IoT BASED INTELLIGENT WIRELESS SUBSTATION MONITORING AND CONTROLLING SYSTEM

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

Department of Electrical and Electronic Engineering
Brac University
November, 2022

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Department of Electrical and Electronic Engineering
Brac University
November, 2022

Declaration

It is hereby declared that

1. The Final Year Design Project (FYDP) submitted is our own original work while completing a degree at Brac University.

2. The Final Year Design Project (FYDP) does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.

3. The Final Year Design Project (FYDP) does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.

4. We have acknowledged all main sources of help.

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Approval

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of Summer, 2022 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Science in Electrical and Electronic Engineering on 01-09-2022.

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Ethics Statement

We confirm that this project on “IoT Based Intelligent Wireless Substation Monitoring And Controlling System” meets the completion criteria of the final thesis and this project is entirely the result of our own efforts and there is no plagiarism. With the support of our Academic Technical Committee and EEE department, we did the whole project by ourselves and collected some data from other duly referenced sources.

Abstract/Executive Summary

As the advancement of technologies, the automation of substations has become a key concept in the current world. In order to improve the power quality it is necessary to have an idea about the constraints that occurred. As a result, this project proposes an IoT based system for the monitoring, controlling and protection of the system and analysis of data in a simpler cost effective manner. The sensor data is conveniently accessed by any device wirelessly through IoT. It incorporates real time error free data of substation. The remote electrical parameters we focused on this project are voltage, current, temperature and frequency. In this prototype, we have a set of predefined values for the parameters. A relay ensures the protective part and sends alerts to the users during any faults and once the problem is resolved the system works again.

Keywords: Internet of Things (IoT); Substation; Predefined values; Arduino; SCADA; Relay

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List of Acronyms

IoT	Internet of Things
HMI	Human Machine Interface
PLC	Programmable Logic Controller
RTU	Remote Terminal Unit
MTU	Master Terminal Unit
DTE	Data Terminal Equipment
DCE	Data Communications Equipment

Glossary

Term	**Definition**
Repercussions	An unintended consequence of an event or action, especially an unwelcome one
Autonomously	With the freedom to act independently.
Interfaced	Connect with (another computer or piece of equipment) by an interface.
Immersion	The action of immersing someone or something in a liquid
Latency	The delay before a transfer of data begins following an instruction for its transfer.
Lifespan	The length of time for which a person or animal lives or a thong functions.
Preventative	Designed to keep something undesirable such as illness or harm from occurring; preventive.
Latter	Occurring or situated nearer to the end of something than to the beginning.
Personalized	Designed or produced to meet someone's individual requirements.
Discrepancies	An illogical or surprising lack of compatibility or similarity between two or more facts.
Computerized	Adapted so as to be operated by computer.
Inspected	Examine something to ensure that they reach an official statement.
Persists	Continue in an opinion or course if action of difficulty or opposition.
Fossil Fuels	A natural fuel such as coal or gas, formed in the geological past from the remains of living organisms.

Consumption	An amount of something which is used up or ingested.
Validate	Demonstrate or support the truth or value of.
Optically	In a way that relates to light or the ability to see, or to what someone sees.
Threshold	The level at which one starts to feel or react to something.
Conventional	Based on or in accordance with what is generally done or believed.
Longevity	Long existence or service
Deterioration	The process of becoming progressively worse.
Infrastructure	The basic physical and organizational structures and facilities (e.g. buildings, roads, power supplies) needed for the operation of a society or enterprise.
Entails	Have as a logically necessary consequence.
Viability	Ability to work successfully.
Adhere	Believe in and follow the practices of.

Chapter 1: Introduction- [CO1, CO2, CO10]

1.1 Introduction

The usage of electricity as a source of energy is tremendously beneficial. It is an important component of the society that we live in today. It is one of the most important components of the infrastructure not only of the nation but also of the entire world. When the system fails, it has significant direct and indirect repercussions for the economy of the country. Therefore, ensuring continued safety is an absolute necessity. We have settled on the name "IoT Based Intelligent Wireless Substation Monitoring and Controlling System" for the system we will be developing as a consequence of our choice. We have high hopes that this effort will contribute significantly in some way.

1.1.1 Problem Statement

Historically, electrical data was collected manually over a period of time. This manual data collecting requires labor, resulting in growing maintenance expenses and data collection problems. Using an IoT module, The goal of this work is to gather voltage, current, and temperature readings from far away and display them in real time. In addition, this will minimize the necessary labor, lower maintenance expenses, and facilitate the collection of error-free data. However, by allowing the substations to operate autonomously, damage-causing spikes in different parameters may be prevented.

1.1.2 Background Study

The collection of data is done through sensors like ZMPT101b, ACS712, NTC Thermistor which allow error-free data collection for voltage, current and temperature respectively. The data is updated to the server using IoT [1]. In this project, real-time data can be read from distant locations as an IoT module is interfaced with the Arduino.

Qing-Hai suggested an Internet of Things (IoT) method for monitoring the health of electricity distribution networks and developing early warning systems [2]. The writers make an effort to address environmental monitoring topics including water immersion and temperature and humidity. The system will display monitoring points of the most up-to-date environmental temperature, humidity, and water immersion status data in distribution equipment by using door magnetic sensors in strategic locations, such as the cable channel, cable well cover, ring net cabinet, and transformer control cabinet surface. This allows for real-time monitoring of temperature information of distribution network equipment, early warning, alarm, and theft finding.

The Internet of Things (IoT) has the potential to revolutionize online transmission line monitoring, and R. Li, J. Liu, and X. Li have created a paradigm for developing an IoT-based networking approach for this purpose [3]. And it takes into account the low-power needs of node devices while optimizing networking protocols with minimum overhead management. X. Shen et al. [4] built a model of the management system for the life cycle of power transmission and transformation equipment using the Internet of Things. It has features including abnormal alerts for electrical equipment, in-depth examination of equipment state, and a cost-benefit analysis of electrical equipment's lifespan. To keep tabs on things like customer usage, outages, power quality control, and pole transformer condition, the authors modeled IoT-based SCADA combined with fog for automated power distribution. This is aided by fog computing, which focuses on streaming analytics in real time. Faster regulation is achieved at the expense of less internet capacity and latency [5].

The following guiding principles serve as the foundation for the policy governing the management of high voltage electrical equipment operation and maintenance [6]. When maintaining or even replacing electrical equipment, the current technical state should be taken into account rather than the age, To reduce the likelihood of significant outages, whether or not they are accompanied by fire or other losses, the on and/or off-line monitoring activities should quickly identify changes in the current technical situation, Extending the operational service lifespan with proper maintenance. The majority of current maintenance practices are corrective and preventative (time-based) [7]. The former is successful for assets that are plentiful, unnecessary, and simple to replace as well as for those that have already failed if the failure is repairable. In another instance, it needs to be replaced by a purchase. The latter is currently the most popular. It entails evaluating the state of the assets at each scheduled interval according to the specifications of the producer and utility experience. The kind of asset and the intended assessment will determine how long it takes.

The IEC 61850 series provides immediate information in real-time in addition to control and safety features [8].This is an important issue for applications that must use monitoring or metering methods [9]. Substation operators may get insight into when maintenance is due, how to prevent equipment failure, how to regulate it actively, how to improve commissioning tests, and how to determine when equipment has reached the end of its useful life, all via monitoring. Analysis of the manifestations, root causes, and consequences of failures in a given component or system is the goal of the Failure Modes and Effects Analysis (FMEA) methodology. The introduction of monitoring may be aided by a failure mode and effects analysis (FMEA), which can be carried out during the design phase or after the equipment has been put into operation. Then, monitoring should be selected to provide early warning of known dangers. The state of the equipment causes and is indicative of an approaching breakdown. Over a local area network, relay communications may take either a serial or a networked form [10]. It is possible to synchronize the relays using GPS time. All fault records and event sequence files may then be compared to draw conclusions about what went wrong.

To name a few examples of functional characteristics: opening and closing periods, travel traits, lock-out pressure thresholds, and automated features like pole discrepancy [11]. From the standpoint of the CB's essential functions, major failures are specified, but from the perspective of the system, such a failure may not affect with the system's fundamental operations (for example, it does not open or shut on an operator's command). Therefore, because the information described by IEC is stated from the viewpoint of the equipment, there may be difficulties when utilities want to directly correlate their failure reporting, which is linked to power interruption.

With the improvement of the reliability of the power supply requirements and the development of the smart grid in the community, it is necessary to improve the level of automation for the power distribution substation, but because the structure of the distribution grid often changes, the distribution automation systems are not mature in the short term [12].

If the configuration of the distribution substation is according to the hub substation monitoring, the cost is too high, and the one-time investment is too large. Therefore, we are required to analyze the problems in-depth in the distribution substation operation, maintenance, and management, and to research and develop a reasonable cost for comprehensive monitoring and early warning analysis systems, which could improve the reliability and automation level of the distribution substation operation. An rise in the proportion of renewable energy sources used to generate electricity, however, might lead to complications in the power system [13].The transmission and distribution grids that make up the electric power system are made up of a large number of dispersed, autonomously controlled, and very expensive assets. Power plants, wires, transformers, and safety gear are all examples of such assets [14]. It is possible to turn off the transformers if a parameter is detected to be beyond of the acceptable range [15]. It's important to note that microcontrollers often have more than just a central processing unit [16].

1.1.3 Literature gap

The AC voltage is measured with the use of a perfect voltage transform, ZMPT101B. It measures voltage and power up to 250V AC with extreme precision, operates smoothly, and can be adjusted to any desired ADC output with a simple turn of a trim potentiometer[1]. TSensing a Powerful Overlay The Internet of Things relies on sensor id gear to achieve data collection, identification, and convergence [2]. The key problem in data exchange standard of IoT is addressing the uniqueness problem of naming; this is especially true in the context of power networks, where it is challenging to replace sensors due to the sheer number of different types of sensors and the information associated with each sensor's mark, semantics, and data format. This is a growing issue as IoT-based use cases gain traction. If you need a reliable technical guarantee for always following up on errors, online monitoring is the way to go. In order to effectively deploy risk management measures for power grid equipment, reasonable alarm must be in place [4]. With the advent of cloud computing, IoT has become a practical possibility. Unfortunately, not all IoT devices can benefit from cloud services. High-speed control actions are essential in industrial IoT systems, and this can only be achieved by instantly analyzing data collected from sensors. [5]. The online monitoring systems provide technical information extremely useful that the operation personnel and the ex[erts could not obtain in any other way, related to faults produced at the two mentioned power transformer units [6]. Evaluation of the oil condition (dielectric and refrigerant) is the primary focus of power transformer monitoring, with the goal of providing an estimate of the cellulose (dielectric) status of the active component (core and windings) [7]. The IEC 61850 series provides a number of benefits, including control and protection features and real-time data availability. This is a major concern for programs that must use monitoring strategies [8]. Outputs from a current and voltage transformer, digital relay probing for fault magnitude and interrupting time, inputs and outputs for controlling the timing of events, and temperature readings are all accessible [9]. Both serial and IP networks may be used for relay communications [10]. Compared to the first survey's 1.58 major failures per 100 CBY, the second survey's 0.67 major failures per 100 CBY, and the third survey's 0.30 major failures per 100 CBY showed significant improvement [11]. Acquisition of 14 separate thermal pictures utilizing a FLIR thermal camera at NIT's Tiruchirappalli, Thuvakudi substation (110 kV/11 kV) has confirmed the suggested algorithm's usefulness in real time [12]. An independent data collection and control unit was implemented using an Arduino board to remotely monitor and operate field equipment through a mobile terminal unit (MTU) and locally using a tablet computer [13]. Substation microcontroller records current, voltage, and temperature readings over a set time period [14]. All of the data is recorded and may later be seen on an LCD screen. The ACS712 current sensor is a 5V device that provides an analog voltage reading that is directly proportional to the current flowing through its measuring terminals [15]. A sizeable fraction of the energy sector is already wired for the Internet, which facilitates communication with utilities and allows for the balancing of power production and the optimization of energy use overall [16].

1.1.4 Relevance to current and future Industry

As we are in the process of developing a safety prototype for local substations, none of the local substations have implemented an IoT-based substation control and monitoring system. Due to the fact that this is a test subject, there may be unanticipated results. After receiving public comments and doing various test cases, the system can be modified to meet the specifications.

1.2 Objectives, Requirements, Specification and Constraint

1.2.1. Objectives:

- Ensuring error-free data collection.
- Monitoring real-time data from any location.
- Ensuring comparatively low cost.
- Reducing power consumption.
- Reducing labor cost by automated readings of data.

1.2.2 Functional and Nonfunctional Requirements

Functional requirements:

- Implementing a user friendly and organized monitoring and controlling system.
- Real-time updates of data of different parameters.
- Personalized alerts over any sort of discrepancies in the system.
- Requires DC input with a magnitude of less than 5V.
- Parameters: 220V voltage, Current according to load, Frequency 50Hz, Temperature 40C.

Non Functional requirements:

- To ensure the system works with efficiency by lowering the manpower and avoiding the manual collection of data.
- A portable system that can be carried anywhere

1.2.2 Specifications:

System Level Specifications:

Transformers, switching, and protection and control equipment are typical components of substations. For the purpose of preventing damage to the substation's electrical infrastructure from possible network short circuits or overload currents, circuit breakers are used in large substations. Smaller distribution stations may safeguard distribution circuits with recloser circuit breakers or fuses. Although power plants sometimes have substations nearby, substations seldom have their own generators. Capacitors, voltage regulators, and reactors are some of the other parts that may be found in a substation.

Substations may be set up in specialized buildings, underground, or in enclosed enclosures above ground. Inside such tall buildings, there might be a plethora of substations. Indoor substations are often used in urban areas to lessen transformer noise, improve aesthetics, or shield switchgear from extreme weather or pollution.

Creating a grounding (earthing) system is necessary. The touch and step potentials, as well as the total ground potential increase, must be calculated to ensure the safety of pedestrians in the event of a short circuit in a transmission system. An elevated ground potential might be the consequence of earth faults near a substation. Contact with metal objects that have a significantly different voltage from the ground due to currents running on the surface of the Earth during a fault might result in electrocution. In order to protect people from this danger, the iron fence around a substation has to be securely fastened to the ground.

For a power engineer, reliability and cost-effectiveness are top priorities. To achieve both durability and cost, a good design strikes a compromise between the two. Additional station capacity should be included into the design.

Parameters that are considered in one phase system for voltage is 230v, for current it is 0.42mA, for frequency it is 50Hz (South Asian region), and for temperature it is 25℃-35℃.

Component Level Specification:

First Approach:

Sub-system	Requirements	Components	Specifications
Monitoring system	Central Processing unit	Arduino Uno (ATmega328P microcontroller)	● 5V is the operating voltage. ● Suggestions for Input Voltage: 7-12V ● Limiting Input Voltage to 6-20V ● Connectors for Digital Outputs, Pins 14 (of which 6 provide PWM output) ● Connector Pins for Pulse Width Modulation Digital Output 6 ● Pins 6 (Analog Input) ● Twenty milliamperes of DC current for each input/output pin. ● 50 mA of DC current for a 3.3V pin ● The boot loader occupies 0.5 KB of the 32 KB of flash memory on the ATmega328P. ● A 2 KB SRAM (ATmega328P) ● 1 KB EEPROM (ATmega328P) ● Rate of 16 Megahertz ● Number Thirteen in the LED BUILTIN Sequence ● Inches: 68.6

	voltage measurement unit	ZMPT101B Voltage Sensor	• Analog 0-5V Volt-Phase Output Signal • Power Supply Voltage Range: DC 5V-30V • Accurately gauging voltages below 250 volts • Maximum 2mA current input rating • Dimensions are 49.5" by 19.4" • Micro-precision voltage transformer on board • The equivalent amount of the analog output may be modified. • Power and voltage readings are consistently accurate. • Module for sensing ac voltage with an active output, one phase
	Current measurement unit	ACS712 current sensor	• 80 kHz bandwidth • Internal resistance of 1.2 Mohm • The ability to run on a single 5V power source • Output voltage range of 66-185 mV/A
	Frequency measurement unit	PC817 optocoupler/photocoupler	• Maximum collector emitter voltage 80V • Operation temperature range(degree C)- 30 to 100
	Temperature measurement unit	LM35	• Directly in degrees Celsius (Centigrade) • +10mV/(degree C) linear Comparative factor • Half a degree Celsius Confident Accuracy (at 25 degrees C) • Temperature Resistance from 55 to 150 degrees • Power supply range: 4V to 30V • Current Drainage less than 60-µA • Self-Heating: 0.08°C (or Less) in Quiet Air

			● Typical Non-Linearity is only ±¼°C ● One-MilliAmpere (mA) Load Impedance of Only 0.1 Low-Impedance Output
	Display unit	16*2 LCD	● The range of allowable working voltage is between 4.7V and 5.3V. ● No illumination, 1mA current
Controlling system	Voltage regulato r	IC 7805	● An Optimistic 5V Voltage Regulator ● The input voltage must be at least 7V. ● There's a cap at 35V for the input voltage. ● 5mA is the operating current (Iq). ● This device has built-in thermal overload and short circuit current limiting safety. ● Maximum 125 degrees Celsius at the junction. ● TO-220 and KTE packaging are also on hand.
Protection unit	Relay module	SRD-05VDC-SL-C	● Runs on 5V ● 5 pins(3 NC, COM, NO of them are high voltage terminals that connect to be controlled) ● 2 Coils(coil 1 and coil 2)
	Piezo buzzer	Summer CPM121	● Piezo crystal between 2 conductors ● Mostly produced sound range (2-4 kHz)

Second Approach:

Sub-systems	**Requirements**	**Components**	**Description**
Remote terminal unit	CPU	Wago (750-8212)	The PFC200 Controller is a Second-Generation Dual-ETHERNET Board. Modular WAGO I/O

			System controller space requirements are met by the small form factor PFC200 Controller. The controller is compatible with all digital, analog, and speciality modules from the 750/753 Series, in addition to network and fieldbus interfaces. Wiring on a line topology is made possible by two ETHERNET interfaces and an internal switch. The PFC200's current status and user-selectable configuration settings may be seen on an embedded Web Server. The PFC200 is often used for basic machinery and equipment control in addition to the processing sector and building automation.
Modbus	Communication Module	Wago (750-652)	A WAGO I/O System 750 may be linked to devices with a C interface using this serial interface module. The WAGO I/O System 750 also includes gateways that connect the serial interface to the fieldbus systems it supports. The module is fully functional with lower-level protocols as well. In this way, the serial interface module may be used in a variety of situations without requiring any further configuration to communicate with the corresponding fieldbus master.
Fieldbus coupler module	TCP (Transmission Control Protocol)	Wago (750-362)	ETHERNET protocols HTTP(S); BootP, DHCP, DNS, SNTP, (S)FTP, and SNMP; Modbus TCP Fieldbus Coupler; 4th generation; Modbus (TCP, UDP) communication Transmission medium, Baud rate 10/100 Mbit/s, Cat 5 cable; 100 ; twisted pair; maximum cable length of 100 m Class D transmission performance as defined by EN 50173 A maximum of 250 modules may be installed on each node. Modules that don't need an extra bus extension (max.) I/O Ports, Total: 64 (fieldbus) transform the picture (max.) English (1020)German (1020) DC 24 V (-25 to +30%); receptacle plug-in power supply (system).
End Module	Buscoupler	Wago (750-600)	The fieldbus node's end module is snapped onto the constructed buscoupler and I/O modules. It's the last piece of the data circuit and guarantees proper data flow throughout the system.

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

Technical Consideration

- Checking loose connections.
- Continuous connectivity of the internet.

Non-technical Consideration

- Components availability.
- Easy to maintain.
- Cost effective.

Constraints:

- Requires continuous connectivity of the internet and power.
- Requires DC input with a magnitude of less than 5V.
- Can not detect multiple fault at a time

1.2.4 Applicable compliance, standards, and codes

Standard Code	Definition	Comment
IEEE P80	Guide For Safety in AC Substation Grounding	Outdoor conventional or gas-insulated ac substations are the primary focus of this guide. Substations are found in distribution facilities, transmission lines, and power plants. The procedures described here may be applied, with care, to indoor sections of such substations or to substations that are entirely inside. The unique grounding issues of dc substations are not addressed.
IEEE 802.11	Wireless Fidelity (Wi-Fi)	This Technology is used to fetch the data from the system and put it in the server to control it.
IEEE 1233	System Requirements Specifications	System Requirements Specification (SyRS) is a document that outlines how to create the collection of requirements necessary to meet a certain goal. The steps involved in creating a SyRS include determining what needs to be done, organizing that information, presenting it to others, and then tweaking.
IEEE 2413	Standard for architectural framework for the Internet of Things(IoT)	With the help of this standard's stated architectural framework, communication across different domains will be facilitated, as will system interoperability and functional compatibility, all of which will contribute to the expansion of the IoT industry.

1.3 Systematic Overview/summary of the proposed project

We focused on building a system that will ensure monitoring and controlling of the substations. The system consists of three sub-systems: monitoring system, controlling system and protection unit.

1. Monitoring system

In this section, we will use the microcontroller-connected sensors to keep tabs on the system's voltage, current, temperature, and frequency. The microcontroller will display the real-time values through the LCD and also update them on the server accordingly. The received data will be compared with the preset values of the parameters. If any value exceeds or is less than the preset value, the microcontroller will display a fault alert along with the buzzer on.

2. Controlling system

This subsystem focuses mainly on the voltages. Firstly, to operate the microcontroller, a regulated power supply will be applied, which consists of a step down transformer, which will convert ac 230V to 12V. Then, a bridge rectifier and filter will convert this to 12V ac to 12V dc.

3. Protection Unit

We are using a relay in the protection unit, which will isolate the devices as soon as the microcontroller detects any faults by ensuring safety.

1.4 Conclusion

Instead of regularly monitoring the local substations, our system can provide monitoring information in real time. Additionally, one may receive updates from remote areas, saving both time and money. Moreover, the computerized gathering of data optimizes substation maintenance. Due to the presence of high voltage devices in substations, exposure to these devices may be harmful to human health. As a consequence, our initiative will decrease risks by collecting data in a more secure manner. If devices in substations are routinely inspected for defects, they will survive longer.

Chapter 2: Project Design Approach [CO5, CO6]

2.1 Introduction

We found two design methods to achieve the desired result. One of our designs is microcontroller-based, whilst the other one is SCADA-based. The functioning procedures of these two designs are different, yet they both provide the desired result.

2.2 Identify multiple design approach

Design Approach 01:

We are using Arduino as the main processing unit. To run the microcontroller a regulated power is being supplied in order to operate. Since the arduino has a built-in ADC which helps to receive digital data through the sensors that are interfaced and which will further be displayed on LCD. The data collected are also updated on the server through the IoT module. And in case of any errors in the data the relay gets activated along with the alerts.

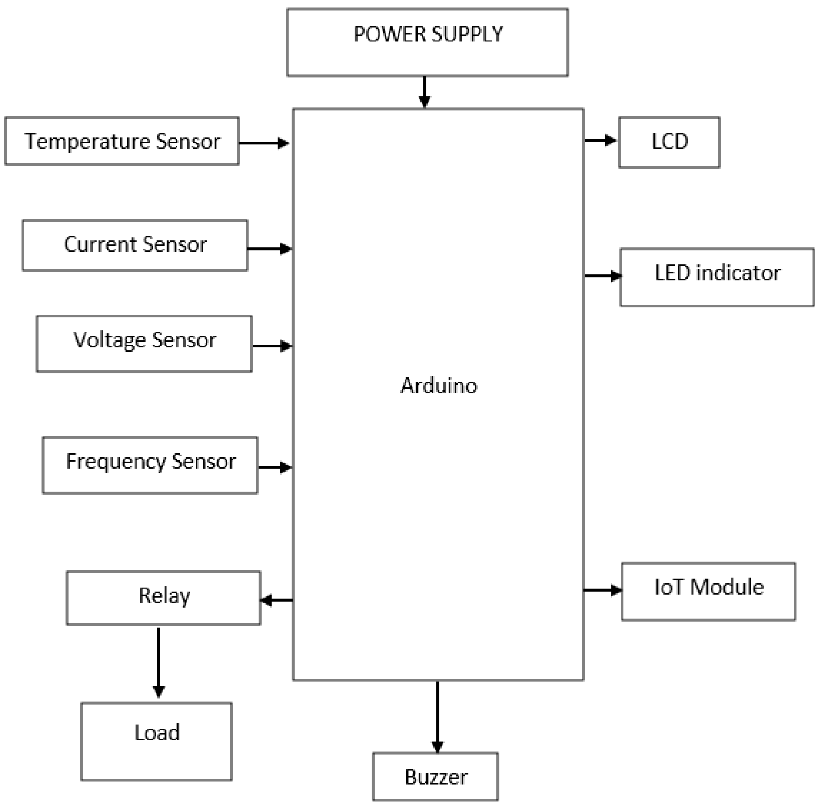


Figure 1: Block diagram of Design-01

Design Approach 02:

The HMI and PLC ladder diagrams are utilized for the second design method. Through the PLC ladder diagram, we are attempting to present all the parameters, such as voltage, current, frequency, and temperature, which will function properly if all the established parameters are within their specified bounds.

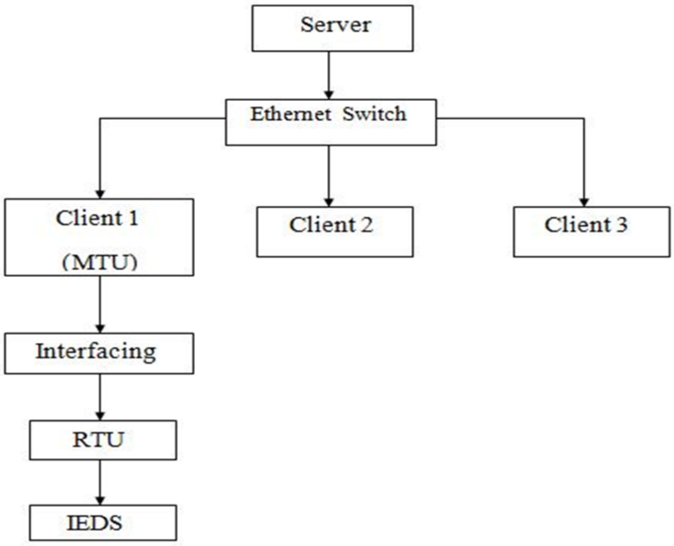


Figure 2: Block diagram of design-02

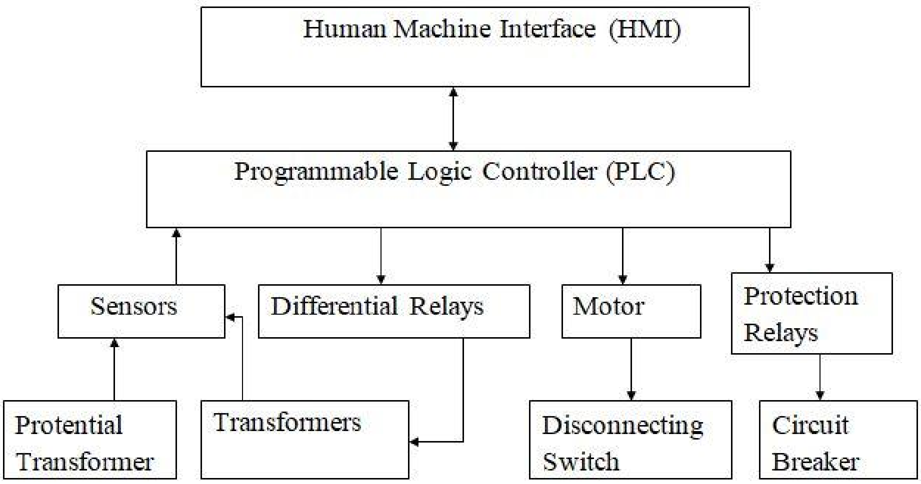


Figure 3: Remote terminal unit (RTU)

2.3 Describe multiple design approach

Design Approach 01:

In our first design approach, the Arduino Uno will serve as the primary microcontroller (Fig. 1). In addition, we'll make use of a relay, a buzzer, a frequency measurement unit, a temperature sensor, a voltage sensor, a temperature sensor, a current sensor, and an IoT module. Additionally, we will use a supply unit including a transformer to translate the 230V AC into 12V AC and a bridge rectifier unit to transfer the 12V AC into 12V DC. This 12 Volt DC is sent into the 7805 Voltage regulator, which reduces the voltage to 5 Volts regulated DC for use by the Arduino Uno and certain sensors. High current is needed to power the buzzer and relay. We will use a relay driver for the relays, and two BC 547 transistors in Darlington configuration for the buzzers. In order for the green and red LEDs to function as indicators, they require a substantial amount of electricity due to their amplified current requirements. There were two BC 547 transistors used, one for each purpose. When our prototype is turned on, it displays a warm welcome message and immediately begins monitoring the current, voltage, frequency, and temperature, and updates the server and the display accordingly.It compares all the current values to the predetermined values. If any of the readings goes outside of the allowed range, a fault alert will be transmitted to the relay and buzzer, and the screen will be refreshed to reflect the new information. After a certain length of time has passed with no resolution to the issue, the relay will off power to the loads.

Design Approach 02:

In an alternate method, physical equipment including switches and other devices is controlled by an RTU[13]. MTU enables operators to examine the condition of any equipment component and drives the majority of operator engagement through alerts (Fig-2). Interfacing enables the connection of communications devices from various vendors. Data Terminal Equipment (DTE) is a piece of hardware used to send and receive data, whereas Data Communications Equipment (DCE) is the hardware responsible for transmitting data between a DTE and a physical data communications connection. Relay Transmitting Units (RTUs) are microprocessor-based electrical gadgets that come with setup software for connecting data input streams to data output streams (Fig-3).An isolated source of voltage or current is used to achieve this. In a supervisory control and data acquisition (SCADA) network, a remote terminal unit (RTU) collects data, converts it into a transmittable format, and then sends it to a master terminal unit (MTU). Additionally, it implements operations that are directly under the master's control and gathers data from the master device. They have controllable output channels and input channels for sensing or metering. This device may come with a battery or a charger. It will gather data, encode the data into a transmittable format, and send the data to MTU. Channels for input, such as sensing or metering, and control outputs are provided. With the use of serial communication, IEDs may relay RTU status to a server. It is capable of all protection, control, monitoring, metering, and communication tasks.

2.4 Analysis of multiple design approach

Cost: The entire cost of the first design approach is around 3,860 BDT. In contrast, the total cost of the second design approach is around 5,750,000 BDT. Consequently, we can observe that the first design approach is more cost-efficient than the second.

Success rate: The rate of success for both designs is high.

Usability: As it is based on a microcontroller, the first design method is extremely user-friendly. On the other hand, the second design method is a SCADA system, which is extremely difficult to operate. Consequently, the first design approach will be the optimal solution for this project.

Environment sustainability: The equipment utilized in the first design method does not need the use of fossil fuels or excessive energy consumption that would have an adverse effect on the environment. In the second design strategy, however, fuels or gas may be required, which would have an adverse effect on the environment. Consequently, the first design strategy would be ecologically beneficial

Maintainability: The initial system will be a safety prototype to which only authorized personnel will have access. Therefore, there is no possibility of theft. However, the system would contain costly components that could be stolen. For this criterion, the first strategy will be appropriate.

After analyzing all of the criteria and simulation results, we've determined that the initial design method is the best alternative.

2.5 Conclusion

After examining all of the requirements, the microcontroller-based system is the optimal solution. Consequently, executing this project in hardware will be considerably more user-friendly, taking into account all relevant factors such as cost, usability, and maintenance, etc.

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

3.1 Introduction

We have used some modern engineering and IT tools To design, develop and validate the solution for the prototype of this project. These tools were chosen according to prototyping needs.

3.2 Select appropriate engineering and IT tools

First Design Approach:

Hardware Parts	Software Parts
ACS712(Current sensor)	Proteus design suite 8.12
PC817 (Optocoupler)	Arduino IDE
LM35 (Temperature sensor)	
PCF8574	
Bridge Rectifier	
Relay	
LEDs (Green and Red)	
Buzzer	
Transformer (TRAN-2P2S)	
LM044L (LCD Display)	
Virtual Terminal	

Second Design Approach:

Hardware Part	Software Part
CPU Wago (750-8212)	WPLsoft V2.48 delta PLC software
Modbus Wago (750-652)	
Fieldbus Coupler Wago (750-361)	
End Module Wago (750-600)	

3.3 Use of modern engineering and IT tools

First Design Approach:

Arduino Nano: We are using Arduino Nano for the prototype design which will work as the main figure for the monitoring system.

ZMPT101B: This module is being used to measure the voltage so that we can determine whether or not the voltage is consistent. In addition to its great precision and excellent consistency when measuring voltage and power, this device is also capable of measuring up to 250V AC. In addition to being easy to use, it is equipped with a multi-turn trim potentiometer that may be used to alter the ADC output.

PC817: It contains an IRED optically coupled to a phototransistor. It includes an LED and phototransistor which are connected jointly optically. The signal can be transmitted optically in between an i/p and o/p side without any physical connection.

Relay(SRD-05VDC-SL-C): The module is equipped with three high voltage terminals (Nc, C, and NO), each of which is attached to a different device that may be controlled. On the other side is a set of three low voltage pins that connect to the Arduino. These pins are labeled GND, Vcc, and signal.

Buzzer(Summer CPM121): It produces the fault alert if any of the values exceed predefined values

Proteus design suite 8.12: The program known as Proteus is used for both virtual system modeling and circuit simulation. The mixed mode SPICE circuit simulation, animated component models, and microprocessor models that are included in this package make it possible to do co-simulation on designs that are based entirely on microcontrollers. In order to design our circuit utilizing first design techniques, we are making use of the Proteus program. Using this piece of software, we are attempting to mimic the system that has been presented.

Arduino IDE: The Arduino Software Development Environment (IDE) is free software that allows users to develop code and upload it to Arduino boards. C and C++ are two of the programming languages that may be used with it. Here, IDE stands for Integrated Development Environment. In order to upload the code, we are use the Arduino IDE program.

Second Design Approach:

WPLsoft V2.48 delta PLC software: WPLSoft is a piece of program editing software that was developed for the Delta DVP-PLC series that runs on the WINDOWS operating system. WPLsoft is being used in the process of designing the ladder diagram for the second design strategy.

CPU Wago (750-8212): Wiring on a line topology is made possible by two ETHERNET interfaces and an internal switch. The PFC200's current status and user-selectable configuration settings may be seen on an embedded Web Server. Common uses for the PFC200 include regular machinery and equipment control in addition to the processing sector and building automation.

Modbus Wago (750-652): A WAGO I/O System 750 may be linked to devices with a C interface using this serial interface module. The WAGO I/O System 750 also includes gateways that connect the serial interface to the fieldbus systems it supports. The module is fully functional with lower-level protocols as well. In this way, the serial interface module may be used in a variety of situations without requiring any further configuration to communicate with the corresponding fieldbus master.

Fieldbus Coupler Wago (750-361): ETHERNET protocols HTTP(S); BootP, DHCP, DNS, SNTP, (S)FTP, and SNMP; Modbus TCP Fieldbus Coupler; 4th generation; Modbus (TCP, UDP) communication Transmission medium, Baud rate 10/100 Mbit/s, Cat 5 cable; 100 ; twisted pair; maximum cable length of 100 m Class D transmission performance as defined by EN 50173 A maximum of 250 modules may be installed on each node. Modules that don't need an extra bus extension (max.) I/O Ports, Total: 64 (fieldbus) transform the picture (max.) English (1020)German (1020) DC 24 V (-25 to +30%); receptacle plug-in power supply (system).

End Module Wago (750-600): The fieldbus node's end module is snapped on once the necessary bus coupler and I/O modules have been installed. It's the last piece of the data circuit and guarantees proper data flow throughout the system.

3.4 Conclusion

In this chapter, we went through the modern engineering and information technology technologies that we are utilizing for the software prototype of this project. In addition, every single tool that will be used in the prototype is highly recommended by IEEE**.**

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

4.1 Introduction

Two design techniques have been discovered to achieve the desired results. One of our concepts is based on Arduino Uno and the other is based on SCADA. These two designs behave differently, but give the same results. After many test results, simulations, and test cases, we came across the desired optimal design approach with good explanations.

4.2 Optimization of multiple design approach

First Design Circuit:

In our proposed design, we are using Arduino Uno R3 as the central processing unit which will help us to monitor and simulate the parameters. In this circuit we are using Vsine as the input of 220V ac supply and step it down to 12V dc using a step down transformer and bridge rectifier.

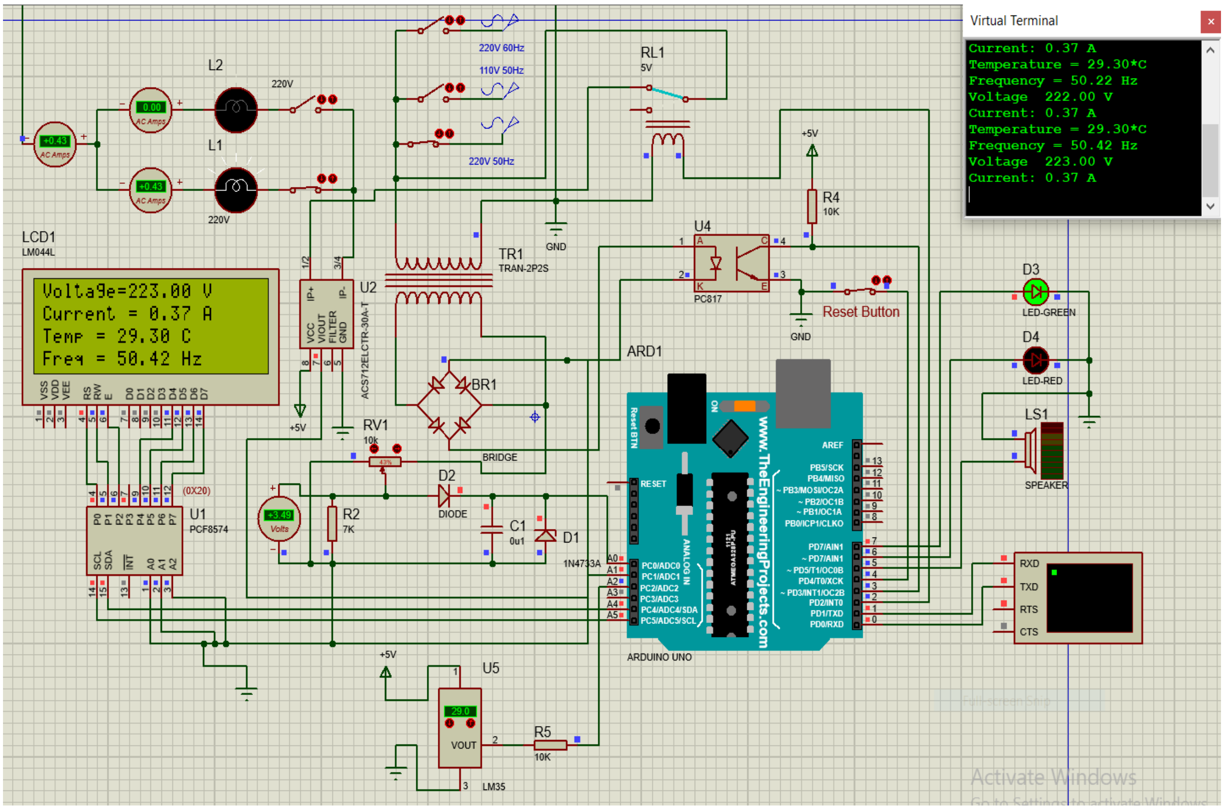


Figure 4: Simulation of design approach-01

We will be measuring the voltage using the voltage divider rule. The Ac amp meters are added in order to monitor the amount of current flowing. In the middle of the design, a current sensor has been added. It will help to observe how much current has been flowing and will send a signal to Vout which will send it to Arduino Uno pin A1. The bulbs are used here as loads and with the separate ac amp meters to measure the reading individually. Furthermore, a LCD display has been used there and it will help to give a clear view of values. With the display, an LCD driver has also been connected which will minimize the number of pins that have been used to connect to Arduino Uno. Moreover, an optocoupler has been used to measure the frequency values and after calculating the values and it will send signal to Arduino Uno. LM35 has been added to monitor the temperature values. For the iot part, we have used compim. Relay has been added in order to ensure protection by isolating the system.

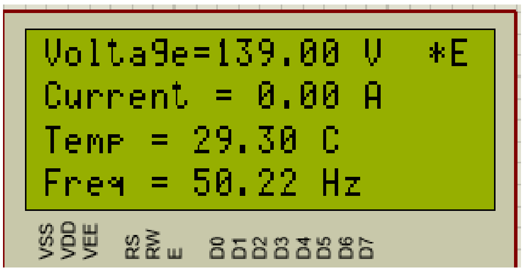


Figure 5: Voltage error

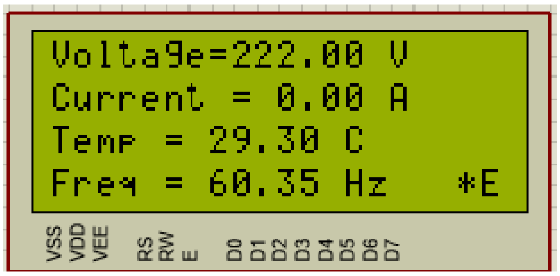


Figure 6: Frequency Error

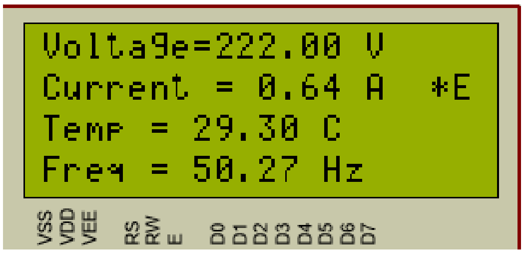


Figure 7: Current Error

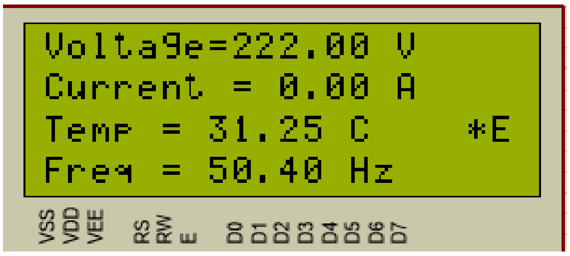


Figure 8: Temperature Error

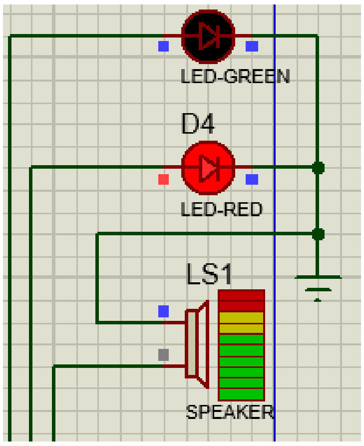


Figure 9: Red LED and Buzzer ON

Here we indicated the errors as "*E" (Fig 5-8). While there is any error with the range of values for the above parameters in the circuit this can be seen that the system displays *E as error on display and Red LED turns On, also the sound from the speaker helps to notify that an error has occurred (Fig 9). Above all, the relay gets disconnected when any error occurs by ensuring protection and safety for the loads and the system. Once the problems are resolved, the values are displayed on the LCD with no errors (*E), as shown in (Fig 4) ,and the Green LED stays on indicating that there are no errors. Besides, the relay stays connected.

Second Design Approach:

This system is based on the SCADA system. For further simulation, the PLC ladder diagram has been used to show the desired results.

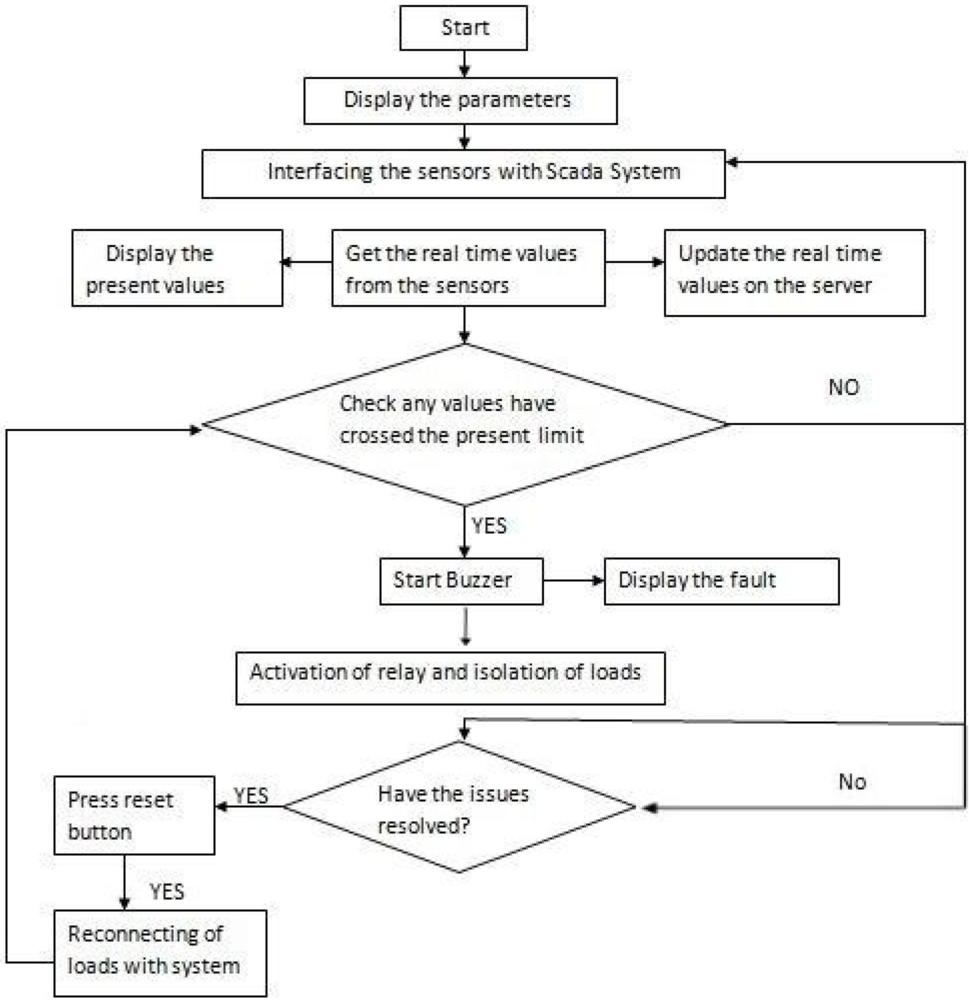
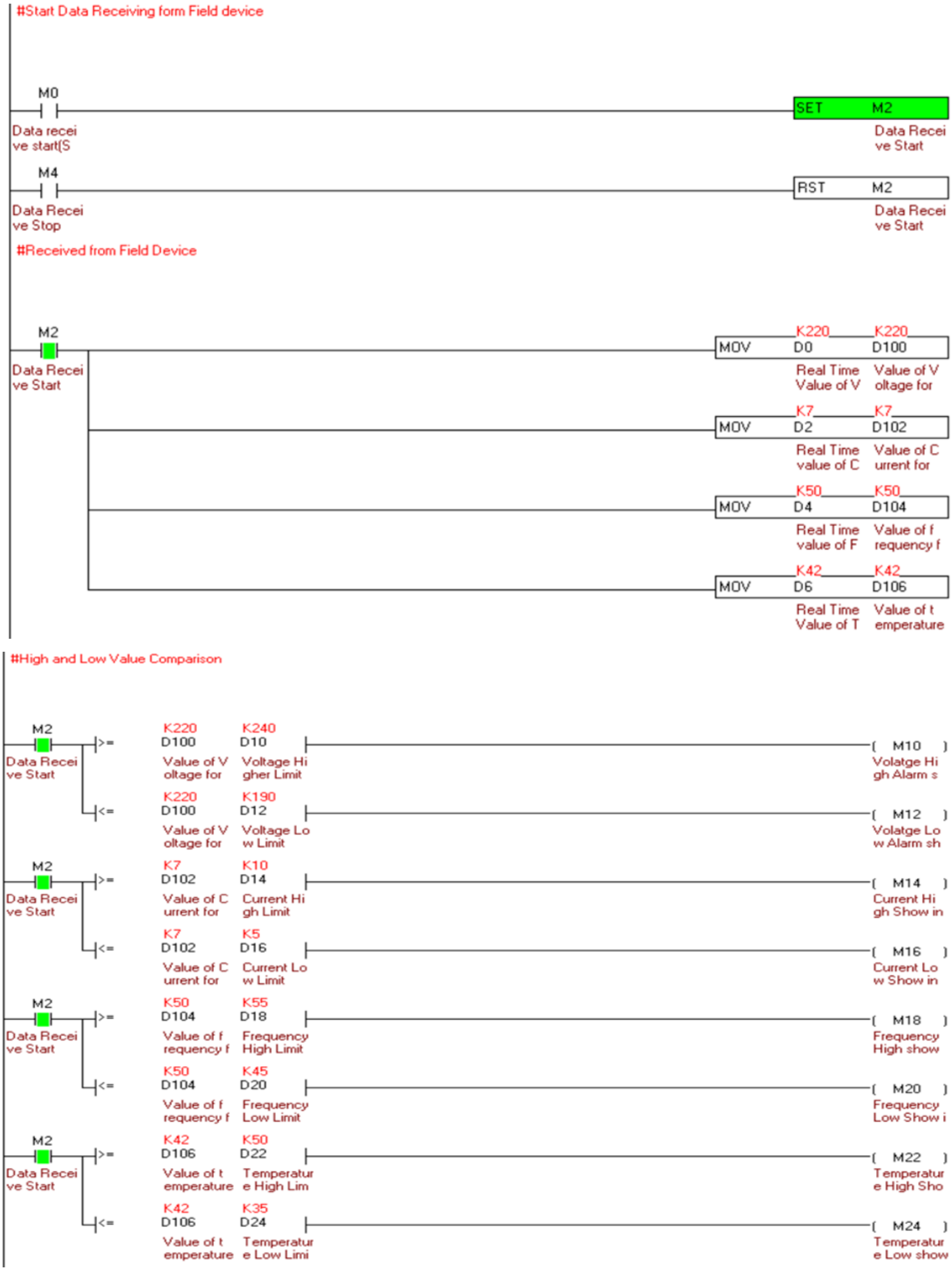
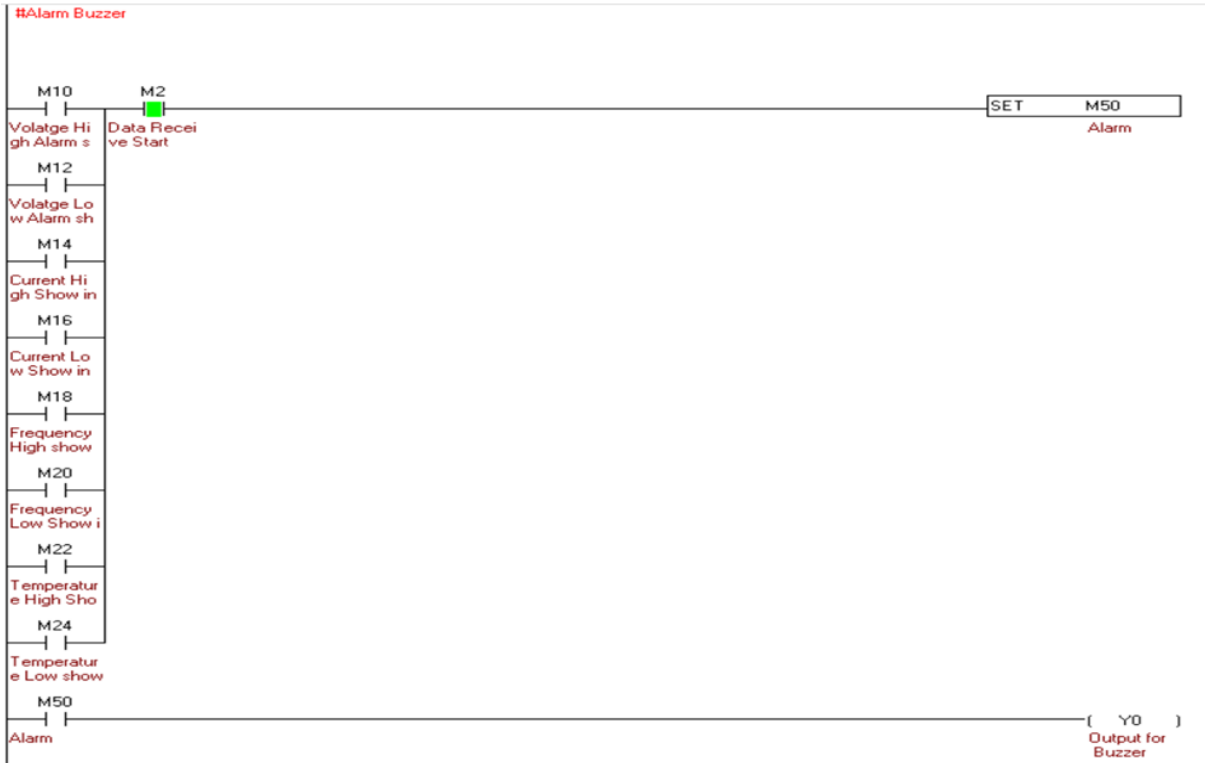


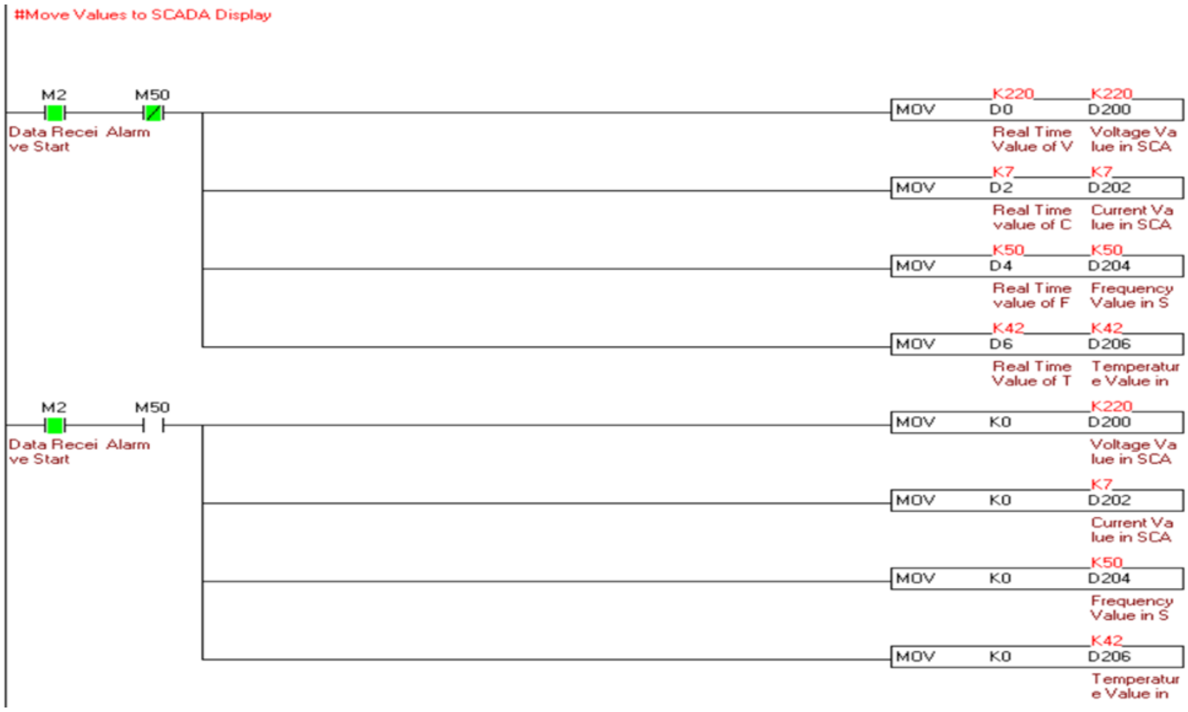
Figure 10: Flowchart of design approach 2

PLC Ladder Diagram:

In this system, all four parameters have been set as a logic gate. By using those gates, it is going to show that the data will be coming from a field device. If it finds any fault in the system, it will alert the alarm system.




#Alarm Buzzer
M10
Volatge Hi gh Alarm s
M2
Data Recei ve Start
SET M50
Alarm
M12
Volatge Lo w Alarm sh
M14
Current Hi gh Show in
M16
Current Lo w Show in
M18
Frequency High show
M20
Frequency Low Show i
M22
Temperatur e High Sho
M24
Temperatur e Low show
M50
Alarm
Y0
Output for Buzzer


#Move Values to SCADA Display
M2
Data Recei ve Start
M50
Alarm
MOV D0 D200
K220 K220
Real Time Value of V
Voltage Va lue in SCA
MOV D2 D202
K7 K7
Real Time value of C
Current Va lue in SCA
MOV D4 D204
K50 K50
Real Time value of F
Frequency Value in S
MOV D6 D206
K42 K42
Real Time Value of T
Temperatur e Value in
M2
Data Recei ve Start
M50
Alarm
MOV K0 D200
K220
Voltage Va lue in SCA
MOV K0 D202
K7
Current Va lue in SCA
MOV K0 D204
K50
Frequency Value in S
MOV K0 D206
K42
Temperatur e Value in

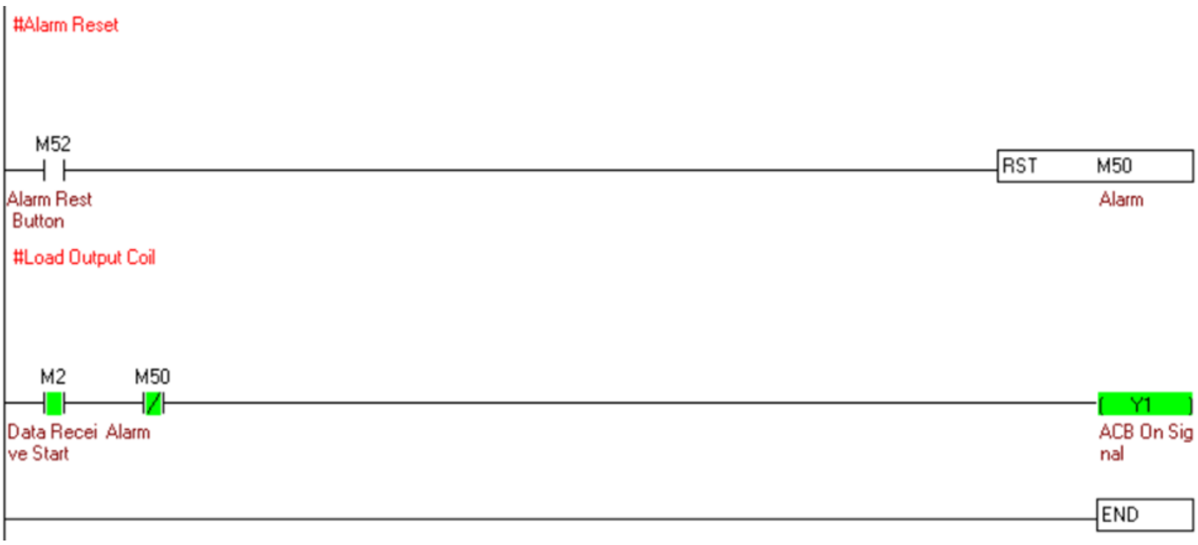
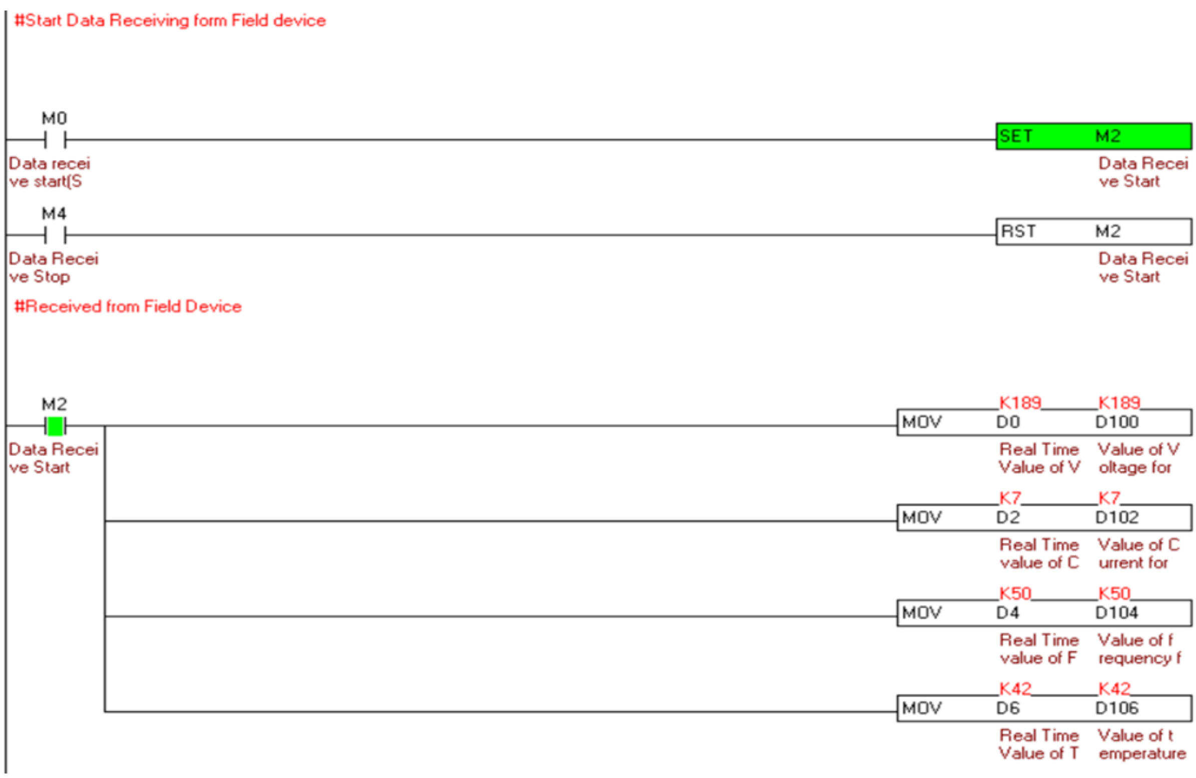
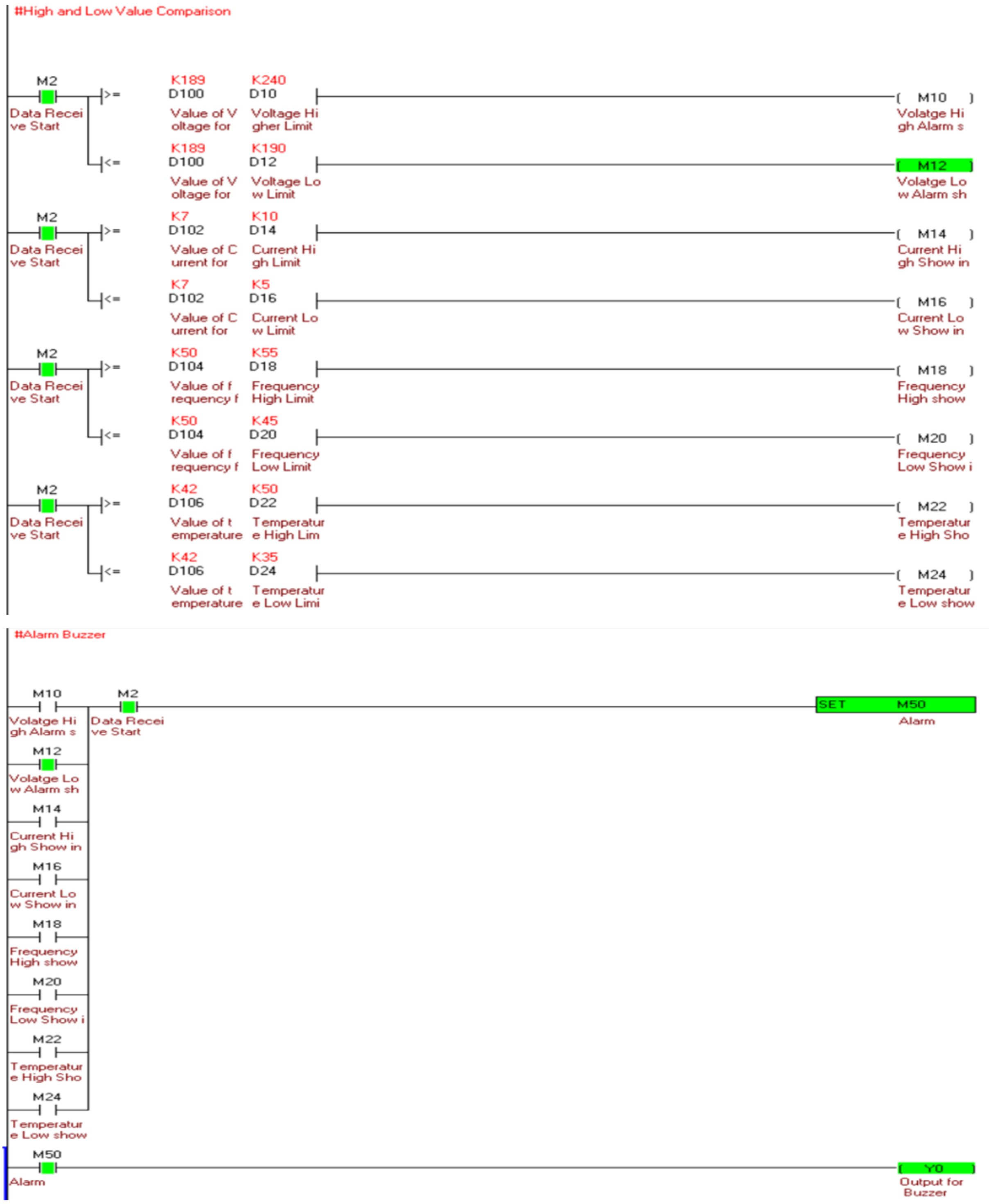


Figure 11: Data collecting when it is in between higher and lower limits

A fault detection has been shown below where voltage is low and the alert system is on. Along with that, all the values will show as zero. Then we have to push the alarm reset button and fix the problem for low voltage.




#High and Low Value Comparison
M2
Data Receive Start
>=
K189
D100
Value of Voltage for
K240
D10
Voltage Higher Limit
M10
Volatge High Alarm s
<=
K189
D100
Value of Voltage for
K190
D12
Voltage Low Limit
M12
Volatge Low Alarm sh
M2
Data Receive Start
>=
K7
D102
Value of Current for
K10
D14
Current High Limit
M14
Current High Show in
<=
K7
D102
Value of Current for
K5
D16
Current Low Limit
M16
Current Low Show in
M2
Data Receive Start
>=
K50
D104
Value of frequency f
K55
D18
Frequency High Limit
M18
Frequency High show
<=
K50
D104
Value of frequency f
K45
D20
Frequency Low Limit
M20
Frequency Low Show i
M2
Data Receive Start
>=
K42
D106
Value of temperature
K50
D22
Temperature High Lim
M22
Temperature High Sho
<=
K42
D106
Value of temperature
K35
D24
Temperature Low Limi
M24
Temperature Low show
#Alarm Buzzer
M10
Volatge High Alarm s
M2
Data Receive Start
SET M50
Alarm
M12
Volatge Low Alarm sh
M14
Current High Show in
M16
Current Low Show in
M18
Frequency High show
M20
Frequency Low Show i
M22
Temperature High Sho
M24
Temperature Low show
M50
Alarm
Y0
Output for Buzzer

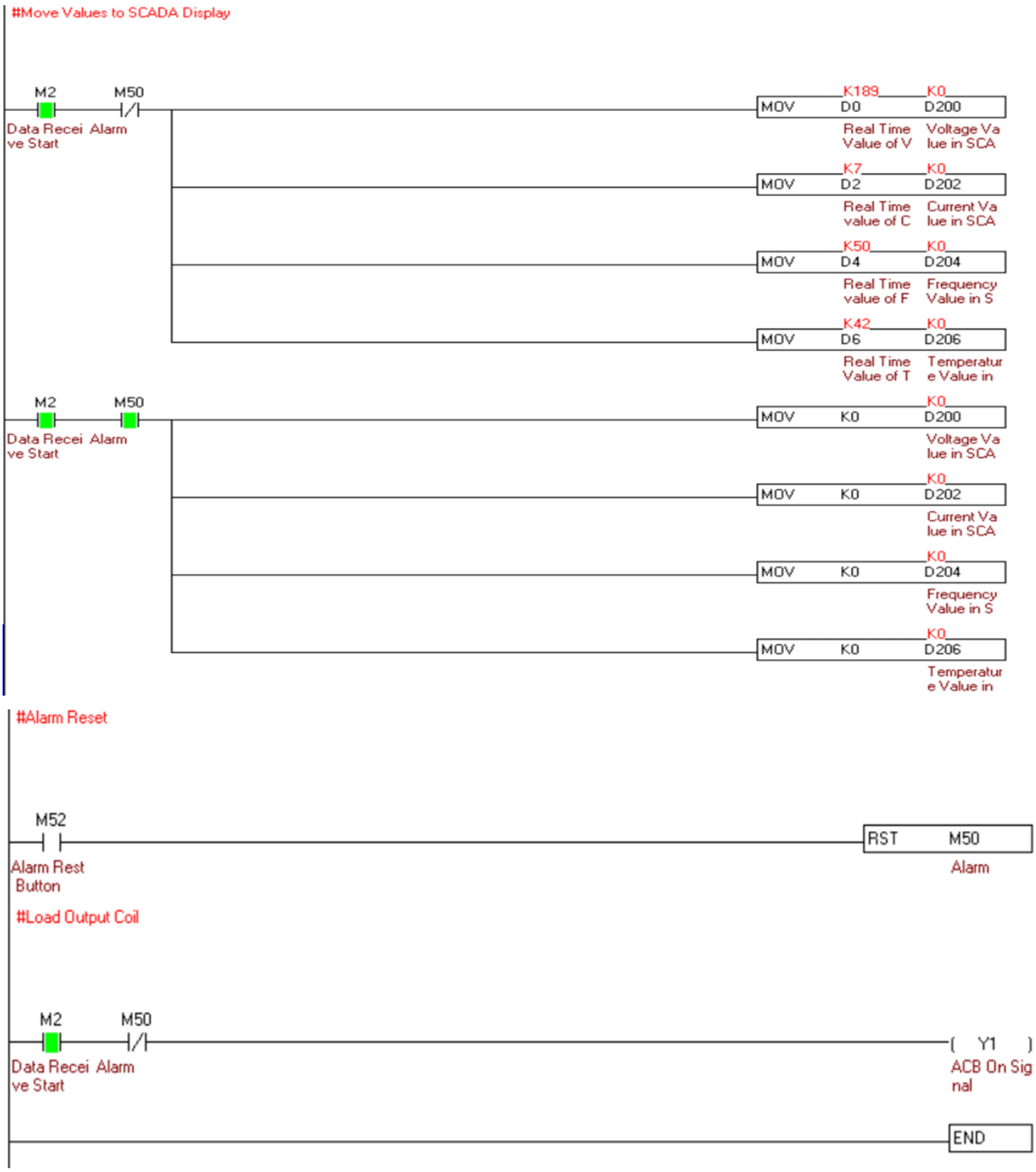


Figure 12: Alarm and buzzer are on when Voltage is low.

When the simulation will start it will receive data from the field device (Fig 10). M0 (Data receive start button) will work as a virtual switch. When the M0 switch is ON, it will set a bit M2, which will be ON, and if we press the OFF switch then the M2 will be OFF. When the M2 is ON, it will receive the data until the M4 switch is ON. The M4 will work as the data receiving stop button. As we are putting the values manually so real-time values and other values will be set. For such as, D0 and D100 have been set for Voltage. D0 will give the real-time value and it will move the value to D100. If the M2 is OFF then it will not work. For current, D2 will get the real-time value and move it to D102 for the value comparison. D4 will get the real-time value for frequency and move it to D104. For temperature, D6 will get the real-time value and move it to D106 for value comparison. Those moved values will be compared by the higher and lower limit values for the value comparison. For voltage, D10 and D12 have been set as Voltage higher limit and Voltage lower limit and for current its D14 (Current Higher limit) and D16 (Current Lower Limit), for frequency its D18 (Frequency Higher Limit) and D20 (Frequency Lower Limit), for temperature its D22 (Temperature Higher Limit) and D24 (Temperature Lower Limit). If any of the values is exceeding the limit then M50 will be ON as an alarm sign and it will ON the Y0 (Output for Buzzer). To reset the alarm, we have to press the Alarm reset button M52. Otherwise, Y0 will be ON. To show the values in SCADA, we set D0 as the real-time value that will be moved to D200 which will show the Voltage value in SCADA. For current D2 is the real-time value that will be moved to D202 which will show the Current value in SCADA. For frequency D4 is the real-time value that will be moved to D204, showing the Frequency value in SCADA. For temperature D6 is the real-time value that will be moved to D206 which will show the Temperature value in SCADA. As we are putting the values manually if any values are at fault, then M50 will show the alarm sign and all values will be shown as zero.

As an example (Fig 11), when the real-time value of voltage is low, the M12 button will be ON and it will alarm the signal which is M50. After that, it will show all the values in SCADA display zero. Moreover, there will be no load output signal as Y0 is OFF. Then we have to push the alarm reset button and fix the problem for low voltage. When it is fixed the system will run smoothly. Furthermore, not only voltage but also other parameters will face this kind of problem if they exceed the predefined values.

4.3 Identify optimal design approach

Criteria	1st Approach (IoT)	2nd Approach(SCADA)
Cost	3559/-	5,75,000/-
Success rate	High	High
Usability	Easy to use	Complicated
Environmental sustainability	High	Comparatively low
Maintainability	No risks of being stolen	Need of human interaction, some parts might be stolen

Cost: The first approach costs roughly 3860 BDT in total. The overall cost of the second approach, on the other hand, is roughly 5,75,000 BDT. As a result, we can see that the first approach is more cost-effective than the second.

Success rate: The success rate of both designs are high.

Usability: The first approach is very much easy to use as it is based on a microcontroller. On the other hand, the second approach is very complicated to use as it is a SCADA system. Therefore, the first approach will be the best option for this project.

Environment sustainability: As the equipment we're utilizing in the first approach doesn't require any fossil fuels or excessive power consumption that would have a negative impact on the environment. But in the second approach, fuels or gas might be needed, which would have a negative impact on the environment. Therefore, the first approach would be environmentally friendly.

Maintainability: The first system will be a safety prototype and only the authorized person can have access to the system. Therefore, there is not any risk of being stolen. However, the system would have some expensive components which might get stolen. For this criteria, the first approach will be suitable.

The first approach is the best option after examining all of the criteria and simulation results.

4.4 Performance evaluation of developed solution

In this segment, the results of all the four sensors has been stored. The necessary documents are given below:

Voltage system:

In our proposed system one of the most important parameters is voltage parameters. For analysis purposes, some of the values have been taken into consideration. In the given table below, it can be seen that in the range of 190v-230v the system is working fine. But, when it is crossing the threshold the system will alert by buzzing the buzzer and keeping the red light on.

Data table for different types of voltages parameters:

Voltage (V)	Fault Detection	RED Light	GREEN Light	Buzzer	Results
139v	YES	YES	NO	NO	System OFF
190v	NO	NO	YES	YES	System ON
230v	YES	NO	YES	YES	System ON
247v	NO	YES	NO	NO	System OFF

Current System:

For analysis purposes, some of the values of currents have been taken. When the value is crossing the estimated values the system will start the alert process by the buzzer and the red light.

Data table for different types of currents parameters:

Current (A)	Fault Detection	RED Light	GREEN Light	Buzzer	Results
0A	NO	NO	YES	NO	System ON
0.3A	NO	NO	YES	NO	System ON
0.64A	YES	YES	NO	YES	System OFF

Frequency System:

For the analysis of this system, the value has been fixed at 50Hz. If it is going below or above that the alert system will be on and the display will show its fault detection.
Data table for different types of frequency parameters:

Frequency (Hz)	Fault detection	RED Light	GREEN Light	Buzzer	Results
49 Hz	YES	YES	NO	YES	System OFF
50 Hz	NO	NO	YES	NO	System ON
51 Hz	YES	YES	NO	YES	System OFF

Temperature System:

The threshold of this system has been set from 25° C to 35° C. If it is below or above the range the system will alert like the other fault detection by using a buzzer and the red light.
Data table for different types of temperature parameters:

Temperature (° C)	Fault Detection	RED Light	GREEN Light	Buzzer	Results
25°C	YES	YES	NO	YES	System OFF
28°C	NO	NO	YES	NO	System ON
33°C	NO	NO	YES	NO	System ON
37°C	YES	YES	NO	YES	System OFF

Here is the data table of test cases for all the parameters and the accuracy rate of the system:

NO.	**Voltage (V)**	**Current (mA)**	**Frequency (Hz)**	**Temperature (°C)**	**Accuracy (%)**
1.	201	87.89	50	28	100
2.	190	91.41	50	28	100
3.	206	312.34	50	29	100
4.	210	242.43	50	28	100
5.	196	110.79	51	27	75
6.	254	330.51	50	27	75
7.	222	210.65	49	27	75
8.	164	322.14	50	28	75
9.	221	180.80	50	28	100
10.	188	938.94	51	27	50

4.5 Conclusion

After considering all the factors, the most appropriate option is a microcontroller-based substation monitoring based on many factors such as cost, success rate, usability, environment sustainability and maintainability. As a result of this feature, using the project's hardware makes it much more user-friendly and cost-effective to complete the project.

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

5.1 Introduction

We picked our ideal design and put the system into place in the prior chapter. We made the decision to tweak several aspects of the design while we were carrying out the project in order to make it more complex and effective. The modifications that were done in order to finish the prototype's design are discussed in this chapter.

5.2 Completion of final design

We replaced the Arduino UNO with an Arduino NANO because it is smaller and does the same function. The LM35 temperature sensor has also been replaced with an NTC thermistor, which performs the same function with no harmful side effects.

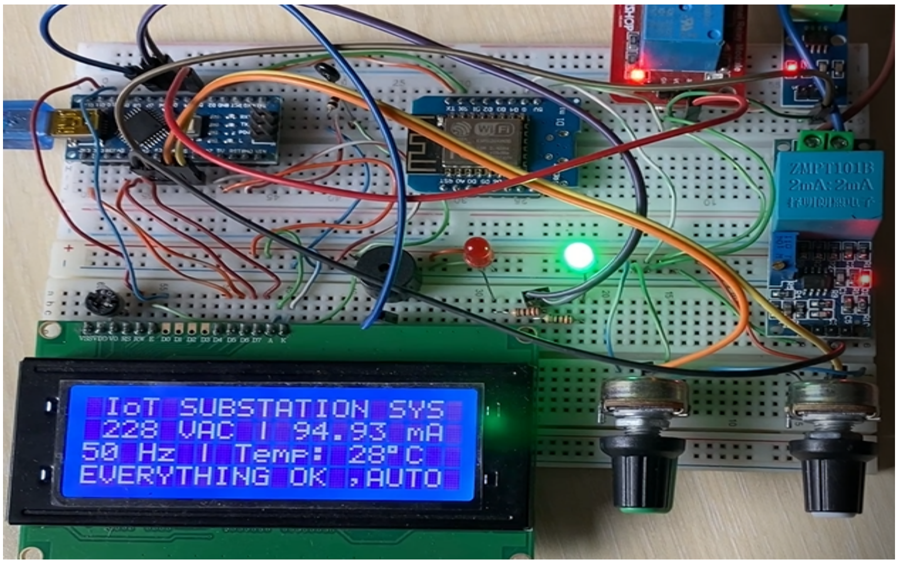


Figure 13: Final hardware prototype system

5.3 Evaluate the solution to meet desired need

To begin, we have ensured that all of the components can communicate with the Arduino Nano. We have set the threshold for the Voltage to be between 190V and 230V, for the Frequency to be either higher than or less than 50Hz, for the Current to be between 0mA and 450mA, and for the Temperature to be between 25°C and 35°C. Because every number is within the threshold limit, the LCD screen is displaying the message "EVERYTHING OK."

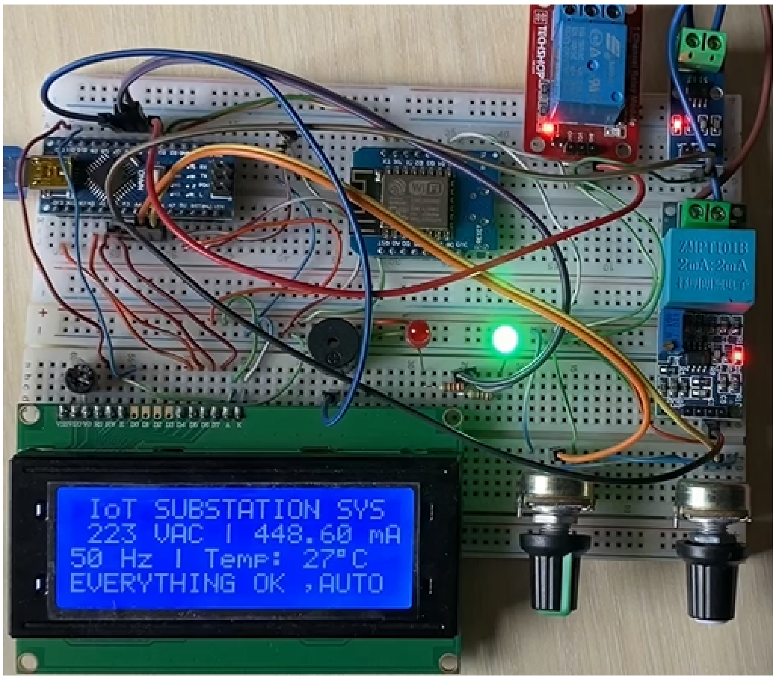


Figure 14 : All parameters within the threshold limit

While we are now raising the voltage using a potentiometer, an error message that reads "VOLTAGE FAULT" has been identified since the current voltage of 234V is more than the threshold limit. Additionally, a buzzer and a red light have been activated.

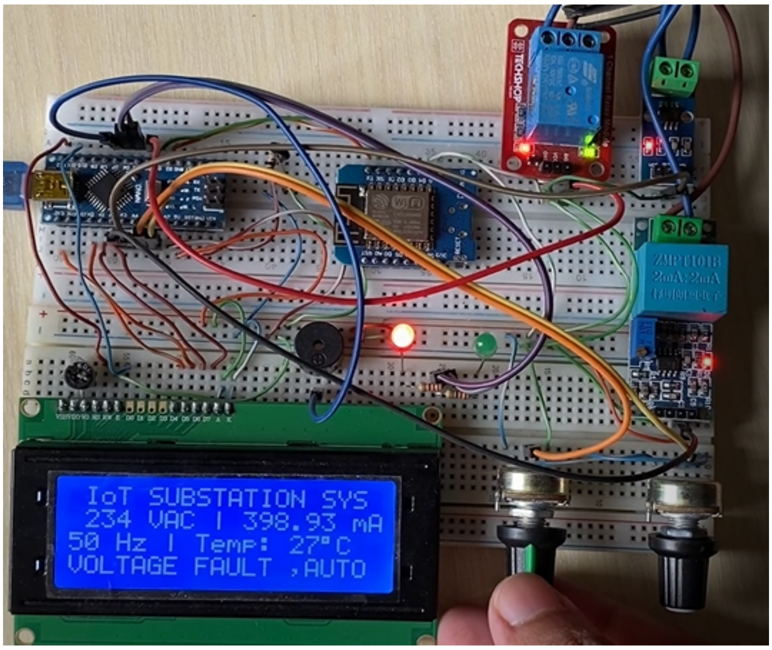


Figure 15: Fault detection in Voltage parameter; alarm and red light ON

As we now turn down another potentiometer to bring the frequency down from 50 Hz to 49 Hz, an error message that reads "FREQUENCY FAULT" appears on the screen because the reading is below the threshold limit. Additionally, a red light illuminates and a buzzer sounds to draw our attention to the situation.

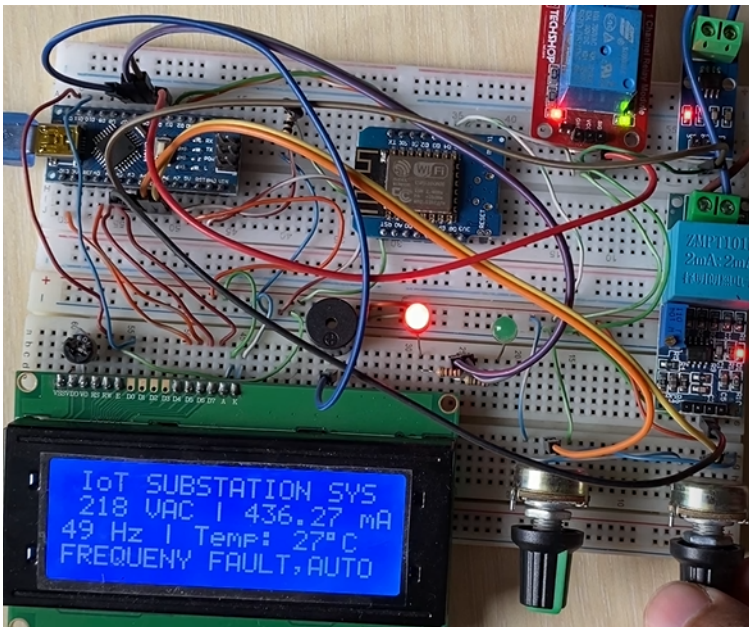


Figure 16: Fault detection in Frequency system; alarm and red light ON

Now that we have heated the metal and got it close to the temperature sensor, it is displaying 36 degrees Celsius, which is higher than the threshold limit. As a result, the error message "TEMP. FAULT" has been detected, the red light is on, and the buzzer is sounding an alarm.

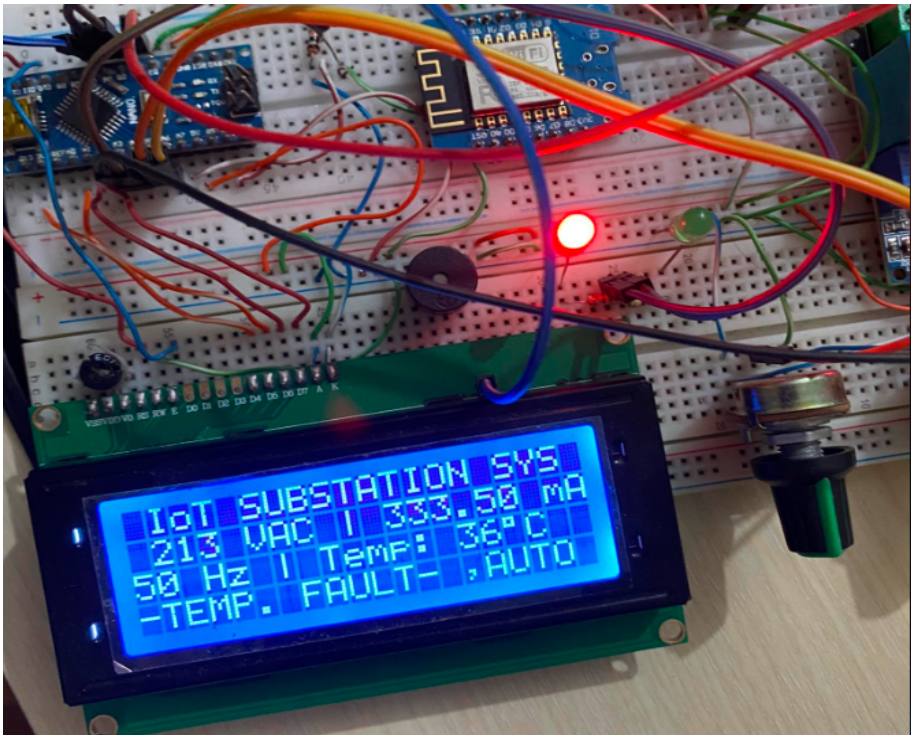


Figure 17: High temperature detected; alarm and red light ON

We are in complete control of the system thanks to the use of the relay. Once it is activated, the system will be turned off. The 5v that it needs will come from the 5v VCC pin. The signal pin is the component that is in charge of operating the relay. This pin may function in either active low or active high modes, depending on the situation. In an active low case, the relay will trigger as soon as we provide a low signal to the signal pin, whereas in an active high case, the relay will trigger as soon as we provide a high signal to the signal pin. So, in an active low case, the relay will activate as soon as we provide the signal pin with an active low signal. The switching contacts are opened or closed by the relay with the help of the current supply. In most cases, this may be accomplished with the help of a coil, which magnetizes the switch contacts and, once engaged, pulls them together. When the coil is not reinforced, a spring forces each of them in their own direction. There are primarily two advantages to making use of this technique. The first of these advantages is that the current that is needed to activate the relay is lower when compared to the current that is utilized by the relay contacts while switching. Another advantage is that the contacts and the coil are galvanically separated from one another, which means that there is no electrical connection between the two of them.

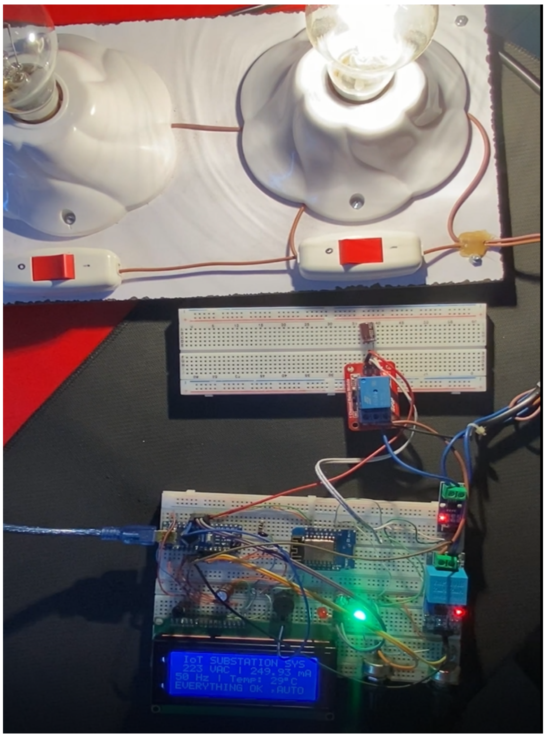


Figure 18: Controlling the system with relay

Since we have loads with two lights, and if the current draws more over 450mA, an alarm goes off (shown by a red light and a siren), protecting us from potential danger.

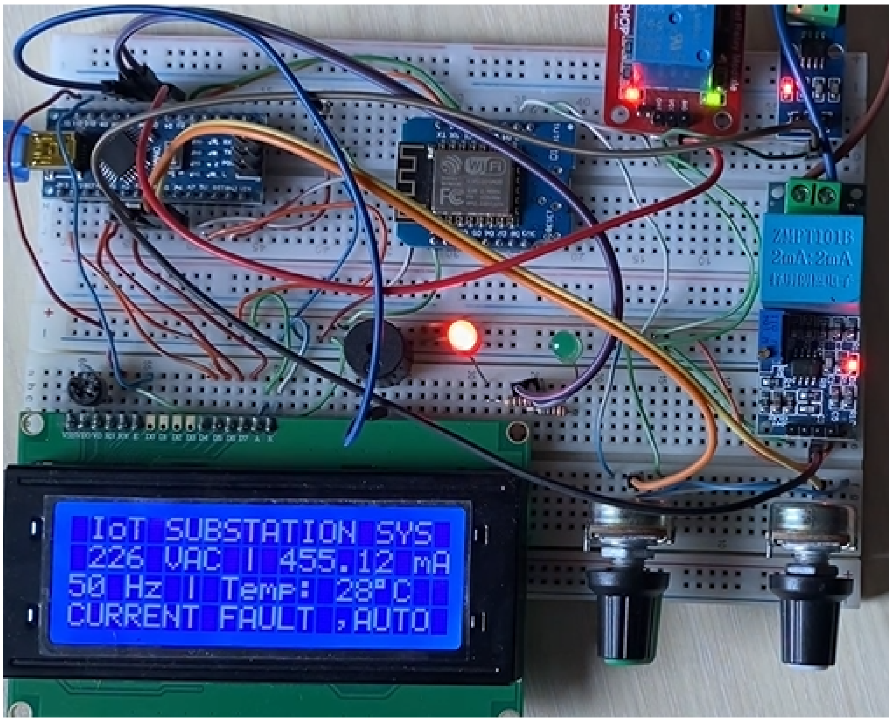


Figure 19: Fault in current system; alarm and red light ON

Through the use of a wifi module, the system is linked to a blynk server. This server will be responsible for displaying all of the sensor data and will also storing all of the data collected by the system. The data will be shown on the server regardless of whether or not it is the server's fault.

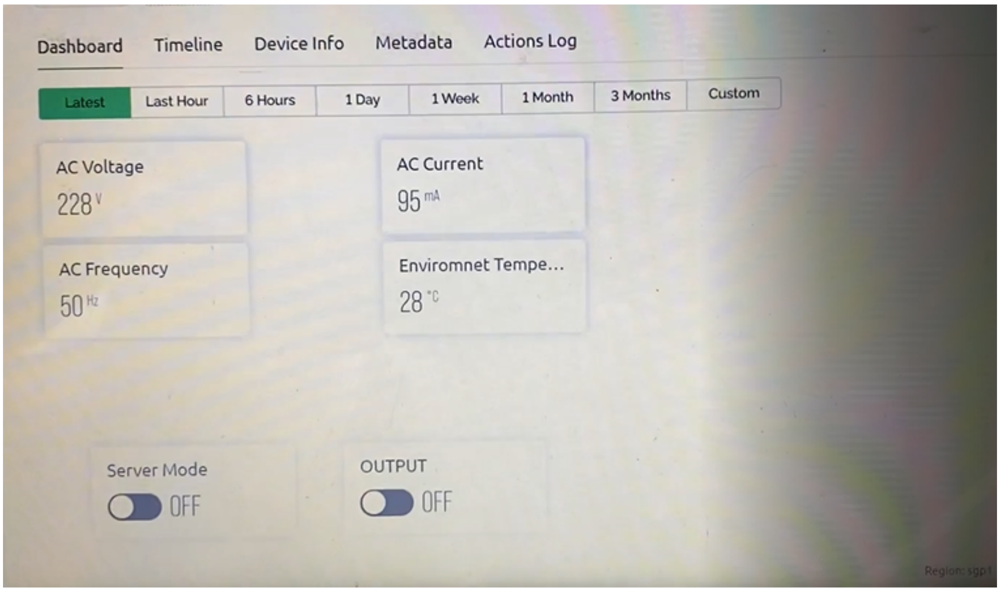


Figure 20: Values showing on blynk server

Consumers from anywhere in the world who have the access can easily see the parameters by login into blynk apps.

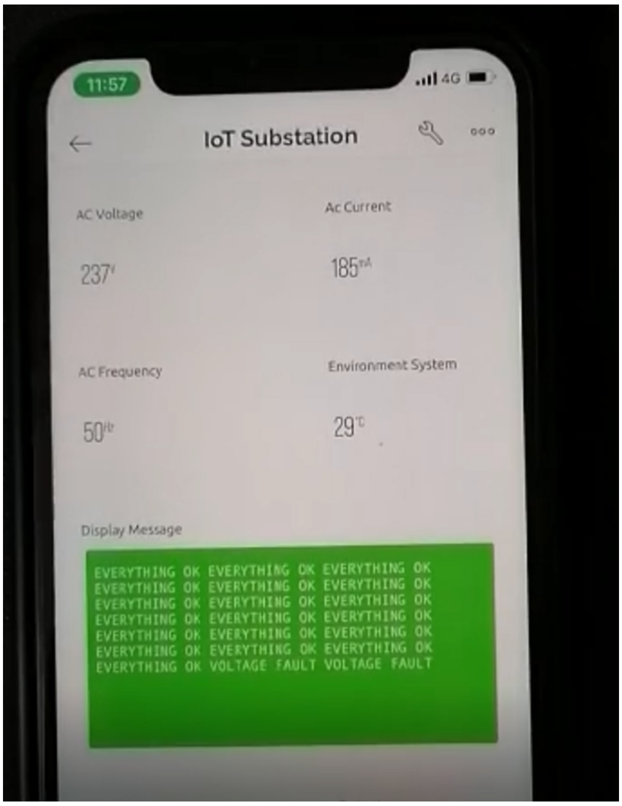


Figure 21: Showing parameters from blynk application server

5.4 Conclusion

In conclusion, it can be observed that the final design successfully meets all the requirements. The sensors can show some variations. However, it is far lower. The alarm system has performed well. The system starts to function once it passes the threshold. Thus, after several tests, we became able to get the required outcome from our prototype system.

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

6.1 Introduction

Impact analysis and project sustainability are one of the key elements in any project implementation. The main concern when launching a project is to check impact and sustainability. Impact analysis refers to the process of determining the impact of changes on deployed products or applications. It provides details about parts of the system that may be affected by changes in specific sections or features of the application. A sustainability plan outlines the different parts of a project that must be maintained in order for the project to continue functioning over the long term. The long-term viability of the project is outlined in the sustainability plan.

6.2 Assess the impact of solution

Receive real time information for monitoring: Our system has the capability to receive information for monitoring in real time, which may be used instead of regularly monitoring the local substations. As new sophisticated technologies emerge, traditional substations are undergoing a transition to IoT-based substations. This is due to the fact that the internet of things is becoming more widespread. The drawbacks of the old technique of manual inspections done on a regular basis are solved by the real-time monitoring of substation equipment, which also prevents electrical equipment failures before they may lead to a disaster.

Provide updates from distant locations: Through our system one can acquire updates from far regions, which saves both time and money. In addition, the maintenance of substations is made more efficient thanks to the digital gathering of data. This is one of the primary benefits that will result from carrying out this project. Because all of the real-time data is gathered and uploaded to the IoT server, we are able to receive all of the real-time data as easily and as remotely as possible. This indicates that there is no need for us to personally confirm the data by going to the control room.

Reduce risks with a safer way in data collection: Substation poses a great number of risks due to its dangerous environment. Our system will lessen the risks by developing a more secure method of data collecting in order to account for the fact that substations include high voltage devices and that may have a negative impact on human health.

Regular monitoring for the lifespan of devices in substation: Regular monitoring, which helps detect any potential problems that may occur, may enhance the lifetime of the equipment used in substations, which is a potential benefit. The information that was gathered is very useful for problem management as well as scheduled maintenance. Natural or unintentional degradation over time may be followed using the most cutting-edge competitive technologies and devices for continuous monitoring and diagnostics. This is made possible by the availability of these technologies and equipment. They do not generate severe events that may cause extremely expensive harm to electricity providers and customers if they are found and repaired in a timely way. If they are not recognized and corrected in a timely manner. At the same time, it may lengthen the life of the equipment, improve the efficiency of the maintenance programs, cut down on failures, and lower the costs of the facility's scheduled repairs..

6.3 Evaluate the sustainability

Our Project ensures safety, effectiveness, efficiency, and an environment-friendly system. Substation monitoring and control is an important task in this period of automation to provide consumers with safe electricity. However, the risk of power outages, voltage drops, and fires is rapidly increasing due to older configurations. The automated systems of our project to monitor critical conditions in substation systems will ensure safety. The IoT infrastructure is used for monitoring all the events. This feature may help businesses in the construction sector save money, cut down on wasted time, improve the overall quality of their workday, move toward a paperless workflow, and achieve higher levels of productivity. The use of Real-Time Data Analysis may facilitate the generation of quicker judgments and the preservation of financial resources. Moreover, our system will have the ability to function continuously and effectively for hours after hours. Besides, our system does not cause any pollution in the environment, for example, any toxic gas or noise. Thus, our system is environmentally friendly too.

6.4 Conclusion

Our proposed system has met the criteria it is needed for an sustainable and environment friendly project and in future we will try to develop it so that it’s performance get’s better and better in the future.

Chapter 7: Engineering Project Management [CO11, CO14]

7.1 Introduction

Project management is an important aspect of any project. Planning all progress with a designed plan helps organize the entire project. Assigning specific responsibilities to keep Project smooth helps with better outcomes.

7.2 Define, plan and manage engineering project [400P] :

1st Semester FYDP-P (400P)				
Task Name	Start date	Duration	End date	Task Responsibilies
Finalized the project title	17-10-21	19	05-11-21	Jawad, Serajul
Summary of concept note	06-11-21	8	14-11-21	Sifat, Pramit
Prepared the Slide of progress presentation-1	15-11-21	2	17-11-21	Jawad, Serajul,Sifat, Pramit
Progrss presentation-1	18-11-21	1	18-11-21	Jawad, Serajul,Sifat, Pramit
Corrected the mistake of concept note	19-11-21	12	01-12-21	Jawad, Serajul,Sifat, Pramit
Submitted the concept note	02-12-21	1	02-12-21	Jawad, Serajul,Sifat, Pramit
Prepared the project proposal	03-12-21	22	25-12-21	Jawad, Serajul,Sifat, Pramit
Prepared the Slide of progress presentation-2	26-12-21	3	29-12-21	Jawad, Serajul,Sifat, Pramit
Submission of draft proposal	30-12-21	1	30-12-21	Jawad, Serajul,Sifat, Pramit
Progrss presentation-2	30-12-21	1	30-12-21	Jawad, Serajul,Sifat, Pramit
Final progress presentation	06-01-22	1	06-01-22	Jawad, Serajul,Sifat, Pramit

Figure 22: Table of work distribution for 400P

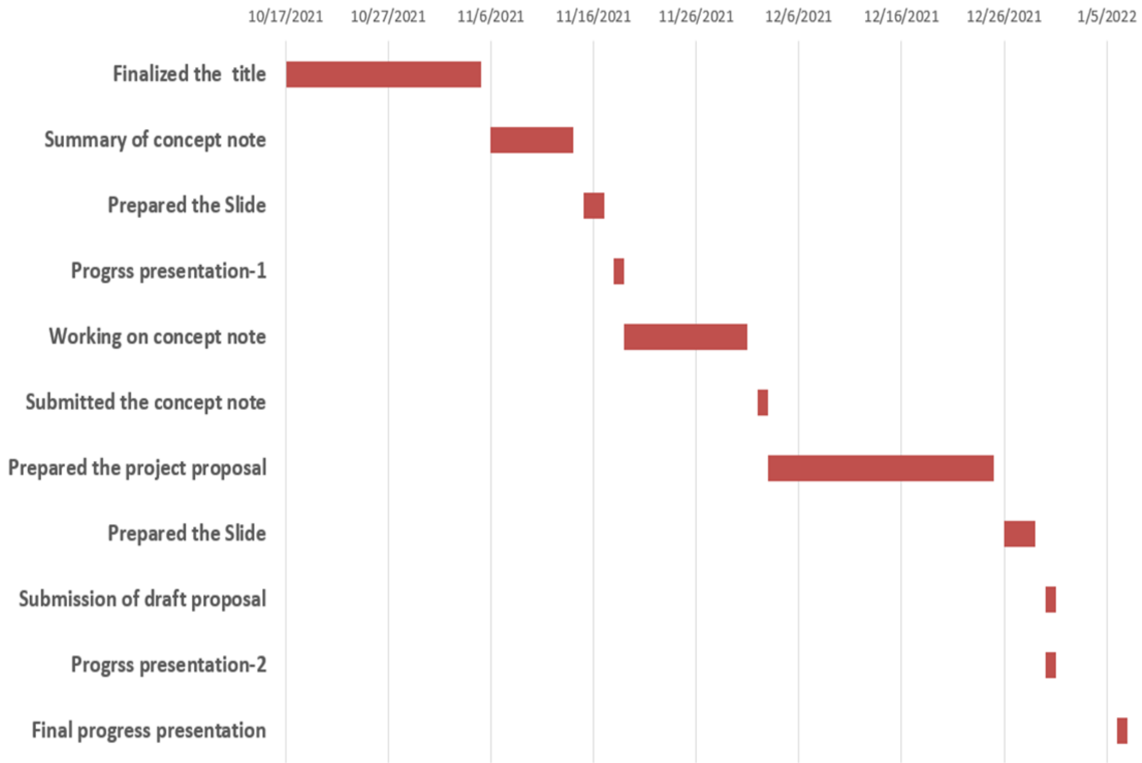


Figure 23: Gantt chart of 400P

[400D]

2nd Semester FYDP-D (400-D)	Start date	Duration	End date	Task Responsibilities
Preliminary design of multiple engineering solutions	02-02-22	7	09-02-22	Jawad, Sifat
Tool selection to design and analyze solutions	10-02-22	7	17-02-22	All
Perform analysis and optimization of alternate design	18-02-22	7	25-02-22	Serajul
Prepare for Progress presentation	26-02-22	5	02-03-22	All
Identify the most appropriate solution	03-03-22	7	10-03-22	All
Validate the appropriate solution with test cases	11-03-22	7	18-03-22	Pramit
Identify ethical issues and professional responsibilities	19-03-22	7	26-03-22	All
Project management	27-03-22	7	02-04-22	Serajul
Draft Design Report Submission to ATC	02-04-22	7	09-04-22	All
Final Design Report prepare	10-04-22	11	20-04-22	All
Mock Presentation and Final Design Report Submission	21-04-22	1	21-04-22	All
Final Project Presentation	28-04-22	1	28-04-22	All

Figure 24: Table of work distribution for 400D

Figure 25: Gantt chart of 400D

[400C]

a) Initial plan:

3rd Semester FYDP-C (400C)				
Task Name	Start date	Duration	End date	Task Responsibilies
Prototype testing	15-05-22	18	02-06-22	Jawad, Serajul,Sifat, Pramit
Progress presentation-1	08-06-22	1	08-06-22	Jawad, Serajul,Sifat, Pramit
Prototype demontration preparation	06-06-22	39	15-07-22	Jawad, Serajul,Sifat, Pramit
Progrss presentation-2	16-07-22	1	16-07-22	Jawad, Serajul,Sifat, Pramit
Final report preparation	17-07-22	34	20-08-22	Jawad, Serajul,Sifat, Pramit
Project demonstration	01-04-22	14	15-04-22	Jawad, Serajul,Sifat, Pramit
Progrss presentation-3	21-08-22	1	21-08-22	Jawad, Serajul,Sifat, Pramit

Figure 26: Initial table of work distribution for 400C.

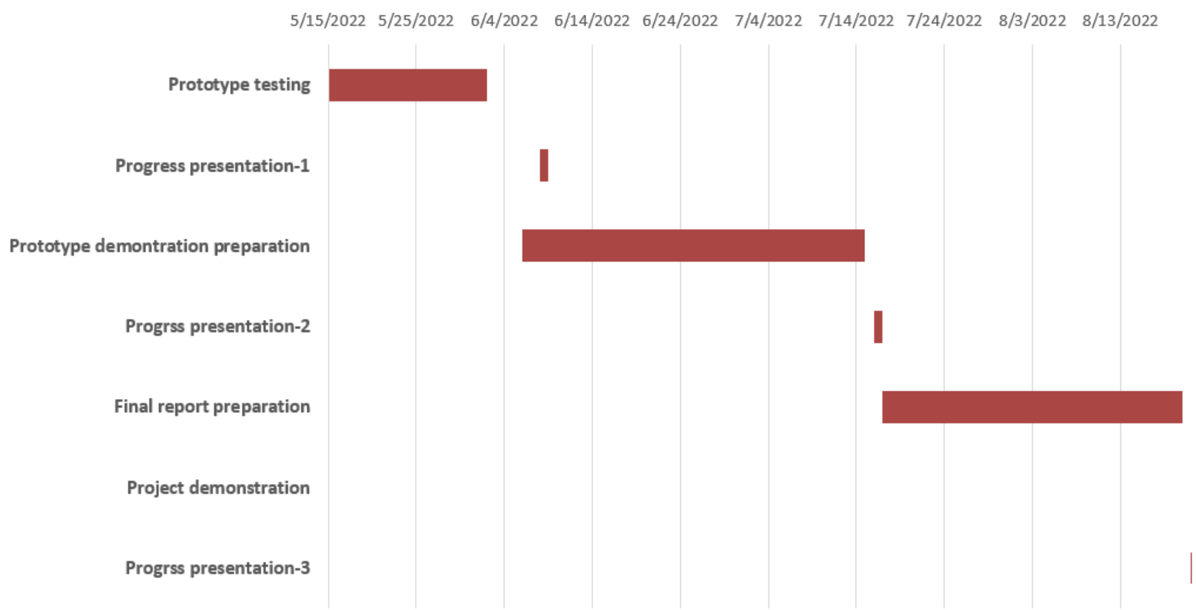


Figure 27: Initial Gantt chart of 400C

b) Updated plan:

3rd Semester FYDP-C (400C)				
Task Name	Start date	Duration	End date	Task Responsibilities
Purchasing Components	28-05-22	5	02-06-22	All
Prototype demontration	03-06-22	26	29-06-22	All
Programming & Implementation	30-06-22	6	06-07-22	All
Prototype testing	07-07-22	10	17-07-22	All
Progress presentation	18-07-22	3	21-07-22	All
Final report preparation	10-06-22	61	10-08-22	All
Final presentation	11-08-22	6	18-08-22	All
Project showcase	19-08-22	6	25-08-22	All

Figure 28: Updated table of work distribution for 400C.

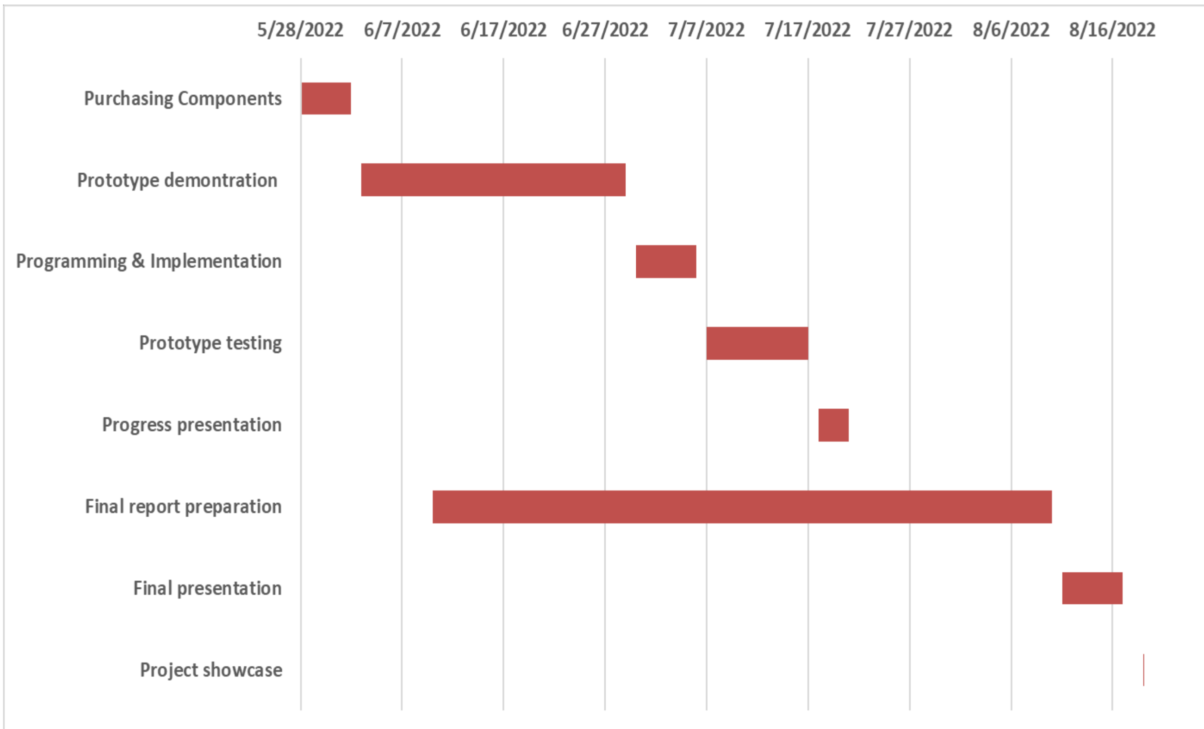


Figure 29: Updated Gantt chart of 400C

7.3 Evaluate project progress

Project management is essential to achieving consistent results through the completion of tasks. Firstly, a plan was made. However, the original plan did not go according to our plan and the program needs to be updated throughout the project timeline. Therefore, a revised plan was made with a new timeline that provides more accurate project progress.

In addition, the workload is shared by all four members of the group, making it easier and more accurate. In addition, a resource management backup plan is essential, so we can overcome any risks. We also conducted a risk management analysis that added all the risk factors that could impede the progress of the project. Many components were damaged and troubleshooted throughout the project. However, these restrictions do not hinder our progress, as contingency plans are already in place.

Accidents can create a wide variety of risks such as accidental short circuits and damage to components. To manage such risks we are dividing responsibilities into specific topics.

Risk Response Matrix:

Risk Event	Responsibility	Contingency Plan	Trigger
Interface Issues	Mitigate: Testing prototype and find the issues	Supply off and try to fix the issues as soon as possible	Solved with 45 mins
System Failure	Mitigate: Testing prototype and find issues	Check the loose connections problem and restart the system	Solved with 1 hour
User backlash	Mitigate: Demonstrate prototypes and try to find the best solution	Make the best improvised decisions	Inability to manage resources and budgets
Equipment malfunction	Mitigate: Choose a reputable provider that offers guarantees	Component replacement	Equipment fails

7.4 Conclusion

In summary, project management acts as the backbone of any project. An organized project plan helps us move forward and work on your solution as soon as an error occurs. Therefore, risk management is an integral part of project management. Finally, improvising the project management plan as the project progresses is important to ultimately achieve a good project.

Chapter 8 : Economical Analysis

8.1 Introduction

The examination of both expenditures and returns is integral to the process of economic analysis. To begin, initiatives are ranked according to their economic feasibility in order to facilitate more efficient resource allocation. Its purpose is to do research about the influence a project will have on people's wellbeing. An examination of a manufacturing process or a sector of industry might also fall under this category. The purpose of the study is to determine whether or not the economy as a whole or a particular sector of it is doing well. When doing an economic analysis of a company, for instance, the primary emphasis is on determining how much profit the company creates. Furthermore, it also estimates the business outcomes through data-driven techniques, enables convenient decision-making, and shows the best way to utilize resources. Evaluation of costs and benefits is essentially what economic analysis includes. To help with improved resource allocation, start by evaluating projects according to their economic viability. Its goal is to evaluate how a project will affect wellbeing. A research study into a manufacturing process or industry is still another option that may be considered. The purpose of the study is to find out how well the economy as a whole or a specific section of it is doing. For instance, the primary focus of an economic examination of a certain firm is to be placed on that company's level of annualized profits. Additionally, it facilitates decision-making, provides an estimation of business outcomes using data-driven methodologies, and illustrates the most efficient use of resources.

8.2 Economic Analysis

Economic analysis is a tool for better resource allocation, which leads to higher investment returns and efficient resource usage. The purpose of doing economic analysis for a project is to provide a comprehensive picture of the state of the economy at the time of the study in order to evaluate how efficiently the economy functions and how profitable the business is. What impact will the current economic climate have on the project's commercial production, if any? This project involves developing an IoT-based substation monitoring and control system, so setting up such a system demands intensive resource management. This makes it possible to achieve the intended outcome effectively.

8.3 Cost benefit analysis

There are many distinct approaches to economic analysis. Cost-benefit analysis seeks to ascertain a project's viability. For this study, the project's prospective benefits are weighed against the cost. The comparison focuses on the costs and results of various courses of action. Cost-effectiveness does not necessitate that we do the job for the cheapest price available. The most important factor is the project's effectiveness. Therefore, a lower cost does not always imply greater effectiveness. We need to use this cost-benefit analysis method to determine the least expensive way to complete a project when there are multiple options. For each component to function properly and efficiently, there are some advantages and downsides.There are a variety of marketable components that can be used to finish each operation. To achieve the best results, we must select the component that is both affordable and effective when used with other elements. This management procedure is essential to guaranteeing that the final product will satisfy customers.

Components	**Price**	**Strength**	**Weakness**
Arduino nano	600/-	1.Its little size makes it ideal for modest tasks. 2. Compatibility with a breadboard facilitates prototyping.	1.Lack of native connection restricts Internet of Things (IoT) applications. 2.Limited on-board memory might make it harder to execute sophisticated applications.
ZMPT101B Sensor	320/-	1.Ability to perform high accuracy measurement.	1.High power consumption compared to other analogue signal types. 2. Supply not isolated from output.
ACS712 Sensor (5A)	180/-	1. Capable of measuring both alternating current and direct current (AC and DC) 2.It is simple to integrate with MCU since it produces an analog voltage output.	1. The load is raised away from the connection to the direct ground. 2.An inherent non-linearity in the response brought on by Joule heating, which causes the resistance value to wander. the load and the sensing portion do not have sufficient electrical separation from one another. .
NTC Thermistor	9/-	1. A high resistance to the effects of temperature. 2.A high degree of sensitivity, a low heat capacity, and a lightning-fast reaction	1. Lack of adaptability to other contexts. 2.The non-linearity of the thermoelectric properties
Relay	90/-	1.The system can be controlled automatically or manually by the user through the browser. 2. It has a lower cost.	1.The system can only be controlled by on and off, but cannot be adjusted for its performance. 2.Its parts can wear out as the switch contacts become dirty,

			as high voltage and current cause sparks between contacts.
Buzzer	15/-	1.Convert the signal from audio to sound. 2.Simply Compatible.	1.Generates Annoying Sound. 2.Controlling is a little hard.
Wi-Fi Module D1 mini wemos	275/-	1.Convenient to utilize for Internet of Things applications thanks to its built-in micro-USB connection and IEEE 802.11 b/g/n WiFi. 2.A reduced amount of power usage during the deep sleep mode.	1.It may not be compatible with some peripherals

8.4 Evaluate economic and financial aspects

The project's prototype version is finished. It is performing as we had anticipated. If any businesses, offices, or educational institutions request this system, we will prepare it in accordance with their needs. We will require an appropriate fund for that. We will assist them in building this system. A prototype is implemented to obtain the desired result, and it has a specific budget, which is listed below:

Components Name	**Price (BDT)**
Arduino nano	600/-
ZMPT101B Sensor	320/-
ACS712 Sensor (5A)	180/-
NTC Thermistor	9/-
LCD Display (20*4)	350/-
Relay	90/-
Potentiometer 100K (2)	140/-
Buzzer	15/-
Wi-Fi Module D1 mini wemos	275/-

Wires	100/-
Breadboard	510/-
LED (2Pcs)	10/-
Miscellaneous Cost	1000/-
Total	**3559/-**

8.5 Conclusion

A system's performance is insufficient to support a project. Understanding how the project will operate both now and in the future requires an understanding of economics. The financial analysis assesses the resources needed when the project is begun. Economic analysis, as a result, helps us manage the project and make sure everything runs well.

Chapter 9 : Ethics and Professional Responsibilities

9.1 Introduction

Focusing on the ethical and professional responsibilities in engineering situations and making informed decisions is very important for an engineer to become a skilled and mature practitioner in every engineering perspective. Given these facts, one must take into account the effects of engineering solutions on (1) global impact, (2) economic impact, (3) environmental impact, and (4) societal impact. From a moral or societal perspective, these ethical matters represent the proper course of action. The professional issue is that, from a technical standpoint, one must execute it correctly and follow the proper procedures based on training as a practicing engineer.

9.2 Identify ethical issue and professional responsibility

Building any type of innovative engineering project ethically and honestly is always a top goal in order to increase its professionalism and public credibility.In that case, finishing any crucial tasks with integrity should always come first. As a result, we tried our best to adhere to all ethical guidelines and standards of conduct when creating the project and composing the essay**.** Every engineer knows that any engineering project's main objective is to develop a durable, dependable, and highly effective hardware setup that can alter people's viewpoints and improve the quality of their daily lives. However, technologists have worked to make these people's lives simpler.Engineers should keep in mind their ethical duties and commitments so that people will continue to trust the initiatives that aspiring engineers or businessmen hope to build or offer. Using inexpensive items can cut costs, but the quality of the work should be preserved. The context is as follows:

- Due to the equipment being used not requiring any fossil fuel, excessive power consumption, or gas leakage that would have a large negative influence on our environment, this project is completely environmentally benign.
- Taking the necessary security precautions to prevent hackers from accessing our system
- The task was divided to preserve the engineering ethical standard and to make each portion of our work more efficient and descriptive. We also concentrated on being true to ourselves by avoiding internet plagiarism when producing reports. The duties were completed independently, using suitable research, reliable information, and brainstorming.

9.3 Apply ethical issues and professional responsibility

- **Maintaining Equity :** Focusing on quality-based components in every area where the product or project is offered is one of the fundamental guidelines for engineers and other entrepreneurs. The public's confidence in the project's implementation would decline if this method is not carried out properly, and The whole thing won't be noticed. Therefore, if we can guarantee product supply equity, they will.
- **Project Efficiency :** To run the project effectively, all of the equipment must be kept in good operating order. Each piece of equipment is essential to the project, so if any of them breaks down, the entire endeavor could be put on hold. Specifically, we are designing these structures,and we think it's crucial to evaluate all hazards associated with upcoming designs and constructions.Before implanting on a bigger scale, some issues will need to be further investigated.
- **Maintenance of relationship:** As was previously stated, maintaining the public's trust in the project's implementation is essential to its success because the project we seek to establish can have a large positive influence. In that case, we must maintain our expertise to ensure the public keeps believing in us and is urged to carry out our initiative in their fields.
- **Project Optimization :** It is only logical that this project will advance over time with increasingly sophisticated algorithms and components given that we live in a competitive society. Therefore, it is the exclusive obligation of engineers and business owners to occasionally work on optimization such that Customers can get the finest outcomes for their fieldwork efforts. Consequently, the connection between the interests of our stakeholders and customers will be protected, and their continued faith in us will be very beneficial for the project's future.

9.4 Conclusion

The product we're working on is essentially a fresh and distinctive technology that could revolutionize how we approach substation monitoring. However, it is solely our job as engineers and business owners to respect all moral and professional standards of the proper conduct of an engineer. People will be more polite if these rules are followed. To use this project for their daily requirements is encouraged. Additionally, it will improve the relationship between clients and stakeholders, ultimately enhancing the visibility of our initiative.

Chapter 10: Conclusion and Future Work

10.1 Project Summary/Conclusion

We have finalized an approach among the two designs that meets all of the requirements, objectives, constraints, and specific conditions. Both designs have been tested in a variety of scenarios to determine their functionality and the best solution. Individual subsystems were subjected to multiple test cases. There were some issues encountered during the implementation of each component. After some analysis and research, the desired output was obtained. This strategy lowers the amount of time an individual spends in touch with a high-voltage equipment. This suggested system is intended to monitor the status of substation transformers installed in many locations. Numerous metrics must be examined often.Monitoring the parameters by appointing a person at each location is both costly and difficult, and the data is also prone to error if the monitoring is done manually. All of the problems discussed above can be greatly reduced by our proposed system.

10.2 Future Work

There are numerous factors to consider, as there is no limit to a better system. However, a prototype cannot accommodate all of them. As a result, some of the future works are listed below:

- Along with the technological advancement, there will be updated and latest components available which will ensure better precision in data collection
- Wireless Camera Addition is the installation of wireless cameras within the substation's switchyard, enabling for a more thorough visual inspection of the substation. Given that transformers are generally located in scattered places, this would be incredibly beneficial for monitoring them.
- Introduction of personalized app can ensure faster user experience and better data security

Chapter 11: identification of complex Engineering problems and Activities

11.1: identify the attributes of Complex Engineering Problem (EP)

A. Attributes of Complex Engineering Problem (EP)

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

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

A. Attributes of Complex Engineering Problems (EP)

- **P1(Depth of knowledge required):** This requires fundamental theoretical knowledge gained from our academic courses to solve and develop the designs. We also went through other activities that went beyond the basic teaching level, which was also required for this project.
- **P3 (Depth of analysis required):** We conducted numerous studies to determine the best solution for this assignment. Furthermore, we have analyzed cost, success rate, usability, environment sustainability and maintainability and we have decided that the first approach is the best option after examining all of the criteria and simulation results.
- **P7(Interdepence):** As our project is divided into three sub-system. That is why it is fulfilling this attribute.

11.3: Identify the attribute of Complex Engineering Activities(EA):

B. Attributes of Complex Engineering Activities (EA):

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

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

B. Attributes of Complex Engineering Activities (EA)

- **A1 (Range of resource):** In terms of achieving our main goal and making the prototype practically complete, the essential products are available. For our prototype design, some products will be purchased by us, while others will be collected from the EEE department if necessary. Also, with the proper resources, we did software simulation.
- **A2 (Level of interaction):** Through this project we are ensuring all the engineering issues to be solved.

References:

[1] Al-Allaf, Ahmad. IoT-Based Monitoring and Management Power Sub-Station of the University of Mosul. IOP Conference Series: Materials Science and Engineering. 928.2020.

[2] Q. Hai, W. Zheng, Z. Yan, L. X. Zhen, and Z. Si, "Status monitoring and early warning system for power distribution network based on IoT technology," International Conference on Computer Science and Network Technology (ICCSNT), Dalian, pp. 641-645, Oct. 2013.

[3] R. Li, J. Liu and X. Li, "A networking scheme for transmission line on-line monitoring system based on IoT," International Conference on Computing Technology and Information Management (NCM and ICNIT), Seoul, pp. 180-184, Oct. 2012.

[4] X. Shen, M. Cao, Y. Lu, and L. Zhang, "Life cycle management system of power transmission and transformation equipment based on Internet of Things," International Conference on Electricity Distribution (CICED), Xi'an, pp. 1-5, Aug. 2016.

[5] R. J. Tom and S. Sankaranarayanan, "IoT based SCADA integrated with Fog for power distribution automation," Iberian Conference on Information Systems and Technologies (CISTI), Lisbon, pp. 1-4, Jun. 2017.

[6] C. Moldoveanu et al., "Smart grids: On-line monitoring and condition assessment of high voltage substations," 2016 IEEE PES 13th International Conference on Transmission & Distribution Construction, Operation & Live-Line Maintenance (ESMO), pp. 1-5, 2016.

[7] J. L. Velasquez et al., "Development and implementation of a Condition Monitoring System in a Substation," 2007 9th International Conference on Electrical Power Quality and Utilisation, pp. 1-5, 2007.

[8] P. Lloret, J. L. Velasquez, L. Molas-Balada, R. Villafafila, A. Sumper and S. Galceran-Arellano, "IEC 61850 as a flexible tool for electrical systems monitoring," 2007 9th International Conference on Electrical Power Quality and Utilisation, pp. 1-6, 2007.

[9] W. J. Bergman, "Selecting substation monitoring," 2001 IEEE/PES Transmission and Distribution Conference and Exposition. Developing New Perspectives (Cat. No.01CH37294), pp. 964-969, 2001.

[10] B. Pickett et al., "Reducing Outages Through Improved Protection, Monitoring, Diagnostics, and Autorestoration in Transmission Substations—(69 kV and Above)," in IEEE Transactions on Power Delivery, vol. 31, no. 3, pp. 1327-1334, June 2016.

[11] A. Janssen, D. Makareinis and C. Sölver, "International Surveys on Circuit-Breaker Reliability Data for Substation and System Studies," in IEEE Transactions on Power Delivery, vol. 29, no. 2, pp. 808-814, April 2014.

[12] X. Liu, S. Song, D. Li and Z. Cheng, "Research on operation condition monitoring and security early warning system of distribution substation," 2015 5th International Conference on Electric Utility Deregulation and Restructuring and Power Technologies (DRPT), pp. 1541-1544, 2015.

[13] Zahran, M., Atia, Y. and Abulmagd, A., Reliable, Cheaper, and Modular New SCAAuto restorationireless Remote Applications. Kingdom SCADA Summit, pp.2-4, 2012.

[14] A.Sachan, “Microcontroller based substation monitoring and control system with GSM modem” ISSN: 2278-1676 Volume 1, Issue 6, pp 13-21, July-Aug. 2012.

[15] Baburao, S., Balasaheb, B. and Sampat, B., “IoT Based sensing system for substation automation and monitoring. Pune: “Iot based sending system for substation automation and monitoring, pp 6-7.2018.

[16] S.gorai, K.N. Sah and P.Kharadhara, “Substation Monitoring & Control System”, Kolkata, RCC Institute of Information Technology, pp.29-30, 2017-18.

[17] P.Suneel, Dr.V.U.reddy, “Monitoring and controlling of electrical loads from the substation by using Zigbee technology”,Tirupati, India, March, 2017.

[18] V.Panchade, K.B.Tarase, “Monitoring and controlling of substation using IoT in distribution power grid”, 2020 5th international Conference on Devices, Circuits and systems (ICDCS), March, 2020.

[19] E.Csanyi, “The basic things about substations you must know in the middle of the night”, January, 2019.

[20] E.Csanyi, “Primary and secondary power distribution systems (layouts exlained)”; March, 2019.

FYDP (C) Summer 2022 Summary of Team Log Book

	Final Year Design Project (C) Summer 2022		
Student Details	**NAME & ID**	**EMAIL ADDRESS**	**PHONE**
Member 1	Pramit Das 16321110	pramit.das@g.bracu.ac.bd	01777170363
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ATC Details:			
ATC 3			
Chair	Dr. AKM Abdul Malek Azad, Professor, Department of EEE, Brac University	a.azad@bracu.ac.bd	
Member 1	Afrida Malik, Lecturer, Department of EEE, Brac University	afrida.malik@bracu.ac.bd	
Member 2	Mohammed Thushar Imran, Lecturer, Department of EEE, Brac University	thushar.imran@bracu.ac.bd	

Project Title:

IoT-Based Intelligent Wireless Substation Monitoring and Controlling System

Group no. 10

FYDP (C) Summer 2022 Summary of Team Log Book

Date/Time/Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
02.06.2022 (FYDP-C Class)	1.Pramit 2.Serajul 3.Jawad	Introductory session of EEE400 (C)		Sifat was absent
09.06.2022 (Meeting 1 with the ATC members)	1.Dr. AKM Abdul Malek Azad (ATC Chair) 2.Afrida Malik (ATC Member) **Students:** 1.Sifat 2.Serajul 3.Pramit 4.Jawad	1.Modify the Gantt chart of 400C 2. Start writing the report. 3. Show the component bought and demonstrate progress.	Task 1: Serajul Task 2: Sifat, Serajul, Pramit, Jawad Task 3: Sifat, Serajul,Pramit, Jawad	Finish the prototype demonstration before Mid.
14.06.2022 (Online Meeting with the group members) Recording	1.Sifat 2.Serajul 3.Pramit 4.Jawad	1.Modified the Gantt chart of 400C 2. Started writing chapter 1,2,3,7,11 of the report	Task 1: Completed Task 2: Partially Completed Task 1: Serajul Task 2: Sifat, Serajul, Pramit, Jawad	

15.06.2022 (Offline Meeting with the group members)	1.Sifat 2.Serajul 3.Pramit 4.Jawad	1.Worked on prototype demonstration	Task 1: Partially Completed Task 1: Sifat, Serajul, Pramit, Jawad	
21.06.2022 (Offline Meeting with the group members)	1.Sifat 2.Serajul 3.Pramit 4.Jawad	1. Discussed about few points of report 2.Worked on prototype demonstration	Task 1: Partially Completed Task 2: Partially Completed Task 1: Sifat, Serajul, Pramit, Jawad Task 2: Sifat, Serajul, Pramit, Jawad	
23.06.2022 (Meeting 2 with the ATC members)	1.Dr. AKM Abdul Malek Azad (ATC Chair) 2.Afrida Malik (ATC Member) 3.Mohammed Thushar Imran(ATC Member) **Students:** 1.Sifat 2.Serajul 3.Pramit 4.Jawad	1. Test and see the prototype is working. 2. Correct all the mistakes of the report and continue working.	Task 1: Sifat, Serajul, Pramit, Jawad Task 2: Sifat, Serajul, Pramit, Jawad Task 1: Partially Completed Task 2: Partially Completed	1. Sensor name add in the background 2. Elaborate the background more and literature gap 3. Specification for second approach 4.Mention parameters name 5.Add short description in chapter 2.2 6.Start new chapter from new pages 7.Write in points in chapter 6.2 8.Restructure the sentence in chapter 6.3 9.Organise the table with gantt chart 10.Add updated chart for 400C 11.Add cost benefit analysis in Chapter 8

25.06.2022 (Offline Meeting with the group members)	1.Sifat 2.Serajul 3.Pramit 4.Jawad	1.Divided the report work. 2. Worked on coding and demonstration	Task 1: Partially Completed Task 2: Completed Task 1: Sifat, Serajul, Pramit, Jawad Task 2: Sifat, Serajul, Pramit, Jawad	1. Chapter 1,2,3 divided to Sifat and Jawad 2. Chapter 6,7 divided to Serajul 3. Chapter 8,9 divided to Pramit.
29.06.2022 (Offline Meeting with the group members)	1.Sifat 2.Serajul 3.Pramit 4.Jawad	1. Tested the prototype in the thesis lab.	Task 1: Partially Completed Task 1: Sifat, Serajul, Pramit, Jawad	1.Current sensor is not working. We are trying to fix the issue.

30.06.2022 (Meeting 3 with the ATC members)	1.Dr. AKM Abdul Malek Azad (ATC Chair) 2.Afrida Malik (ATC Member) 3.Mohammed Thushar Imran(ATC Member) **Students:** 1.Sifat 2.Serajul 3.Pramit 4.Jawad	1. Fix the problems mentioned in chapter 1,2,3 2.Add the chapter 4 3.Fix the font and alignment of chapter 6 and elabore. Add other points of chapter 7 4.Redo the chapter 8 and 9 and add other points 5.Validation of simulation and hardware results 6. Check all sensor are working perfectly.	Task 1:Sifat, Jawad Task 2:Sifat, Serajul Task 3:Serajul Task 4: Pramit Task 5:Sifat, Serajul, Pramit, Jawad Task 6: Sifat, Serajul, Pramit, Jawad Task 1:Partially Completed Task 2: Completed Task 3:Partially Completed Task 4: Partially Completed Task 5: Completed Task 6: Completed	1.Include ATC meeting number 2.Redo background study 3. Write the points in the report even if you don't start. 3. Add requirements in the specification of 2nd design approach. 4. Constraints will be after technical and no technical consideration. 5. 2-3 lines before block diagram should be added. 6. Design approach 2 elaborate. 7. IT tools software and hardware components only. No need of description 8. Add hardware part for 2nd design approach. 9. Add chapter 4 10. Chapter 6.3 elaborate. Formatting issue 11. Chapter 7.3 elaborate 7.4 add 12. Chapter 8.1 Redo 13. Chapter 8.3 add 14. Chapter 9 add other points

02.07.2022 (Offline Meeting with the group members)	1.Sifat 2.Serajul 3.Pramit 4.Jawad	1.Divided the report work 2.Worked on ground connections of hardware parts 3. Fixed the problems mentioned in chapter 1,2,3 4.Fix the font and alignment of chapter 6 and elabore. Add other points of chapter 7	Task 1: Sifat, Serajul, Jawad, Pramit Task 2: Sifat, Serajul, Jawad, Pramit Task 3:Sifat, Jawad, Task 4:Serajul Task 1: Partially Completed Task 2: Completed Task 3:Completed Task 4: Partially Completed	

06.07.2022 (Offline Meeting with the group members and one ATC member)	Mohammed Thushar Imran(ATC Member) **Students:** 1.Sifat 2.Serajul 3.Pramit 4.Jawad	1.Checked all the sensors are working properly. 2. Changed the frequency and current parameter 3.Validation of simulation and hardware results 4. Chapter 8 and 9 redo and added other points 5. Added Chapter 4	Task 1: Sifat, Serajul, Jawad, Pramit Task 2: Sifat, Serajul, Jawad, Pramit Task 3:Sifat, Serajul, Jawad, Pramit Task 4:Pramit Task 5:Sifat, Serajul Task 1: Completed Task 2: Completed Task 3: Completed Task 4:Partially Completed Task 5: Completed	1. Frequency must be fixed at 50hz 2. Change the parameters of current sensor
21.07.2022 (Meeting 4 with the ATC members)	1.Dr. AKM Abdul Malek Azad (ATC Chair) 2.Afrida Malik (ATC Member) 3.Mohammed Thushar Imran(ATC Member) **Students:** 1.Sifat 2.Serajul 3.Pramit 4.Jawad	1. Make slide for presentation 2. Add a demonstration video in the slide and show how the temperature sensor is working as well. 3. Correct all the mistakes of the report and start writing other points. 4.Show the references of the threshold	Task 1: Sifat, Serajul, Jawad, Pramit Task 2: Sifat, Serajul Task 3:Sifat, Serajul, Jawad, Pramit Task 4:Sifat Task 1: Completed Task 2: Completed Task 3: Partially Completed Task 4: Completed	1.Increase the font size of the report. 2. Fix the Spacing, alignment and formatting issues of the report 3. Add explanation before every diagram 4. Maintain the sequence of the figure number.

23.07.2022 (Offline Meeting with the group members)	1.Sifat 2.Serajul 3.Pramit 4.Jawad	1. Added Slide 1-6 2. Added Slide 7-9 3. Added Slide 10-11 4. Added Slide 12-17 5. Made a demonstration video for the slide.	Task 1: Sifat Task 2:Jawad Task 3:Serajul Task 4:Pramit Task 5: Sifat,Serajul Task 1: Completed Task 2: Completed Task 3: Completed Task 4: Completed Task 5: Completed	
28.07.2022 (Progress presentation)	1.Sifat 2.Serajul 3.Pramit 4.Jawad	1. Presented Slide 1-6 2. Presented Slide 7-9 3. Presented 10-11 4. Presented 12-17	Task 1: Sifat Task 2:Jawad Task 3:Serajul Task 4:Pramit Task 1: Completed Task 2: Completed Task 3: Completed Task 4: Completed	1. System has no controlling part. 2.Can't detect multiple faults

3.08.2022 (Offline Meeting with the group members)	1.Sifat 2.Serajul 3.Pramit 4.Jawad	1. Corrected all the mistake of Chapter 1,2 and added literature gap 2. Corrected all the mistakes of chapter 3 and added other points. 3. Corrected all the mistakes of chapter 4 and added other points. 4. Corrected all the mistakes of chapter 6,7 and added other points. 5. Added few points of chapter 8,9	Task 1: Sifat Task 2:Jawad Task 3: Sifat,Serajul Task 4:Serajul Task 5: Pramit Task 1: Completed Task 2: Completed Task 3: Completed Task 4: Completed Task 5: Partially Completed	
4.08.2022 (Meeting 5 with the ATC members)	1.Dr. AKM Abdul Malek Azad (ATC Chair) 2.Afrida Malik (ATC Member) 3.Mohammed Thushar Imran(ATC Member) **Students:** 1.Sifat 2.Serajul 3.Pramit 4.Jawad	1. Take test data and add to the report. 2. Change the temperature threshold. 3. Modify the flowchart of design approach 2 4. Add Chapter 5 5. Add Chapter 8.3, 8.4 6. Add Chapter 10	Task 1: Sifat,Serajul Task 2:Sifat Task 3:Serajul Task 4: Sifat,Serajul Task 5: Pramit Task 6: Jawad Task 1: Completed Task 2: Completed Task 3: Completed Task 4: Partially Completed Task 5: Not Completed Task 6: Not Completed	1. Remove controlling part from title 2.Add progress presentation in log book 3.Show the IoT is working simultaneously after changing the value of each sensor. 4. 1.2.2 System level specification 5. 3.3 explain bit more about the sensor 6. Short explanation after figure 11 7. 4.4 describe the obtained result.

10.08.2022 (Offline Meeting with the group members)	1.Sifat 2.Serajul 3.Pramit 4.Jawad	1. Took the data after testing and added it to the report. 2. Changed the temperature threshold. 3. Modified the flowchart of design approach 2 4. Added Chapter 5	Task 1: Sifat,Serajul Task 2:Sifat Task 3:Serajul Task 4: Sifat,Serajul Task 1: Completed Task 2: Completed Task 3: Completed Task 4: Partially Completed	
11.08.2022 (Meeting 6 with the ATC members)	1.Dr. AKM Abdul Malek Azad (ATC Chair) 2.Afrida Malik (ATC Member) 3.Mohammed Thushar Imran(ATC Member) **Students:** 1.Serajul	1. Try to add the controlling part 2. Add system level specification 3. Use other transitional word and elabore Chapter 5.3 4. Complete Chapter 8.3 and 8.4 5. Add Chapter 10	Task 1: Sifat, Serajul, Jawad, Pramit Task 2:Sifat Task 3:Serajul, Sifat Task 4:Pramit Task 5: Jawad Task 1: Completed Task 2: Completed Task 3: Partially Completed Task 4: Completed Task 5: Completed	1. Sifat was absent. His grandmother passed away 2. Jawad was absent. He was in class. 3. Pramit was present for 10 mins and then left the meeting.

17.08.2022 (Offline Meeting with the group members)	1.Sifat 2.Serajul 3.Pramit 4.Jawad	1. When any fault occurs loads become automatically off. If this addresses the controlling part then it is added. 2. System level specification is added 3. Chapter 5.3 is still under progress. 4. Added Chapter 8.3 and 8.4 5. Added Chapter 10	Task 1: Sifat, Serajul, Jawad, Pramit Task 2:Sifat Task 3:Serajul, Sifat Task 4:Pramit Task 5: Jawad Task 1: Completed Task 2: Completed Task 3: Partially Completed Task 4: Completed Task 5: Completed	
24.08.2022 (Offline Meeting with the group members)	1.Sifat 2.Serajul 3.Pramit 4.Jawad	1. Slide 1-8 2. Slide 9-11 3. Slide12 4. Slide 13-19	Task 1: Sifat Task 2:Jawad Task 3:Serajul Task 4:Pramit Task 1: Completed Task 2: Completed Task 3: Completed Task 4: Completed	

25.08.2022 (Meeting 7 with the ATC members)	1.Dr. AKM Abdul Malek Azad (ATC Chair) 2.Afrida Malik (ATC Member) 3.Mohammed Thushar Imran(ATC Member) **Students:** 1.Sifat 2.Serajul 3.Pramit 4.Jawad	1. Specify system level and component level specification in the report 2. Add risk response matrix in Chapter 7.3 3. Add table under cost benefit in chapter 8 4. Install blynk app in mobile to monitor from mobile and add in the demonstration video 5. Send a demonstration video explaining how the controlling mechanism is working	Task 1: Sifat Task 2: Serajul Task 3:Pramit Task 4: Jawad Task 5: Sifat,Serajul Task 1: Completed Task 2: Completed Task 3: Completed Task 4: Completed Task 5: Completed	1. Add final presentation feedback in the log book 2. Change the pictures of the slide. 3. Use pointer when present
29.08.2022 (Offline Meeting with the group members)	1.Sifat 2.Serajul 3.Pramit 4.Jawad	1. System level and component level specification is written in the report 2. Added risk response matrix in Chapter 7.3 3. Added table under cost benefit in chapter 8 4. Install blynk app in mobile to monitor from mobile and add in the demonstration video 5. Send a demonstration video explaining how the controlling mechanism is working	Task 1: Sifat Task 2: Serajul Task 3:Pramit Task 4: Jawad Task 5: Sifat,Serajul Task 1: Completed Task 2: Completed Task 3: Completed Task 4: Completed Task 5: Completed	

01.09.2022 (Final presentation)	1.Sifat 2.Serajul 3.Pramit 4.Jawad	1. Presented Slide 1-6 2. Presented Slide 7-10 3. Presented Slide 11 4. Presented Slide 12-18	Task 1: Sifat Task 2: Jawad Task 3: Serajul Task 4:Pramit Task 1: Completed Task 2: Completed Task 3: Completed Task 4: Completed	1. Title should be changed according to the project. 2. The points of Economical analysis in the slide should be more specific 3.The points of Ethical and professional analysis in the slide should be more specific

IoT BASED INTELLIGENT WIRELESS SUBSTATION MONITORING AND CONTROLLING SYSTEM

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