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FINAL YEAR PROJECT

DESIGN AND IMPLEMENTATION EMBEDDED SYSTEM BASED ON TOUCH SAFETY FOR ELECTRICIANS

P.O.BOX 2280 KIGALI
DEPARTMENT: ELECTRICAL AND ELECTRONICS ENGINEERING

OPTION: ELECTRICAL TECHNOLOGY

Final year project Submitted in Partial Fulfillment of the Requirements for the award of an Advanced Diploma in Electrical Technology

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Kigali, October 2024

DECLARATION A

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Student Name: MISIGARO JONATHAN

Signature: ……

Date: ……..

DECLARATION B

I confirm that the work reported in this project was carried out by the candidate under my supervisor and it has been submitted with my approval as the ULK POLYTECHNIC INSTITUTE Supervisor.

Supervisor Name: **Eng**. APPOLINAIRE TUYISHIMIRE

Signature: …….

Date: …….

DEDICATION

To end up this work, I dedicate this book to:

The Almighty God that helps us day by day to deal with my project.

MY beloved parents and families.

Beloved lecturers, their assistants, instructors.

All of our Electrical Technology classmates and generally schoolmates at ULK POLYTECHNIC INSTITUTE.

MY working supervisor and workmates in general who let to attend and fulfill all module courses required to have my advanced diplomas.

ACKNOWLEDGEMENT

Firstly, I thank Almighty God for the gift of life and spirit of hard work that he has always stowed in us especially during this project. Moreover, I thank ULK POLYTECHNIC INSTITUTE.

Administration and the whole ULK POLYTECHNIC INSTITUTE community for their uncountable support during my studies.

Afterward, I would like to acknowledge the contribution of Family for giving great support.

I cannot forget to offer special thanks to my supervisor for his guidance and support during my project analysis and design.

There is no suck meaningful word than to ask the mighty God to bless you.

Thank you!

ABSTRACT

The" Embedded System Based on touch safety for electricians"" project addresses the pressing concern of increasing electrical accidents among Line-Men, stemming from miscommunication and safety lapses. This innovative project draws inspiration from the works to enhance the safety and efficiency of electrical line management. The project"s core revolve around an embedded system that enables Line-Men and Maintenance staff to authenticate and control the opening and closing of electrical lines through a touch-based interface. Biometric authentication ensures secure access and operation of the system. The system will allow the Line-Men to switch on/off the faulty lines in the shortest time and in a safe way in cases of electrical line faults. This reduces troubleshooting time and restores the supply in the shortest time possible. To improve this project, IoT is involved in sending realtime status to personnel at the repair station, and it helps to prevent unauthorized activation of circuit breakers during maintenance. The proposed method involves Global System for Mobile communication Technology is used to transmit the SMS and detection alert automatically to the authorized but when the first personal switch off the system the second personal try to switch on will get short

SMS and system block the second personal to preventing unauthorized circuit break activations during Maintenance activities. The

“Embedded System Based on Touch Safety for Electricians“““ project significantly enhances Line-Men safety and ensures a more reliable electrical supply infrastructure.

Keywords: Fingerprint, GSM module, LCD display, Arduino uno, Buzzer, LED, Relay module.

TABLE OF CONTENTS

LIST OF FIGURE

LIST OF TABLE

LIST OF ACRONYMS AND ABBREVIATION

A1: Advanced Diploma

AC: Alternating Current

DC: Direct Current

EEPROM: Electrically Erasable Programmable Read-Only Memory

GND: Ground

GPRS: General Packet Radio Service

GPS: Global Positioning System

GSM: Global System for Mobile communications

ICSP: In-Circuit Serial Programming
IDE: Integrated Development Environment

IoT: Internet of Thing

LED: Light Emitting Diode

MHZ: Megahertz

PCB: Printed Circuit Board

PWM: Pulse width Modulation

RST: Reset

SIM: Subscriber Identity Module

SMS: Short Message Service

USB: Universal Serial Bus

VAC: AC Voltage

VDC: DC Voltage

DEFINITION OF KEY TERMS

AC-to-DC conversion refers to the process of converting alternating current (AC) electrical power into direct current (DC) electrical current power. This conversion is necessary because many electronic device and appliances, especially those with internal electronic components, operate on DC power, while the electricity supplied to homes and businesses is typically in the form of AC power. Bio-metrics refers to the measurement and statistical analysis of people‟s unique physical and behavioral characteristics. **IDE** (integrated Development Environment) is software application that provides a comprehensive set of tools for software development in one centralized interface. **Arduino the Arduino Uno** is widely used open – source microcontroller board on the ATmega328P microcontroller. **Arduino** is an opensource electronics platform based on easy-to-use hardware and software. **Relay** is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. **Power supply** is an electrical device that supplies electric power to an electrical load. The SIM800L **GSM/GPRS Module** is a small-sized GSM module that can easily fit into many loT applications. In practice, this module can perform nearly all functions that a regular cell phone would be able to do. This also includes the capability of sending SMS text messages.

CHAPTER 1. GENERAL INTRODUCTION

1.0 Introduction

Now-a-days, Electrical accidents to the Line-Men are increasing day by day due to the miscommunication and lack of communication [1]. This paper aims at Line-Men safety. In this proposed system, the closing and opening of the Electrical Lines is done by Line himself [2]. In this proposed system, Line-Man or Maintenance Staff has to authenticate the opening closing of the system by Bio-Metric.in this case, if there is any fault in any electrical line, that particular Line-Man will ON/OFF the said line by bio-metric Authentication and comfortably rectify the problem in supply of the particular line. In this paper we have also included IoT, so that the personnel at repair station would know the status of the said. No one can switch on circuit break during repair.

1.1. Background of the Study

The role of line-men in the electrical industry is both critical and hazardous. These professionals are responsible for installing, maintaining, and repairing electrical lines, often working in dangerous conditions. According to industry reports, the frequency of electrical accidents has been linked to poor communication among team members and inadequate safety measures. Misunderstandings regarding the status of electrical lines can lead to severe accidents, including electrocutions and injuries.

1.2 Statement of the problem

This proposed research was done by visiting different electrical repair station like substation and same buildings and also done interview from difference electrical technicians. So, they are difference accidents leading to death caused by electrical power in lines when same switch on line during repair time, and also problem suddenly caused by switch ON /OFF circuit break.

1.3 Purpose of the study

The final year project report is one of the curriculum courses I have to attend while I promoting my study degree A1 advanced diploma degree. This is general purpose of carrying out this study as part of courses I must attend during my course period to fulfill the A1 advanced diploma degree requirements.

The study intends to explore the effectiveness of design and implement embedded system based on touch safety for electricians for improving security effectiveness for electricians.

1.4 Research objectives

1.4.1 Main objective

The main objective of this proposed study is to design and implement an embedded system based on touch safety for electricians.

1.4.2 Specific objectives

The main objective of this research project will be achieved through the following specific objectives:

i. To switch off and on circuit break using finger print for authorized one **ii.** To block unauthorized people to switch off or on circuit breaker.

iii. To protect technician from electric power during repair time **iv.** To block and send SMS other authorized users when there is any one switch off circuit breaker during repair before turn on him or herself using finger print.

v. To add other users to switch on/off circuit breaker through finger print

1.5. Research questions

i. How we can switch off and on circuit breaker using finger print for authorized one? **ii.** How we can block unauthorized people to switch off or on circuit breaker? **iii.**

How we can protect technician from electric power during repair time?

iv. How we can block and send SMS other authorized users when there is any one switch off circuit breaker during repair before turn on him or herself using finger print.

v. How we can add other users to switch on/off circuit breaker through finger print?

1.6 SCOPE

The scope of the" embedded system based on touch safety for electricians" project encompasses the development and deployment of an advanced embedded system design to improve Line-

Men‟s safety And efficiency in managing electrical lines .this project involves the design, construction, and integration Of a touch-based interface with biometric authentication, allowing

Line-Men and maintenance staff to securely control the opening and closing of electrical lines. Additionally, the project includes the Implementation Of Internet of things (loT) technology to enable real-time monitoring of line statuses to repair station and prevent unauthorized circuit break activations during maintenance. The project„s Scope aims to address the critical issue of electrical accidents among Line-Men and enhance the overall reliability of the electrical supply infrastructure. One relays can be used to trip the circuit breaker and one finger print module is used to captures and analyzes fingerprints one buzzer can be used to convert the signal from audio to sound. when the first personal switch off the system the second personal try to switch on will get short SMS and system block the second personal to preventing unauthorized circuit break activations during Maintenance activities. .two persons have access to enter in the system while others are block. This project is applied in substation and transmission line for switching on/off the circuit breaker using finger print modules.

1.7. Significance of research

1.7.1. Personal interest

This proposal enables us to acquire the knowledge about how to develop embedded system based on touch safety for electricians. Apart on texting the project report helps us to be familiar with research skills.

1.7.2. Social interest

This proposed study will make more significance for society. So, Embedded system based on touch electrical facilitate electrical technician for power during repair.

1.7.3. Academic interest

On side of students in electrical and electronic department will facilitate them to research more by referring on my research report and empowering them to have willing of solving society problem.

1.8 Organization of the Study

This project is subdivided into five chapters:

Chapter 1: provides an overview of the study, including its background, problem statement, purpose, research objectives, research question, scope, importance, and report organization.
Chapter 2: Literature Review: in this chapter includes an introduction, Description of apparatus and materials.

Chapter 3: Research Methodology: in this project I find an introduction and Research design, population, sample size, sampling procedures, research instruments, Choice of the research instrument, validity and Reliability of the instrument, data gathering procedures, data analysis, and interpretation, ethical considerations, limitation of the study.

Chapter 4: Design System Analysis and Implementation: this chapter includes an introduction, calculations, implantation, and recommendations.

Chapter 5: Provides Conclusions including brief explanation of project findings, and Recommendations to different partners.

CHAPTER 2. LITERATURE REVIEW

2.0 .Introduction

This chapter provides a description, summary and evaluation of each source and it will indicate all details about used components.it consists of the discussion about the basic of electronic elements and electrical devices that are joined together in order to achieve the desired result during the design and implementation of embedded system based on touch safety for electricians. Although there are several electronic and electrical elements and devices, this chapter will focus on those, which are included in regulation and automation of the system as the purpose of project. They are difference devices and sensors like fingerprint sensor, relay module, ARDUINO, GSM module, LCD, buzzer, PCB, LEDs and power supply. This chapter highlights the summaries and explanations of complete knowledge for theories related to the work done.

2.1. Description of apparatus and materials

2.1.1. Arduino hardware

Arduino is a prototype platform (open-source) based on an easy-to-use hardware and software. That would be a microcontroller, which is essentially a circuit board complete with a programmable chip. The software written and used was Arduino integrated development environment, or IDE, which is used for writing and upload the computer code to the physical board. An Arduino board is capable of reading analog or digital signals from sensors and buttons, respectively; Different Types of input signals from sensors and then convert them into output to carry out actions such as actuating a motor, turning, LEDs on/off, connect to the cloud, and many more actions. Thus, Arduino Uno is a microcontroller board based on ATmega328. It contains a 16 MHz ceramic resonator, 6 analog inputs, 14 digital input/output pins where six can also be utilized as PWM outputs, a USB connection, a power jack, an ICSP header, and a reset button. It comes with everything that is needed to support the microcontroller. You will just simply power it with a battery or AC-to-DC adapter, or connect it using a computer through a USB cable. You can manage the board's operation by uploading software or send instructions to the board's microcontroller via the Arduino IDE. But unlike most of the earlier programmable circuit boards, Arduino does not require another hardware device known as a programmer to load fresh code into it [6].

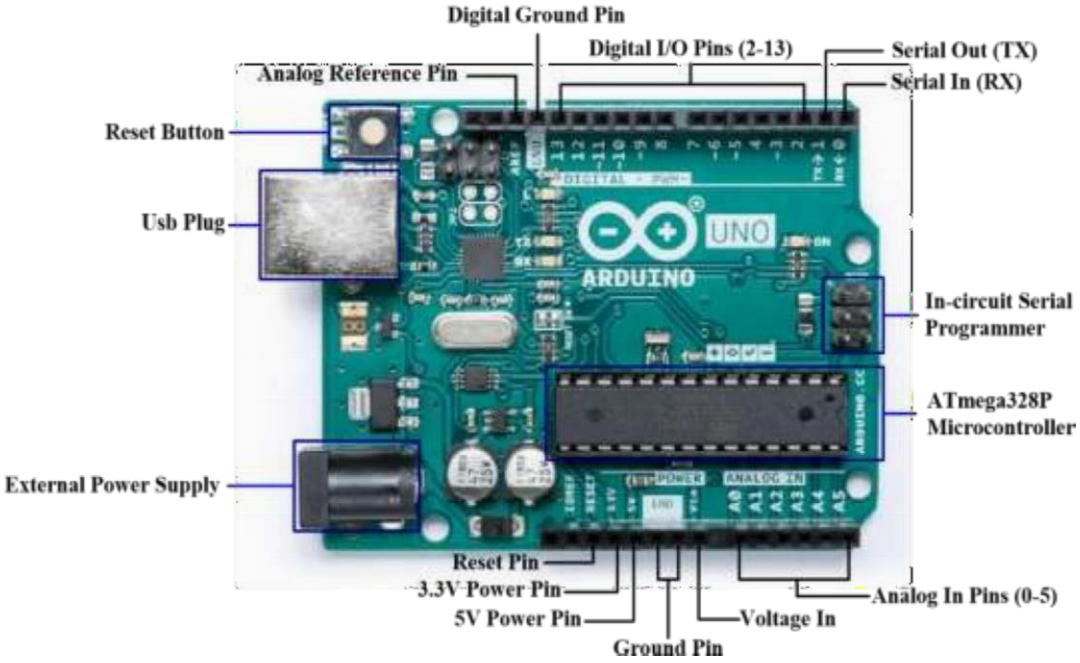

Figure.2. 1.Arduino Uno

Different varieties of Arduino board boards are available, decided by the different microcontrollers being used. Yet, they all employ the same programming methodology: the ARDUINO IDE. The differences concern several factors: operating voltage, speed, form factor, and the number of inputs-one can connect to a single board-such as sensors, LEDs, and buttons. Some boards are designed to be embedded: they do not have a hardware programming interface, which you would have to buy as an accessory. Some will require at least 5V, while others will run on a mere 3.7V battery.

2.2 Liquid Crystal Display (LCD)

LCD stands for Liquid Crystal Display-an electronic display module that finds a wide range of applications. A 16x2 LCD display is a very basic module and finds a wide range of devices and circuit. These modules are preferred over segments and other multi segmented. The reason being: LCDs are economical; easily programmable; have no limitation of displaying special and even custom characters unlike in seven segments, animations and so on. A 16x2 LCD means it can display 16 characters per line and there are two such lines. This LCD has two registers, namely command and data. The command register stores the command instructions given to the LCD. A command is an instruction given to the LCD to do a predefined task like initializing it, clearing its screen setting the cursor position, controlling display etc. Data register stores data to appear on the LCD display [7].

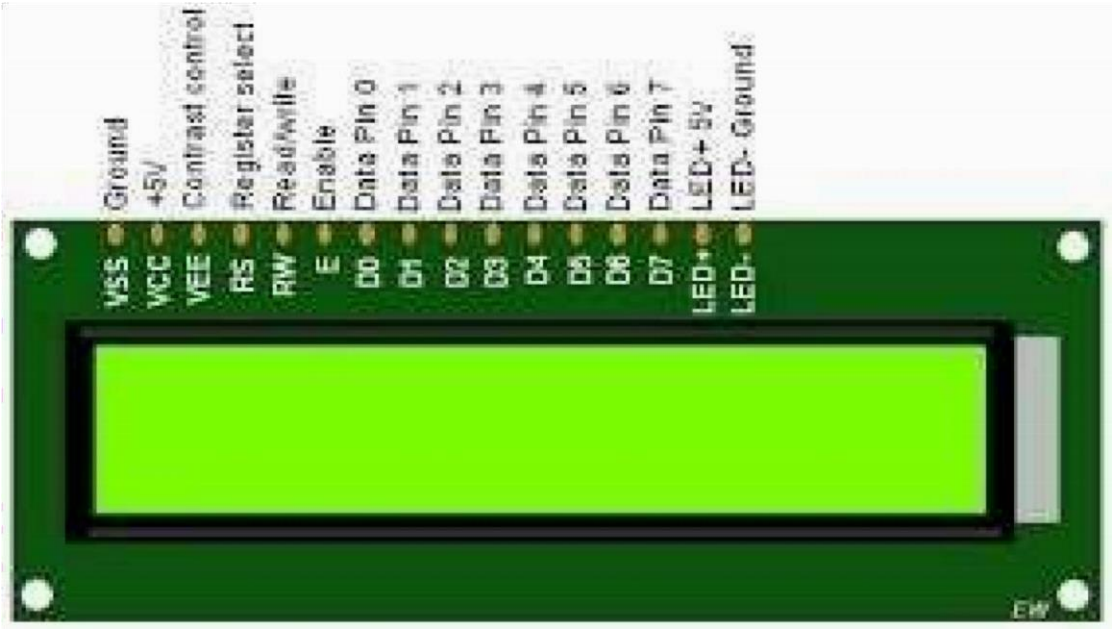

Figure.2. 2.Liquid Crystal Display

Results of BMI on LCD: An LCD can display the calculated value of BMI to the user. The smart device of BMI, with the help of height and weight measured data, processes it and estimates the BMI. Further, an LCD may present the result on the screen in order to enable the user to see the reading about BMI easily and quickly.

2.3 Relay module

A power relay module is an electric switch that is operated by means of an electromagnet. The electromagnet is activated by a different low-power signal from a microcontroller. When turned on, the electromagnet pulls on a solenoid-an iron yoke that delivers a low reluctance path for magnetic flux-to either open or close. One or more set of moving contacts; a movable iron armature. The movable armature is hinge fixed to the yoke and mechanically coupled to one or more set of moving contacts. It is held up by a spring and, when the relay is de-energized, there is an air gap in the magnetic circuit. This position, one set of the two sets of contacts makes or breaks a contact with the fixed contact. Whenever the relay is deenergized, the sets of contacts that were closed open and break the connection and vice-versa if the Contracts were open. When turning off the current to the coil, the armature is turned by force to its relaxed position. But the gravity also can be utilized in some applications. Most of power relays are manufactured to operate in a quick way [8].

Figure.2. 3. Relay module

2.4 Finger printer module

The module known as a fingerprint sensor module is also called a fingerprint scanner or fingerprint reader. It refers to that hardware device designed for capturing and analyzing fingerprints meant for biometric identification and authentication purposes. This is actually designed in such a manner that it would recognize and verify the pattern and ridges of a person's finger. The fingerprint sensor module is finding extensive application in many applications, where access control is required. It finds broad applications in smartphones, laptops, and tablets amongst several other electronic devices to.

Figure.2. 4.Fingerprint sensor module

2.5 Buzzer

An audio signaling device like a beeper or buzzer may be electromechanical or piezoelectric or mechanical type. The main function of this is to convert the signal from audio to sound.

Generally, it is powered through DC voltage and used in timers, Alarm devices, printers, Alarms, computers, etc. Based on the various designs, it can generate different sounds like alarm, music, bell& siren [10].

Figure.2. 5.Buzzer

2.6 PCB (Printed Circuit Board)

A printed circuit board (PCB; also printed wiring board or PWB) is a medium used to connect electronic components to one another in a controlled manner. The simplest form of a PCB is a laminated sandwich structure Of conductive and insulating layers: each of the conductive layers is designed with an art work pattern of traces, planes, and other features (similar to wires on a flat surface) etched from one or more sheet Layers of copper laminated onto and/or between sheet layers of non-conductive substrate. Electrical Components may be fixed to conductive pads on the outer layers in the shape designed to accept the Component's terminals, typically by soldering, to both electrically connect and mechanically fasten them to it. In another manufacturing process, via: plated-through holes are added between layers for interconnection between layers [11].

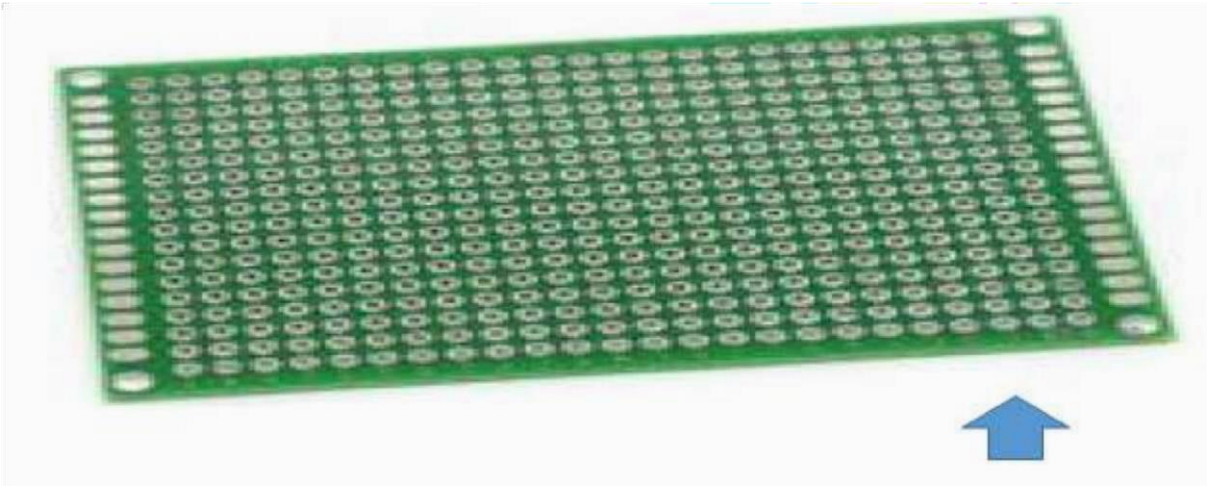

Figure.2. 6.PCB (printed circuit board)

2.7 LEDs

The light-emitting diode LED is among the standard sources of light applied widely in electric equipment. It has a wide field of application, from mobile phones to big adverting billboards.

They find applications in devices showing the time and displaying different types of data [12].

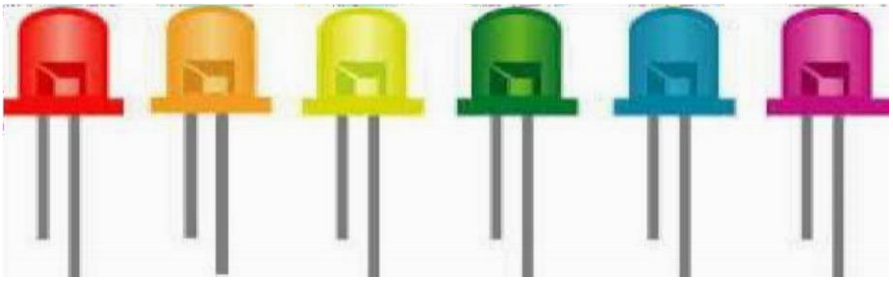

Figure.2. 7.LED (Light emitting diode)

2.8 Power supply

A power supply unit (PSU) converts main AC to low-voltage DC power for the internal components of the computer. Modern personal computers have universally used switchedmode power supplies, which have a manual Input voltage selection switch. The rest of them automatically adjust themselves according to the main voltage [13].

Figure.2. 8.Power supply

SIM800L GSM/GPRS module is a miniature GSM modern, which can be integrated into a great number of loT projects. You can use this module to accomplish almost anything a normal cell phone can; SMS Text messages, Make or receive phone calls, connecting to internet through GPRS, TCP/IP, and more! To top it off, the module support quad-band GSM/GPRS network, meaning it works pretty much anywhere in the world. [1]

2.9. SIM800L GSM MODULE PINOUT

The total number of pins on the SIM800L module that interface it to the outside world is 12. The connections are as follows: NET is a pin where you can solder Helical Antenna provided along with the module. VCC supplies power for the module. This can be anywhere from 3.4v to 4.4 volts. Remember connecting it to the 5v pin will likely destroy your module! It doesn't even run on 3.3v! An external power source like Li-Po battery or DC-DC buck converters rated 3.7V 2A would work. RST (Reset) RST is hard reset pin. If you absolutely got the module in a bad space, pull this Pin low for 100ms to perform a hard reset. Rx D (Receiver) pin is used for serial communication, TX D (Transmitter) pin is used for serial communication. GND: is the Ground pin and needs to be connected to GND pin on the Arduino. RING: is the Ring Indicator pin. Pretty much it‟s the 'interrupt' output from the module. It is by default high and will pulse low for 120ms when a call is received. It can also be configured to pulse when an SMS is received. DTR pin activates/deactivates sleep mode. Pulling it HIGH will put module in sleep mode, disabling serial communication. Pulling it LOW will wake the module up. MIC ±is a differential microphone input. The two microphone pins can be connected directly to these pins. SPK± is a differential speaker interface. The two pins of a speaker can be tied directly to these two Pins.

Figure.2. 9.GSM PINOUT

2.10 Related study

Now-a-days, Electrical accidents to the Line-Men are increasing day by day due to the miscommunication and lack of communication. They are difference projects and system that work related to this proposal.

In 2018 Sanmugapiriya M developed “Electrical Line Man Safety using Finger Print Sensor” This proposed system provides a solution that ensures safety of electric lineman i.e., line man on detecting a fault in electric line the line man senses his finger in fingerprint scanner and the main line is switched off which is again switched on after solving the fault by again sensing his finger, thus it saves the life of lineman working on electric line. The proposed system is fully operated on Arduino [3].

2.10.1 Block diagram

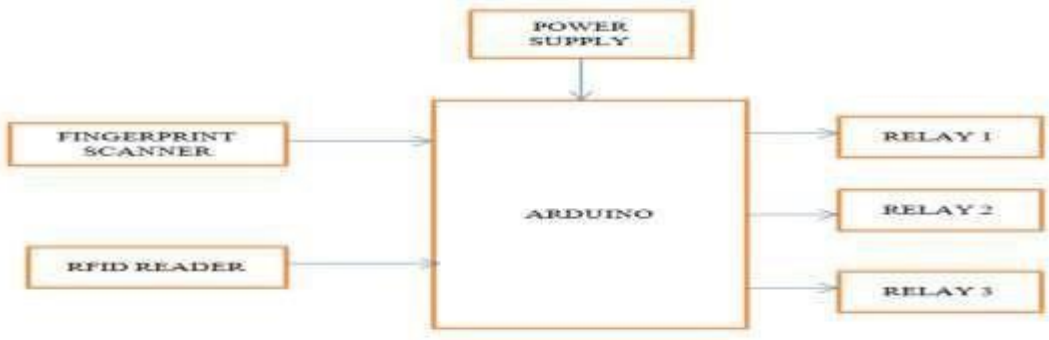

Figure 2.10 Block diagram

2.10.2 Circuit diagram

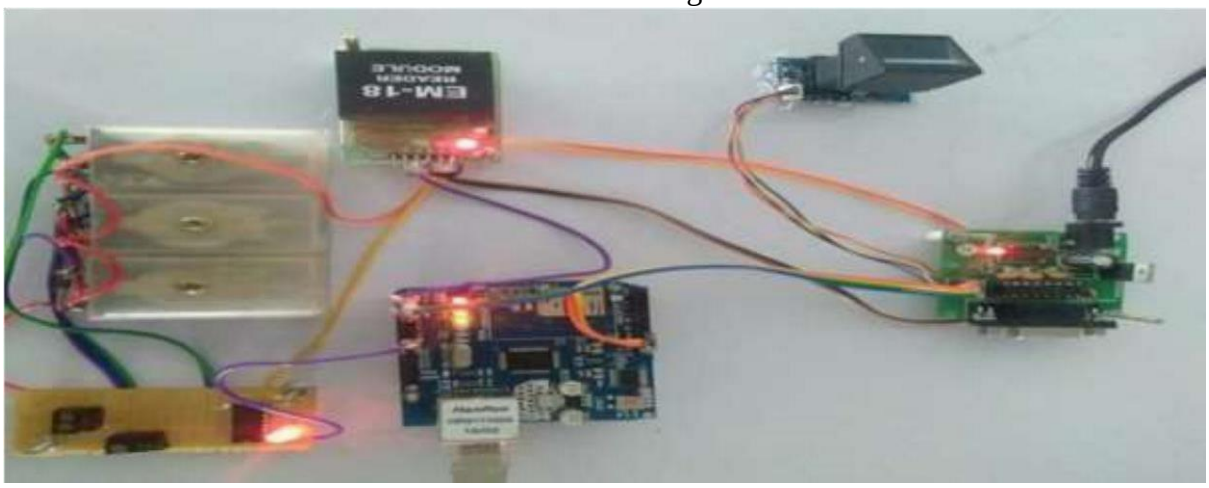

Figure 2.11 Circuit diagram

In 2019 Suneetha developed “Electrical Line Man Safety using Finger Print Sensor” that gives an answer that guarantees security of electric lineman i.e., line man on distinguishing a blame in electric line the line man detects his finger in unique finger impression scanner and the primary line is turned off which is again exchanged on subsequent to comprehending the blame by again detecting his finger, along these lines it spares the life of lineman taking a shot at electric line. The proposed framework is completely worked on [4].

2.10.3 Block diagram

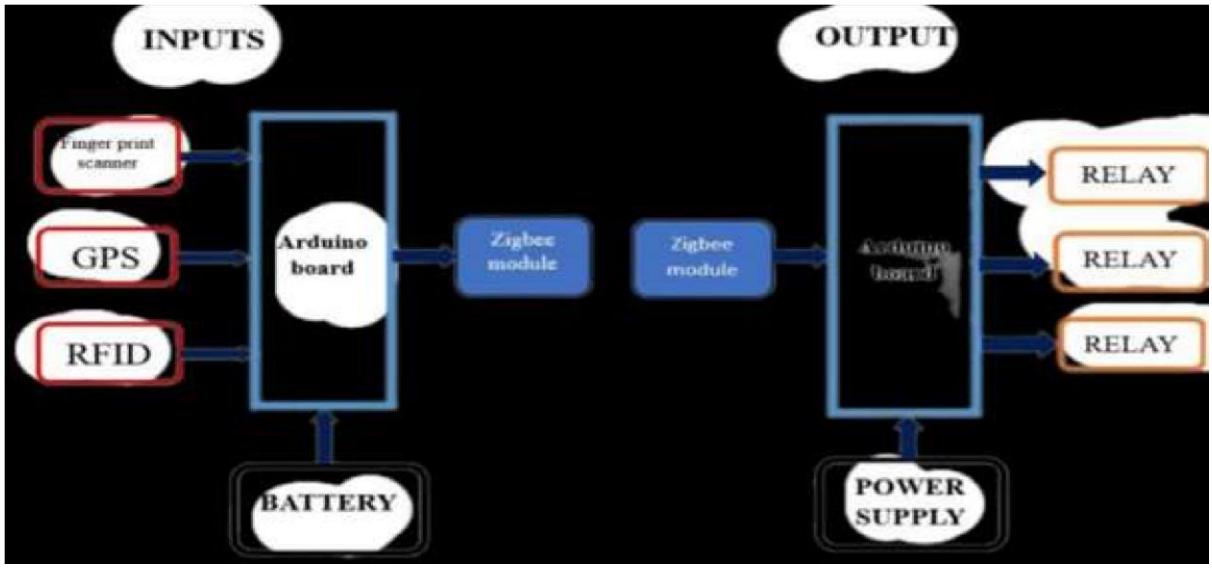

Figure 2.12 Block diagram

2.10.4 Circuit diagram

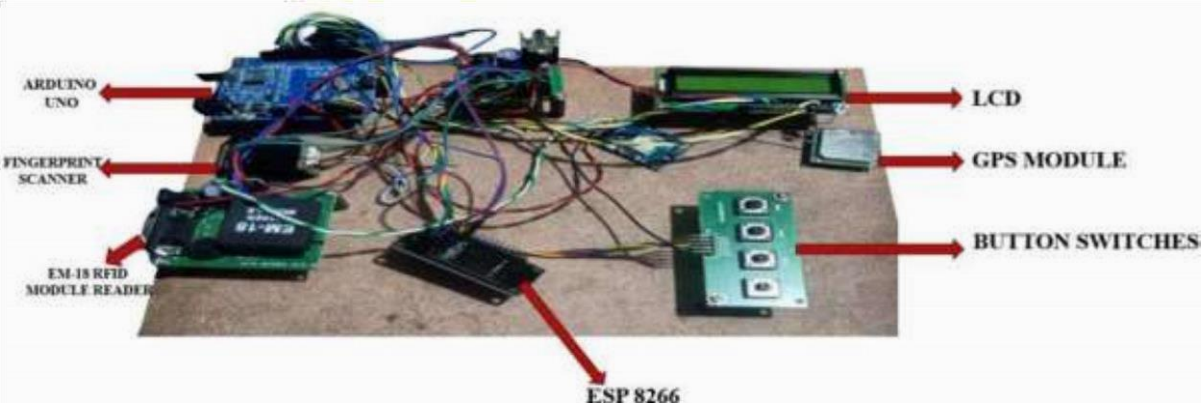

Figure .2.13 Circuit diagram 1

In 2021 Dr. Shubhangi developed "Electrical Line Operator Safety Utilizing with a Unique

Fingerprint Scanner" developed to prevent such accidents, circuit breakers are often designed so that only authorized persons can tamper with passwords or fingerprints. There are also rules for adjusting passwords.

2.10.5 Block diagram

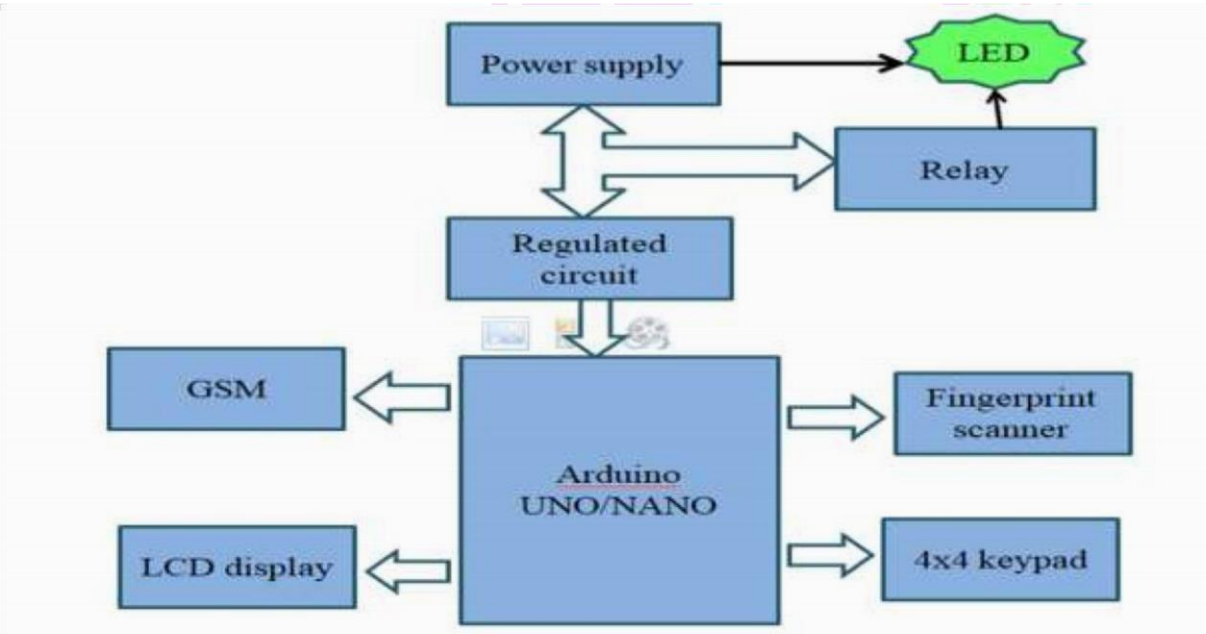

Figure.2.14 Block diagram

2.10.6 Circuit diagram

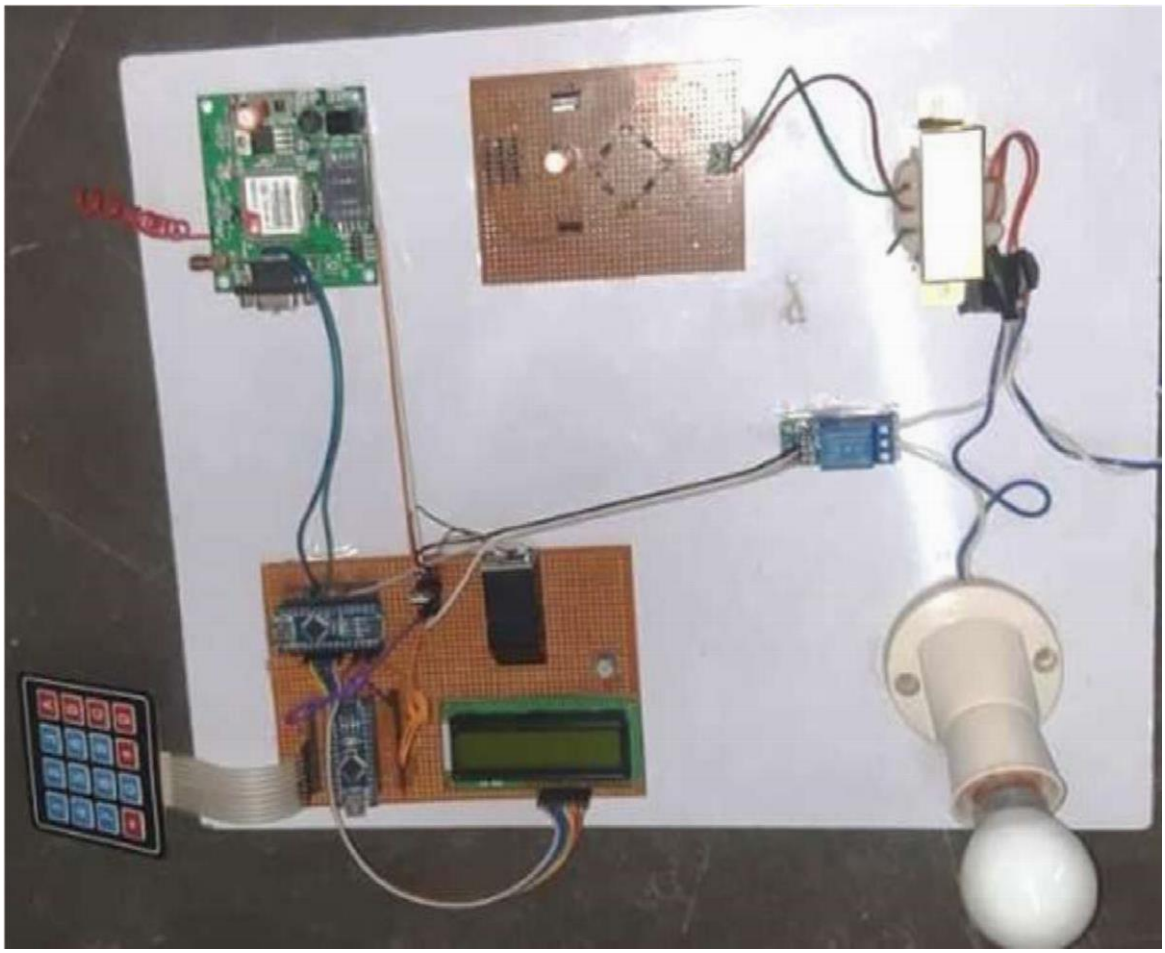

Figure 2.15 Circuit diagram

The framework is completely constrained by their group of 8-bit atmega microcontrollers. The secret word or unique finger impression is put away in the EEPROM and associated with the microcontroller. So, the secret phrase is typically changed whenever, not at all like the tips that are composed constantly on the microcontroller. A relay used to open and close an illuminated circuit breaker with a keypad is used to enter the password when a finger is not detected. It also shows where certain line failures or warnings are occurring. The use of GSM electrical potentials creates a faulty line condition for repair and maintenance purposes [5].

CHAPTER 3: RESEARCH METHODOLOGY

3.0 Introduction

This chapter outlines the research methodologies utilized in the project titled "Design and Implementation of an Embedded System Based on Touch Safety for Electricians." It details the research design, population, sample size, sampling procedures, research instruments, data gathering procedures, data analysis, and interpretation. Additionally, it discusses ethical considerations and potential limitations encountered during the study.

3.1 Research design

The research design for this study is experimental, focusing on the integration of an embedded system aimed at enhancing touch safety for electricians. This approach facilitates the testing of the system‟s effectiveness in real-time scenarios, validating its reliability and efficiency. Both quantitative and qualitative methods were employed for data collection and insights gathering.

3.2 Research population

The target population comprises electricians, safety engineers, and electrical supervisors who have direct experience and expertise in electrical safety practices. Their insights are critical for gathering relevant data regarding touch safety protocols and the potential impact of the embedded system.

3.3 Sample size

A sample size of 110 respondents was selected from the relevant stakeholders and experts in the field. This small sample size is intended to provide a diverse range of perspectives, although the generalizability of the findings may be limited. Future studies could benefit from a larger sample size for more robust data.

3.3.1 Sampling procedure

Purposive sampling was employed to select participants with direct experience in electrical safety and embedded systems. Each participant was approached individually, ensuring their insights would add value to the study through direct invitations and professional connections.

3.4 Research instruments

3.4.1 Choice of research instrument

The research employed structured interviews, observation checklists, and standardized questionnaires. These instruments were chosen to gather both qualitative and quantitative data. The interview guide and observation checklist were developed based on insights from the literature review, while the questionnaire was standardized and pre-tested to ensure its reliability and validity.

3.4.2 Validity and reliability of the instrument

The validity of the instruments was confirmed through expert reviews and pilot testing with a small group of respondents who were not part of the main study. Reliability was achieved by utilizing standardized instruments and conducting consistency checks throughout data collection. Multiple instruments were used to triangulate data and enhance the overall reliability of the findings.

3.5 Data gathering procedures

Data collection followed several systematic steps:

1. **Identification and selection of respondents**: Participants were chosen based on their expertise in electrical safety and familiarity with embedded systems.
2. **Structured interviews and observations**: Conducted through various communication channels to gather primary data on current safety protocols and practices in electrical work..

The collected information was organized, summarized, and analyzed for insights.

3.5.1 Primary data

Primary data was gathered through visits to electrical training centers and workshops, where hands-on experience with embedded systems was obtained. Collaborating with instructors and

industry professionals provided crucial insights into component selection and system design, enhancing the understanding of practical applications for touch safety in electrical work.

3.5.2 Secondary data

Secondary data comprised previously collected and analyzed information relevant to electrical safety and embedded systems. Extensive literature reviews, including books and online resources, were conducted to bridge knowledge gaps and inform the project. The research process involved utilizing academic publications and credible websites to ensure a comprehensive understanding of best practices and current standards in the field. Supervisor and mentorship played a vital role in addressing gaps in the literature, ensuring accurate system design and implementation.

3.6 Data analysis and interpretation

Qualitative data from interviews and observations underwent thematic analysis to identify patterns and insights regarding the effectiveness of the embedded system. The performance and reliability of the quantitative data were assessed using statistical techniques such as chisquare tests, correlation analysis, and ANOVA. This analytical approach facilitated the answering of research questions and the validation of hypotheses set forth in this study.

3.7 Ethical Considerations

Ethical considerations included obtaining informed consent from all participants, ensuring confidentiality, and respecting the privacy and rights of respondents. Ethical approval was sought from the relevant institutional review board, and all data collection and reporting were conducted in accordance with established ethical guidelines.

CHAPTER 4: DESIGN SYSTEM ANALYSIS AND IMPLEMENTATION

4.0. Introduction

In chapter result and discussion is showing construction about project and discussion for every step of project. Working principle of project step by step, including the running photos of project, final implantation of project will be here and cost need to build project and running process.

4.1 calculation

1. Operating Power Calculation

- **Power**: P= 5W
- **Supply Voltage**: V=3.7 V
- **Operating Current**: $I = \frac{P}{V} = \frac{5W}{3.7V}$

2. Fingerprint Module

- **Supply Voltage**: V=5 V
- **Operating Current**: I=300 mA=0.3 A
- **Power**: P=V×I=5 V×0.3 A=1.5 W=1500 mW

3. GSM Module

- **Supply Voltage**: V=3 V
- **Operating Current**: I=300 mA=0.3 A
- **Power**: P=V×I=3 V×0.3 A=0.9 W=900 mW

Summary

- **Operating Power**: 5 W at 3.7V requires ≈ 1.37A
- **Fingerprint Module**: 1.5 W at 5 V, 300 mA

- **GSM Module**: 0.9 W at 3 V, 300 mA

1. Operating Power

- **Power**: 5 W
- **Supply Voltage**: 3.7 V
- **Operating Current**: I≈1.37A

2. Fingerprint Module

- **Supply Voltage**: 5 V
- **Operating Current**: 300 mA (0.3 A)
- **Power**: P=1.5 W=1500 mW

3. GSM Module

- **Supply Voltage**: 3 V
- **Operating Current**: 300 mA (0.3 A)

Power: P=0.9 W=900

Summary of Outputs:

- **Total Operating Current for Fingerprint Module**: 0.3 A
- **Total Operating Current for GSM Module**: 0.3 A
- **Total Current Demand**: 1.37 A + 0.3 A + 0.3 A =1.97 A

Mathematical Equations

Variables: V (t): Voltage at the electrical equipment at time t.

I (t): Current flowing through the equipment at time t.

S (t): State of the embedded system being either 1 for active or 0 for inactive at time t.

P (t): Power consumption of the system at time t.

1. **Safety State Equation:**

   S (t+1) = {10if **V** (t) > **V** threshold or I(t) > **I** threshold otherwise 0

   - **Explanation:**
     - The system is ON (represented by a value of 10) if the voltage V(t) exceeds the voltage threshold V threshold or if the current I(t)
     - exceeds the current threshold I threshold
     - The system is OFF (represented by 0) if neither condition is met.

2. **Power Consumption Equation:**

   P (t+1) = **α**.**S** (t+1) + **β P** (t)

   - **Where:**
     - **P** (t+1) is the power consumption at the next time step.
     - **α** represents the power consumption when the system is active (i.e., **S**(t+1)=10)
     - **β** represents the power consumption when the system is inactive (i.e., **S**(t+1)=0).
     - **P** (t) is the power consumption at the current time step.

Translation:

- The **safety state equation** determines whether the embedded system should be active based on the real-time voltage and current readings.
- The **power consumption equation** calculates the energy consumed by the system, taking into account the state of the system (active or inactive) and how the power consumption varies between these states.

Example Values

Using your previous calculations:

- Let‟s assume:
  - **α** =5 W (when active) ○ **β** =1 W (when inactive)

Scenario:

- If **V**(t)=4 V and **I**(t)=0.5 A with thresholds Vthreshold=3.5 **V** and Ithreshold =0.4A ⇨**Safety State Calculation:**
- **S** (t+1)=10(since both voltage and current exceed thresholds)
  - **Power Consumption Calculation:** If **P**(t)= 1.5 W: ○ **P**(t+1) = 510 + 11.5 = 50+1.5=51.5W

4.3 Drawings

4.3.1 Block diagram

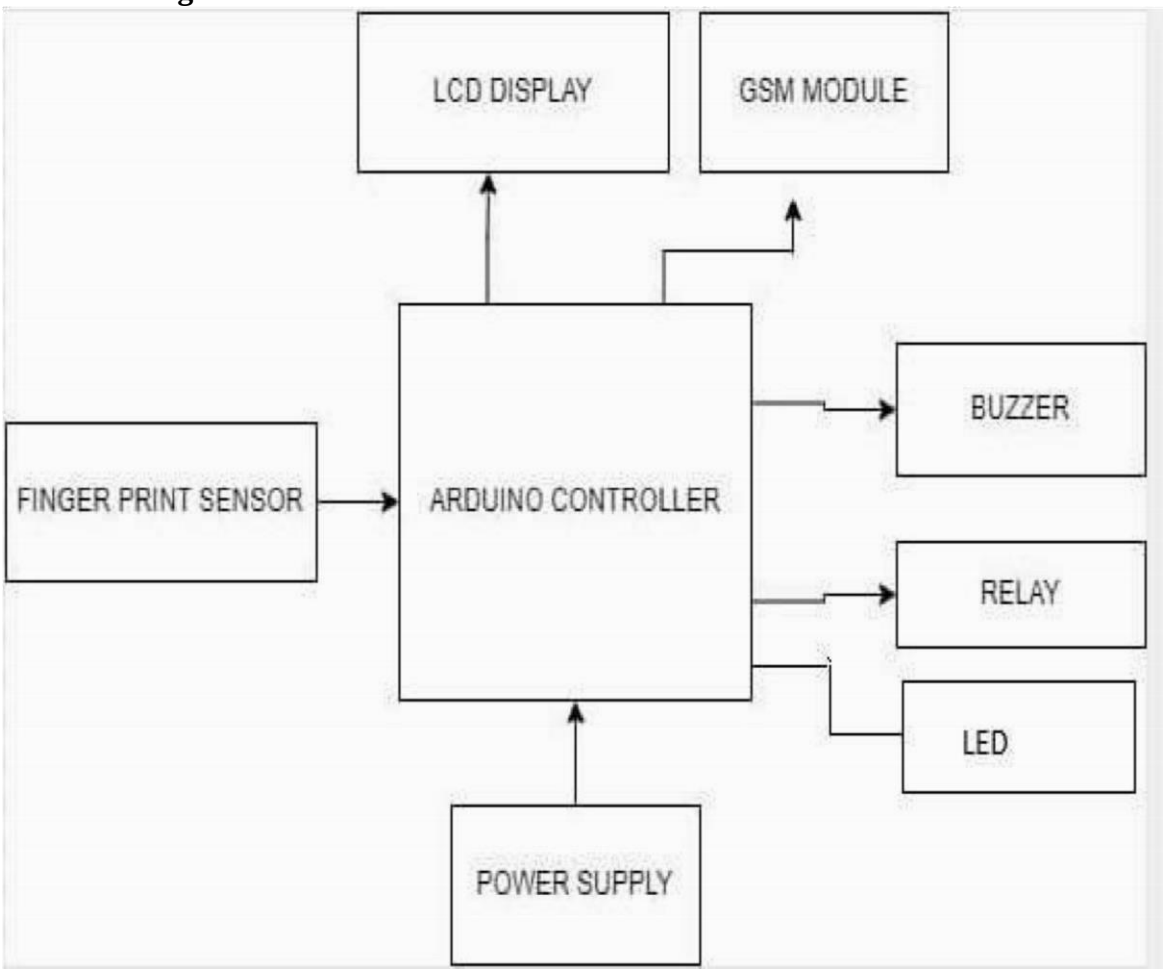

Figure 4.1: Block diagram

In this block diagram Arduino, it will control all system functionalities, fingerprint sensor will scan finger identification and send to Arduino micro controller to be verified and micro

controller take Decision of want to do, GSM Module send SMS and buzzer will make alarm accordingly, relay module will turn on or off circuit Breaker, LEDs will light according to the system status, LCD will display any information.

4.3.2 Flowchart

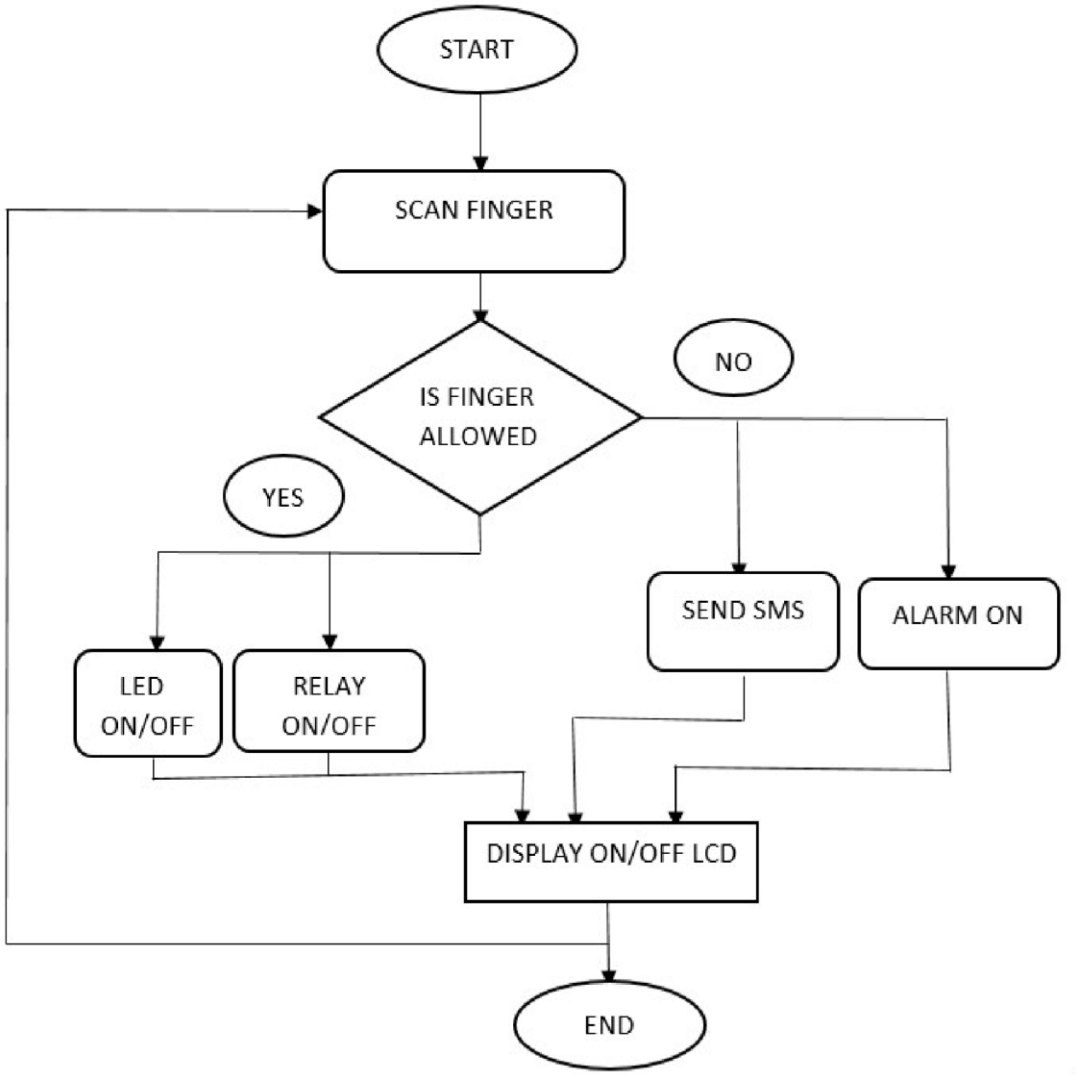

Figure 4.2: Flowchart

On this flowchart fingerprint module will scan finger if yes relay module will switch on or off Circuit break if no, you Will get SMS if the first personal or second personal are in the system you will wait otherwise you are not allowed to switch system will make alarm that notify you are not Allowed to switch then block you.

4.3.3Circuit diagram

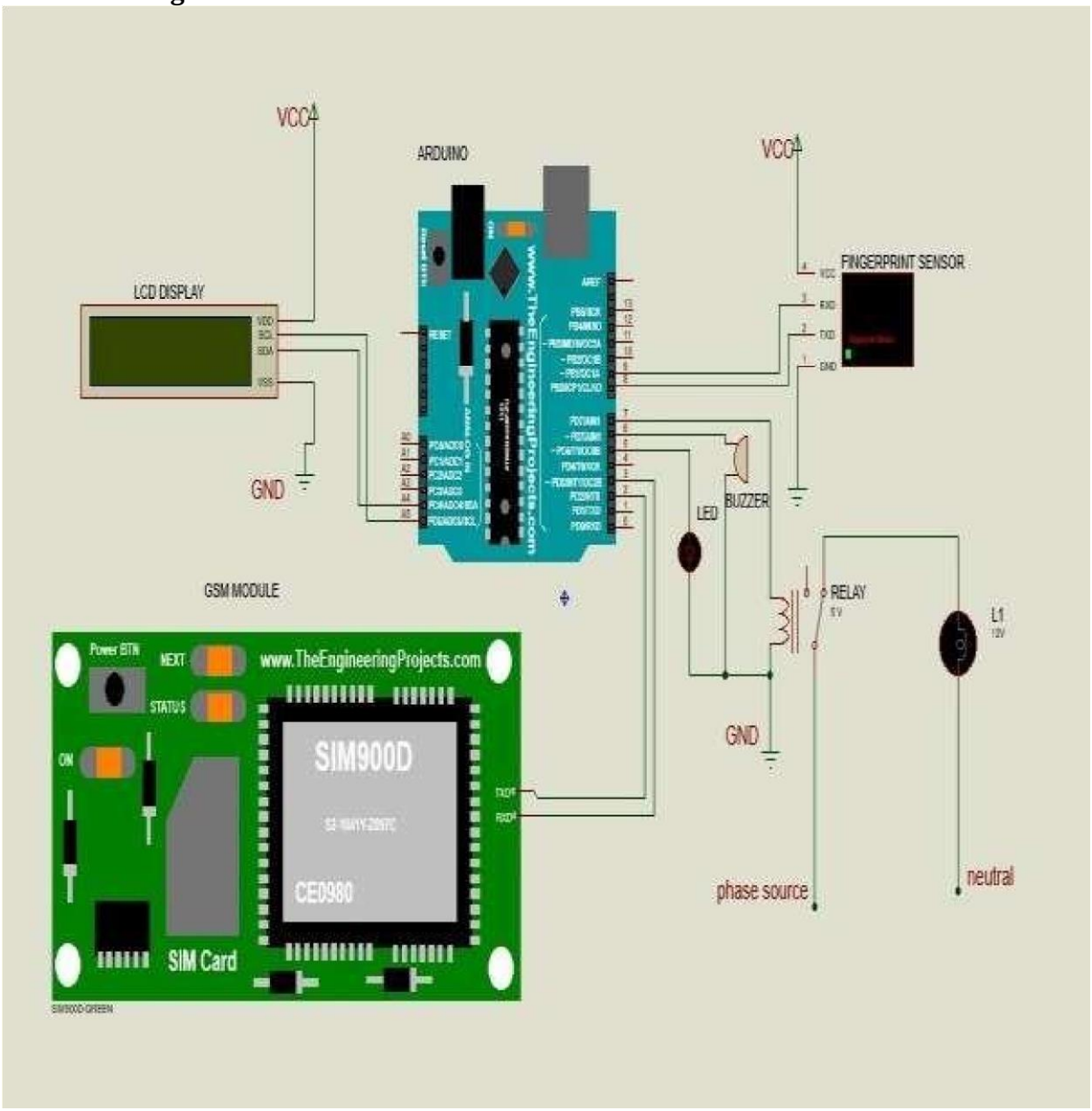

Figure 4.3: Circuit diagram

In this block diagram ARDUINO, it will control all system functionalities, fingerprint sensor will scan finger identification and send to ARDUINO micro controller to be verified and micro controller take Decision of want to do, GSM Module send SMS and buzzer will make alarm accordingly, relay module will turn on or off circuit Breaker, LEDs will light according to the system status, LCD will display any information.

4.4. Working principle of project

The “Design and implementation Embedded System Based on Touch Safety for Electricians” project Operates on a biometric authentication system that allows authorized line-men and maintenance Staff to securely control the opening and closing of electrical lines through a touch-based interface In real-time. Microcontroller will control the functionality of all system all sensors are connected to the Arduino microcontroller, fingerprint module will recognize and verify the unique patterns and Ridges present on an individual's fingertip and send information to the microcontroller and trigger Relay for switch on or off line power, GSM Module Send SMS to other authorized users when there is any one switch off circuit break and LCD will display status, if electrical line is switch on/off, buzzer Make difference sound if fingertip is allowed it makes sound difference from when it is not allowed.

4.5. Components specification Table.4. 1.Components specification

No	Name	Specification
1	Fingerprint	Rated voltage:-3.8 to 7v dc Operating Temperature: – -20° to +60°C (@ 40% to 85% Relative Humidity)
2	Arduino uno	Operating voltage: 5v V input Voltage:7-12v
3	Power supply(AC/DC adaptor)	Input:AC100-240v Output:12v,2A
4	LCD Display	Type:12c 16x2 Operating voltage:5v
5	GSM Module	Type:SIM8001 Operating voltage:4.2v to 4.4v
6	Relay module	Supply voltage: 3.75v to 6v Current when the relay is active:70mA
7	Buzzer	Operating Voltage: Usually 3V to 24V Operating current:10mA

4.6. Implementation

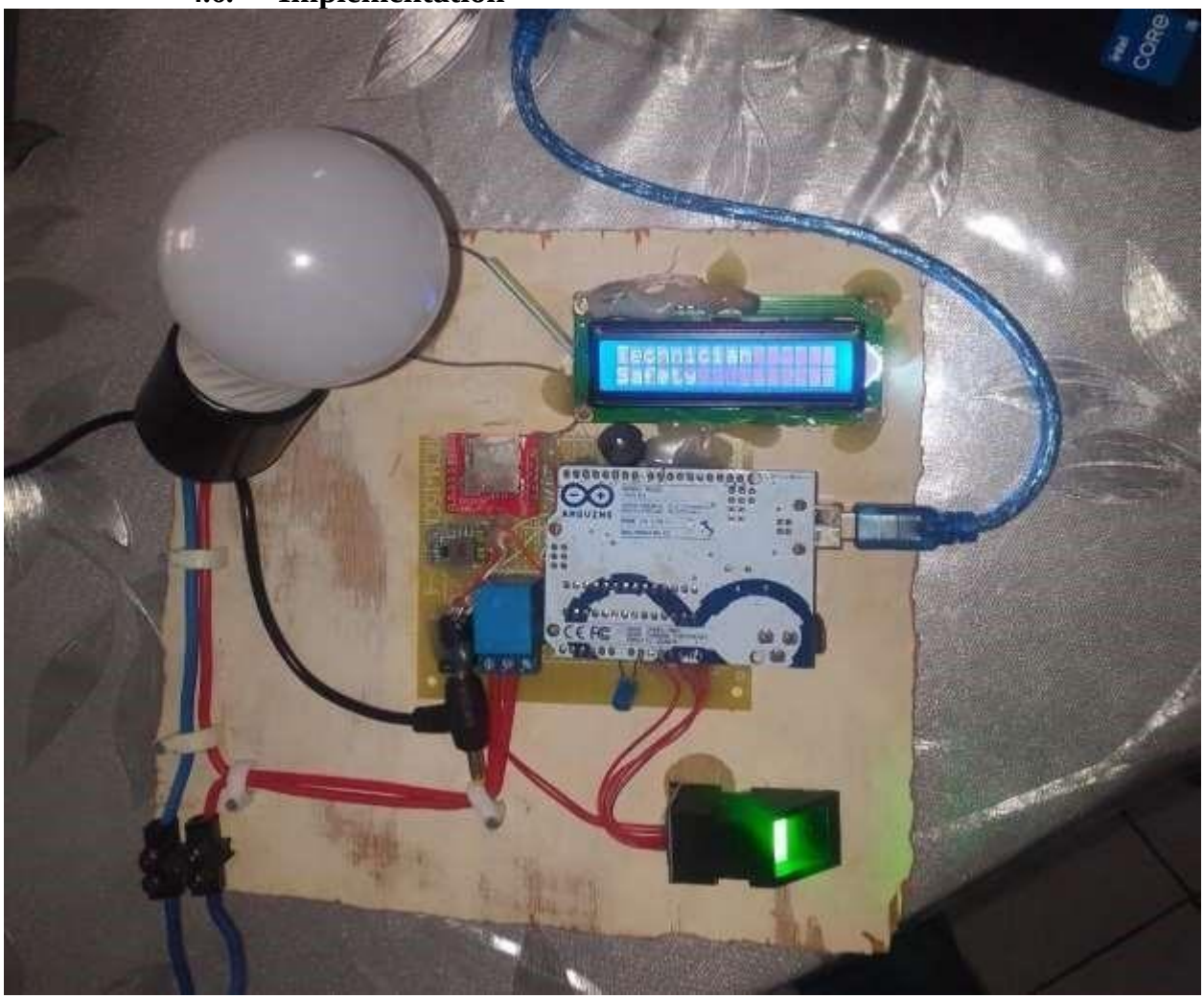

Figure.4. 4: Technician Safety

This image show system devices and sensors are connected here we have LCD, ARDUINO UNO, GSM Module, Fingerprint module and board that all are connected to.

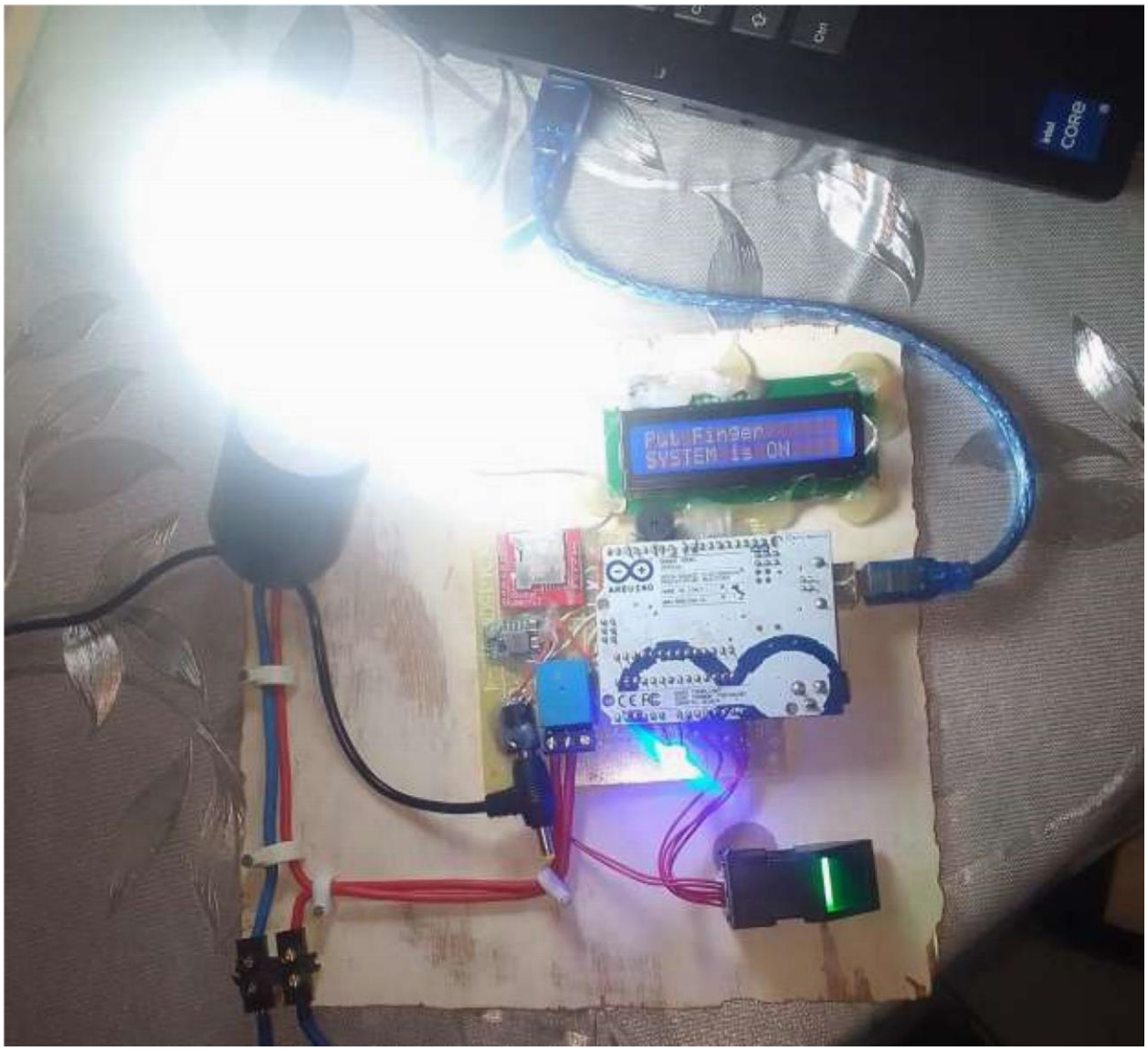

Figure 4.5: system is ON

This image shows system ON, here system is read to be close, no technician is in line when

Electrician biometrical authenticated LCD will display that" system is off" it block other to Open

circuit break.

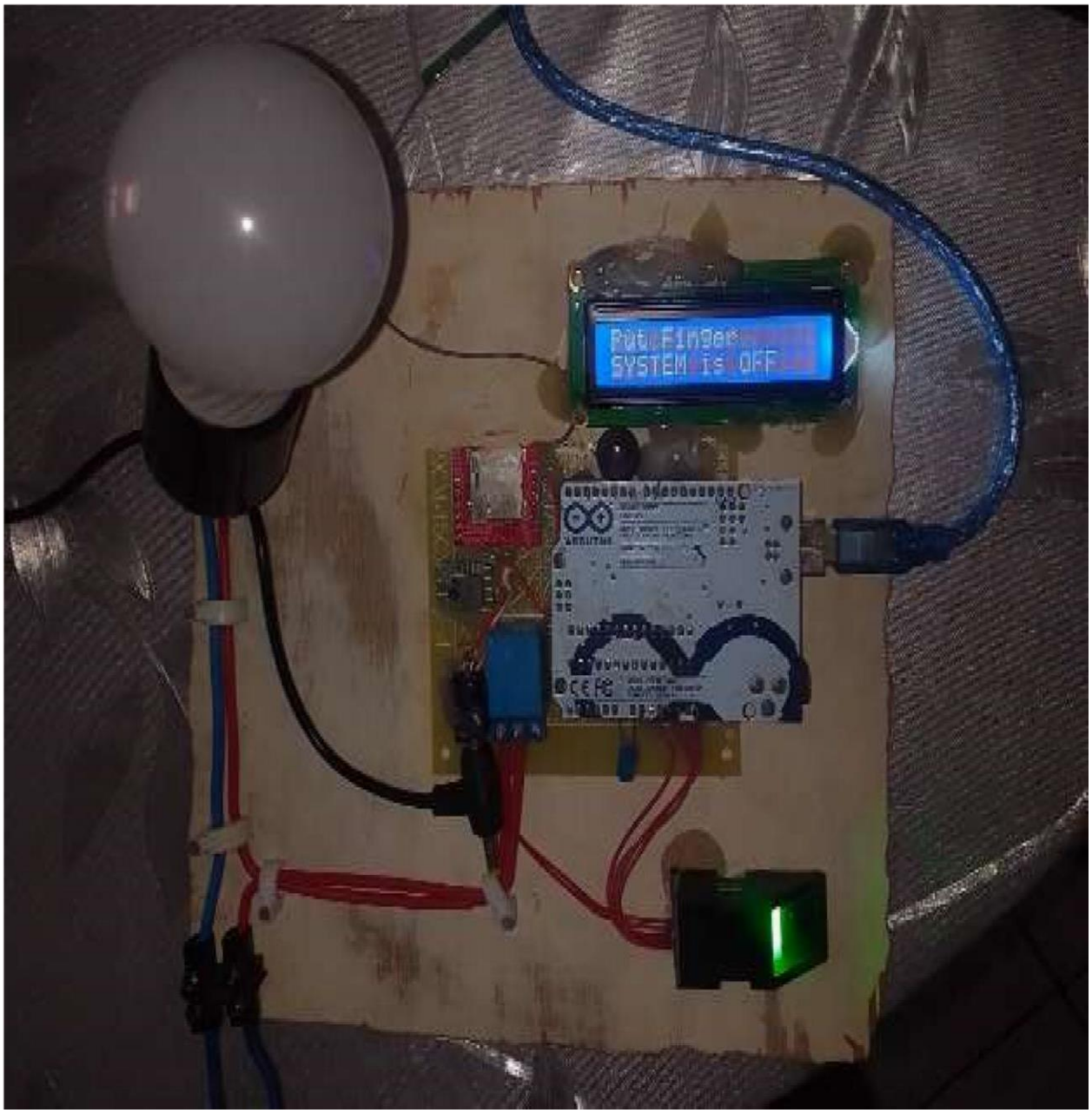

Figure 4.6: System is OFF

This image shows that there is electrician in the line so other are blocked and send SMS other authorized users to wait until electrician tap fingerprint again to switch ON system.

4.7. Output of the system

When system is off when the first personal switch off the system the second personal try to switch on will get short SMS and system block the second personal to preventing unauthorized circuit break activations during Maintenance activities.

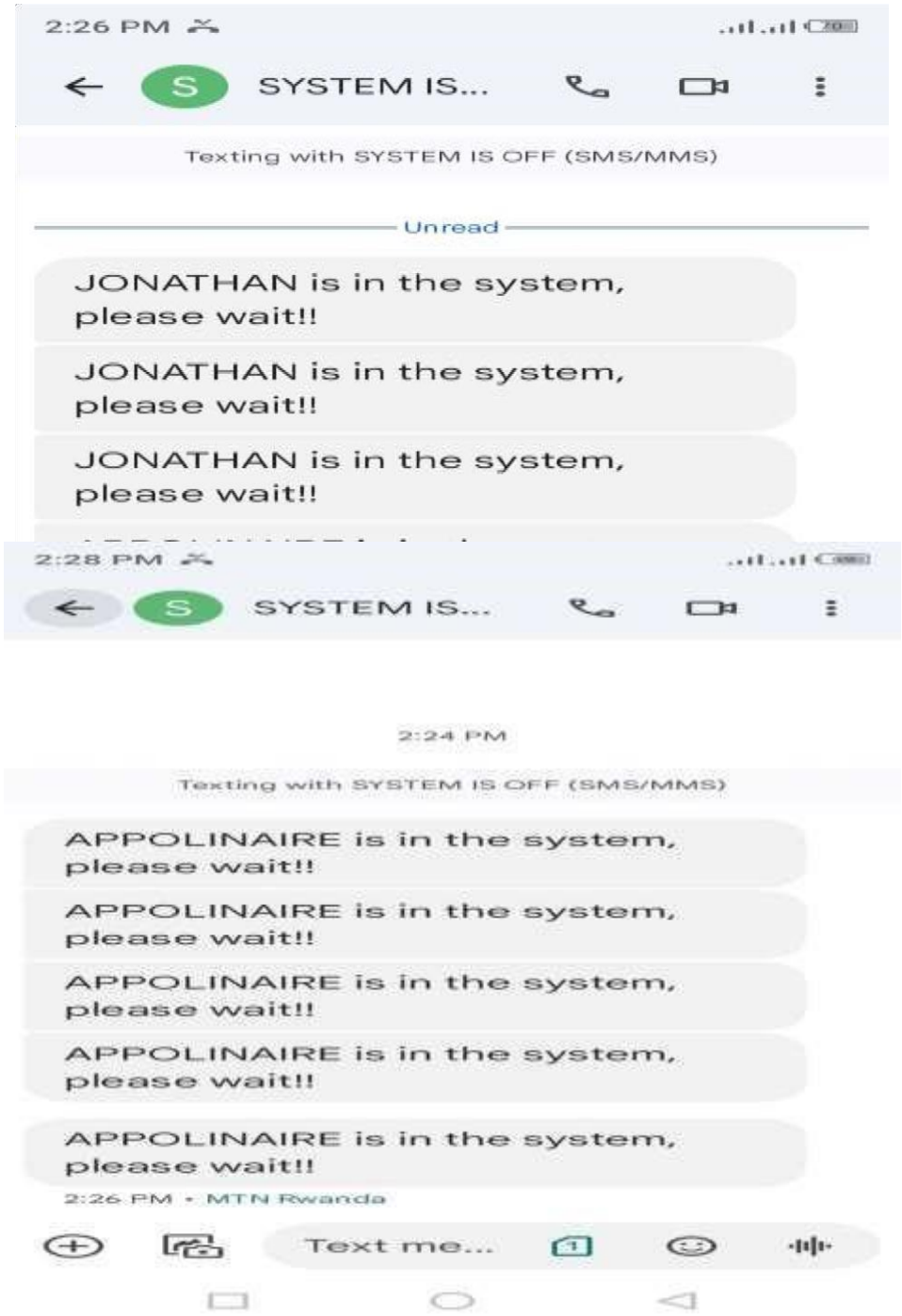

Figure 4.7: Output of the system

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.0. Introduction

The implementation of the embedded system designed for electricians represents a significant advancement in safety and operational efficiency within the electrical maintenance sector. By combining biometric authentication, a user-friendly touch interface, and IoT capabilities, this system provides a robust solution to the challenges faced by line-men in managing electrical lines. The dual-access control mechanism ensures that only authorized personnel can operate the system, reducing the risk of accidents and enhancing accountability during maintenance activities. Furthermore, real-time monitoring facilitates immediate responses to potential issues, contributing to a more reliable electrical supply infrastructure.

5.1. Conclusion

In conclusion, the "Embedded System Based on Touch Safety for Electricians" project offers an Innovative and secure solution to enhance the safety and efficiency of electrical line management for line-men and maintenance staff. By incorporating a biometric authentication system and leveraging a microcontroller to control all system functions, including sensor integration and relay control, the Project ensures that only authorized personnel can access and operate electrical lines. The use of a fingerprint recognition module adds an extra layer of security by verifying the unique patterns on an Individual‟s fingertip, thus preventing unauthorized access. The LCD display provides real-time status updates, allowing users to easily monitor the state of the electrical lines, GSM will send SMS while the buzzer system provides audible feedback to confirm or deny access. Overall, this project represents a significant Advancement in the realm of electrical safety and reliability, greatly benefiting both line-men and the broader electrical infrastructure.

5.2. Recommendations

I strongly recommend that future researchers in this field focus on several key areas to advance the state of knowledge and practical applications. Firstly, it‟s essential to continue exploring novel Biometric authentication methods and their integration into embedded system, particularly investigating the robustness and reliability of technologies such as facial recognition, iris scans, and Voice recognition.

Secondly, researchers should delve deeper into machine learning and artificial Intelligence algorithms, striving to develop adaptive systems capable of learning from real-world Scenarios to enhance fault detection, decision-making, and system performance. Lastly, research should continuously address security and privacy concerns, staying ahead of potential threats and Vulnerabilities, and implementing robust encryption and data protection measures to safeguard user Information and system integrity. In summary, future researchers should embrace innovation, Collaboration, sustainability, and security as core principles in advancing embedded systems with Biometric authentication for enhanced safety and efficiency across diverse domains.

APPENDICES

5.3.1 Cost estimation

Table.5. 1.Cost estimation

	Name	Quantity	Price	Function
1	ARDUINO UNO	1	15000frw	Control system functionalities.
2	Fingerprint Module	1	29000frw	Fingerprint module will recognize and verify the unique Pattern and ridges present on an individual‟s fingertip And send information to the microcontroller.

3	GSM Module	1	12000frw	It will used to send messages
4	Relay Module	1	2500frw	Control the flow of electrical current in a circuit. Relay Will switch on/off of electrical current when microcontroller is recommended it.
5	LCD	1	8000frw	It will used display message
6	Buzzer	1	500frw	It makes sound when fingertip is taped on finger print
7	LED	1	200frw	It will show the status of system
8	Power supply	1	4000frw	It will used to supply ARDUINO
Total =			71200frw	

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Works press, 2009-12.

Appendix

Arduino codes

```
#include <Adafruit_Fingerprint.h>

#include <Wire.h>

#include <LiquidCrystal.h> #include <SoftwareSerial.h> const

int rs = 13, en = 12, d4 = 11, d5 = 10, d6 = 9, d7 = 8;



Liquid Crystal lcd(rs, en, d4, d5, d6, d7);

 #include <SoftwareSerial.h>

SoftwareSerial gsm(2, 3);  // (Tx, Rx)

SoftwareSerial mySerial(7, 6); // RX, TX pins for the fingerprint sensor

Adafruit_Fingerprint finger = Adafruit_Fingerprint(&mySerial); // Define the

pin for controlling the lamp (e.g., using a relay) const int lampPin = 5; // Change

to your lamp control pin const int buzzer = 4; bool lampState = false; // Variable

to track the lamp state (false = off, true = on) int lastOperatorID = -1; // Track

who last operated the lamp
```

```
// Assign fingerprint IDs to each person const
int person1ID = 32; // ID of Person 1 const
int person2ID = 30; // ID of Person 2 int
led=A0; void setup() {    Serial.begin(9600);
gsm.begin(9600);   while (!Serial);
delay(100);   // Initialize the LCD
lcd.begin(16, 2);   lcd.clear();


    // Initialize the lamp control pin

  pinMode(lampPin, OUTPUT);   pinMode(buzzer,
OUTPUT);   digitalWrite(lampPin, LOW); // Turn off the
lamp initially


    // Display a welcome message
lcd.setCursor(0, 0);
lcd.print("Fingerprint");   lcd.setCursor(0,

1);   lcd.print("Scanner Init");   delay(2000); //
Delay to show the message // Initialize
fingerprint sensor   finger.begin(57600);   if
(finger.verifyPassword()) {     lcd.clear();
```

```
lcd.setCursor(0, 0); // First line

lcd.print("Sensor Found!");



   Serial.println("Found fingerprint sensor!");
 } else {     lcd.clear();

lcd.setCursor(0, 0); // First line

lcd.print("Sensor not found");



   Serial.println("Did not find fingerprint sensor :(");     while

(1) {       delay(1);



   }                        }                          lcd.clear();

lcd.setCursor(0, 0); // First line    lcd.print("Reading

Params...");



  Serial.println(F("Reading sensor parameters")); finger.getParameters();
finger.getTemplateCount();   lcd.clear();   lcd.setCursor(0, 0); // First line   lcd.print("Total
Stored:");   lcd.setCursor(0, 1); // Second line   lcd.print(finger.templateCount);

  Serial.print(F("Total  fingerprints  stored:  "));

Serial.println(finger.templateCount);

delay(2000); // Delay to show the message
```

```
// Display initial lamp status   updateLampStatus();



} void loop()


{
  // Continuously check for fingerprints

lcd.clear();   lcd.setCursor(0, 0); // First

line   lcd.print("Place Finger");



  Serial.println("Waiting for valid finger..."); int fingerprintID = getFingerprintID();     if
(fingerprintID == person1ID || fingerprintID == person2ID) {     if (fingerprintID == person1ID)
{       // Person 1 can control the lamp       if (lastOperatorID == person2ID && lampState) {

// Person 1 cannot turn off the lamp if Person 2 was the last operator and the lamp is on

lcd.clear();         lcd.setCursor(0, 0); // First line         lcd.print("Person 2 last");

digitalWrite(buzzer, HIGH);         SendMessage2();       digitalWrite(buzzer, LOW);



     } else {         toggleLamp();

lastOperatorID = person1ID;



     }


   } else if (fingerprintID == person2ID) {       //

Person 2 can control the lamp       if (lastOperatorID
```

```
== person1ID && lampState) {


      // Person 2 cannot turn off the lamp if Person 1 was the last operator and the lamp is on
lcd.clear();              lcd.setCursor(0, 0); // First line              lcd.print("Person 1 last");
digitalWrite(buzzer, HIGH);

      SendMessage1();


      digitalWrite(buzzer, LOW);


    } else {        toggleLamp();

lastOperatorID = person2ID;


    }


   }

 } else if (fingerprintID == -1) {      lcd.clear();

lcd.setCursor(0, 0);


// First line     lcd.print("Put

Finger");


   Serial.println("No fingerprint detected");
```

```
  } else {
digitalWrite(buzzer, HIGH);
lcd.clear();

    lcd.setCursor(0,      0);       //          First     line
lcd.print("Invalid Finger");

    Serial.println("Fingerprint detected but not authorized");      delay(2000);
 digitalWrite(buzzer, LOW);


  }
  updateLampStatus();    delay(100); // Short delay before
checking again


}

// Function to get the fingerprint ID int
 getFingerprintID() {    uint8_t p

= finger.getImage();   if (p !=
FINGERPRINT_OK) {
```

```
   Serial.println("Error:         No       fingerprint       detected.");
return -1;


  }

  p = finger.image2Tz();   if (p !=
FINGERPRINT_OK) {

    Serial.println("Error: Failed to convert fingerprint image.");     return -1;

  } p = finger.fingerFastSearch();
if (p != FINGERPRINT_OK) {
Serial.println("Error: Fingerprint
not found in the database.");
digitalWrite(buzzer, HIGH);
delay(1000);     lcd.clear();
lcd.setCursor(0, 0); // First line
lcd.print(" Finger not

Registed");         digitalWrite(buzzer, LOW);     return -1;


  }
```

```
  // Finger found, return the ID

  Serial.print("Fingerprint ID found: ");
Serial.println(finger.fingerID);   return
finger.fingerID;


}

// Function to toggle the lamp state
void toggleLamp() {   lampState =
!lampState; digitalWrite(lampPin,
lampState ? HIGH : LOW);
updateLampStatus();


}

// Function to update the lamp status on the second line of the LCD
void updateLampStatus() {   lcd.setCursor(0, 1); // Second line   if
(lampState) {     lcd.print("SYSTEM is OFF ");

Serial.println("SYSTEM is OFF");     analogWrite(led,0);

  }       else      {
```

```
analogWrite(led,200);     lcd.print("SYSTEM
is ON");


   Serial.println("SYSTEM is ON");

 } } void
SendMessage1()

{   gsm.println("AT+CMGF=1");  //Sets the GSM Module in Text
Mode   delay(1000); // Delay of 1000 milli seconds or 1 second
gsm.println("AT+CMGS=\"0787195209\"\r"); // Replace x with mobile
number delay(1000);


  gsm.print(" APPOLINAIRE is in the system, please wait!!  ");// The SMS text you want to send
delay(100);   gsm.println((char)26);// ASCII code of CTRL+Z   delay(1000);


}         void
SendMessage2()
{   gsm.println("AT+CMGF=1");  //Sets the GSM Module in Text Mode   delay(1000);
// Delay of 1000 milli seconds or 1 second
gsm.println("AT+CMGS=\"0789223296\"\r"); // Replace x with mobile number
delay(1000);   gsm.print("Jonathan is in the system, please wait!! ");// The SMS text you
```

```
want to send   delay(100);   gsm.println((char)26);// ASCII code of CTRL+Z

delay(1000);



}
```