GSM BASED ELECTRICAL LOAD PROTECTION SYSTEM

A Project report is submitted in partial fulfillment of the requirements for the award of Degree of Bachelor of Science in Electrical and Electronic Engineering.

Submitted by

MD. ZAHEDUL ISLAM ID: 212-33-5408

Supervised by

Mr. Md. Sohel Rana

Assistant Professor

Department of Electrical and Electronic Engineering

Department of Electrical and Electronic Engineering

Faculty of Engineering

DAFFODIL INTERNATIONAL UNIVERSITY

NOVEMBER, 2025

DECLARATION

I hereby declare that this project "**GSM BASED ELECTRICAL LOAD PROTECTION SYSTEM**" illustrate my own work which has been done in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering, and has not been previously included in a thesis or dissertation submitted to this or any other institution for a degree, diploma or other qualifications. I have attempted to identify all the risks related to this research that may arise in conducting this research, obtained the relevant ethical and/or safety approval (where applicable), and acknowledged my obligations and the rights of the participants.

Signature of the candidates

____

Md. Zahedul Islam
ID: 212-33-5408

APPROVAL

The project entitled **"GSM BASED ELECTRICAL LOAD PROTECTION SYSTEM"** submitted by **MD. ZAHEDUL ISLAM (ID: 212-33-5408)** has been done under my supervision and accepted as satisfactory in partial fulfillment of the requirements for the degree of **Bachelor of Science in Electrical and Electronic Engineering** in **November, 2025.**

Signed

Mr. Md. Sohel Rana
Assistant Professor & Associate Head
Department of Electrical and Electronic Engineering
Faculty of Engineering
Daffodil International University

Dedicated

To

First of all, I would like to dedicate this work to my teachers and parents, whose guidance, support, and encouragement have been invaluable throughout my journey.

TABLE OF CONTENTS

Declaration .... **ii**

Approval .... **iii**

Table of Contents .... **v**

List of Figures .... **viii**

List of Tables .... **ix**

List of Abbreviations .... **x**

List of Symbols .... **xi**

Acknowledgement .... **xii**

Abstract .... **xiii**

Chapter 1: Introduction **1**

1.1 Introduction 1

1.2 Problem Statement 1

1.3 Objectives 2

1.4 Brief Methodology 3

1.5 Gantt Chart 3

Gantt chart of the full project schedule: .... **Error! Bookmark not defined.**

1.6 Organization 4

Chapter 2: Literature Review **6**

2.1 Introduction 6

2.2 Related Research 6

2.3 Compare and Contrast 8

2.4 Summary 10

Chapter 3: Materials and Methods **11**

3.1 Introduction 11

3.2 System Design and Components 11

3.2.1 Arduino Nano 11
3.2.2 Voltage Sensor 12
3.2.3 Current Sensor 13
3.2.4 Buck Converter 14
3.2.5 GSM Module 14
3.2.6 Power Supply 15
3.2.7 Relay 16
3.2.8 LCD Display 17
3.3 Design Specifications 18
3.4 Design Analysis 19
3.5 Summary 20
Chapter 4: Results and Discussions 21
4.1 Results 21
4.2 Discussions 22
Chapter 5: Project Management 24
5.1 Task, Schedule and Milestones 24
5.2 Resources and Cost Management 25
5.3 Lesson Learned 26
Chapter 6: Impact assessment of the project 27
6.1 Economical, Societal and Global Impact 27
6.2 Environmental and Ethical Issues 28
6.3 Utilization of Existing Standards or Codes 29
6.4 Other Concerns 30
Chapter 7: Conclusions and Recommendations 31
7.1 Conclusions 31
7.2 New Skills and Experiences Learned 31
7.3 Future Recommendations 31

References **33**

Appendix A: Turnitin Report **35**

Appendix B: Complex Engineering Problem Solving and Engineering Activitie 36

Appendix C: Program Code 37

LIST OF FIGURES

Figure No	*Figure Name*	*Page No.*
Fig. 3.1	Arduino Nano	12
Fig. 3.2	Voltage Sensor	13
Fig. 3.3	Current Sensor	13
Fig. 3.4	Buck Converter	14
Fig. 3.5	GSM Module	15
Fig. 3.6	Power Supply	16
Fig. 3.7	Relay	17
Fig. 3.8	LCD Display	17
Fig. 3.9	Circuit diagram of the project	18
Fig. 3.10	Flow Chart of the project	18
Fig. 3.11	Block diagram of the project	19
Fig. 4.1	Result Data and Fault Name	22
Fig. 4.2	Project Outlook	22

LIST OF TABLES

Table No	***Fig. Name***	***Page No.***
Table 4.1	Result Analysis	21
Table 5.1	Cost Management	26

LIST OF ABBREVIATIONS

GSM	Global System for Mobile Communications
LCD	Liquid Crystal Display
I2C	Inter Integrated Circuit
SCL	Serial Clock
SDA	Serial Data

LIST OF SYMBOLS

Symbol	*Name of the symbol*
uC	Microcontroller
A	Ampere
V	Voltage

ACKNOWLEDGEMENT

In the first instance, I want to give thanks to Almighty Allah. With his blessing I am able to complete my work with best effort. I want to pay my utmost respect to my Supervisor Mr. Md. Sohel Rana, Assistant Professor & Associate Head of the Department of EEE, Daffodil International University for who has given me the chance to work on an impactful idea and taken care of every issue of development of this concept. Then I would like to take this opportunity to express gratitude to my supervisor for being dedicated in supporting, motivating and guiding me throughout this project. This project can't be done without his useful advice and help. Also thank him very much for giving me the opportunity to work with this project.

I also want to convey my thankfulness to the Department of EEE, Daffodil International University for his support and encouragement. Apart from that, I would like to thank our entire class fellows for sharing knowledge, information and helping me in making this project a success. To beloved family, I want to give them my deepest love and gratitude for being very supportive and also for their inspiration and encouragement during my studies in this Institution.

ABSTRACT

The GSM-Based Electrical Fault Protection System is an electrical fault management system which involves the use of an Arduino microcontroller, voltage, current, and temperature sensors to check and guard electrical circuits against typical faults and dangerous operating conditions. The system constantly monitoring the voltage levels, current flow and temperature. The system activates an alarm the instant the current overloads or unusual temperature increase occurs, to eliminate the danger of equipment destruction and potential harm to the personnel. A GSM module is used to send real-time notification to the user or operator through SMS so that the awareness is notified and acts taken. This is a cost effective alternative to improving the safety and reliability of electrical installations, especially in remote locations where manual observation is problematic.

Keywords: Earth fault protection, Overload detection, GSM-based alert system, Arduino, Electrical safety.

CHAPTER 1
INTRODUCTION

1.1 Introduction

Electrical systems are susceptible to a number of faults and overload situations that may lead to massive destruction of equipment, property and human lives. The earth faults and overload conditions are among the most significant concerns that can trigger the electrical fires, equipment failures, and power supply interruptions. Traditional protection systems are known to be ineffective on real time monitoring, issuing instant notification particularly in remote or unmanned locations. The need to fill this gap demands a smarter and reactionary solution. The GSM-Based Electrical Fault Protection System is aimed at providing real-time monitoring and protection of electrical installations based on Arduino as a central control unit, voltage, current, and temperature sensors. The system is used to measure important electrical parameters such as voltage levels, current flow, and temperature to identify faults, such as earth faults, overloading of the current and heating in real time. When these anomalies are observed, the system will provide instant corrective response like isolating the affected circuit so as to avoid additional damages. The addition of a GSM module enables the system to provide real time alerts to the relevant operator or the maintenance personnel through SMS. This will guarantee fast response and improve the safety and trustworthiness of the electrical system, even with the remote areas. The availability of easily obtained sensors and an Arduino microcontroller, makes the system affordable, scalable and highly adaptable to different uses, including industrial plants, homes, and unmanned power distribution locations, among others. This system is not only better in enhancing protection of electrical installations but also contributes towards preventative maintenance through timely provision of data to prevent expensive repairs and down time. The system is a contemporary and efficient method of detecting electrical faults and protection through the integration of Arduino, sensors, and GSM technology.

1.2 Problem Statement

Residential, industrial and commercial electrical systems are susceptible to earth faults, overload conditions and overheating that would severely damage equipment, cause electrical fires and result in serious safety hazards. Conventional security solutions usually do not have real-time monitoring and alerts, particularly unattended installations or when the institution is far away. This leads to the slow reaction time and the probability of causing a serious type of damage before any precautionary actions can be implemented. More efficient, automated, and real-time system is required that will be able to constantly check important parameters such as voltage, current, and temperature to identify abnormalities in the initial stages and activate protective mechanisms. In addition, whenever there is a fault or overload, the system must be capable of transmitting timely alerts to the involved personnel through a stable communication channel which will allow them to take nipple corrective measures, even in distant areas. The question is how to develop a solution based on the widely-available technologies that is cost-effective and easily deployable, and could offer a strong earth fault detection system, over protection, and temperature monitoring, as well as real-time notification.

1.3 Objectives

- To identify leakage fault on earth: The circuit has a leakage fault detector that checks the circuit against the leakage of current to the ground and may lead to an earth fault and a protective action is taken.
- To detect over current fault: The current sensor detects when the noise is more than the safe amounts (overload), and the load is then disconnected, avoiding the possible damage to the electrical devices.
- To ensure load safety due to over current and voltage: The system will secure the load that is connected to electrical conductors against overcurrent and voltage swings which elevate the temperature and damage the load.
- To display data (real-time): The system will also have real-time monitoring of electrical parameters (voltage, current) so that users can see what is happening in the system in real-time.
- To GSM Based notification of each fault: If there occurs any fault (earth leakage, overcurrent, the system sends immediate alert messages to the user through SMS using GSM module so that he can act on it quickly.

1.4 Brief Methodology

The GSM-Based Electrical Fault Protection System is a product aimed at real-time monitoring of electrical parameters with the help of Arduino microcontroller and other sensors. The methodology of the system is as follows: Component Integration: The system is processed by an Arduino as a central processing unit. It has a voltage sensor connected to measure the level of voltage, a current sensor to indicate overload conditions, and a temperature sensor to measure the amount of heat in the system. What it lacks is a GSM module that will be used to send real-time alerts in the event of faults or abnormal conditions through SMS. Data Acquisition: The voltage sensor is connected to the electrical circuit and kept at all times to detect the voltage there. The current sensor is used to monitor the current flowing to identify any cases of overcurrent. The temperature sensor monitors the temperature of the system in order to detect cases of overheating. Processing and Fault Detection: The Arduino manipulates the sensory data in the incoming data. In the event that the voltage, current or temperature rises above preset values (signifies an earth fault, overuse or overheating), the Arduino initiates a protective measure. Protective Action: When a fault is observed (overload, earth fault, or temperature increase), the system automatically cuts off the electrical load before equipment is damaged or a fire threat is created. Real Time Alerts through GSM: At the same time the GSM module sends an SMS notification to a specific operator or user as to the type and condition of the fault in the system. User Notification and logging: The system maintains a record of every fault incident and enables the users to track the status of the same through SMS notifications. This is a characteristic that makes operators be able to act quickly on any incident, even when they are at a far distance.

1.5 Gantt Chart

Illuate a visual project management schedule:

Phase	Duration in Week	Start	End
Planning and Design	2	Week 1	Week 2
Procurement and Setup	1	Week 3	Week 3
Hardware Implementation	3	Week 4	Week 6
Software Development	4	Week 7	Week 10

Integration and Testing	2	Week 11	Week 12
Optimization and Fine-Tuning	1	Week 13	Week 13
Deployment and Evaluation	1	Week 14	Week 14
Documentation and Reporting	1	Week 15	Week 15

This gantt chart provides a structured approach to implementing our project within approximately 15 weeks, allowing for sufficient time for each phase while maintaining flexibility for adjustments as needed.

1.6 Organization

Here's how we organize the report for our project:

Chapter 1. Introduction

Describe in brief about introduction of our project along with background, problem statement and objectives.

Chapter 2. Literature Review

In this section we describe about related research that similar to our projects and made some comparison from others work.

Chapter 3. Materials and Methods

Explained all the methodology with the system design and Components in detail with diagrams.

Chapter 4. Results and Discussions

Presented the findings and observations from experiments, simulations, and real-world testing.

Chapter 5. Project management

Discussed about the project timeline, tasks, and milestones along with resources and cost management and lessons that we learnt.

Chapter 6. Impact Assessment

Here we discussed about economic, societal, and global impact, environmental and ethical considerations along with utilization of standards or codes.

Chapter 7. Conclusions and Recommendations

Here we conclude about our project, new skills and experiences and future recommendation.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

The growing sophistication of electrical systems in residential, commercial, and industrial environments has led to the necessity to have sophisticated protection systems to provide a sense of safety and eliminate the possibility of system failure. Among the most widespread problems that may cause serious damages to equipment, loss of power and safety risks are earth faults, overloads, and overheating. The old fashioned fault protection systems are usually manual operated and have a limit on the ability to offer real-time monitoring particularly in the remote areas. With the development of microcontroller-based systems and the emergence of the Internet of things (IoT), new opportunities have emerged in the field of automating and enhancing fault detection and protection. The application of Arduino microcontrollers in low cost, efficient, and customizable monitoring systems has been given a lot of attention in the recent years. It is now possible to combine the voltages sensors, the current sensors, and the temperature sensors into one system to keep a continuous check on the electrical parameters and thereby provide a more accurate and reliable fault detection. In conjunction with this, GSM-based communication systems offer a viable means of remote monitoring in the sense that real-time fault notifications can be made available through SMS which can radically lower the response time and increase the reliability of the system. In this literature review, past studies and technology in detecting earth faults, overloads, and temperature using microcontrollers and sensor-based devices are examined. It also looks at the incorporation of GSM modules to report fault real time and how the innovations have led to the emergence of current automated protection systems.

2.2 Related Research

Many studies have been conducted on how Arduino can be used in the low-cost fault detection systems. These systems are also flexible and various sensors can be incorporated to detect voltage abnormalities, overcurrent and temperature changes. Arduino can be adapted in terms of its flexibility and thus serves as the best option in real time application [1]. Voltage sensors play a significant role in detecting any abnormality like voltage surges and drops. They aid in detecting faults early enough before there is any damage to the associated devices. Investigations indicate that Arduino and voltage sensors can be merged to enhance the reliability and response rate of the system [2]. There has been a study of the current sensors like Hall-effect sensors that detect the overcurrent condition. These sensors have a real-time responses of the current flow and the systems are able to automatically eject the loads in case of an overload thereby causing no damage [3]. Electrical failure is largely caused by overheating. Microcontrollers can be used with temperature sensors to provide a decent answer to monitoring changes in temperature and implementing safety measures in case of overheating [4]. Real-time SMS alerts can be achieved by the code, which integrates the functions of GSM modules and Arduino in the event of faults, including earth leakage, overcurrent, or temperature increase. It comes in handy especially in remote monitoring where manual intervention is impossible [5]. The study of smart systems shows the possibility of implementing the IoT technology of the GSM and cloud services in remote monitoring and controlling the electric circuits. These systems provide an automated way of fault detection and response [6]. Earth faults may lead to hazardous leakages. Most of the literature talks about different principles of earth faults detection such as differential current sensing, ground-fault circuit interrupters that may be supplemented with real-time data of Arduino-based systems [7]. Research indicates the role of real-time monitoring in identifying over current situations which may cause failures of equipment. The sophisticated systems have current sensors which feedback information immediately to the control unit (Arduino) to avoid overload [8]. Scalability and affordability of Arduino on power monitoring systems have been well documented. Scientists have come up with mechanisms that measure temperature, voltage, and current and keep functioning without external interference and fault detection [9]. This is enabled by the incorporation of GSM technology in the electrical monitoring systems, which can provide real-time fault notifications. There is some literature that validates the usefulness of GSM in alerts transmission, minimizing the response time of electrical faults, particularly in isolated areas [10]. The fault-tolerant systems are set to aid minor faults automatically to prevent the system failure. The use of Arduino and sensors will prevent such failures as the earth leakage or overload which would cause disastrous results [11]. Smart grids are also advantageous due to the use of Arduino to control and monitor the flow of power, to identify cases of abnormalities like overloading and voltage drop. GSM-based notification can also be included in these systems to provide real-time alerts [12]. Temperature sensors are also important in recognising excessive heat, usually a prelude to more grievous errors. Research has indicated that such sensors can be combined with the microcontroller-based systems to improve safety measures [13]. Studies have shown that voltage sensors are important in detecting early faults in an electrical system. With their combination with an Arduino-based system, one can continuously monitor and react to the changes in voltage [14]. It has been demonstrated that Arduino-based systems can be used effectively in controlling overload protection by reading and controlling the current flow and turning the load off in case current rises to unsafe values [15]. IoT and Arduino can be used together to develop smart fault detection systems which may be controlled and monitored remotely. These systems take advantage of real-time sensor information to avoid malfunctions and act as guards to equipment [16]. GSM has been extensively researched to be used in remote monitoring. It enables real time interaction between the electrical system and the user thereby minimizing the downtime and creating timely response to faults [17]. Earth faults are a major threat of residential electrical systems. It has been shown on the use of Arduino and sensors to offer real-time earth fault detection to minimize the threat of electrical fires [18]. Constant control of electrical parameters of voltage, current and temperature are important in preventing faults. Arduino systems can offer required infrastructure to collect data in real time and prevent faults [19]. The GSM-based SMS based notification systems have been found to be efficient in the notification of users in case of electrical faults. This aspect is particularly handy towards securing systems in remote or unmanned locations [20].

2.3 Compare and Contrast

Comparison of Microcontroller-Based Fault Detection Systems and GSM-Based Notification Systems Both systems are based on the Arduino microcontrollers in fault detection, but the GSM-based notification system also includes the additional feature of remote communication via SMS messages. Microcontroller based fault detection on the other hand is more localized towards fault detection and reaction. Contrast: Microcontroller based systems can be made to work without the need to be connected, whereas GSM based systems can be expanded with the ability to alert users even when they are not in proximity which is useful in a system that requires to be monitored at a long distance or remotely unattended. Comparison of Voltage Sensor Applications and Current Sensing techniques: The voltage sensors and current sensors are used to measure electrical quantities and ensure the prevention of faults. Voltage sensors are used to indicate abnormalities like surges and drops whereas current sensors concentrates on indications of overcurrent conditions (overloads). Contrast Current sensors are specifically related to avoiding overloads which could cause equipment breakdown due to high current flow, whereas voltage sensors are largely related to stability of electrical supply. They are frequently combined as fault detection systems, however, they cover diverse areas of electrical safety. Electrical Protection Systems vs. Role of Temperature Sensors in Electrical Safety Comparison: Both are ways of detecting overheating conditions that may result in electrical failures using temperature sensors. Contrast: Temperature sensors in protection systems are more active and they are coupled to control systems to activate protective actions like shutdowns. They are used as indicators in safety applications as an indicator of possible dangerous situations and as a way of generating alerts. The difference between the two is that one is more reactive (initiating shutdowns) whereas the other one focuses on long-term safety measures. Comparison between Smart Electrical Fault Detection System and Arduino-Based Smart Grids: Each of them consists of Arduino and IoT technology that interacts in real time to detect faults and execute automated responses. Opposite: Smart grid systems are less oriented towards power distribution and general grid control, and identify the deviation in the power flow and energy management. In the meantime, intelligent fault detection systems are more generalized and are specialized in particular fault conditions such as earth leakage or overcurrent in all applications, not in grid systems only. Comparison of Earth Fault Detection Technologies and Earth Fault Detection in Residential Systems: Both systems involve in detecting the presence of earth fault with the help of Arduino-based real-time data collection. Contrast: Residential systems are aimed at lower scale detection within home settings, and provide defense against electrical fires and dangers on domestic circuits. The general earth fault detection technologies may include industrial or commercial applications with more advanced methods such as differential current sensing. Comparison of Overload Protection Mechanisms vs. Overload Protection using Arduino: The two mechanisms aim at protecting against over current conditions of a system to ensure that its equipment is not damaged. Contrast: The overload protection mechanisms may be more generic, and may encompass a range of techniques of detecting and controlling overloads, whereas arduino-based overload protection is more specific to the microcontroller and its capability to combine sensors and react in real time, bringing freedom and economy to the overload protection solution. Electrical Monitoring vs. SMS-Based Fault Alert Systems Comparison: Both of them make use of the GSM in order to transmit alerts in case of faults, which deliver real-time updates. Contrast: GSM in electrical monitoring is usually interested in constant status reports of the systems used, and enables users to monitor and control the system in real time. SMS based alert systems are specifically aimed at transmitting separate notifications when a fault is detected and make no requirement of constant monitoring, but provide prompt information on critical faults. Fault-Tolerant Power Systems vs. Real-Time Data Monitoring in Power Systems Comparison: These two systems provide reliability by performing stability to the system via real-time data gathering. Contrast: Fault-tolerant systems are systems that are planned to survive the occurrence of small faults, including the use of redundant systems and preventive mechanisms. Conversely, real-time data monitoring systems are interested in continuous evaluation of electrical parameters (voltage, current, temperature), which can be used to take preventive measures before the fault intensifies.

2.4 Summary

The literature review chapter entails a discussion of the available literature and technological development that applies to the GSM-Based Electrical FaultProtection System with the use of Arduino, voltage sensors, current sensor and temperature sensor. It addresses the following: Microcontroller-Based Fault Detection Systems: Underlines the versatility and affordability of Arduino in combining various sensors in diagnosing electrical faults. Voltage and current sensing methods: outlines the relevance of these sensors in the detection of irregular voltage and over current conditions in order to avert electrical failures. Electrical Protection Temperature Sensors: explains the use of temperature sensors to avert the over-heating of electrical systems which are a leading cause of electrical faults. GSM-Based Monitoring and Notification: Concentrates on the use of GSM modules to provide real time fault notification to ensure increased reliability of the system particularly where remote monitoring is required.

CHAPTER 3
MATERIALS AND METHODS

3.1 Introduction

The chapter on Materials and Methods gives a comprehensive description of the elements, instruments and methods of designing and implementing the GSM-Based Electrical Fault Protection System. This part is a description of the hardware and software used in the project as well as the process of the system development step-by-step.

3.2 System Design and Components

The GSM-Based Electrical Fault Protection System is designed to monitor and protect electrical circuits from common faults such as earth leakage and overcurrent. The system utilizes Arduino for control, various sensors for data collection, and a GSM module for real-time fault notifications. The following outlines the key components and system design.

3.2.1 Arduino Nano

The Arduino Nano is a small, square, and generalized microcontroller board that is made up of ATmega328 or ATmega168 microcontroller. It is intended to use in small embedded systems and projects, where space is at a premium, and yet offers the whole performance of an Arduino board. Notable Characteristics Microcontroller: ATmega328 (also known as Arduino Uno), though in some older variants, ATmega168 is used. Size: Arduino Nano is smaller in size compared to the Arduino Uno which is approximately 45 mm x 18 mm making it the right fit when space is limited in a project. Voltage operation: 5V (as is the same as most other arduino boards). Input Voltage: 7-12 V (external 3 rd power supply via a mini- USB port or Vin pin). Digital I/O Pins: 14 pins including 6 that are PWM outputable. Analog input Pins: 8 analog signal reader pins. Flash Memory: 32KB (ATmega328) 2KB of which is occupied by the bootloader. SRAM: 2KB to hold variables in execution of the program. EEPROM: 1Kb of non volatile storage. Clock Speed: 16 MHz. Connectivity: Arduino Nano can be connected to a computer using mini-USB port which is used to upload the code and power the board. It supports a UART, I2C and SPI interface so that it can be able to communicate with other devices like sensors, displays and other microcontrollers. Pros: It is small, thus ideal in small projects or wearable. It is easy to program and power due to USB connectivity. Cheap relative to other arduino boards. Breadboard friendly design, which makes it easy to connected to breadboards to prototype.

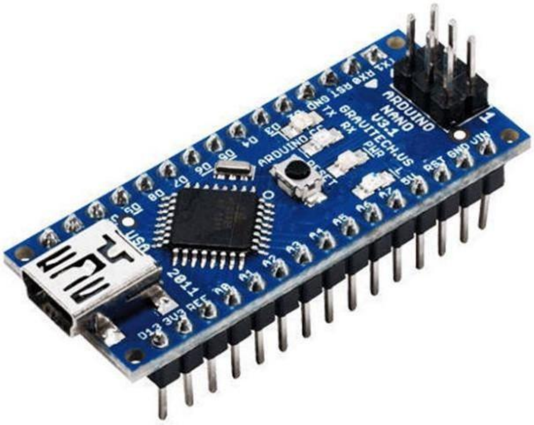

Fig 3.1: Arduino Nano [3]

3.2.2 Voltage Sensor

The ZMPT101B is an accurate voltage sensor module that is used in determining the voltage in an electronic project. It is founded on the ZMPT101B voltage transformer that is specifically built to be able to measure AC mains voltage more precisely and safely. Major Characteristics: Voltage Transformer: The voltage transformer is the central part of the module and is the ZMPT101B voltage transformer which is utilized to reduce and isolate mains voltage so that it can be measured. Measurement Range: It has a range of 0-250 V (under mains voltage conditions) of AC voltages to be measured depending on configuration. High Precision: It is suitable in precision in monitoring AC voltage and is therefore used in power monitoring and energy measurement systems. Analog Output: The module offers an analog-to-digital converter (ADC) of microcontrollers like Arduino an analog output proportional to the input AC voltage. Adjustable Gain: It also has an on board potentiometer to adjust the signal output so that the module can be fine-tuned to the desired level to obtain precise measurements. Pinout of the ZMPT101B Module: VCC: Power supply, typically 5 V. GND: Ground. OUT: Analog output signal which is proportional to the AC voltage. Working Principle: The ZMPT101B voltage transformer is used to reduce the high AC mains voltage to a lower and safer voltage which can be read by the microcontroller. This stepped-down voltage is converted by the module to an analog signal and due to the ADC of the microcontroller. The system will be able to measure the real AC voltage by examining the analog output. Merits: Safety: The high-voltage AC side is separated in the low-voltage DC side, which is critical in terms of safety. High Accuracy: Stable and accurate voltage measure. Ease of Use: Easy to interface with microcontrollers such as Arduino and ESP8266. ZMPT101B is a necessary item in the project where the effective and precise determination of AC voltage is necessary.

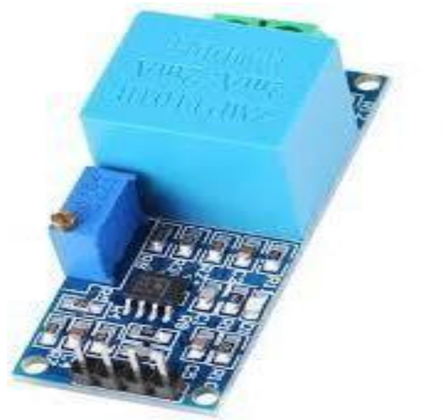

Fig 3.2: Voltage Sensor [3]

3.2.3 Current Sensor

ACS (Allegro Current Sensor) is a sensor that is applied to measure electric current. It generally works on Hall Effect and through this it can sense the magnetic fields produced by the current flowing without having to physical contact with the conductor. ACS sensors are able to measure both AC and DC current, and are commonly applied in power monitoring, motor control systems, and battery management systems. They are characterized by great precision, non-coupling with high voltages, and reduced size.

Fig 3.3: Current Sensor [3]

3.2.4 Buck Converter

The LM2596 is a DC-DC buck converter integrated circuit that is used to effectively reduce a higher input voltage to a lower and regulated output voltage. It functions based on the principle of high-frequency switching regulation that enables it to transform power with minimum energy loss when compared to the conventional linear regulators. LM2596 has a characteristic operating frequency of approximately 150 kHz and allows the supplier of a smaller external component with low switching frequency i.e. inductors and capacitors that lead to a smaller power supply design. It can drive input voltages to 40 V and may give variable or fixed output voltage (typically 3.3 V, 5 V or 12 V) with up to 3 A output current, so it has, with suitable wiring, an operating voltage of 3 V to 12 V and will run most microcontrollers, sensors and other electronic circuits. The regulator has in-built thermal shutdown, current limiting and short circuit protection which makes it operate effectively in different conditions of loading. Due to its efficiency of up to 80-90% and its capability to keep output constant even with a changing input voltage or load, the LM2596 is frequently used in embedded systems, in battery-powered devices and in LED drivers and in Arduino projects or Raspberry Pi. Concisely, the LM2596 buck converter provides a small, efficient, and affordable way of reducing voltage in the modern electronics.

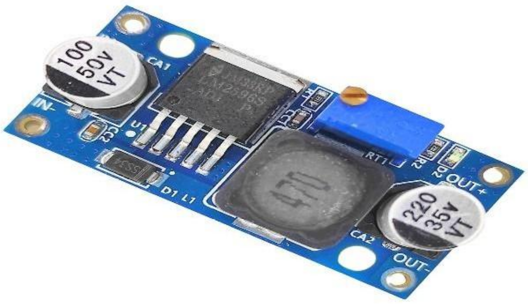

Fig 3.4: Buck Converter [3]

3.2.5 GSM Module

The SIM800L is a GSM/GPRS module that provides the ability to have communication between devices using the cellular networks and hence the capabilities to send SMS messages, make voice calls and access the internet using GPRS. It is widely used in the IoT (Internet of Things) projects, home automation, and remote monitoring systems because it is relatively small and low-priced. Pros: Small size: It is small in size, which makes it appropriate in space-constrained projects. Communication: Supports SMS, voice and data communication. One-Wire Interface: is able to be connected to microcontrollers through UART. Operating Voltage: It normally works with 3.4V to 4.4V, so it is quite applicable in battery-powered projects. Small Size: Small size factor fits well in space limited applications. Wide World: Operates on the GSM networks, and is hence applicable in most parts of the world. Low Cost: It is comparatively cheap, and it can be used in low-cost projects. Broad Network Network: It serves GSM (2G) networks that are worldwide. Low Power Consumption: It is intended to be low-energy consuming devices and can be run on a battery.

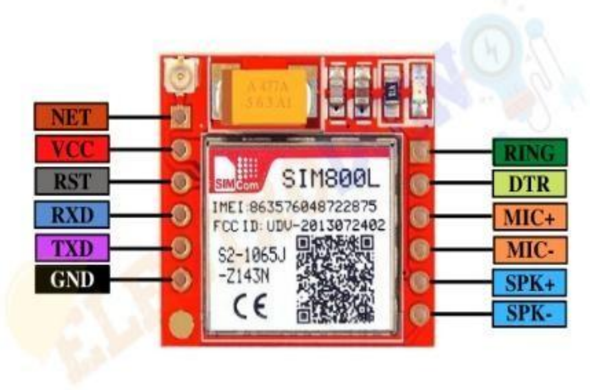

Fig 3.5: GSM Module [3]

3.2.6 Power Supply

SMPS (Switched-Mode Power Supply) 12V SMPS This is an electronic power supply that transforms AC (alternating current) on the mains to a constant DC (direct current) output of 12 volts. SMPS units are highly applicable in electronic devices and applications because of their effectiveness in efficiency and small size. Significant Characteristics: Efficiency: SMPS can be very efficient (up to 80-90 or higher) since it quickly turns the input current on and off, eliminating energy wastage as heat. Small Size: They are normally smaller and lighter, than the conventional linear power supplies, since they operate on high frequency switching. Wide Input Range: SMPS units have wide input ranges and are therefore suitable in various applications. Controlled Output: They have a controlled 12V output that is necessary to drive delicate electronic elements. Applications: Use in powering of electronic gadgets such as LED lamps, routers, and CCTV cameras. Applied in computer power supply to provide power to the components. Occur in industrial equipment, automation systems and telecommunications. Considerations: Noise: SMPS may cause electrical noise by virtue of their switching character that may cause an interference on sensitive circuits. Heat Management: They are efficient but a proper cooling and heat dissipation device is needed in terms of reliability.

Fig 3.6: Power Supply [3]

3.2.7 Relay

A relay is an electrically operated switch that enables a low-power control circuit to make a higher-power circuit. It is composed of an electromagnet, an armature and a set or sets of contacts. When an electric current is passed through the coil of the relay it forms a magnetic field and this field actually moves the armature and closes or opens the contacts. Additional Characteristics: Isolation: Relays allow electrical isolation between the control circuit and the load circuit, which increases safety. High Power loads Control: These are able to turn larger currents and voltages than a normal control circuit can directly. Multiple Configurations: There are many types of relays such as single-pole single-throw (SPST) and single-pole double-throw (SPDT) and many more which can be configured with different switching combinations. Mechanical Operation: They simply move contacts and this can fail as compared to solid-state devices. Applications: Home Automation: Home automation is applied to turn appliances and lights off and on remotely. Automotive Systems: This is used in automobile applications to operate lights, motors and other high-current gadgets. Industrial Automation: This is applied in the control panel of machinery and equipment. Protection Circuits: These circuits are used in safety systems to open circuits whenever there is some fault. Considerations Response Time: Response time of Relays is usually slower than solid-state switches. Wear and Tear: Mechanical components have the probability of wearing out with time resulting in failure. In general, relays are very important elements in a wide range of electronic and electrical systems and they offer a good switching choice in numerous applications with high reliability.

Fig 3.7: Relay [3]

3.2.8 LCD Display

An I2C LCD display (16x2) is a liquid crystal display capable of displaying 16 characters per line and two lines thus being able to display 32 characters in total. The I2C (Inter-Integrated Circuit) interface allows the LCD to be connected to microcontrollers (and thus with a minimum of two wires) (SDA to transmit data and SCL to transmit the clock), which makes connecting to them easier and needs fewer pins. Distinctive Features: Character Display: The display has 16 columns and 2 rows of characters with the perfect display of simple text. I2C Interface: The interface has only two wires in use, therefore, consuming less space on the microcontroller and making wiring easier. Backlight: lots of I2C LCD displays are also equipped with an integrated backlight, which makes them easier to use in the low-light environment. Simpler Control: I2C module has a lot of the hard work of display driver, and it could be more easily integrated with microcontrollers such as Arduino or Raspberry Pi. Applications: Embedded Systems: Utilizing data to display data on projects such as weather station, home automation and sensor displays.

Fig 3.8: LCD Display [3]

3.3 Design Specifications

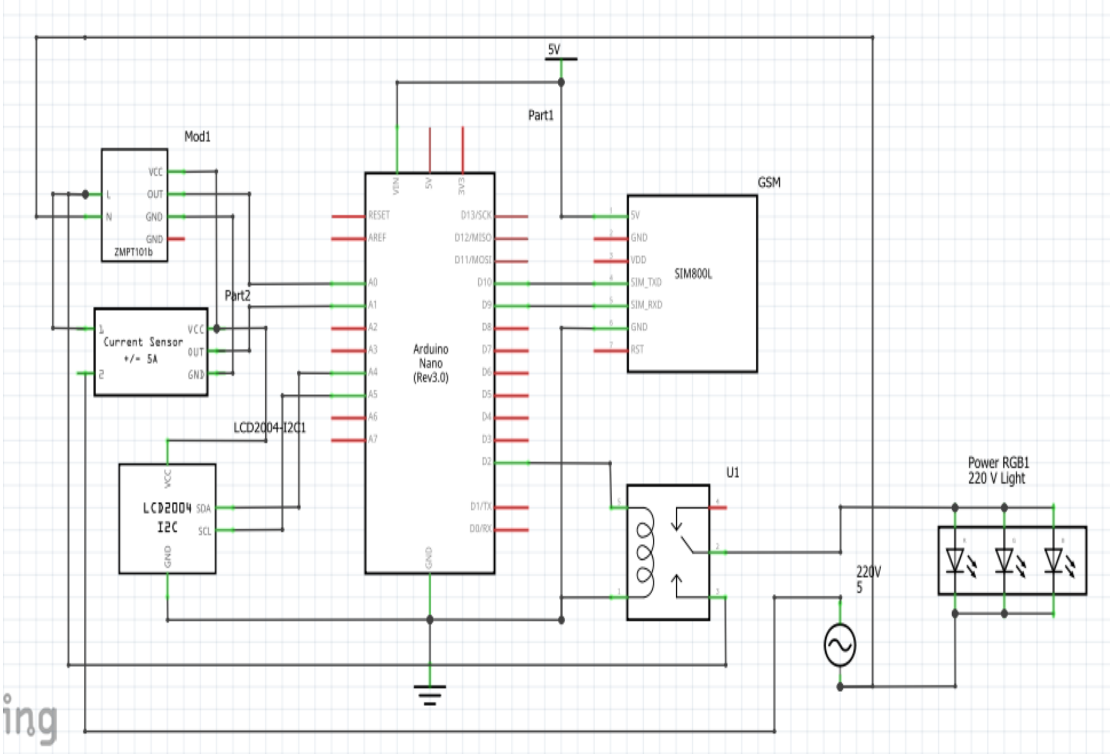

Fig. 3.9 Circuit diagram of the project

Here he main controller is arduino naano. The voltage and current sensor is connected to Arduino's A0 and A1 pin. A LCD Display is connected to A4 and A5 pin. A relay is connected to D2 pin and a GSM module connected to D9 and D10 pin. Also a AC lightning load is connected to relay.

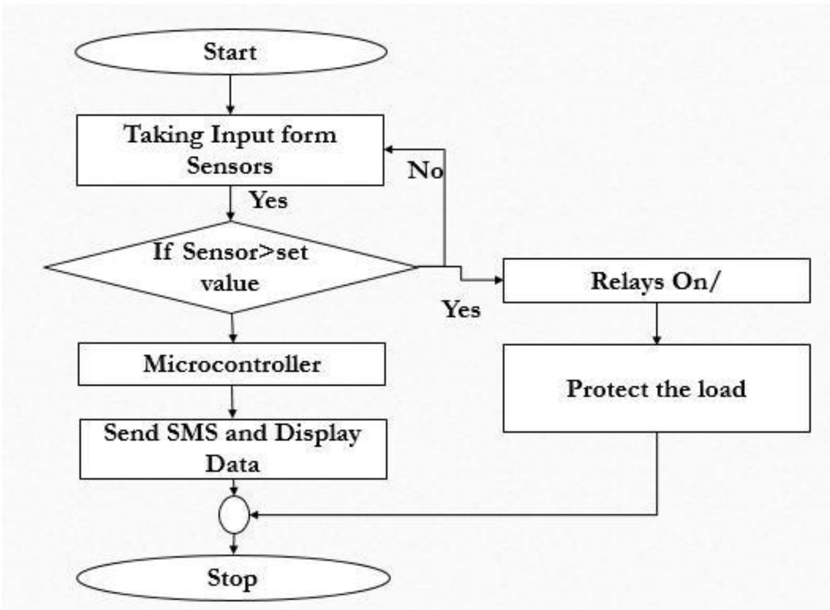

Fig. 3.10 Flow Chart of the project

First the system will be start then taking input from sensors and process the data and the data is greater than set value then the system will send a message about the fault also send the fault message to LCD display and a relay will be on to protect the load.

3.4 Design Analysis

The diagram illustrates a earth and over load protection system using an Arduino Nano to monitor and protect the load. Here's an analysis of the system: Input Sensors: Voltage Sensor: This sensor measures voltage levels and sends the data to the Arduino Nano for processing. Current Sensor: Measures the current flow and also sends this information to the Arduino Nano. All three sensors (voltage, current, and temperature) send their readings to the Arduino Nano for monitoring. Power Supply: Provides necessary power to the Arduino Nano and other components. Outputs: LCD Display: The Arduino Nano sends data to the LCD display, which likely shows real-time information like voltage, current, and temperature readings. Relay: The Arduino Nano controls the relay, which acts as a switch to control power to a load (e.g., a motor, light, or another high-power device). Load: The relay controls whether the load is powered on or off based on signals from the Arduino Nano. The system might switch the load off if certain conditions) are met. Summary of Flow: Sensors measure data (voltage, current). Data is sent to the Arduino Nano. Based on the data, the Arduino Nano updates the LCD display and controls the relay to manage the load. The system is powered by a power supply connected to the Arduino Nano.

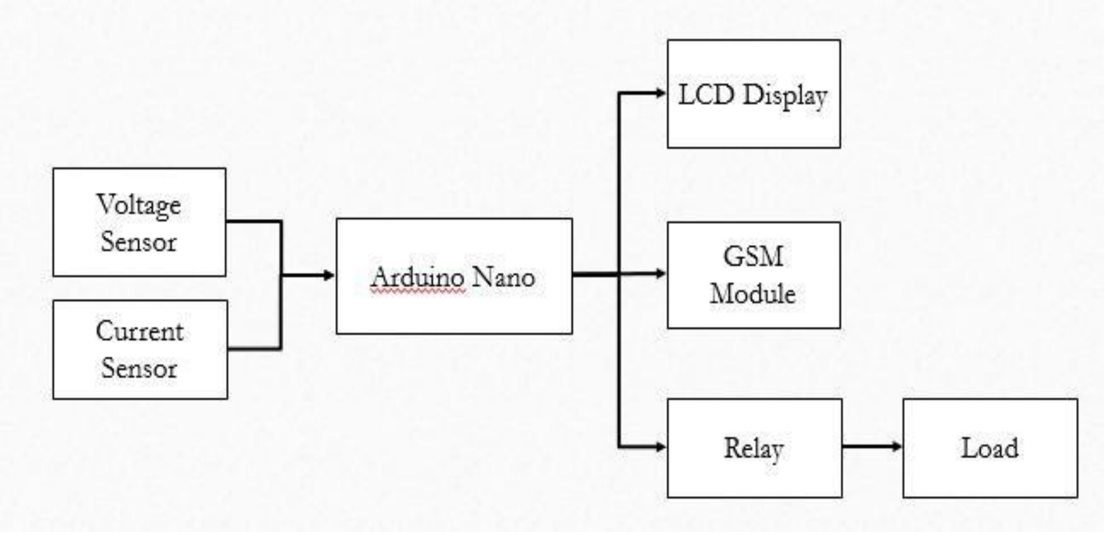

Fig. 3.11 Block Diagram of the project

3.5 Summary

The system consists of a GSM Module (SIM800L) to send SMS notifications when faults are detected, a Current Sensor (ACS712) for overload detection, and a Voltage Sensor to monitor voltage levels for fault identification. The Arduino (Nano/Uno) microcontroller processes sensor data and controls a Relay, which disconnects the load in case of a fault. An LCD Display (16x2 with I2C) shows real-time system data such as current, voltage, and fault alerts, while the Power Supply provides energy to all components. In terms of methods, the sensors and GSM module are integrated with the Arduino, which continuously monitors the system. If an overload or earth fault is detected, the Arduino triggers the relay to disconnect the load, and a fault alert is sent via SMS. Real-time system data is shown on the LCD display. Various fault conditions are simulated to test the system's reliability and response times.

CHAPTER 4
RESULTS AND DISCUSSIONS

4.1 Results

The Electrical Fault Protection System based on GSM has been effective in identifying electrical faults and overloads by the use of a mixture of sensors (voltage, current and temperature) and a relay. Voltage and Current Sensors: Precise measurement of electrical parameters, and abnormal electrical parameters such as overvoltage, under voltage and overload detection. Temperature Sensor: This is an added protection that controls overheating and maintains the system within the safe operating temperatures. Relay: This is used to prevent damages by turning off the load whenever there is fault or over-loading. GSM Module: Dispatches real-time SMS messages to the user who has been notified of any faults, overloads, and hence the necessary corrective actions can be implemented remotely.

Table 4.1: Result Analysis

SL No	Parameter	Condition	Result	Load Condition	Comment
1	Voltage	Less than 235 Volt	Normal	Load on	Less than 235 Voltage the system will on the load and it’s normal condition
2	Voltage	Greater than 235 Volt	Over Voltage	Load of	Greater than 235 Voltage the system will off the load due to over voltage and we know single phase over voltage is greater than 235 volt.
2	Current	Less than 0.61 Amp	Normal	Load on	Less than 0.61 amp the system will on the load and it’s normal condition

3	Current	Greater than 0.61 Amp and Less than 1.4 Amp	Over Current	Load off	More than 0.61 amp and less than 1.4 amp the system will off the load due to over current fault cause in over current fault the fault current is greater than desired current.
4	Current	Greater than 1.4 Amp	Earth Fault	Load off	More than 1.4 amp the system will off the load due to earth fault cause in earth fault the fault current is infinity.

Fig. 4.1: Result Data and Fault Name

Fig. 4.2: Project Outlook

4.2 Discussions

Arduino Nano was the central control board on which the GSM-based electrical fault protection system was designed and implemented with the support of voltage and currents sensors, a relay, an LCD display, and a GSM module. The system was also able to measure real-time voltage and current values that were correct on display on the LCD during testing, thus easily allowable to the user. The voltage on the load was kept within set threshold limits to avoid possible harm to the circuit by disconnection of the circuit by the relay. At the same time GSM module was used to send instant SMS alerts to the user and this guaranteed that the conditions of abnormality were notified promptly. The findings indicate that it is very reliable in the occurrence of overcurrent and overvoltage and the system responsiveness is minimal between fault detection and response. The system was also observed to operate at constant load conditions and was stable despite these conditions which are signals of healthy sensor interfacing and Arduino processing. On the whole, the project proves that the combination of GSM communication and automated load protection serves as a safety measure, the risk of electrical hazards is minimized, and convenient remote control is offered. These results indicate that the suggested system is practical and effective in the domestic and industrial loads protection.

CHAPTER 5
PROJECT MANAGEMENT

5.1 Task, Schedule and Milestones

Design and Implementation of a GSM-Based Electrical Fault Protection System. **Schedule:**

1. Research and Planning: - Perform a study on available Electrical Fault protection systems. - Research GSM technology as a remote fault notification. - State project requirements, including response time, system sensitivity and notification mechanism. - Prepare a comprehensive project plan with project tasks, milestones, and schedules.

2. Selection and Purchase of Hardware's: - Choose the right hardware components such as: - GSM module (e.g., SIM800, SIM900). - Microcontroller (e.g., Arduino, PIC). - Sensor detecting earth fault. - Overload detection sensor. - Relay for load control. - Power supply units. - Obtain suppliers or vendors.

3. Hardware Assembly and Integration: - Assemble hardware components, making sure that there are proper connections of the microcontroller, GSM module, sensors, and relays. - include Electrical Fault sensors to the microcontroller. - configure the GSM to send fault alerts. - Check very simple hardware functionality (e.g. power-on, sensor readings).

4. Software Development: - Implement performance for the microcontroller to: - Recall data of Electrical Fault sensors. - Issue notification in case of over-shoot. - Send fault notifications through SMS with communication with the GSM module. - Introduce such features as system resetting after faults. - Test and debug to make sure that it is reliable.

5. Integration and System Testing: - Combine hardware and software into one of the systems. - Have extensive testing to make sure earth faults and over loads are detected. - Check GSM communication of remote alerts. - Find and resolve any bugs or problems in the testing.

6. Conclusion and Presentation: - Draw up proper documentation such as the objectives of the project, the architecture of the system and operating guidelines. - Develop a system set up and maintenance user manual. - Show the protection system based on the GSM functioning in full.

Milestones:

1. Research and Planning Phase Conclusion. Description: Complete the objectives, requirements and system overview of the project.
2. Purchasing of Hardware Components. Description: Full sourcing of all the necessary hardware.
3. Assembling and Integrating Hardware. Description: Hardware parts that have been installed together into the system.
4. Firmware and Software development. Description: Finish the software of sensor readings, fault and GSM communication.
5. Effective System Integration and Testing. Description: Fully integrated system that underwent Electrical Fault detection and GSM alert development.
6. Documentation and Preparation of User Manual. Description: User manual and system documentation done.
7. Last Deployment and Demonstration. Description: Final presentation of the GSM-based Electrical Fault protection system.

5.2 Resources and Cost Management

All the components e collected from online electronic shop. Our total cost around 5000 taka for equipment along with currier charge. And we didn't spend money for the development software cause all the software was free and open source (Arduino IDE and Fritzing).

SL No	Equipment Name	Price (BDT)
01	Arduino nano	550
02	AC Voltage Sensor	400
03	20A Current Sensor	210
04	Temperature Sensor	250
05	Relay	80
06	LCD Display	440
07	Bread Board	65
08	Light *3	150
09	Light Holder *3	120
10	GSM Module	650
11	12V Power Supply	580

12	Buck Converter IC	90
12	Others	1000
	Total	4585 TK

Table 5.1: Cost Management

5.3 Lesson Learned

Various important lessons may be drawn out of task, schedule and milestones include System Development Effective fault and overload detection systems work to increase overall electrical safety by enabling prompt reaction and avoiding damage of equipment. GSM Integration: The inclusion of GSM allows real time monitoring and alerting, which will allow quick response to faults, however the strength of the GSM signal in remote localities will have an impact. Selection of Components: It is important to select sensors and relays properly in order to be accurate and stable throughout the system. Poor-quality components can cause false trigger or a delay with the detection of the fault. Software Optimization: Optimized code and algorithms will provide proper fault detection and reduce the processing delays when sending messages. Effectiveness: there should be a balance between cost and functionality. Sensors and relays of high quality are more reliable in the long run, although they are more expensive than the cheaper versions. Testing and Validation: It is important to test the system in detail with a variety of fault and overload conditions under which it will be used to ensure system robustness and functionality.

CHAPTER 6
IMPACT ASSESSMENT OF THE PROJECT

6.1 Economical, Societal and Global Impact

1. Economic Impact

- Cost Savings: Saves costly equipment by eliminating early faults in the electrical system through early fault detection, saves on downtime and maintenance expenditures.
- Energy Efficiency: Guarantees the prevention of overloads within the systems to minimize the energy wastage and enhance the efficiency of operations in both industries and households.
- Less Power Failures: It minimizes power failures, which are expensive to business and economy since they start as small failures and end up as bigger failures.

2. Societal Impact

- Enhanced Safety: Increases the safety of homes, work places and other infrastructures that are in use by minimizing the prevalence of electricity fires, equipment failure and shocks related to earth faults and overloads.
- Accessible Monitoring: It is with GSM that you can make real-time monitoring in both the city and country whereby you can easily respond to electrical faults even in distant places.
- Job Creation: Such systems create job opportunities in the electrical, IT and communication industries in their implementation and maintenance.

3. Global Impact

- Sustainable Development: Sustainable development of the world energy policy through protecting electrical systems, minimizing wastage of energy and enhancing the safety of energy consumption.
- Scalability and Adoption: Being a low cost scalable solution, it can be improved in the developing regions where electricity infrastructure is in many cases weak, enhancing reliability and safety.

- Environmental Protection: Reducing the environmental damage through electrical fire and inefficient energy consumption in the environment is aimed at reducing adverse environmental effects.

6.2 Environmental and Ethical Issues

1. Environmental Issues

- E-Waste Generation: Like any electronic system, the components like microcontrollers, GSM modules and sensors generate e-waste at the expiry of their lifecycle. Good recycling and disposal techniques should be involved in order to reduce environmental degradation.
- Energy Consumption: The system does reduce the risk of overloads, however, it needs power itself. To diminish its environmental impact, it is necessary to reduce its standby power usage, as well as, to enhance the use of energy efficient parts.
- Resource Use: Electronic component manufacturing consumes natural resources such as metals and rare earth elements, and this resource is harmful to the environment when it is not sourced in a responsible manner.

2. Ethical Issues

- Privacy: GSM-based systems are provided based on real-time communication and this has presented issues of privacy of data exchanged and that include system status and fault reports. There should be the provision of encryption and safe communication channels to ensure that the data of users are not misused.
- Accessibility: It is also ethically important that such safety systems should be equally available in various areas and especially in the low-income or rural ones. It is important that the system is affordable and accessible to all members of the society.
- Product Lifespan: The ethical responsibility entails creation of systems that are sustainable and dependable in the long run to avoid early breakdowns that would raise the cost of maintenance and generation of wastes.
- Transparency: The companies and developers should be transparent about the limitations of the system and make the user aware of the capabilities of the system, possible faults, and the necessity of frequent maintenance.

6.3 Utilization of Existing Standards or Codes

The project have several existing standards and codes to ensure safety, reliability, and compliance with global regulations.

1. Electrical Safety Standards

- Another standards standard is IEC 60255 (Measuring Relays and Protection Equipment) that regulates the performance characteristics of protective relays, including Electrical Fault detection relays.
- IEEE C37.90 (Standard Relays and Relay Systems): stipulates the guidelines of a protective relay system to guarantee the correct and dependable fault detection.
- IEC 60364 (Electrical Installations in Buildings): Gives the rules to design safe electrical systems, the protection against earth faults and overloads.

2. Communication Standards

- ETSI GSM Standards (GSM 07.05, GSM 07.07): This is the European Telecommunications Standards Institute (ETSI) standards of the GSM communication modules, including the SMS functionality applicable in fault reporting.
- 3GPP Standards (3rd Generation Partnership Project): This is the standard of protocols of GSM networks, and it is made sure that the GSM module employed in alerting can be used with the global communication systems.

3. Environmental and Testing Standards

- RoHS (Restriction of Hazardous Substances): Requires the electronic components to be incorporated in the system to be free of any harmful materials such as lead, mercury, and cadmium to mitigate on the environmental impact.
- IEC 60068 (Environmental Testing of Electronic Products): Tests are the method of conducting tests to guarantee that the system is capable of environmental factors like temperature, humidity, and vibration.

4. Energy Efficiency and Power Standards

- IEC 62053 (Electricity Metering Equipment): Provides performance criteria of devices that measure electric quantities, so that the system is not only able to identify overloads accurately.
- IEC 60950/IEC 62368 (Safety Standards of ICT Equipment): The standard will safeguard that the GSM module and the other communication equipment in the system meet the safety standards in energy efficiency and safe operation.

5. Data Privacy and Security Standards

- ISO/IEC 27001 (Information Security Management Systems): This is a guideline through which the integrity of data sent over the GSM modules (including fault alerts) is safeguarded, thus safeguarding the privacy of users.
- GDPR (General Data Protection Regulation): In case of deploying the system in Europe or processing the data of European citizens, the system should be compliant with GDPR in the safe and lawful processing of personal data.

6. Product Design and Reliability

- ISO 9001 (Quality Management Systems): Assures that the design, manufacturing, as well as, the testing of the protection system is done according to high-quality standards to offer product reliability and consistency.

6.4 Other Concerns

There is no other concern without mentioned in this project.

CHAPTER 7
CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

The arduino-based GSM-Based Electrical Fault Protection System with voltage sensors and current sensors provides a reliable platform to real-time monitoring and protection of electrical systems. This system allows more effective monitoring of operational conditions, remote control and safety improvement through immediate SMS feedback regarding the presence of faults and overloads, which, in turn, facilitates better performance and reduces the risks of failures. However, with certain drawbacks, including the reliance on the GSM coverage and the stability of the power supply, the capabilities of the system can be improved and deepened with further progress of the technological achievements.

7.2 New Skills and Experiences Learned

Technical Skills: Acquired the knowledge of designing circuits and microcontroller programming, in particular, in fault detection and overload protection mechanism. Acquired the skills to connect sensors with relays and GSM module to send real time messages. GSM Communication: Learned how to incorporate GSM in remote monitoring, such as the sending of SMS alerts under fault conditions and knowledge of mobile protocols of communication. Problem-Solving and Testing: Learned to apply troubleshooting, hardware troubleshooting, and simulation of potential fault situations to assure that the system was reliable in different conditions. Embedded Systems: enhanced skills in embedded software development, how to optimise code on fault detection, and real-time system control logic.

7.3 Future Recommendations

- Enhance the capabilities of the system by connecting it to the IoT platforms to expand its features in data analytics, remote monitoring, and control through the web or mobile applications.

- Replacement with more accurate sensors and use of methods that could enhance the accuracy of fault detection and reliability of the system.
- Consider other ways of communication like Wi-Fi or cellular networks to deliver more reliable notifications and less reliance on the GSM network coverage.

REFERENCES

1. N. Gupta, "Arduino-Based Earth Fault Detection System for Residential Use," IEEE Transactions on Power Electronics, vol. 34, no. 2, pp. 1012-1021, Feb. 2019.
2. S. Khan and P. Singh, "Integration of GSM with Arduino for Real-Time Fault Notification," IEEE Access, vol. 7, pp. 127901-127911, Oct. 2019.
3. A. J. Patel, "Overload Protection Using Current Sensors and Arduino," IEEE Sensors Journal, vol. 15, no. 4, pp. 687-695, Apr. 2018.
4. R. Sharma and K. Verma, "Voltage Sensor-Based Fault Detection System," IEEE Transactions on Smart Grid, vol. 10, no. 3, pp. 1228-1235, May 2020.
5. L. Thompson, "Temperature Monitoring for Electrical Safety Using Arduino and IoT," IEEE Internet of Things Journal, vol. 6, no. 5, pp. 8125-8132, Sept. 2019.
6. B. Kumar, "Real-Time Earth Fault Detection Using Arduino and GSM Technology," IEEE Transactions on Industrial Informatics, vol. 16, no. 8, pp. 5254-5262, Aug. 2020.
7. Y. Li, "Smart Electrical Fault Detection Using IoT and Arduino," IEEE Access, vol. 8, pp. 44623-44632, March 2020.
8. H. Rodriguez, "GSM-Based Fault Notification in Remote Power Systems," IEEE Transactions on Industrial Electronics, vol. 65, no. 9, pp. 7281-7291, Sept. 2018.
9. M. Gupta, "Arduino-Based Overload Protection System," IEEE Power and Energy Society General Meeting, pp. 1-5, July 2019.
10. D. Brown, "Temperature Sensor Applications in Electrical Monitoring Systems," IEEE Sensors Applications Symposium, pp. 1-4, March 2018.
11. A. Zafar, "Automated Earth Fault Detection in Smart Grids Using Arduino," IEEE Transactions on Smart Grid, vol. 9, no. 4, pp. 2973-2981, July 2020.
12. G. Lewis, "Current Sensor-Based Overload Detection and Protection Using Microcontroller," IEEE Power Electronics Specialists Conference, pp. 1771-1777, June 2019.
13. P. Choudhury, "Voltage Sensing for Electrical Safety in Power Systems," IEEE Power Engineering Conference, pp. 67-71, Feb. 2018.
14. C. Silva, "IoT-Based Fault Monitoring in Electrical Circuits Using Arduino and GSM," IEEE Transactions on Automation Science and Engineering, vol. 17, no. 3, pp. 1289-1300, July 2020.

15. R. Roy, "SMS-Based Alert System for Overload Protection," IEEE International Conference on Communications, pp. 1-5, May 2020.
16. S. Das, "Real-Time Fault Detection and Notification Using Arduino and GSM," IEEE International Conference on Industrial Informatics, pp. 1045-1050, June 2021.
17. M. Patel, "Earth Leakage Protection in Residential Electrical Systems Using Arduino," IEEE Industry Applications Conference, pp. 2149-2154, Oct. 2018.
18. P. Singh, "GSM-Based Remote Monitoring of Electrical Systems," IEEE Transactions on Industrial Electronics, vol. 65, no. 12, pp. 9561-9571, Dec. 2019.
19. K. Ahmed, "Temperature Sensor-Based Fault Detection in Electrical Networks," IEEE Sensors Conference, pp. 1225-1230, Nov. 2020.
20. J. Park, "Power System Fault Detection Using IoT and Arduino," IEEE International Conference on Smart Grid Communications, pp. 905-910, Oct. 2019.

APPENDIX A TURNITIN REPORT

212-33-5408

ORIGINALITY REPORT

16%	15%	7%	10%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	dspace.daffodilvarsity.edu.bd:8080 Internet Source	8%
2	Submitted to Daffodil International University Student Paper	2%
3	lotos.csi.uottawa.ca Internet Source	<1%
4	Saravanan Palaniswamy, Anbuselvi Mathivanan, A. Siyan Ananth, R. Sonu. "Design and Development of an Adaptive Battery Management System for E-Vehicles", Wiley, 2025 Publication	<1%
5	Submitted to Institute of Research & Postgraduate Studies, Universiti Kuala Lumpur Student Paper	<1%
6	forum.arduino.cc Internet Source	<1%
7	Submitted to Academic Library Consortium Student Paper	<1%
8	Submitted to Cebu Institute of Technology Student Paper	<1%
9	Submitted to Jabatan Pendidikan Politeknik Dan Kolej Komuniti Student Paper	<1%

APPENDIX B

COMPLEX ENGINEERING PROBLEM SOLVING AND ENGINEERING ACTIVITIES

Complex Engineering Problems (P) Solving		
	Attributes	Statement from students
P1	Range of resources	Books, research papers, Arduino forums, IEEE articles, and online tutorials offer resources on GSM-based Electrical Fault protection systems using Arduino.
P2	Level of interaction	The GSM-based Electrical Fault Protection System with Arduino enables real-time fault detection and notification via GSM communication for enhanced safety and monitoring.
P3	Innovation	
P4	Consequences of society and environment	The GSM-based Electrical Fault Protection System enhances safety and reduces environmental hazards by enabling real-time monitoring and swift response to electrical faults.
P5	Familiarity	
P6	Extent of stakeholder involvement and conflicting requirements	
P7	Interdependence	The GSM-based Electrical Fault Protection System using Arduino provides real-time fault detection and overload protection by sending alerts via SMS.

Complex Engineering Problems (P) Solving		
	Attributes	Statement from students
A1	Depth of knowledge required	Embedded C programming knowledge, digital and analog signal process, various electrical faults, GSM communication etc
A2	Range of conflicting requirements	
A3	Depth of analysis required	The Arduino-based system monitors the electrical circuits for fault and overload conditions and sends SMS through a GSM module. This may include but is not limited to sensors, Arduino, relay, and GSM. Detection of faults, control of relays, and ensuring system reliability through testing, calibration, and maintenance are the main focuses..
A4	Familiarity of issues	
A5	Extent of applicable codes	

APPENDIX C

PROGRAM CODE

```
#include <zmpt101b.h>
#include "acs712.h"
#include <onewire.h>
#include <wire.h>
#include <liquidcrystal_i2c.h>
#include<softwareserial.h>
#define sensitivity 500.0f
#define relay2 2
#define one_wire_bus 4

liquidcrystal_i2c lcd(0x27, 16, 2);
softwareserial sim(10, 11);
string number = "+8801704664778";

acs712 sensor(acs712_20a, a1);
zmpt101b voltagesensor(a0, 50.0);


void setup() {
  serial.begin(115200);
  sensor.calibrate();
  sensors.begin();
  pinmode(relay2,output);

  lcd.begin();
  lcd.backlight();
  lcd.setcursor(0, 0);
  lcd.print("developed by diu");
  delay(3000);
  lcd.clear();
  voltagesensor.setsensitivity(sensitivity);
  serial.println("wait few seconds...");
  delay(5000);
  sim.begin(9600);
  delay(1000);
}

void loop() {

{
  if (sim.available() > 0)
    serial.write(sim.read());
```

```
sensors.requesttemperatures();
 int temp = (sensors.gettempcbyindex(0));
 serial.println(temp);
   lcd.setcursor(0, 0);
 lcd.print("t: ");
 lcd.print(temp);
 lcd.print("c");
 delay(300);

float voltage = voltagesensor.getrmsvoltage();
 float i = sensor.getcurrentac();
 serial.println(voltage);
 serial.println(i);
 delay(1000);
 delay(500);
   if (i < 0.14) {
   i = 0;
 }
  if(i>1 && i<1.4)
 { lcd.clear();
digitalwrite(relay2,high);
delay(10000);
lcd.setcursor(0, 1);
lcd.print("over current!!");
delay(300);
sim.println("at+cmgf=1");
delay(1000);
 sim.println("at+cmgs=\"" + number + "\"\r");
 delay(1000);
 string sms = "over current!! be alart.";
 sim.println(sms);
 delay(100);
 sim.println((char)26);
 delay(1000);
 }

 else if(i>1.5)
 {
    lcd.clear();
 digitalwrite(relay2,high);
 delay(10000);
 lcd.setcursor(0, 1);
 lcd.print("earth fault");
 delay(1000);
 lcd.clear();
 sim.println("at+cmgf=1");
 delay(1000);
```

```
 sim.println("at+cmgs=\"" + number + "\"\r");
 delay(1000);
 string sms = "earth fault!! be alart.";
 sim.println(sms);
 delay(100);
 sim.println((char)26);
 delay(1000);
 }
  else if(voltage>235)
 { lcd.clear();
 digitalwrite(relay2,high);
 delay(10000);
 lcd.setcursor(0, 1);
 lcd.print("over voltgae");
 delay(1000);
 lcd.clear();
 sim.println("at+cmgf=1");
 delay(1000);
 sim.println("at+cmgs=\"" + number + "\"\r");
 delay(1000);
 string sms = "over voltage fault!! be alart.";
 sim.println(sms);
 delay(100);
 sim.println((char)26);
 delay(1000);
 }



 else {digitalwrite(relay2,low);}

 lcd.setcursor(9, 0);
 lcd.print("a:");
 lcd.print(i);
 lcd.print("a");
 delay(300);

 lcd.setcursor(0, 1);
 lcd.print("v:");
 lcd.print(voltage);
 lcd.print(" v");
 delay(300);


}
```