

GSM BASED EARTH FAULT AND OVER 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.

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JANUARY, 2025

DECLARATION

I hereby declare that this project “**GSM BASED EARTH FAULT AND OVER LOAD PROTECTION SYSTEM**” represents 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.

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APPROVAL

The project entitled “**GSM BASED EARTH FAULT AND OVER LOAD PROTECTION SYSTEM**” submitted by **Esteiak Ahamed (201-33-1040) & Tanmoy Majumder (201-33-1112) & Fozla Rabby (201-33-1196)** 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 **January, 2025**.

Signed

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To

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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

<i>Symbol</i>	<i>Name of the symbol</i>
uC	Microcontroller
A	Ampere
V	Voltage

ACKNOWLEDGEMENT

First of all, we want to give thanks to Almighty Allah. With his blessing we are able to complete our work with best effort. We want to pay our utmost respect to our Supervisor Dr. Tama Fouzder, Associate Professor of the Department of EEE, Daffodil International University for who has given us the chance to work on an impactful idea and taken care of every issue of development of this concept. Then we would like to take this opportunity to express gratitude to our supervisor for being dedicated in supporting, motivating and guiding us throughout this project. This project can't be done without her useful advice and help. Also thank him very much for giving us the opportunity to work with this project.

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

ABSTRACT

The GSM-Based Earth Fault and Overload Protection System utilizes an Arduino microcontroller, along with voltage, current, and temperature sensors, to monitor and protect electrical circuits from common faults and hazardous conditions. The system continuously measures voltage levels, current flow, and temperature. In the event of an earth fault, current overload, or abnormal temperature rise, the system immediately triggers an alarm and disconnects the power supply to prevent equipment damage and safety hazards. Using a GSM module, real-time notifications are sent via SMS to the user or operator, ensuring prompt awareness and action. This solution offers an efficient and cost-effective method for enhancing the safety and reliability of electrical installations, particularly in remote areas where manual monitoring is difficult.

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

CHAPTER 1

INTRODUCTION

1.1 Introduction

Electrical systems are vulnerable to various faults and overload conditions that can cause significant damage to equipment, property, and human life. Among the most critical issues are earth faults and overload conditions, which can lead to electrical fires, equipment failures, and interruptions in power supply. Conventional protection systems often lack real-time monitoring and the ability to provide instant notifications, especially in remote or unmanned areas. This gap necessitates a more intelligent and responsive solution. The GSM-Based Earth Fault and Overload Protection System is designed to offer real-time monitoring and protection for electrical installations using Arduino as the central control unit, along with voltage, current, and temperature sensors. The system monitors key electrical parameters, including voltage levels, current flow, and temperature, to detect abnormalities such as earth faults, current overloads, and thermal stress in real time. When such anomalies are detected, the system takes immediate corrective action by isolating the affected circuit to prevent further damage. The integration of a GSM module allows the system to send real-time alerts via SMS to the concerned operator or maintenance personnel. This ensures quick intervention and enhances the overall safety and reliability of the electrical system, even in remote locations. The use of readily available sensors and an Arduino microcontroller makes the system cost-effective, scalable, and highly customizable for various applications, such as industrial plants, residential areas, and unmanned power distribution sites. This system not only improves the protection of electrical installations but also facilitates preventive maintenance by providing timely data, helping to avoid costly repairs and downtime. Through the combination of Arduino, sensors, and GSM technology, the system represents a modern and effective approach to electrical fault detection and protection.

1.2 Problem Statement

Electrical systems in residential, industrial, and commercial environments are prone to faults such as earth faults, overload conditions, and overheating, which can cause significant damage to equipment, lead to electrical fires, and pose serious safety risks.

Traditional protection methods often lack real-time monitoring and effective alert mechanisms, especially in remote or unattended installations. This results in delayed response times and increases the risk of severe damage before any preventive measures can be taken. There is a need for a more efficient, automated, and real-time system that can continuously monitor critical parameters like voltage, current, and temperature to detect anomalies early and trigger protective measures. Furthermore, in the event of a fault or overload, the system should be able to immediately notify the concerned personnel via a reliable communication channel, enabling them to take timely corrective action, even in remote locations. The challenge is to develop a cost-effective and easily deployable solution using commonly available technologies that can provide robust earth fault detection, overload protection, and temperature monitoring, along with real-time alerts. The proposed GSM-based Earth Fault and Overload Protection System using Arduino, voltage sensors, current sensors, and temperature sensors addresses this challenge by providing a real-time, automated protection mechanism with SMS-based alerting for remote monitoring and rapid intervention.

1.3 Objectives

To detect earth leakage fault: The system monitors the electrical circuit for any leakage of current to the ground, which could indicate an earth fault and trigger a protective response.

To detect over current fault: The current sensor detects when the current exceeds safe levels (overload), preventing potential damage to the electrical equipment by disconnecting the load.

To make load safety from over current and voltage: The system ensures the connected electrical load is protected from overcurrent and voltage fluctuations, preventing overheating or damage.

Real-time display data: The system provides live monitoring of electrical parameters (voltage, current, temperature), allowing users to view system status in real time.

GSM Based notification for each fault: In case of any fault (earth leakage, overcurrent, and temperature), the system sends immediate alerts via SMS using a GSM module, notifying the user for quick action.

1.4 Brief Methodology

The GSM-Based Earth Fault and Overload Protection System is designed to monitor electrical parameters in real-time using an Arduino microcontroller and various sensors. The following steps outline the methodology for the system:

Component Integration: The system uses an Arduino as the core processing unit. A voltage sensor is connected to monitor voltage levels, a current sensor is used to detect overload conditions, and a temperature sensor measures heat levels in the system. A GSM module is integrated to send real-time alerts via SMS in case of faults or abnormal conditions.

Data Acquisition: The voltage sensor continuously measures the voltage in the electrical circuit. The current sensor monitors the flow of current to detect any overcurrent situations. The temperature sensor keeps track of the system's temperature to identify overheating conditions.

Processing and Fault Detection: The Arduino processes the incoming data from the sensors. If the voltage, current, or temperature exceeds predefined thresholds (indicating an earth fault, overload, or overheating), the Arduino triggers a protective action.

Protective Action: Upon detection of a fault (overload, earth fault, or temperature rise), the system automatically disconnects the electrical load to prevent damage to equipment or fire hazards.

Real-Time Alerts via GSM: Simultaneously, the GSM module sends an SMS notification to a designated operator or user, detailing the fault type and status of the system.

User Notification and Logging: The system keeps a log of each fault event and allows users to monitor the status via SMS alerts. This feature ensures that operators can respond promptly to any incidents, even from remote locations. This methodology ensures an efficient, real-time fault detection system that protects electrical installations while offering remote monitoring and rapid intervention capabilities through GSM communication.

1.5 Gantt Chart

Gantt chart of the full project schedule:

Phase	Duration in Month	Start	End
Planning and Design	2	10 October 23	9 December 23
Procurement and Setup	1	10 December 23	9 January 24
Hardware Implementation	3	10 January 24	10 March 24

Software Development	2	11 March 24	10 May 24
Integration and Testing	2	11 May 24	10 July 24
Optimization and Fine-Tuning	1	11 July 24	10 August 24
Deployment and Evaluation	1.5	11 August 24	25 September 24
Documentation and Reporting	1	26 September 24	25 October 24

This gantt chart provides a structured approach to implementing our project within approximately 14 months, 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 increasing complexity of electrical systems in residential, commercial, and industrial settings has brought about a need for advanced protection mechanisms to ensure safety and prevent system failures. Earth faults, overloads, and overheating are some of the most common issues that can lead to significant equipment damage, power disruptions, and safety hazards. Traditional fault protection systems often rely on manual intervention and are limited in their capacity to provide real-time monitoring, especially in remote locations. The evolution of microcontroller-based systems and the rise of the Internet of Things (IoT) have opened new avenues for automating and improving fault detection and protection. In recent years, the use of Arduino microcontrollers for low-cost, efficient, and customizable monitoring systems has gained widespread attention. Voltage sensors, current sensors, and temperature sensors can now be integrated into a single system to monitor electrical parameters continuously, ensuring more accurate and reliable fault detection. Alongside this, GSM-based communication systems provide an effective method for remote monitoring, allowing real-time fault notifications via SMS, which can drastically reduce response times and enhance system reliability. This literature review explores previous research and technological advancements in earth fault detection, overload protection, and temperature monitoring using microcontrollers and sensor-based systems. It also examines the integration of GSM modules for real-time fault reporting and how these advancements have contributed to the development of modern, automated protection systems. The review aims to highlight the gaps in existing solutions and demonstrate the potential of combining Arduino, sensors, and GSM technology to create an efficient and cost-effective earth fault and overload protection system.

2.2 Related Research

Numerous studies have explored the use of Arduino for low-cost fault detection systems. These systems are versatile, allowing the integration of multiple sensors to detect voltage irregularities, overcurrent, and temperature fluctuations. The flexibility of Arduino makes it an ideal choice for real-time applications [1]. Voltage sensors are

critical for identifying abnormalities such as voltage surges and drops. They help in early fault detection, preventing damage to connected devices. Research shows that integrating voltage sensors with Arduino improves system reliability and response times [2]. Studies have focused on current sensors such as Hall-effect sensors for detecting overcurrent conditions. These sensors provide real-time data on current flow, allowing systems to automatically disconnect loads in the event of an overload, thus preventing damage [3]. Overheating is a major cause of electrical failure. Temperature sensors, when combined with microcontrollers, offer an effective solution for monitoring temperature variations and triggering safety protocols when overheating is detected [4]. The integration of GSM modules with Arduino enables real-time SMS alerts in the case of faults such as earth leakage, overcurrent, or temperature rise. This is particularly useful for remote monitoring where manual intervention is not feasible [5]. Research into smart systems demonstrates the potential of integrating IoT technologies like GSM and cloud services for remote monitoring and control of electrical circuits. These systems offer an automated approach to fault detection and response [6]. Earth faults can result in dangerous leakage currents. The literature discusses various methods for detecting earth faults, including differential current sensing and ground-fault circuit interrupters, which can be enhanced with real-time data from Arduino-based systems [7]. Studies highlight the importance of real-time monitoring for detecting overcurrent conditions that could lead to equipment failure. Advanced systems use current sensors to provide immediate feedback to the control unit (Arduino), preventing overload [8]. The scalability and cost-effectiveness of Arduino in power monitoring systems are well documented. Researchers have developed systems that monitor voltage, current, and temperature, ensuring continuous operation with automatic fault detection [9]. The integration of GSM technology in electrical monitoring systems allows for real-time fault notifications. Literature supports the effectiveness of GSM for sending alerts, reducing response times to electrical faults, especially in remote locations [10]. Fault-tolerant systems are designed to automatically handle minor faults without causing system-wide failures. Incorporating Arduino and sensors ensures that faults like earth leakage or overload do not lead to catastrophic failures [11]. Smart grid technologies benefit from the use of Arduino to manage and control power flow, detecting anomalies such as overloads and voltage drops. These systems can also incorporate GSM-based notification features for real-time alerts [12]. Temperature sensors play a key role in detecting overheating,

which is often a precursor to more serious faults. Studies show that combining these sensors with microcontroller-based systems enhances safety protocols [13]. Research indicates that voltage sensors are critical for early fault detection in electrical systems. By integrating them with an Arduino-based system, it is possible to continuously monitor and respond to voltage fluctuations [14]. Arduino-based systems have been shown to effectively manage overload protection by monitoring current flow and disconnecting the load when current exceeds safe limits [15]. The combination of IoT and Arduino allows for the creation of smart fault detection systems that can be monitored and controlled remotely. These systems use real-time data from sensors to prevent faults and protect equipment [16]. GSM technology has been widely studied for remote monitoring applications. It allows for real-time communication between the electrical system and the user, reducing downtime and ensuring prompt response to faults [17]. Earth faults pose significant risks in residential electrical systems. Research highlights the use of Arduino and sensors to provide real-time earth fault detection, reducing the risk of electrical fires [18]. Continuous monitoring of electrical parameters such as voltage, current, and temperature is essential for preventing faults. Arduino-based systems provide the necessary infrastructure for real-time data collection and fault prevention [19]. SMS-based notification systems using GSM modules have proven effective for alerting users in the case of electrical faults. This feature is especially useful for protecting systems in remote or unmanned locations [20].

2.3 Compare and Contrast

Microcontroller-Based Fault Detection Systems vs. GSM-Based Notification Systems Comparison: Both systems rely on Arduino microcontrollers for fault detection, but the GSM-based notification system specifically adds a layer of remote communication by sending real-time alerts via SMS. Microcontroller-based fault detection, on the other hand, is focused more on local fault detection and response. **Contrast:** Microcontroller-based systems can operate independently, while GSM-based systems extend functionality by notifying users remotely, making them ideal for systems that need to be monitored from distant or unattended locations. **Voltage Sensor Applications vs. Current Sensing Techniques for Overload Protection Comparison:** Both types of sensors are essential for monitoring electrical parameters and preventing faults. Voltage sensors detect abnormalities such as surges and drops, while current sensors focus on

detecting overcurrent conditions (overloads). Contrast: Voltage sensors are primarily concerned with the stability of electrical supply, whereas current sensors specifically prevent overloads that may result in equipment failure by detecting excess current flow. These two are often used together in fault detection systems but address different aspects of electrical safety.

Temperature Sensors in Electrical Protection Systems vs. Role of Temperature Sensors in Electrical Safety Comparison: Both approaches use temperature sensors to monitor for overheating conditions that could lead to electrical failures. Contrast: In protection systems, temperature sensors are more proactive, integrated with control systems to trigger protective measures such as shutdowns. In safety applications, they act as indicators to signal potential hazards and initiate alerts. The distinction lies in one being more reactionary (triggering shutdowns) while the other emphasizes long-term safety protocols.

Smart Electrical Fault Detection Systems vs. Arduino-Based Smart Grid Systems Comparison: Both systems integrate Arduino and IoT technologies for real-time monitoring and fault detection, enabling automated responses. Contrast: Smart grid systems are more focused on power distribution and overall grid management, detecting anomalies in power flow and energy management. Meanwhile, smart fault detection systems are broader and focus on specific fault conditions like earth leakage or overcurrent across various applications, not just grid systems.

Earth Fault Detection Technologies vs. Earth Fault Detection in Residential Systems Comparison: Both systems deal with detecting earth faults using Arduino-based real-time data collection. Contrast: Residential systems are focused on smaller scale detection in home environments, ensuring protection from electrical fires and hazards in domestic circuits. General earth fault detection technologies might cater to broader applications, including industrial or commercial environments, using more advanced techniques like differential current sensing.

Overload Protection Mechanisms vs. Overload Protection Using Arduino Comparison: Both mechanisms protect systems from overcurrent conditions, preventing equipment damage. Contrast: Overload protection mechanisms can be more general, potentially including a variety of methods for detecting and managing overloads, while Arduino-based overload protection is specifically tied to the microcontroller and its ability to integrate sensors and respond in real time, adding flexibility and cost-efficiency to the solution.

Use of GSM in Electrical Monitoring vs. SMS-Based Fault Alert Systems Comparison: Both use GSM technology to send alerts when faults are detected, providing real-time notifications. Contrast: GSM in electrical monitoring tends to focus on continuous system status

updates, allowing users to monitor and control the system in real time. SMS-based alert systems focus specifically on sending discrete notifications upon the detection of faults, reducing the need for continuous monitoring but ensuring that critical faults are communicated immediately.

Fault-Tolerant Power Systems vs. Real-Time Data Monitoring in Power Systems Comparison: Both systems enhance reliability by ensuring system stability through real-time data collection. Contrast: Fault-tolerant systems are designed to continue operation even when minor faults occur, employing redundant systems and preventive mechanisms. In contrast, real-time data monitoring systems focus on continuous assessment of electrical parameters (voltage, current, temperature), allowing for preventive actions before faults escalate.

Arduino-Based Monitoring Systems for Power Distribution vs. IoT in Electrical Fault Detection Comparison: Both systems use Arduino to monitor electrical parameters such as voltage and current, ensuring system reliability. Contrast: Arduino-based monitoring systems focus more on local monitoring of power distribution systems, while IoT in fault detection leverages cloud connectivity and smart devices to provide remote access and control, extending the scope of monitoring to include remote data access and system control.

Voltage Sensing in Fault Detection vs. Current Sensing Techniques for Overload Protection Comparison: Both voltage and current sensors are used to detect irregularities in electrical systems. Contrast: Voltage sensing is aimed at detecting voltage surges, drops, or other instabilities in the electrical supply, while current sensing focuses on preventing overloads by identifying instances of excess current flow.

GSM for Remote Electrical Monitoring vs. Earth Fault Detection Technologies Comparison: Both involve monitoring electrical systems for faults and alerting the user remotely. Contrast: GSM monitoring is a broad system for remotely detecting and notifying users about faults such as voltage, current, or temperature anomalies. Earth fault detection technologies are specifically focused on detecting ground faults, which could lead to dangerous electrical conditions if not managed.

Arduino-Based Fault Detection vs. Smart Electrical Fault Detection Systems Comparison: Both systems involve the use of microcontrollers to detect faults in electrical systems. Contrast: Arduino-based fault detection refers to general, low-cost, flexible implementations of fault detection using Arduino. Smart electrical fault detection systems integrate advanced technologies such as IoT, AI, or cloud computing for more automated and intelligent fault detection and system management.

2.4 Summary

The literature review chapter provides an overview of existing research and technological advancements relevant to the GSM-Based Earth Fault and Overload Protection System using Arduino, voltage sensors, current sensors, and temperature sensors. It explores the following key areas: **Microcontroller-Based Fault Detection Systems:** Emphasizes the flexibility and cost-effectiveness of Arduino in integrating multiple sensors for detecting electrical faults. **Voltage and Current Sensing Techniques:** Highlights the importance of these sensors in monitoring voltage irregularities and overcurrent conditions to prevent electrical failures. **Temperature Sensors for Electrical Protection:** Discusses the role of temperature sensors in preventing overheating, a common cause of electrical faults. **GSM-Based Monitoring and Notification:** Focuses on the integration of GSM modules for real-time fault notifications, enhancing system reliability, especially for remote monitoring. **Smart and Fault-Tolerant Systems:** Reviews advancements in smart grid technologies and fault-tolerant systems that use Arduino and sensors for automated fault detection and response. Overall, the literature identifies gaps in integrating these technologies into a cohesive, real-time fault detection and alert system, pointing to opportunities for improved safety and efficiency in power systems.

CHAPTER 3

MATERIALS AND METHODS

3.1 Introduction

The Materials and Methods chapter provides a detailed overview of the components, tools, and techniques used to design and implement the GSM-Based Earth Fault and Overload Protection System. This section describes the hardware and software employed in the project, along with the step-by-step process for system development.

3.2 System Design and Components

The GSM-Based Earth Fault and Overload 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, compact, and versatile microcontroller board based on the ATmega328 or ATmega168 microcontroller. It is designed for use in embedded systems and projects where space is limited, while still providing the full functionality of an Arduino board. Key Features: Microcontroller: ATmega328 (same as Arduino Uno), or sometimes ATmega168 in older versions. Size: The Arduino Nano is much smaller than the Arduino Uno, measuring about 45 mm x 18 mm, making it ideal for space-constrained projects. Operating Voltage: 5V (similar to most other Arduino boards). Input Voltage: 7-12V (external power supply through a mini-USB port or Vin pin). Digital I/O Pins: 14 pins, of which 6 can be used as PWM outputs. Analog Input Pins: 8 pins for reading analog signals. Flash Memory: 32KB (ATmega328), of which 2KB is used by the bootloader. SRAM: 2KB for storing variables during program execution. EEPROM: 1KB for non-volatile data storage. Clock Speed: 16 MHz. Connectivity: The Arduino Nano can be connected to a computer via a mini-USB port, which is used for uploading code and powering the board. It has a UART, I2C, and SPI interface, which allows it to communicate with other devices such as sensors, displays, and other microcontrollers. Advantages: Compact size makes it ideal for small projects

or wearable devices. USB connectivity makes it easy to program and power. Affordable compared to other Arduino boards. Breadboard-friendly design, allowing it to be easily plugged into breadboards for prototyping.

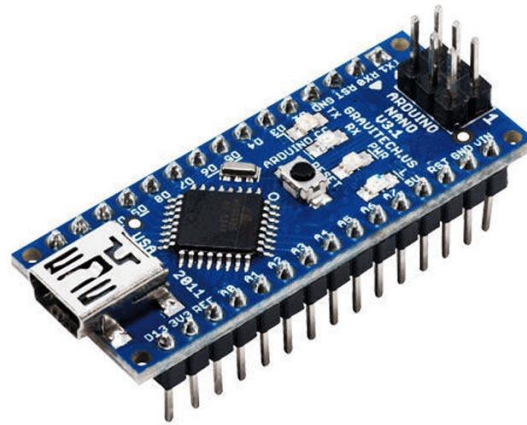


Fig 3.1: Arduino Nano [3]

3.2.2 Voltage Sensor

The ZMPT101B is a precision voltage sensor module commonly used for AC voltage measurement in electronic projects. It is based on the ZMPT101B voltage transformer, which is specially designed for accurate and safe measurement of AC mains voltage. Key Features: Voltage Transformer: The core of the module is the ZMPT101B voltage transformer, which is used to step down and isolate the mains voltage for measurement. Measurement Range: It can measure AC voltages typically in the range of 0-250V (for mains voltage applications) depending on how it is configured. High Precision: It provides good accuracy for monitoring AC voltage, which makes it ideal for use in power monitoring and energy measurement systems. Analog Output: The module provides an analog output proportional to the input AC voltage, which can be read by an analog-to-digital converter (ADC) in microcontrollers such as Arduino. Adjustable Gain: It has an onboard potentiometer to adjust the output signal, allowing the user to fine-tune the module for accurate measurements. Pinout of the ZMPT101B Module: VCC: Power supply, usually 5V. GND: Ground. OUT: Analog output signal, proportional to the AC voltage. Working Principle: The ZMPT101B voltage transformer steps down the high AC mains voltage to a safer, lower voltage that can be read by the microcontroller. The module converts this stepped-down voltage to an analog signal, which is then processed by the microcontroller's ADC. By analyzing the analog output, the system can calculate the actual AC voltage. Advantages: Safety: The

module isolates the high-voltage AC side from the low-voltage DC side, which is essential for safety. High Accuracy: Provides stable and accurate voltage measurement. Ease of Use: Simple to integrate with microcontrollers like Arduino and ESP8266. The ZMPT101B is an essential module for projects that require accurate and safe measurement of AC voltage.



Fig 3.2: Voltage Sensor [3]

3.2.3 Current Sensor

The ACS (Allegro Current Sensor) is a type of sensor used to measure electric current. It typically operates using Hall effect technology, which allows it to detect magnetic fields generated by current flow without needing to make direct electrical contact with the conductor. ACS sensors can provide measurements of both AC and DC currents and are often used in applications like power monitoring, motor control, and battery management systems. They are known for their high accuracy, isolation from high voltages, and compact design.



Fig 3.3: Current Sensor [3]

3.2.4 Temperature Sensor

The DS18B20 is a digital temperature sensor that communicates over a one-wire bus, making it easy to connect multiple sensors to a single data line. It provides accurate temperature readings ranging from -55°C to $+125^{\circ}\text{C}$ with a resolution of up to 12 bits. The sensor is popular in various applications, including weather stations, HVAC systems, and home automation projects, due to its ease of use, low power consumption, and ability to provide temperature data in digital form, which simplifies integration with microcontrollers and other digital systems.



Fig 3.4: Temperature Sensor [3]

3.2.5 GSM Module

The SIM800L is a GSM/GPRS module that enables devices to communicate via cellular networks, allowing functionalities like sending SMS messages, making voice calls, and accessing the internet using GPRS. It's a popular choice for IoT (Internet of Things) projects, home automation, and remote monitoring systems due to its compact size and affordability. Advantages: Compact Design: Its small size makes it suitable for space-constrained projects. Communication: Supports SMS, voice, and data transmission. One-Wire Interface: Can connect to microcontrollers via UART for easy integration. Operating Voltage: Typically operates at 3.4V to 4.4V, making it suitable for battery-powered projects. Compact Size: Small form factor ideal for space-constrained applications. Global Coverage: Works on GSM networks, making it usable in many regions worldwide. Low Cost: It's relatively inexpensive, making it accessible for budget-conscious projects. Wide Network Support: It supports GSM (2G) networks, which are available globally. Low Power Consumption: Designed for low-energy devices, it can operate efficiently on battery power. Disadvantages: Limited to 2G

Networks: With the phase-out of 2G in some regions, its usability may be limited in the future. Low Data Speeds: Since it uses GPRS for internet access, it provides slow data rates compared to modern technologies like 4G or 5G. Challenging Integration: Although powerful, integrating it with microcontrollers like Arduino or ESP may require extra components and careful voltage regulation to avoid damage.

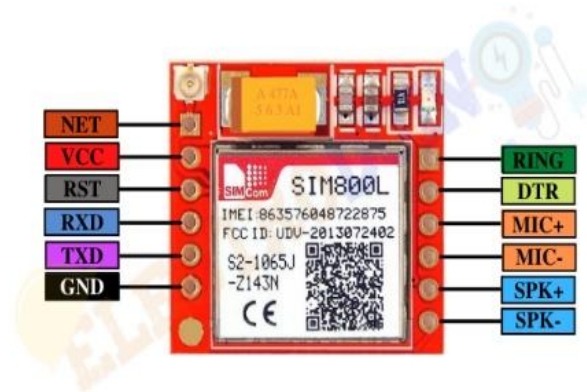


Fig 3.5: GSM Module [3]

3.2.6 Power Supply

A 12V SMPS (Switched-Mode Power Supply) is an electronic power supply that converts AC (alternating current) from the mains into a stable 12V DC (direct current) output. SMPS units are commonly used in various electronic devices and applications due to their efficiency and compact size. Key Features: Efficiency: SMPS can achieve high efficiency (often 80-90% or more) by rapidly switching the input current on and off, reducing energy loss as heat. Compact Size: They tend to be smaller and lighter compared to traditional linear power supplies because they use high-frequency switching. Wide Input Range: Many SMPS units can accept a wide range of input voltages, making them versatile for different applications. Regulated Output: They provide a stable 12V output, which is essential for powering sensitive electronic components. Applications: Powering electronic devices like LED lights, routers, and CCTV cameras. Used in computer power supplies to deliver power to components. Found in industrial equipment, automation systems, and telecommunications. Considerations: Noise: SMPS can generate electrical noise due to their switching nature, which might interfere with sensitive circuits. Heat Management: Although they are efficient, adequate cooling and heat dissipation methods are important for

reliability. Overall, a 12V SMPS is a reliable choice for powering various electronic applications where a stable and efficient power source is required.



Fig 3.6: Power Supply [3]

3.2.7 Relay

A relay is an electrically operated switch that allows a low-power control circuit to control a higher-power circuit. It consists of an electromagnet, an armature, and one or more sets of contacts. When an electric current passes through the coil of the relay, it creates a magnetic field that moves the armature, either closing or opening the contacts.

Key Features:

- Isolation:** Relays provide electrical isolation between the control circuit and the load circuit, enhancing safety.
- Control High Power Loads:** They can switch larger currents and voltages than a typical control circuit can handle directly.
- Multiple Configurations:** Relays come in various types, including single-pole single-throw (SPST), single-pole double-throw (SPDT), and more, allowing for different switching configurations.
- Mechanical Operation:** They physically move contacts, which can be a point of failure compared to solid-state devices.

Applications:

- Home Automation:** Used to control appliances and lights remotely.
- Automotive Systems:** Commonly found in cars for controlling lights, motors, and other high-current devices.
- Industrial Automation:** Used in control panels for machinery and equipment.
- Protection Circuits:** Employed in safety systems to disconnect circuits during faults.

Considerations:

- Response Time:** Relays generally have slower response times compared to solid-state switches.
- Wear and Tear:** Mechanical parts can wear out over time, leading to potential failure.

Overall, relays are essential components in many electronic and electrical systems, providing reliable switching capabilities for various applications.



Fig 3.7: Relay [3]

3.2.8 LCD Display

An I2C LCD display (16x2) is a liquid crystal display that can show 16 characters per line and has two lines, allowing for a total of 32 characters. The I2C (Inter-Integrated Circuit) interface enables the LCD to communicate with microcontrollers using just two wires (SDA for data and SCL for the clock), simplifying connections and reducing the number of pins required. Key Features: Character Display: 16 columns and 2 rows of characters, ideal for simple text output. I2C Interface: Uses only two wires for communication, which saves space on the microcontroller and simplifies wiring. Backlight: Many I2C LCD displays come with a built-in backlight, making it easier to read in low-light conditions. Easier Control: The I2C module handles many of the complexities of driving the display, allowing for simpler code and easier integration with microcontrollers like Arduino or Raspberry Pi. Applications: Embedded Systems: Displaying data in projects like weather stations, home automation, and sensor displays. User Interfaces: Providing user feedback in various electronic devices. Educational Projects: Often used in learning environments for teaching programming and electronics. Considerations: Addressing: Each I2C device has a unique address; conflicts can arise if multiple devices share the same address.



Fig 3.8: LCD Display [3]

3.3 Design Specifications

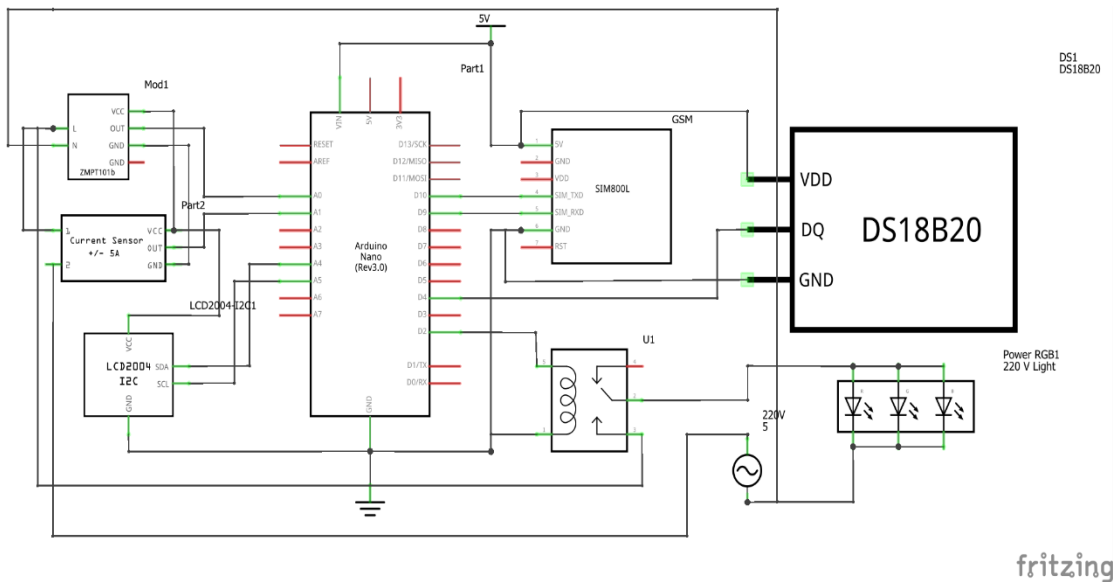


Fig. 3.9 Circuit diagram of the project

Here the main controller is Arduino Nano. 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 an AC lighting load is connected to relay. Also a temperature sensor is connected to D4 pin.

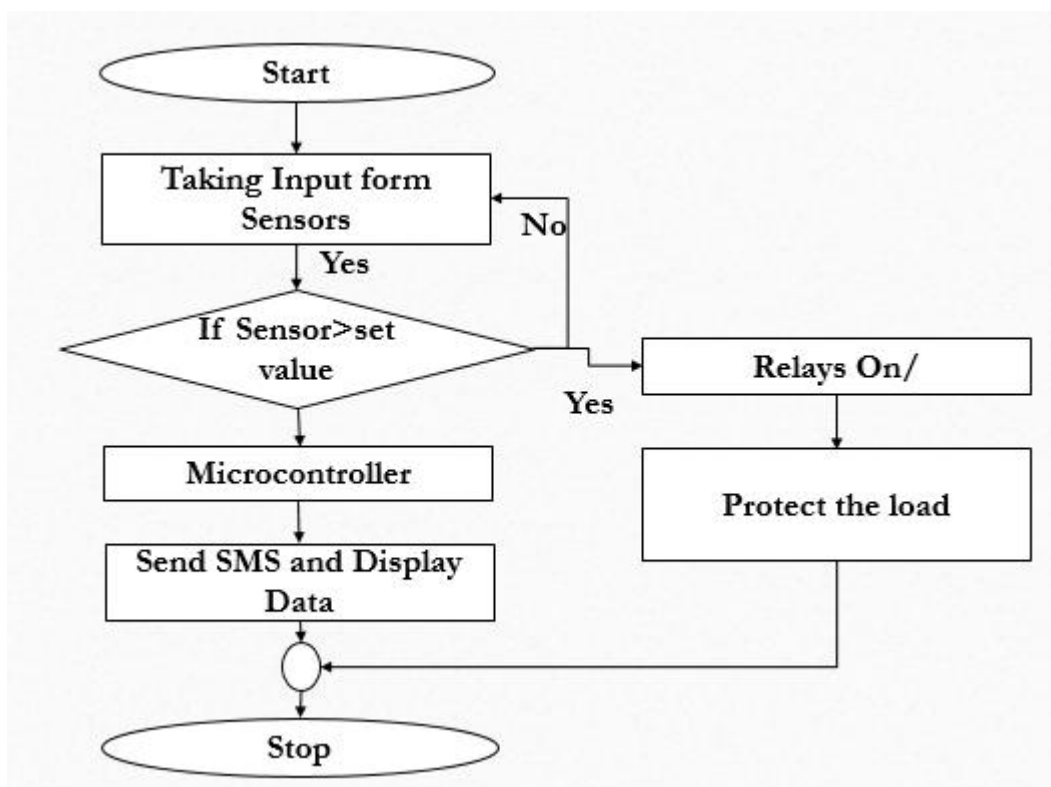


Fig. 3.10 Flow Chart of the project

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. **Temperature Sensor:** Detects temperature changes and relays the data 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, temperature). 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.

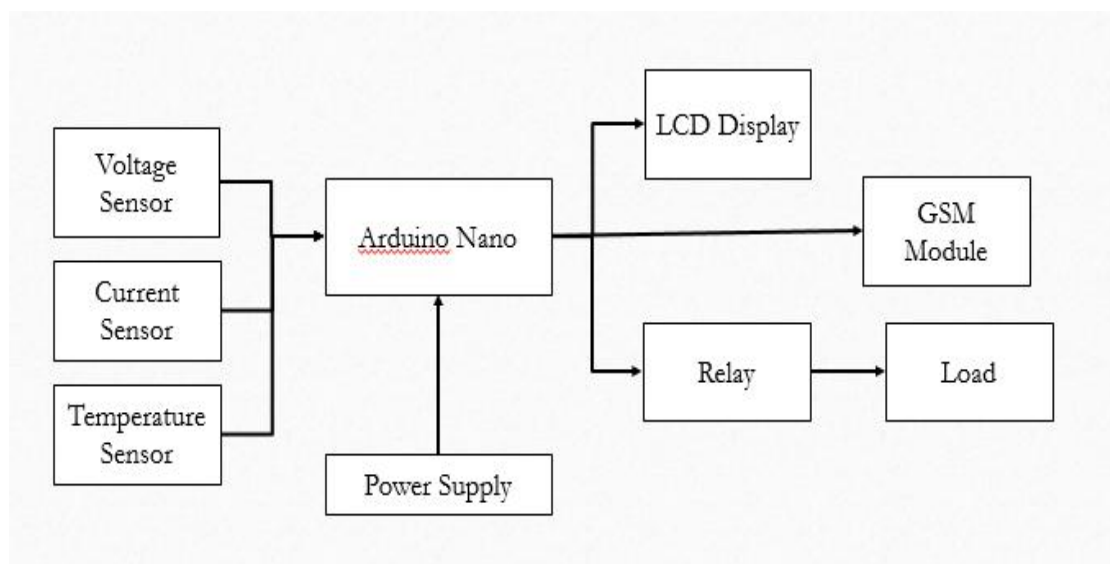


Fig. 3.11 Block Diagram of the project

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 GSM-based Earth Fault and Overload Protection System successfully detects electrical faults and overloads using a combination of sensors (voltage, current, and temperature) and a relay. Voltage and Current Sensors: Accurately monitor electrical parameters, detecting abnormal fluctuations like overvoltage, undervoltage, and overload conditions. Temperature Sensor: Provides an additional layer of protection by monitoring overheating, ensuring the system remains within safe operating temperatures. Relay: Automatically disconnects the load during faults or overloads to prevent damage. GSM Module: Sends real-time SMS alerts to the user, notifying them of detected faults, overloads, or temperature rises, ensuring prompt action can be taken remotely. Overall, the system ensures improved safety, quick fault response, and remote monitoring, enhancing the reliability of electrical systems.

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.
5	Temperature	Greater than 35 Degree C	Over temperature	Load off	In the system we set the temperature at 35 degree Celsius and above this value the system declare the temperature as over temperature and cut off the load.



Fig. 4.1: Result Data and Fault Name

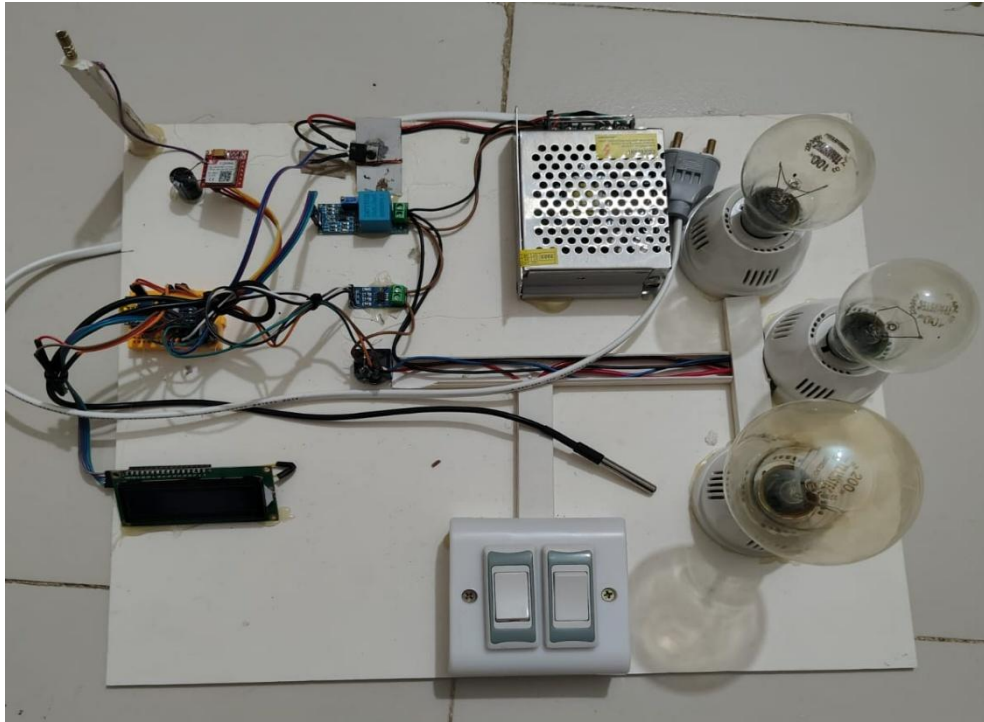


Fig. 4.2: Project Outlook

4.2 Discussions

The discussion part should explain what the results show, analyzes uncertainties, notes significant trends, compares results with theory, evaluates limitations or the chance for faulty interpretation, or discusses assumptions. The discussion section is a very important section of the report which describe to what extent you achieved your goals. It is important to remember that when you are discussing the results, you must be specific and present a scientific reason.

CHAPTER 5

PROJECT MANAGEMENT

5.1 Task, Schedule and Milestones

Task: Design and Implement a GSM-Based Earth Fault and Overload Protection System

Schedule:

1. Research and Planning:

- Conduct research on existing earth fault and overload protection systems.
- Study GSM technology for remote fault notifications.
- Define project requirements, such as response time, system sensitivity, and notification mechanism.
- Develop a detailed project plan outlining tasks, milestones, and timelines.

2. Hardware Selection and Acquisition:

- Select appropriate hardware components, including:
 - GSM module (e.g., SIM800, SIM900).
 - Microcontroller (e.g., Arduino, PIC).
 - Earth fault detection sensor.
 - Overload detection sensor.
 - Relay for load control.
 - Power supply units.
- Procure necessary components from suppliers or vendors.

3. Hardware Assembly and Integration:

- Assemble hardware components, ensuring correct connections between the microcontroller, GSM module, sensors, and relays.
- Integrate earth fault and overload sensors with the microcontroller.
- Set up the GSM module for sending fault alerts.
- Test basic hardware functionality (e.g., power-on, sensor readings).

4. Software Development:

- Develop firmware for the microcontroller to:
 - Read data from earth fault and overload sensors.
 - Trigger alerts when thresholds are exceeded.
 - Communicate with the GSM module to send fault notifications via SMS.
- Implement features like resetting the system after faults.
- Perform thorough testing and debugging to ensure reliability.

5. Integration and System Testing:

- Integrate hardware and software components into a cohesive system.
- Conduct comprehensive testing to ensure proper detection of earth faults and overloads.
 - Verify GSM communication for remote alerts.
 - Identify and fix any bugs or issues during testing.

6. Final Documentation and Demonstration:

- Prepare detailed documentation, including the project's objectives, system architecture, and operational instructions.
 - Create a user manual for system setup and maintenance.
 - Demonstrate the fully functional GSM-based protection system.

Milestones:

1. Completion of Research and Planning Phase

Description: Finalize the project's objectives, requirements, and system overview.

2. Acquisition of Hardware Components

Description: Complete procurement of all required hardware components.

3. Assembly and Integration of Hardware

Description: Hardware components assembled and integrated into the system.

4. Development of Firmware and Software

Description: Complete the software for sensor readings, fault detection, and GSM communication.

5. Successful Integration and Testing of the System

Description: Fully integrated system tested for earth fault and overload detection and GSM alert functionality.

6. Documentation and User Manual Preparation

Description: Complete system documentation and user manual prepared.

7. Final Deployment and Demonstration

Description: Final demonstration of the GSM-based earth fault and overload 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

Several key lesson can be learned from task, schedule and milestones involve in System development of Effective fault and overload detection systems improve overall electrical safety by providing timely responses and preventing equipment damage. GSM Integration: Incorporating GSM technology enables real-time monitoring and

alerts, ensuring swift action during fault events, but the GSM signal strength in remote areas can affect performance. **Component Selection:** Proper selection of sensors and relays is crucial to ensure accuracy and system stability. Low-quality components may lead to false triggers or delays in fault detection. **Software Optimization:** Efficient coding and algorithm design ensure accurate fault detection and minimize processing delays in sending alerts. **Cost-Effectiveness:** A balance between cost and functionality is essential. Investing in high-quality sensors and relays increases long-term reliability, despite higher upfront costs. **Testing and Validation:** Thorough testing under different fault and overload scenarios is critical to guarantee system robustness and functionality.

CHAPTER 6

IMPACT ASSESSMENT OF THE PROJECT

6.1 Economical, Societal and Global Impact

1. Economic Impact

- **Cost Savings:** Prevents costly equipment damage by detecting faults early, reducing downtime and maintenance costs in electrical systems.
- **Energy Efficiency:** Protects systems from overloads, reducing energy waste and improving operational efficiency in industries and households.
- **Reduced Power Outages:** By preventing faults from escalating into larger failures, it minimizes power outages, which are costly to businesses and economies.

2. Societal Impact

- **Improved Safety:** Enhances the safety of homes, workplaces, and public infrastructures by reducing the risk of electrical fires, equipment failures, and shocks caused by earth faults and overloads.
- **Accessible Monitoring:** With GSM technology, it enables real-time monitoring in both urban and rural areas, allowing quick responses to electrical faults even in remote locations.
- **Job Creation:** The implementation and maintenance of such systems generate employment opportunities in the electrical, IT, and communication sectors.

3. Global Impact

- **Sustainable Development:** Contributes to global energy sustainability by protecting electrical systems, reducing energy losses, and promoting safer energy use.
- **Scalability and Adoption:** As a low-cost, scalable solution, it can be deployed in developing regions where electricity infrastructure is often fragile, improving reliability and safety.

- **Environmental Protection:** By minimizing electrical hazards and system failures, it reduces environmental damage caused by electrical fires and inefficient energy use.

6.2 Environmental and Ethical Issues

1. Environmental Issues

- **E-Waste Generation:** As with any electronic system, the components such as microcontrollers, GSM modules, and sensors contribute to e-waste at the end of their lifecycle. Proper recycling and disposal methods are needed to minimize environmental harm.
- **Energy Consumption:** Although the system helps prevent overloads, the system itself requires power to operate. Minimizing its standby power consumption and promoting energy-efficient components is essential to reduce its environmental footprint.
- **Resource Use:** Manufacturing of electronic components uses natural resources, including metals and rare earth elements, which can have a negative environmental impact if not sourced responsibly.

2. Ethical Issues

- **Data Privacy:** GSM-based systems rely on real-time communication, raising concerns over the privacy of data transmitted, such as system status and fault reports. Ensuring encryption and secure communication protocols is necessary to protect users' data from misuse.
- **Accessibility:** Ethical concerns arise when such safety systems are not equally accessible across different regions, particularly in low-income or rural areas. Ensuring the system's affordability and availability to all segments of society is crucial.
- **Product Lifespan:** Ethical responsibility demands designing systems that are durable and reliable over time, preventing premature failures that would increase maintenance costs and waste generation.
- **Transparency:** Companies and developers must be transparent about the limitations of the system, ensuring users are fully aware of its capabilities, potential faults, and need for regular maintenance.

Addressing these environmental and ethical concerns involves sustainable practices, secure data handling, and equitable access to ensure long-term benefits without causing harm.

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

- IEC 60255 (Measuring Relays and Protection Equipment): Governs the performance requirements for protective relays, including those used for earth fault and overload detection.
- IEEE C37.90 (Standard for Relays and Relay Systems): Specifies requirements for protective relay systems to ensure accurate and reliable fault detection.
- IEC 60364 (Electrical Installations for Buildings): Provides guidelines for designing safe electrical systems, including protections against earth faults and overloads.

2. Communication Standards

- ETSI GSM Standards (GSM 07.05, GSM 07.07): These are the European Telecommunications Standards Institute (ETSI) regulations for GSM communication modules, covering the SMS functionality used in fault reporting.
- 3GPP Standards (3rd Generation Partnership Project): Specifies protocols for GSM networks, ensuring that the GSM module used for alerting is compatible with global communication systems.

3. Environmental and Testing Standards

- RoHS (Restriction of Hazardous Substances): Ensures that electronic components used in the system are free from hazardous materials like lead, mercury, and cadmium, reducing environmental impact.

- IEC 60068 (Environmental Testing of Electronic Products): Defines testing methods to ensure the system can withstand environmental conditions such as temperature, humidity, and vibration.

4. Energy Efficiency and Power Standards

- IEC 62053 (Electricity Metering Equipment): Sets performance standards for devices monitoring electrical quantities, ensuring that the system can accurately detect overloads.
- IEC 60950/IEC 62368 (Safety Standards for ICT Equipment): Ensures that the GSM module and associated communication equipment used in the system comply with safety standards for energy efficiency and safe operation.

5. Data Privacy and Security Standards

- ISO/IEC 27001 (Information Security Management Systems): Provides guidelines for ensuring data transmitted through GSM modules (such as fault alerts) is secure, protecting users' privacy.
- GDPR (General Data Protection Regulation): If the system is deployed in Europe or dealing with European citizens' data, it must comply with GDPR for the safe and lawful handling of personal data.

6. Product Design and Reliability

- ISO 9001 (Quality Management Systems): Ensures that the design, manufacturing, and testing processes for the protection system follow high-quality standards to ensure 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 GSM-Based Earth Fault and Overload Protection System utilizing Arduino, voltage sensors, and current sensors offers a robust solution for real-time monitoring and protection of electrical systems. By providing immediate SMS alerts for detected faults and overloads, this system enhances safety, enables remote oversight, and improves operational reliability. Despite some limitations, such as dependency on GSM coverage and power supply stability, the system's capabilities can be further refined and expanded with future advancements.

7.2 New Skills and Experiences Learned

Technical Skills: Gained expertise in circuit design and microcontroller programming, specifically in fault detection and overload protection mechanisms. Learned to interface sensors with relays and the GSM module for real-time alerts. **GSM Communication:** Acquired knowledge of integrating GSM technology for remote monitoring, including sending SMS alerts during fault conditions and understanding mobile communication protocols. **Problem-Solving and Testing:** Developed skills in troubleshooting, debugging hardware issues, and simulating fault scenarios to ensure the system's reliability under various conditions. **Embedded Systems:** Improved proficiency in embedded software development, learning to optimize code for fault detection, and control logic in real-time systems.

7.3 Future Recommendations

- Expand the system's capabilities by integrating it with IoT platforms for enhanced data analytics, remote monitoring, and control via web or mobile applications.
- Upgrade to more precise sensors and implement calibration techniques to improve fault detection accuracy and system reliability.
- Explore alternative communication methods such as Wi-Fi or cellular networks to provide more reliable notifications and reduce dependency on GSM network coverage.

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APPENDIX A

TURNITIN REPORT

201-33-1040

ORIGINALITY REPORT

19%	17%	8%	12%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	dspace.daffodilvarsity.edu.bd:8080 Internet Source	9%
2	Submitted to Daffodil International University Student Paper	2%
3	www.coursehero.com Internet Source	1%
4	eprint.iitd.ac.in Internet Source	<1%
5	forum.arduino.cc Internet Source	<1%
6	Submitted to Ibri College of Technology Student Paper	<1%
7	Submitted to University of Greenwich Student Paper	<1%
8	Submitted to Academic Library Consortium Student Paper	<1%
9	Submitted to University of Central Lancashire 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 earth fault and overload protection systems using Arduino.
P2	Level of interaction	The GSM-based Earth Fault and Overload 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 Earth Fault and Overload 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 Earth Fault and Overload 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	System using Arduino monitors electrical circuits for faults and overloads, sending SMS alerts via a GSM module. It involves components like sensors, Arduino, relay, and GSM, with a focus on detecting faults, controlling relays, and ensuring system reliability through testing, calibration, and maintenance.
A4	Familiarity of issues	
A5	Extent of applicable codes	

APPENDIX C

PROGRAM CODE

```
#include <zmpt101b.h>
#include "acs712.h"
#include <onewire.h>
#include <dallastemperature.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);

onewire onewire(one_wire_bus);
dallastemperature sensors(&onewire);

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 if(temp>40)

{ lcd.clear();
digitalwrite(relay2,high);
delay(10000);
lcd.setCursor(0, 1);
lcd.print("over temprature");
delay(1000);
lcd.clear();
sim.println("at+cmgf=1");
delay(1000);
sim.println("at+cmgs=\"" + number + "\"\r");
delay(1000);
string sms = "over temperature 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);
```

```
}
```