah Rukh Islam 2. Mehedi Hasan 3. Yousuf Mohammad	1. Finalize design and develop the solution 2. progressing on report		

2. Necessary Code:

: For Blynk and load control:

```
#define BLYNK_PRINT Serial
#include  <WiFi.h>
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>// Blynk library included from
here:https://github.com/blynkkk/blynk-library/releases/latest

char auth[] = "Au5Q51s60sodSMcER6msYUCHXu-fFgcg";//authcode of blynk
char ssid[] = "dishting dishting_plus";//wifi credentials.
char pass[] = "XHHFRHHT14481925";//wifi password

void setup()
{
  // Debug console
  Serial.begin(9600);

  Blynk.begin(auth, ssid, pass);
}

void loop()//An infinite loop to run the code from the included library
{
  Blynk.run();// library code run
}
```

For Sensors & Actuators:

```
#include<Servo.h>
Servo myservo;
int pos = 0;
int val;
#include <LiquidCrystal.h>
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);
#include <SoftwareSerial.h>
SoftwareSerial mySerial(9, 10);
byte tx = 1;

const int Buzzer = 6;
const int DC_Motor = 7;

int gasC_1 = 0; //set initial tempC 0 for all MQ 3
int smkC_1 = 0; //set initial tempC 0 for all MQ 2

const int SensorPin1 = A0; //fire input sensor pin
const int SensorPin2 = A1;

String textForSMS;
void setup()
{
  lcd.begin(16, 2);
  delay(100);
```

```
  pinMode(tx, OUTPUT);
  myservo.attach(13);
  pinMode(Buzzer, OUTPUT);
  pinMode(SensorPin1, INPUT);
  pinMode(SensorPin2, INPUT);
  pinMode(Buzzer, OUTPUT);
  pinMode(DC_Motor, OUTPUT);

  mySerial.begin(9600);
  Serial.begin(9600);
}
void loop()
{
  int gasC_1 = analogRead(SensorPin1);
  int SmkC_1 = analogRead(SensorPin2);
  gasC_1 = analogRead(SensorPin1); //read the value from the LM35 sensor
  gasC_1 = (5.0 * gasC_1 * 100.0) / 1024.0; //convert the analog data to
temperature
  smkC_1 = analogRead(SensorPin2); //read the value from the MQ 2 sensor
  smkC_1 = (5.0 * smkC_1 * 100.0) / 1024.0; //convert the analog data to
temperature
  delay(50);



  if (gasC_1 >= 100 || smkC_1 >= 100)
  {
    val = analogRead(pos);
    val = map(val, 0, 1023, 0, 180);
    myservo.write(val);
    delay(50);
    digitalWrite(DC_Motor, HIGH);

    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("  THERE IS FIRE ");
    lcd.setCursor(0, 1);
    lcd.print(" NOT SAFE HERE ");
    delay(100);
    lcd.clear();
    lcd.print("Sending SMS...");
    delay(100);

    digitalWrite(Buzzer, HIGH);
    delay(200);
    digitalWrite(Buzzer, LOW);
    delay(200);
    digitalWrite(Buzzer, HIGH);
    delay(200);
    digitalWrite(Buzzer, LOW);
    delay(5);


    Serial.print("AT+CMGF=1\r");
    delay(100);
    Serial.print("AT+CMGS=\"+233266302607\"\r"); // Contact number That
recieve the message
```

```
    Serial.print("FIRE ALERT! Please Be Informed that Fire has Occured!\r");
// message


    delay(200);
    Serial.println((char)26); // End AT command with a ^Z, ASCII code 26
    delay(200);
    Serial.println();
  }
  else
  {
    digitalWrite(DC_Motor, LOW);
    myservo.write(95);
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("    NO FIRE    ");
    lcd.setCursor(0, 1);
    lcd.print("   ALL SAFE   ");
  }
}
```

: For ThinkSpeak:

```
#include <ESP8266WiFi.h>
#include "secrets.h"
#include "ThingSpeak.h" // always include thingspeak header file after other
header files and custom macros
#include "DHT.h"

#define DHTTYPE DHT11
#define DHTPIN 2

char ssid[] = SECRET_SSID;   // your network SSID (name)
char pass[] = SECRET_PASS;   // your network password
int keyIndex = 0;            // your network key Index number (needed only
for WEP)
WiFiClient  client;

unsigned long myChannelNumber = SECRET_CH_ID;
const char * myWriteAPIKey = SECRET_WRITE_APIKEY;


String myStatus = "";
DHT dht(DHTPIN, DHTTYPE);
void setup() {
  Serial.begin(115200); // Initialize serial
  while (!Serial) {
    ; // wait for serial port to connect. Needed for Leonardo native USB port
only
  }

  WiFi.mode(WIFI_STA);
  ThingSpeak.begin(client); // Initialize ThingSpeak
     dht.begin();
}
```

```
void loop() {

  // Connect or reconnect to WiFi
  if(WiFi.status() != WL_CONNECTED){
    Serial.print("Attempting to connect to SSID: ");
    Serial.println(SECRET_SSID);
    while(WiFi.status() != WL_CONNECTED){
      WiFi.begin(ssid, pass); // Connect to WPA/WPA2 network. Change this
line if using open or WEP network
      Serial.print(".");
      delay(5000);
    }
    Serial.println("\nConnected.");
  }

 int h = dht.readHumidity();

 int t = dht.readTemperature();
  if (isnan(h) || isnan(t))
    {
      Serial.println("Failed to read from DHT sensor!");
      return;
    }


  // set the fields with the values
  ThingSpeak.setField(1, t);
  ThingSpeak.setField(2, h);




  // write to the ThingSpeak channel
  int x = ThingSpeak.writeFields(myChannelNumber, myWriteAPIKey);
  if(x == 200){
    Serial.println("Channel update successful.");
  }
  else{
    Serial.println("Problem updating channel. HTTP error code " + String(x));
  }



  delay(20000); // Wait 20 seconds to update the channel again
}
```

: For master-slave ESP32 & Arduino:

```
#include <WiFi.h>
```

```
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>
#define LED 14
#define flame_sensor 12
char auth[] = "P1yG69YN4AxEwYFfeSuqYAw7j7RmJDVH";//authcode of blynk
char ssid[] = "dishting dishting_plus";//wifi credentials.
char pass[] = "01521331371";//wifi password
void setup()
{
  Serial.begin(19200);
  Blynk.begin(auth, ssid, pass);
  pinMode(LED, OUTPUT);
  pinMode(flame_sensor, INPUT);

}

void loop()
{

     Blynk.run();// library code run

 int flame_detected = digitalRead(flame_sensor);
  if (flame_detected == 1 )
  {
    Serial.println("Flame detected...! take action immediately.");
    digitalWrite(LED, HIGH);


  }
  else
  {
    Serial.println("No flame detected. stay cool");

    digitalWrite(LED, LOW);
  }
  delay(1000);
}
```

5.3.5: For GSM module:

```
#include<Servo.h>
Servo myservo;
int pos = 0;
int val;
#include <LiquidCrystal.h>
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);
#include <SoftwareSerial.h>
SoftwareSerial mySerial(9, 10);
byte tx = 1;

const int Buzzer = 6;
const int DC_Motor = 7;

int gasC_1 = 0; //set initial tempC 0 for all MQ 3
int smkC_1 = 0; //set initial tempC 0 for all MQ 2
```

```
const int SensorPin1 = A0; //fire input sensor pin
const int SensorPin2 = A1;

String textForSMS;
void setup()
{
  lcd.begin(16, 2);
  delay(100);
  pinMode(tx, OUTPUT);
  myservo.attach(13);
  pinMode(Buzzer, OUTPUT);
  pinMode(SensorPin1, INPUT);
  pinMode(SensorPin2, INPUT);
  pinMode(Buzzer, OUTPUT);
  pinMode(DC_Motor, OUTPUT);

  mySerial.begin(9600);
  Serial.begin(9600);
}
void loop()
{
  int gasC_1 = analogRead(SensorPin1);
  int SmkC_1 = analogRead(SensorPin2);
  gasC_1 = analogRead(SensorPin1); //read the value from the LM35 sensor
  gasC_1 = (5.0 * gasC_1 * 100.0) / 1024.0; //convert the analog data to
temperature
  smkC_1 = analogRead(SensorPin2); //read the value from the MQ 2 sensor
  smkC_1 = (5.0 * smkC_1 * 100.0) / 1024.0; //convert the analog data to
temperature
  delay(50);



  if (gasC_1 >= 100 || smkC_1 >= 100)
  {
    val = analogRead(pos);
    val = map(val, 0, 1023, 0, 180);
    myservo.write(val);
    delay(50);
    digitalWrite(DC_Motor, HIGH);

    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("  THERE IS FIRE ");
    lcd.setCursor(0, 1);
    lcd.print(" NOT SAFE HERE ");
    delay(100);
    lcd.clear();
    lcd.print("Sending SMS...");
    delay(100);

    digitalWrite(Buzzer, HIGH);
    delay(200);
    digitalWrite(Buzzer, LOW);
    delay(200);
    digitalWrite(Buzzer, HIGH);
    delay(200);
```

```
    digitalWrite(Buzzer, LOW);
    delay(5);


    Serial.print("AT+CMGF=1\r");
    delay(100);
    Serial.print("AT+CMGS=\"+233266302607\"\r"); // Contact number That
recieve the message
    Serial.print("FIRE ALERT! Please Be Informed that Fire has Occured!\r");
// message


    delay(200);
    Serial.println((char)26); // End AT command with a ^Z, ASCII code 26
    delay(200);
    Serial.println();
  }
  else
  {
    digitalWrite(DC_Motor, LOW);
    myservo.write(95);
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("    NO FIRE    ");
    lcd.setCursor(0, 1);
    lcd.print("   ALL SAFE   ");
  }
}
```