Republic of Iraq
Ministry of Higher Education and Scientific Research
University of Misan
College of Engineering
Department of Electrical Engineering

Remote Monitoring and Control of Voltage and Current and send sms or e_mail

A graduation project submitted to the **Department of Electrical Engineering**, in partial fulfillment for the requirements for the award of the degree of Bachelor of **Electrical Engineering**

By

1-Muqtada Abdul-Hussein Hassan

2-Mohammed Baqir Jasim Mohammed

3- Ali Yasser Khudhur

4- Maryam Jawad Kadhim

SUPERVISED BY

Asst. Lec. Zahraa mehssen aghdeeb

Maysan, Iraq

2025

بسم الله الرحمن الرحيم

((وَلَقَدْ آتَيْنَا دَاوُودَ وَسُلَيْمَانَ عِلْمًا ۖ وَقَالَا الْحَمْدُ لِلَّهِ الَّذِي فَضَّلَنَا عَلَىٰ كَثِيرٍ مِّنْ عِبَادِهِ

الْمُؤْمِنِينَ)) النمل اية(١٥)

صدق الله العلي العظيم

SUPERVISOR CERTIFICATION

I certify that the preparation of this project entitled "Remote Monitoring and Control of Voltage and Current and send sms or e_mail" prepared by " Muqtada Abdul-Hussein Hassan" "Mohammed Baqir Jasim Mohammed" "Ali Yasser Khudhur" "Maryam Jawad Kadhim" was under my supervision at College of engineering, Electrical Engineering Department, University of Misan in partial fulfilment of the requirements for the degree of Bachelor of Science in Electrical Engineering.

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Scientific Degree:

Date:

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We certify, as an examining committee, that we have read this project report entitled **" Remote Monitoring and Control of Voltage and Current and send sms or e_mail"** examined the students **"Muqtada Abdul-Hussein Hassan" "Mohammed Baqir Jasim Mohammed" "Ali Yasser Khudhur" "Maryam Jawad Kadhim"** in its contents and found the project meets the standard for the degree of Bachelor of Science in Electrical Engineering.

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DEDICATION

:قال تعالى

﴿قُلْ هَلْ يَسْتَوِي الَّذِينَ يَعْلَمُونَ وَالَّذِينَ لَا يَعْلَمُونَ﴾ا

وقال الإمام جعفر الصادق عليه السلام

".عالمٌ يُنتفَعُ بعلمهِ أفضلُ من سبعين ألفَ عابد"

إلى مشاعل النور وسفن النجاة محمد وآل محمد صلوات الله وسلامه عليهم الذين بهم اهتدينا إلى الحق وارتقينا في مراتب الفهم والعلم أُهدي هذا الجهد المتواضع عرفانًا لهم وطلبًا .لرضاهم

وإلى والديّ العزيزين

إلى من كانا الدعاء والسند والنور في دروب التعب

إلى أمي نبع الحنان والمثابرة

وإلى أبي مثال الصبر والعطاء

وإلى إخوتي وأخواتي الذين كانوا عونًا لي في كل مراحل حياتي

.أُهديكم ثمرة هذا السعي تقديرًا وعرفانًا لا تكفيه الكلمات

ولا أنسى أن أخصّ بالشكر والعرفان أساتذتي الكرام الذين لم يبخلوا بعلمهم وتوجيههم وكانوا لي منارات هدى في مسيرتي الأكاديمية

كما أُعبر عن بالغ امتناني لجامعتي العزيزة هذا الصرح العلمي الذي احتضن طموحي .وصقل مهاراتي ومهّد لي طريق النجاح

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*Praise be to **ALLAH** who enabled us to complete this work under his benediction.*

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ABSTRACT

Today, remote monitoring and smart control systems have become very important in protecting homes and electrical devices from damage caused by sudden voltage or current changes. In this project, we designed and implemented a remote system that monitors voltage and current values in real-time using Arduino Uno R3 and PZEM-004T sensor. The system is able to detect when the voltage goes above a safe level and automatically takes action to protect the load.

The main idea of the system is to send a phone call to the user when over-voltage happens. If the user rejects the call, the Arduino will activate a relay to disconnect the load, which in our project is a motor. We also used a SIM900 GSM module for the call function, and an LCD screen to display the voltage, current, and system status.

The project is divided into four chapters. The first chapter introduces the topic and explains the problem and objectives. The second chapter describes the components we used, like the Arduino, SIM900, PZEM sensor, relay, and LCD. The third chapter covers the design steps, wiring, and programming. The last chapter discusses the results, tests, and shows how the system worked well in real situations by sending one alert and reacting correctly to user input.

This system helps protect homes in simple and low-cost ways, and it can be improved in the future by adding features like Telegram notifications or e-mail .

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Chapter One
Introduction

1.1 Introduction

In modern smart home systems, safeguarding household appliances against voltage and current fluctuations has become essential especially with the increasing dependence on electrical devices. This research focuses on designing and implementing a remote monitoring and protection system that ensures the safety of home appliances by cutting off the power supply in case of overvoltage or overcurrent. The system uses wireless communication technology through the GSM module allowing the user to be notified in real-time via SMS or phone call when an abnormal condition is detected. Additionally the user can control the load remotely by replying with a specific SMS command or rejecting a call which triggers a relay to disconnect the appliance. The system is cost-effective and adaptable providing an ideal solution for remote protection in residential areas.
The design is divided into two main sections the hardware and software components. The hardware section includes the Arduino Uno R3 microcontroller, a SIM900 GSM module a PZEM-004T sensor for realtime voltage and current measurement, a relay for load control, and an I2C LCD display for user feedback. The software part involves writing embedded C code in the Arduino IDE using AT commands for GSM communication and custom logic to evaluate sensor data and execute load control operations. The system was successfully built and tested demonstrating reliable performance in detecting abnormal power conditions, sending alerts and enabling remote control. This approach provides a robust solution for protecting electrical devices in unattended homes and adds an important layer of safety and convenience to smart home automation.

1.2 Historical Overview

The concept of remote control has a long history, dating back to the mid-20th century. In 1955, Zenith engineer Eugene Polley introduced the "Flashmatic," which was the first wireless TV remote control. This early device relied on a flashlight to trigger photocells located at the corners of the television screen, allowing the user to change channels or adjust the volume from a distance. However, it had limitations, such as interference from sunlight and the need for precise aiming.

By the 1990s, infrared (IR) technology became the standard in remote controls. IR remotes work by sending low-frequency light beams, invisible to the human eye, which are detected by sensors in the receiving device. This method greatly improved reliability and ease of use. However, IR communication is line-of-sight and limited to short distances, which motivated the search for more flexible solutions.

As embedded electronics and wireless communication technologies advanced, researchers began exploring alternative methods for remote control. The emergence of mobile networks and SMS (Short Message Service) introduced new opportunities. Instead of being limited to short-range control like IR, SMS allowed users to control devices over long distances, from virtually anywhere with cellular coverage.

The first practical application of SMS for remote control was developed in 2001 by Sera Sedis. This concept was later improved in 2007 by Nigerian engineer Yakubu Mohammed, who redesigned the system and named it the Mobile Phone/Personal Computer Remote Controlling (MPRC) Device. These early innovations laid the groundwork for modern GSM-based automation systems.

With the increasing need for convenience and safety, especially when users are away from home, GSM-based control systems became more relevant.

These systems offer not only flexibility and long-range control but also the possibility of feedback and security updates via SMS or calls. This is particularly useful in managing home appliances or protecting electrical systems from overload or failure.

In this research, we aim to design and implement a GSM-based remote control system that allows users to monitor voltage and current levels in real-time and remotely control the load. The system uses a GSM module to send alerts and receive commands, ensuring that appliances can be safely operated or turned off when needed. This offers a cost-effective and user-friendly solution for remote home management, combining both hardware and software components to ensure reliability and ease of use.

For clarity and organization, this research is structured into five sections. Section one introduces the concept and historical background. Section two reviews related work in the field. Section three describes the design and implementation of the proposed system. Section four presents and discusses the experimental results. Finally, section five concludes the research and outlines possible future improvements.

1.3 Motivation

Remote correspondence is expanding step by step. This has propelled us to utilize cell phones to distantly control family unit appliances and to get feedback CALL about the security and wellbeing of the house. Throughout the previous few years, home protection is a fundamental requirement for family units to maintain their homes secure from collisions in order to split up.So the analysts and organizations attempt to execute calculations and make some gradates that keep your home protected

1.4 The Aim of This Project

The main goal of this project is to design a system that can monitor and control voltage and current remotely. The system will measure these values in real time and notify the user if any abnormal condition occurs, such as high voltage or current. It will send alerts through SMS to help the user respond quickly and prevent damage. The system also allows remote control of the electrical load, making it easier to manage devices when the user is not physically present. This project is useful for homes, small businesses, or any place where monitoring and protection of electrical devices is important.

Chapter Two

Remote Monitoring and Control of Voltage and Current

2.1 An overview of Remote Monitoring and Control of Voltage and Current:

This chapter provides information about the project's hardware implementation. With the aid of a circuit diagram and a thorough explanation of the circuit diagram, it describes the design and how the design functions .It explains functionality ,programming, and serial connectivity. It also describes the many modules that were employed in this project… .

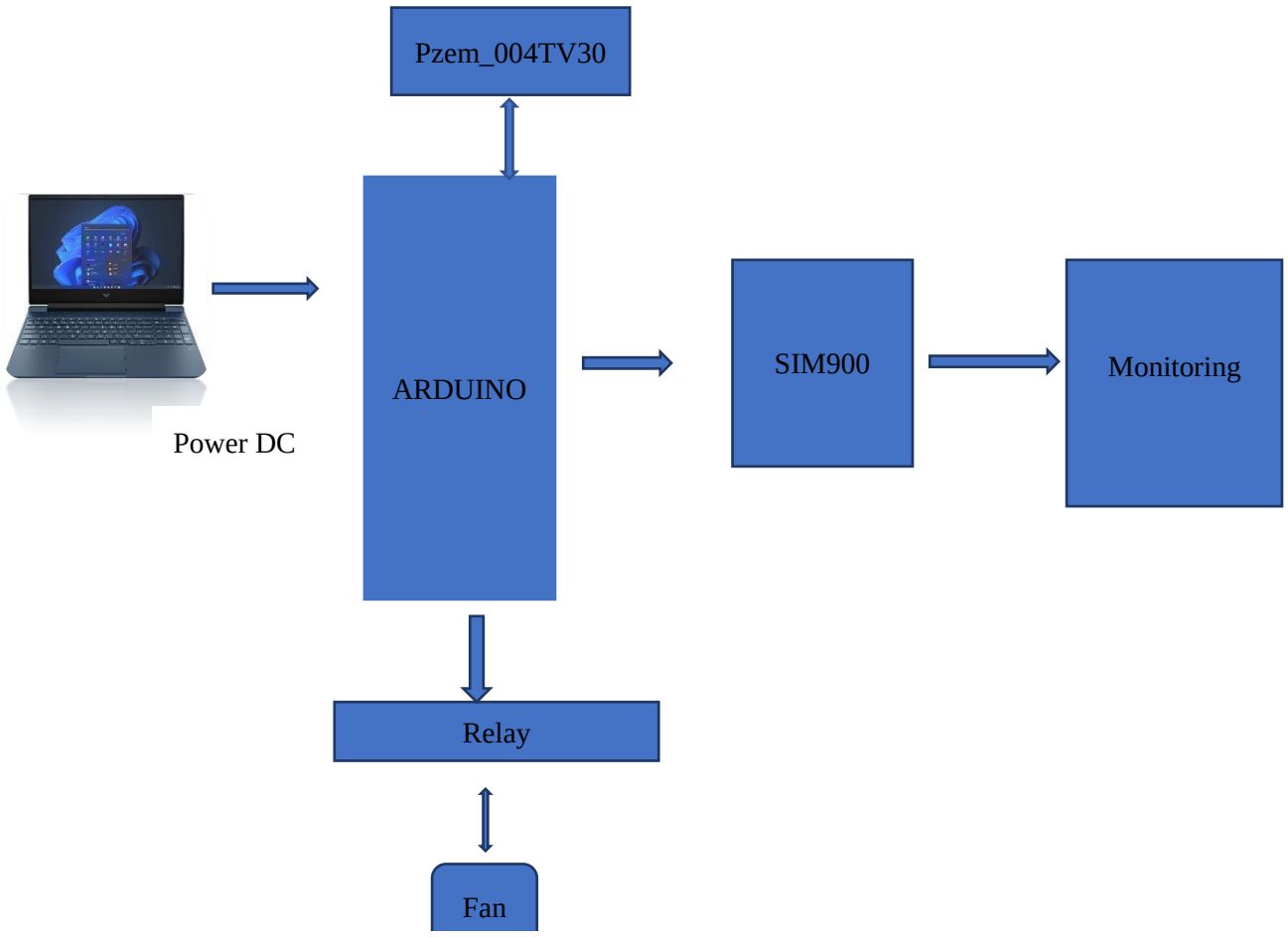


Figure 2.1 Block diagram of remote monitoring and control System

2.2 An Overview Remote Monitoring and Control of Voltage and Current

Remote monitoring and control systems for voltage and current allow real-time supervision of electrical parameters (like voltage, current, and power) in various electrical equipment and circuits. This type of system is essential for ensuring the proper functioning and safety of electrical installations in industries, commercial facilities, and even residential settings. With the added capability of SMS (Short Message Service) or calling alerts, the system offers immediate notifications to users about any irregularities or faults.

2.2.1 Related Research/ Works

Remote Monitoring and Control of Voltage and Current Controlling using GSM Modem

The purpose of this project is to acquire the remote electrical parameters like voltage, current, and send these real-time values over the network. This project is also designed to protect the Transformer in the future..

monitoring system, which integrates a Global Mobile System (GSM) modem with a standalone single-chip Arduino uno controller, works like a mini-computer. When there is any abnormal or emergency condition, the system sends a short message through GMS based mobile network i.e SMS or calling to the mobile phone

2.2.2 GSM Based Remote Monitoring System

The main motive of this thesis research pertains to designing and implementing a remote machine-to-human (M2H) communication system that provides a remote monitoring (DTCM) system. The proposed system is a remote mobile embedded system that integrates a GSM/GPRS module, interfaced with an Arduino microcontroller board, and sensors**.**

2.2.3 Design and Implementation of a GSM-based Monitoring System

A monitoring system that can continuously check the Voltage and current level and An increase in voltage is predicted, and this increase is transmitted to the mobile phone through a GSM modem. After receiving the message or reject the calling of any abnormality remedial action can be taken immediately**.**

2.3 Hardware components

The devices were used in the project, which are summarized as follows:-

2.3.1 Arduino Microcontroller:

"Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards ('shields') or breadboards (For prototyping) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers can be programmed using C and C++ programming languages. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.

There are kinds of Arduino pieces:

1. Arduino Uno (R3)
2. LilyPad Arduino
3. Arduino Mega (R3)
4. Arduino Leonardo

And in our project we used Arduino Uno(R3):

Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as

PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.. You can tinker with your Uno without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards

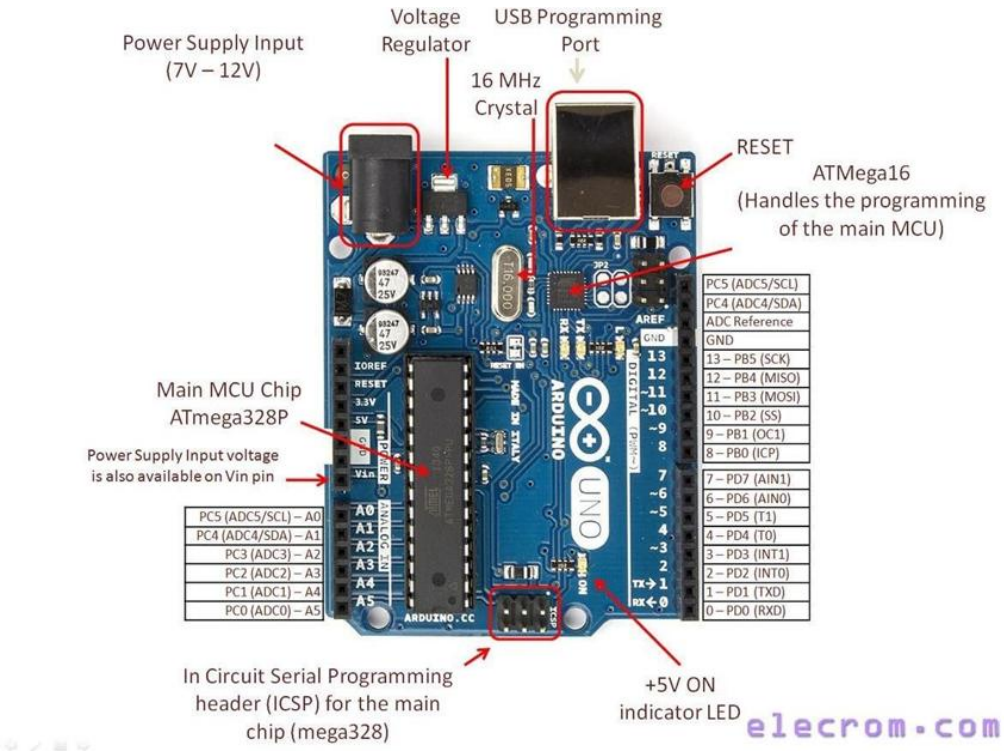


Figure (2.2): Arduino Uno

At project we will need one uno arduino and it meets the demand we need.

Arduino is an open source physical computing [4] platform based on a simpel microcontroller board and development environment that implements the processing language[5] arduino will control the station and it depends on its programming according to what we need, You will make a comparison between fixed natural values and the values entered as inputs , If these inputs do not apply with normal values, , At the same time, it also gives an order to transfer this data wirelessly to the GPRS/GSM SIM900 segment, which contains a receiver and a transmitter and connects with a similar segment so that the data is saved inside the server.

Serial port

The Arduino UNO, when using the SoftwareSerial library, transmits data on its digital IO pins at their voltage levels. When the Uno is supplied at 5V the maximum output voltage is 4.2V, and is 2.3V when supplied by 3V. At first I put a voltage divider into the transmit signal path, but found it was not necessary, and it works to transmit and receive serial data between the module and the Uno

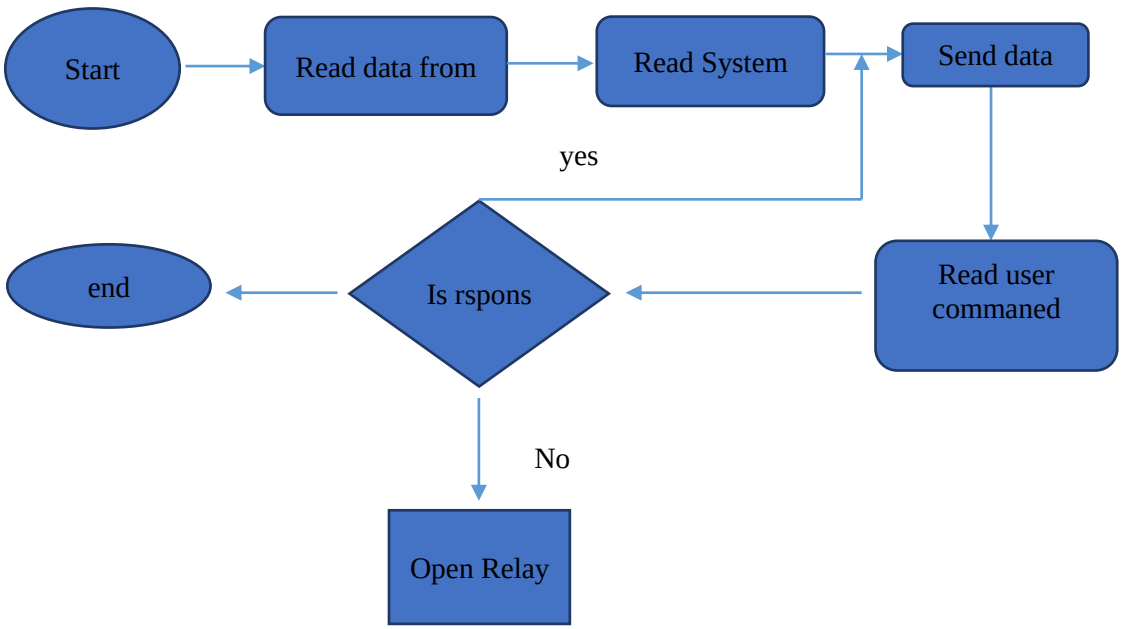
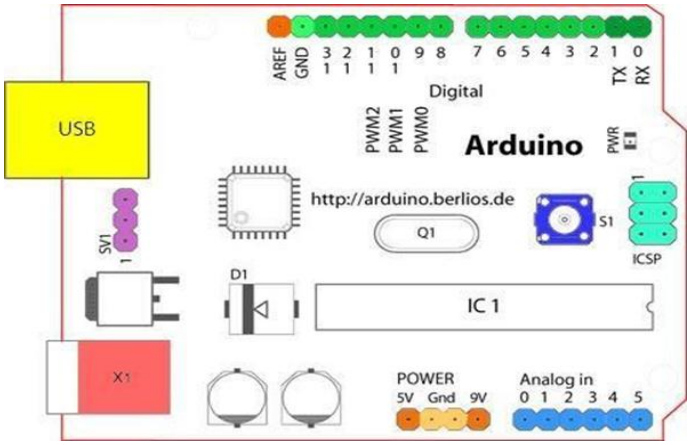


Figure (2.3): Flow chart for arduino process

The Arduino Board

Looking at the board from the top down, this is an outline of what you will see (parts of the board you might interact with in the course of normal use are highlighted):



Starting clockwise from the top center*:*

Analog Reference pin (orange)

- Digital Ground (light green)
- Digital Pins 2-13 (green)
- Digital Pins 0-1/Serial In/Out - TX/RX (dark green) - These pins cannot be used for digital i/o (digitalRead and digitalWrite) if you are also using serial communication (e.g. Serial.begin)
- Reset Button - S1 (dark blue)
- In-circuit Serial Programmer (blue-green)
- Analog In Pins 0-5 (light blu)
- Power and Ground Pins (power: orange, grounds: light orange)
- External Power Supply In (9-12VDC) - X1 (pink)
- Toggles External Power and USB Power (place jumper on two pins closest to desired supply) - SV1 (purple)

USB (used for uploading sketches to the board and for serial communication between the board and the computer)

2.3.2 GSM device (type sim900):

The Arduino GSM shield allows an Arduino board to connect to the internet, send and receive SMS, and make voice calls using the GSM library.The shield will work with the Arduino Uno out of the box. The shield will work with the Mega, Mega ADK, Yun, and Leonardo boards with a minor modification. The Due is not supported at this time.

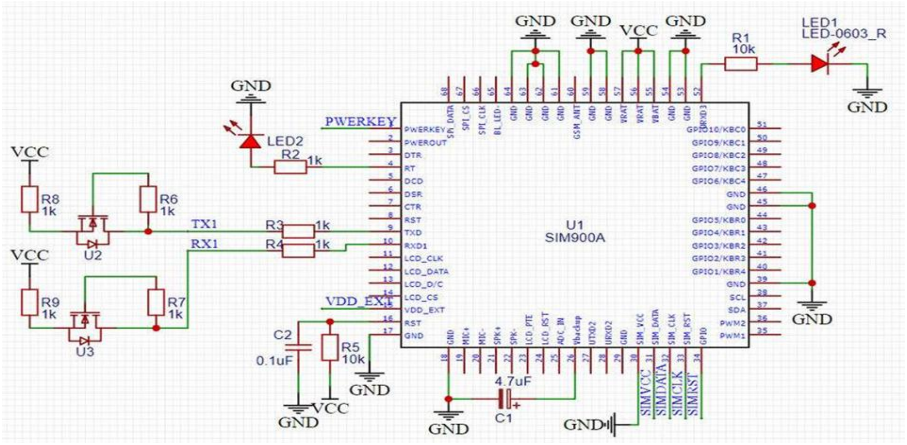
The GSM library is included with Arduino IDE 1.0.4 and later.

GSM is an international standard for mobile telephones. It is an acronym that stands for Global System for Mobile Communications. It is also sometimes referred to as 2G, as it is a second-generation cellular network.

To use GPRS for internet access, and for the Arduino to request or serve webpages, you need to obtain the Access Point Name (APN) and a username/password from the network operator. See the information in Connecting to the Internet for more information about using the data capabilities of the shield.

Among other things, GSM supports outgoing and incoming voice calls, Simple Message System (SMS or text messaging), and data communication (via GPRS).

The Arduino GSM shield is a GSM modem. From the mobile operator perspective, the Arduino GSM shield looks just like a mobile phone. From the Arduino perspective, the Arduino GSM shield looks just like a modem.



Sim900 circuit

What is GPRS:

GPRS is a packet switching technology that stands for General Packet Radio Service. It can provide idealized data rates between 56-114 kbit per second.A number of technologies such as SMS rely on GPRS to function. With the GSM shield, it is also possible to leverage the data communication to access the internet Similar to the Ethernet and WiFi libraries, the GSM library allows the Arduino to act as a client or server, using http calls to send and receive web pages.

SIM cards:

In addition to the GSM shield and an Arduino, you need a SIM card. The SIM represents a contract with a communications provider. The communications provider selling you the SIM has to either provide GSM coverage where you are, or have a roaming agreement with a company providing GSM coverage in your location.It's common for SIM cards to have a four-digit PIN number associated with them for security purposes. Keep note of this number, as it's necessary for connecting to a network. If you lose the PIN associated with your SIM card, you may need to contact your network operator to retrieve it. Some SIM cards become locked if an incorrect PIN is entered too many times. If you're unsure of what the PIN

is, look at the documentation that came with your SIM. Using a PUK (PIN Unlock Code), it is possible to reset a lost PIN with the GSM shield and an Arduino. The PUK number will come with your SIM card documentation.

Look at the PIN Management example in the "tools" folder, bundled with the GSM library for an example of how to manage your PIN number with the PUK

Figure (2.4): SIM900 GSM/GPRS shield

2.3.3 LCD

It is an easy-to-use display module. Using it can make making easier, allowing makers to focus on the work itself. as shwon in figure(2.7)

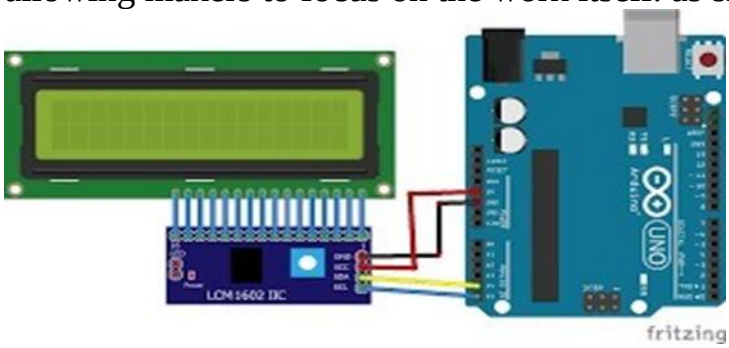


Figure (2.5): LCD with Arduino.

2.3.4 Jumper wires:

The end of a wire that allows it to be used to connect two points without soldering. as shwon in figure(2.9)

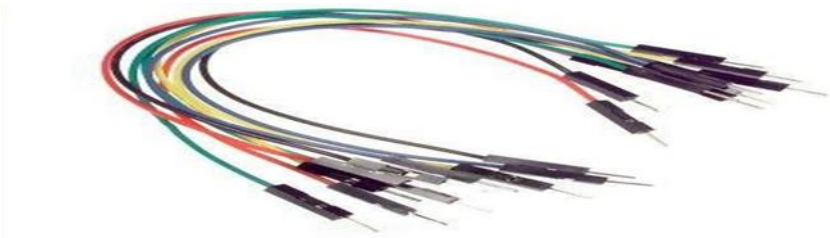


Figure (2.6): Jumper wires

2.3.5 Breadboard:

There is a way to build electronics without a soldering iron. Components are pushed into the breadboard's sockets and then connected with jumper wires. as shwon in figure(2.10)

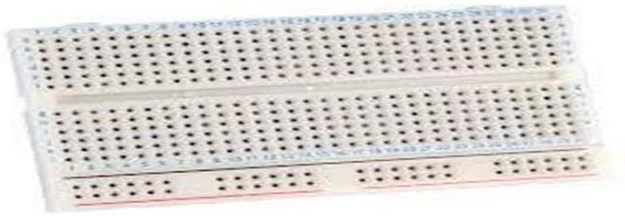


Figure (2.7): Breadboar

2.3.6 Power Adapter

A power adapter (AC Adapter) is an electronic device used to convert AC (Alternating Current) from a high-voltage power source into DC (Direct Current) with a lower voltage, making it suitable for powering various electronic devices. Most electronic systems cannot use AC power directly, so adapters are essential for ensuring safe and efficient operation

In projects like home protection against voltage and current surges, this adapter can serve as a power source for Arduino, SIM900, and sensors like PZEM004T

Figure (2.8): Power Adapter

2.3.7 Relay :

This 5V Relay Module is designed by Single with the aim of providing inexpensive but quality-focused Relays to hobbyists, Makers and general users. Despite the small size, the 1 Channel 5V Relay Module can control a separate isolated circuit of up to 10A and 250V – making it a great choice for most home project applications.

With a relay, you don’t have to stress about the dangers of high current and high voltage escaping the circuit you are controlling, as the relay provides isolation to protect both you and your low-voltage circuitry from any possible leakage. Additionally, it only requires a single input/output channel and can be operated from a wide range of different microprocessors or chip-based boards – meaning that you don’t need to have special equipment to run the relay, and can simply power and operate it with a simple circuit.

Figure(2.9):relay

2.3.8 PZEM-004T Sensor

The PZEM-004T module is a multifunctional sensor module that functions to measurepower, voltage, current and energy contained in an electric current. This module is equipped with an integrated voltage and current sensor (CT) sensor. In its use, this tool is specifically for indoor use (indoor) and the installed load is not allowed to exceed the specified power

1. Measurement function (voltage / current, current / active power).
2. Power button clear / reset energy (PZEM-004T V2.0)
3. Power-down data storage function (cumulative power down before saving)
4. TTL Serial Communication
5. Power measurement: 0 ~ 9999kW
6. Voltage Measurement: 80 ~ 260VAC
7. Current Measurement: 0 ~ 100A
8. Working voltage of 5 VDC.
9. Equipped with operational amplifier to increase external sensitivity.The circuit that converts AC current into DC is called a

DC Power Supply or in Indonesian is called a DC power supply. DC Power Supply or Power Supply is also often known as an Adapter.

Figure (2.10): PZEM-004T sensor

Chapter Three

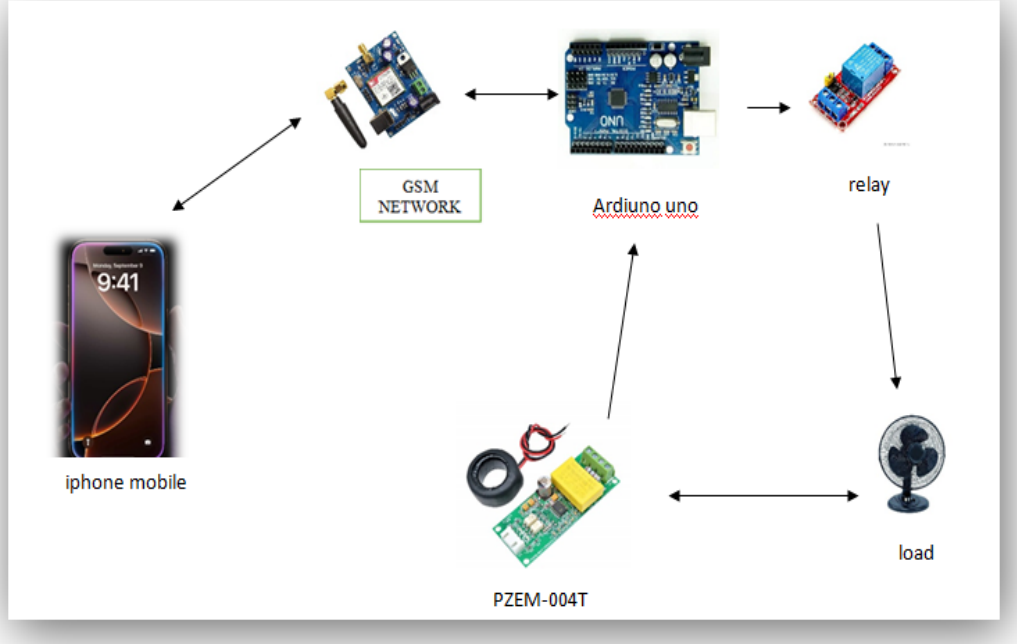
PROJECT/SYSTEM DESIGN

3.1 Introduction

This chapter discusses the detailed implementation of the design system. The system's requirements and implementation are also explained. Following testing and achieving the required findings. In this system , An pzem004tv30 is used to measure the voltage and current a warning message containing to sms or calling**.**

3.2 PROPOSED SYSTEM

The architecture of the proposed system is shown in figure 3.1. As can be seen that the core part of the system is an arduino board which receives the signals from all the sensors connected to it inputs then sends the instructions to the GSM module and turns on the . When the system works as home automation system, The SIM900 module informs the Arduino about the call status. If the call is rejected, the Arduino should immediately disconnect the load.. In our system the home appliances can be controlled not only through GSM network, but also mobile App and remote control. The electrical devices connected to the relays can be turned on and off in either way



Fiqure 3.1 general The architecture of the system

Figure (3.1) is the that shows the mechanism of the system's work, as it appears that the system consists of several devices connected with each other, as some of them are considered inputs for data and others as outputs. The voltage and current is sensed by the voltage and current sensor PZEM-004T and displayed in the serial monitor , and when the voltage and current exceeds the permissible limit, will be sent a message or calling via the sim900 device.

3.3 system implementation

The system is divided into two parts: hardware and software..

The hardware architecture consists of an embedded system based on the Arduino Uno board that is linked to the GSM devices, as well as a PEZM_004Tsensor and a screen that continuously displays .The PEZM_004T Sensor detects the voltage and current of the surrounding

environment. If the voltage and current rises and exceeds the storage condition, and the GSM device is instructed to include the exact location in the SMS message or calling. which is then sent to the phone number…

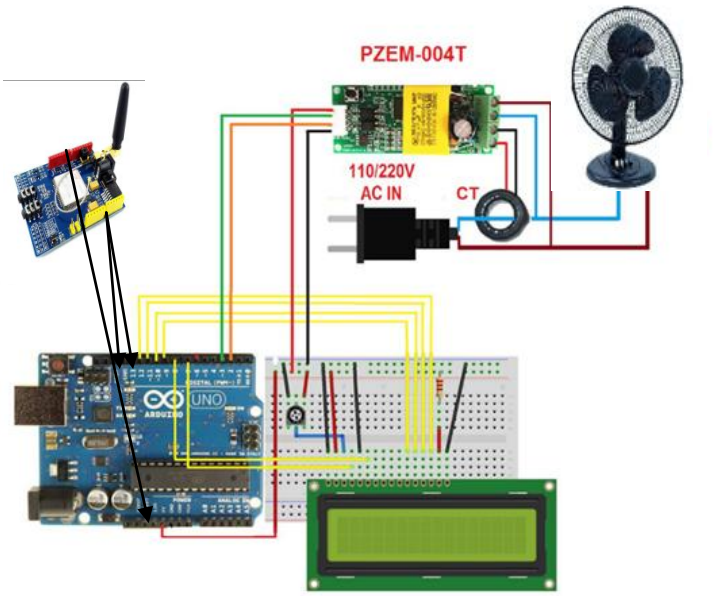


Figure 3.2Circuit diagram of the monitoring System

3.4 Components:

Components Used:

1_ Power Supply

2_Sensors (PZEM_004T)

3_GSM Modem (SIM900D)

4_Arduino UNO r3

5_ Alphanumeric LCD Display (4x20)

6_Load

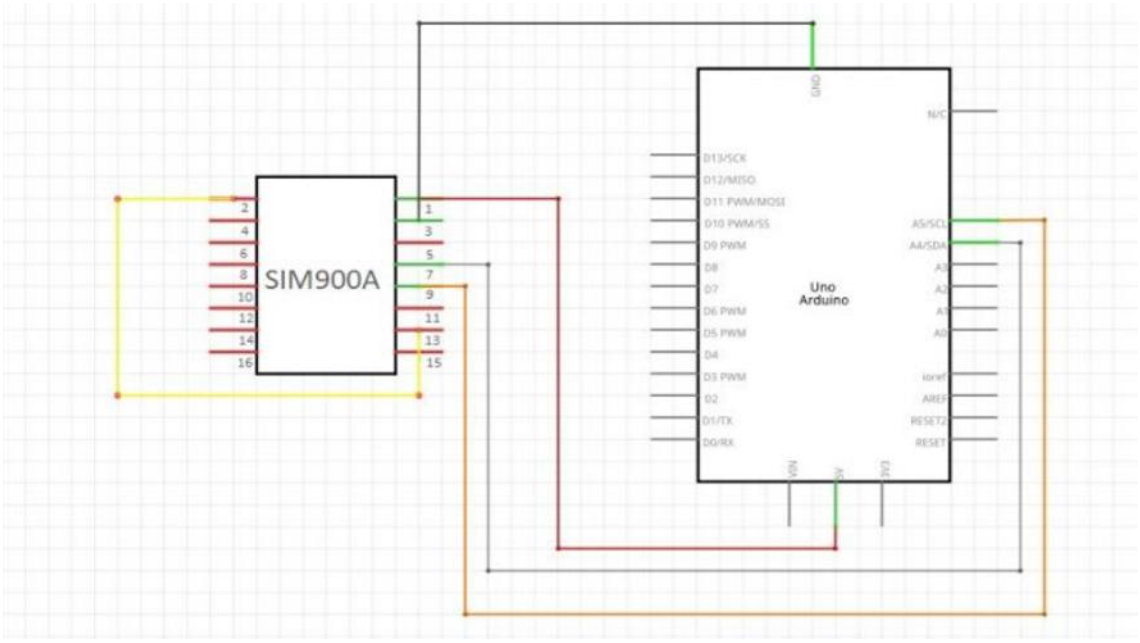


Figure3.3. Circuit diagram of SIM900A module connected with Arduino Uno

The SIM900A module is connected as it shown in the following figure:

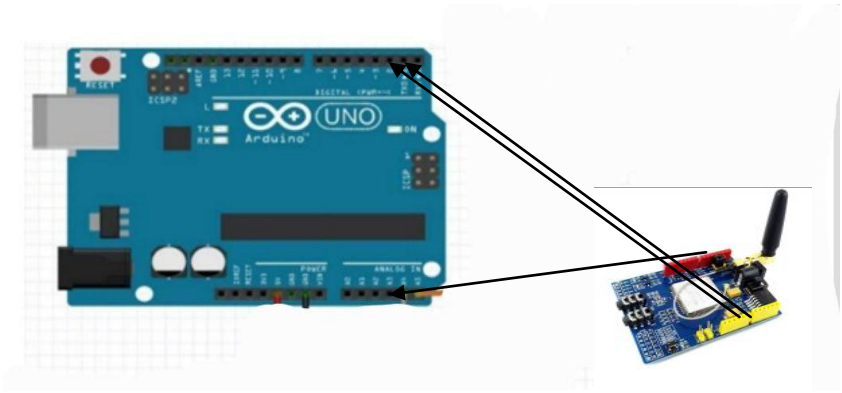
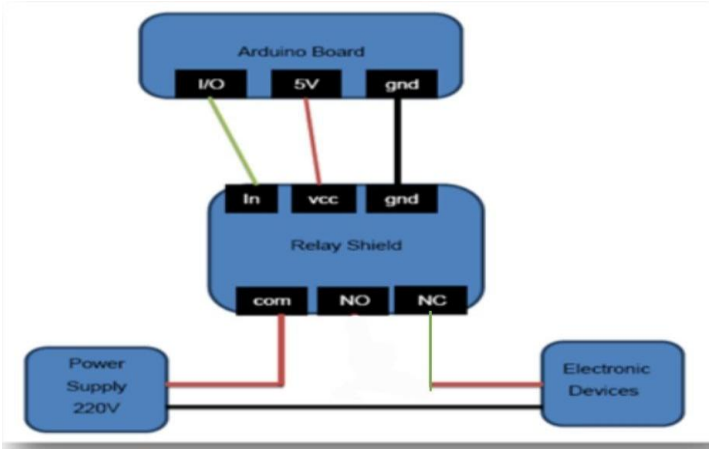


Figure 3.4: Connection scheme of SIM900A module connected with Arduino Uno

Arduino Uno r3	SIM900A Module
5V	VCC
GND	GND
Pin 10	TX
Pin 11	Rx

Table 3.1connection Arduino Uno r3 with SIM900A Module



Fiqure 3.5 Wiring the Relay Module with Arduino UNO

Arduino Uno r3	Relay Module
V5	Vcc
GND	GND
I/O	IN

Table 3.2 Wiring the Relay Module with Arduino UNO

Arduino can provide only a 5 V DC current, a relay is used in between the Arduino and the load The relay can be controlled by the I/O pins of the Arduino which finally controls the load. The circuit diagram in fiq 3.5 to control the electronic devices using the I/O pins of the Arduino Board via

the relay in the table 3.2

Wired LCD Display:

The LCD display is used to show instructions and real-time updates for the user, such as "It displays voltage and current readings " This display enhances the user experience by providing clear visual feedback during the authentication process. Table3. 4.3 shows how to connect the LCD display to the Arduino uno

Table3.3 Wiring LCD Display with Arduino uno r3

Arduino uno r3	LCD Display
5V	Vcc
GND	GND
A4	SCL

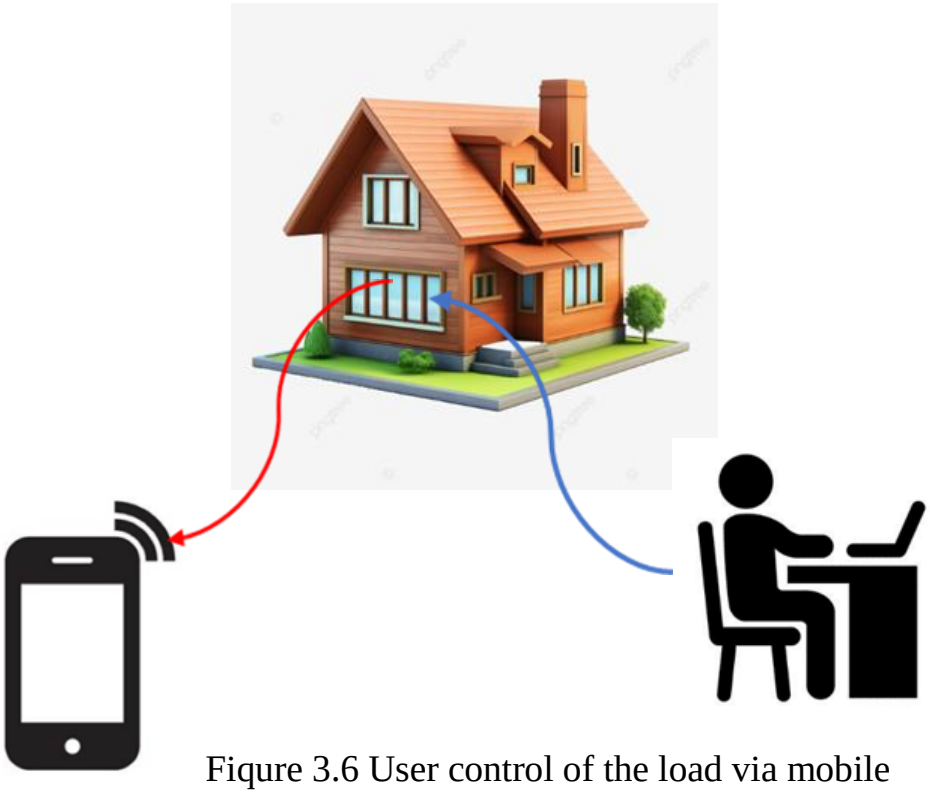
Table 3.4 Wiring Pzem_004T Sensor with Arduino Uno:

Arduino Uno r3	Pzem_004T Sensor
5v	Vcc(Power)
GND	GND(Ground)
D2	Tx(Sensor Data outbout)
D3	RX(Sensor Data Input)

3.5 THE SYSTEM MODEL CONSTRUCTIONS:

The project is configured into main parts, the transmitter and the receiver. illustrates the scenario which interpreting the function of the device. There are two of lines .The blue lines representing the request from the local

electricity equipping the house with energy power …in the house there are sensor that sense Voltage and current. While the solid red lines represent the respond This reading of voltage and current when increased and sent to the user's mobile phone via SMS requests…



Fiqure 3.6 User control of the load via mobile

3.6 Transmitter Part (Sending Side):

The Arduino reads voltage and current from the PZEM-004T sensor.

If the voltage or current exceeds preset thresholds (220V or 2A), the Arduino uses the SIM900 GSM module to make a phone call to the predefined phone number.

During the call, Arduino checks if the call was rejected or not answered within 15 seconds.

If the call is rejected or times out, Arduino turns off the load by disabling the relay connected to pin 5.

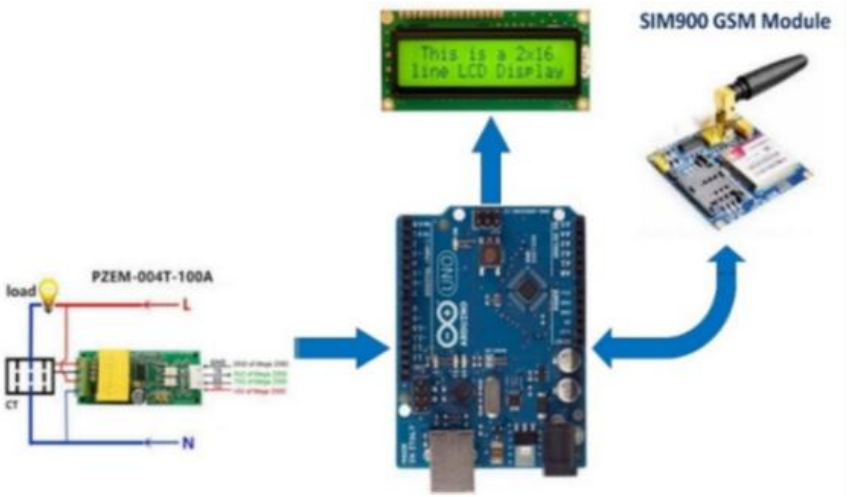


Figure 3.7 The components and data flow in the smart meter

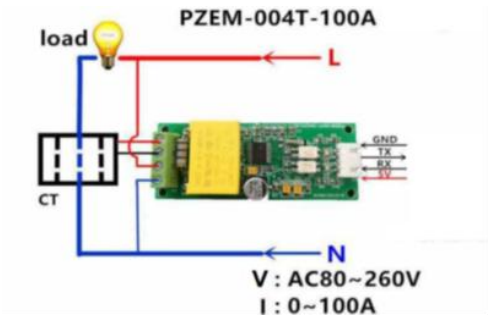


Figure 3.8 PZEM-004T module wiring diagram

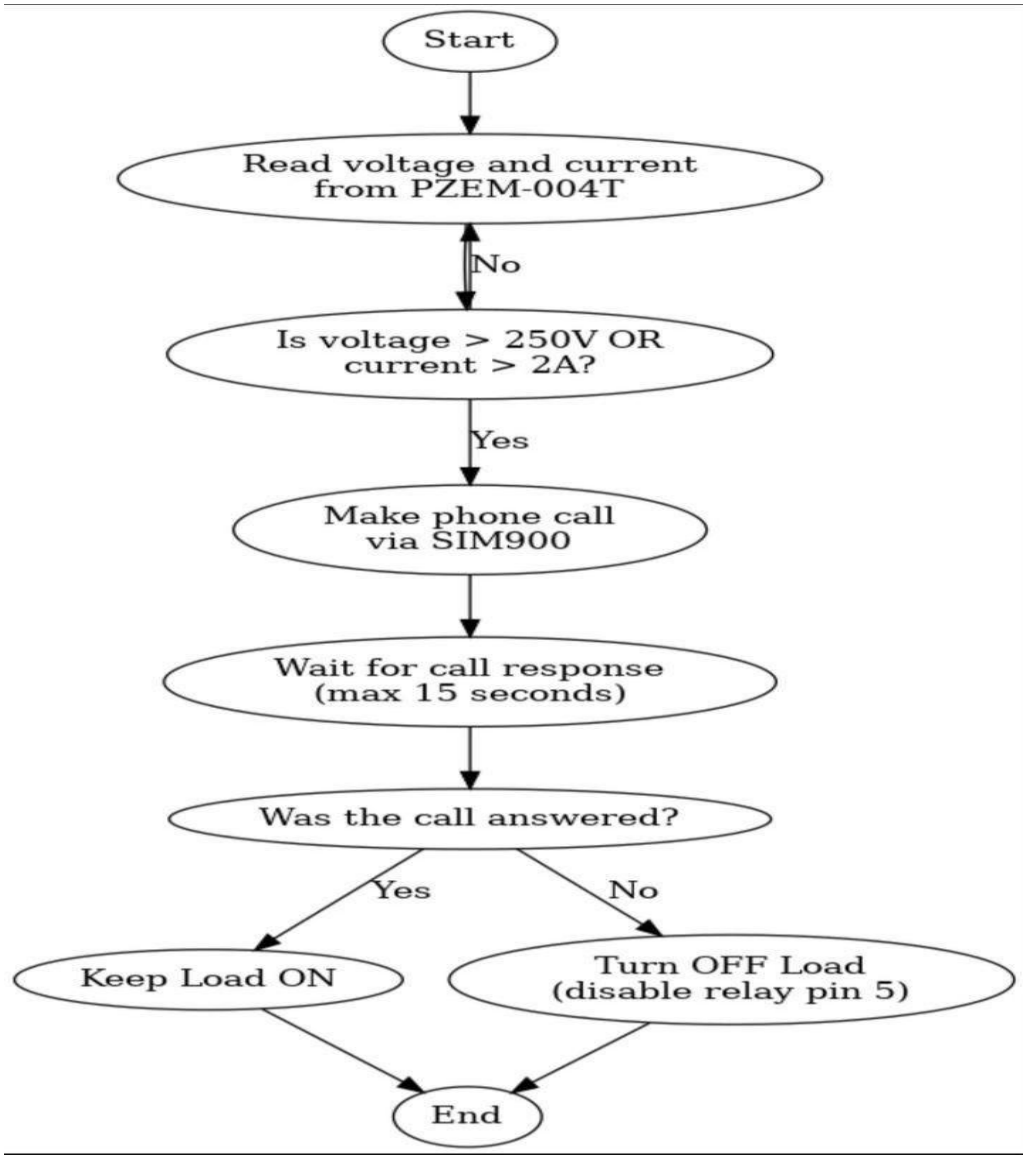


Figure 3.9 Flow chart of the data processing in the transmitter part

3.7 Receiver Part (Receiving Side):

The user receives a phone call when an overload condition happens.

If the user rejects the call (or if the call times out without being answered), this action signals the Arduino to cut off the load to protect the system.

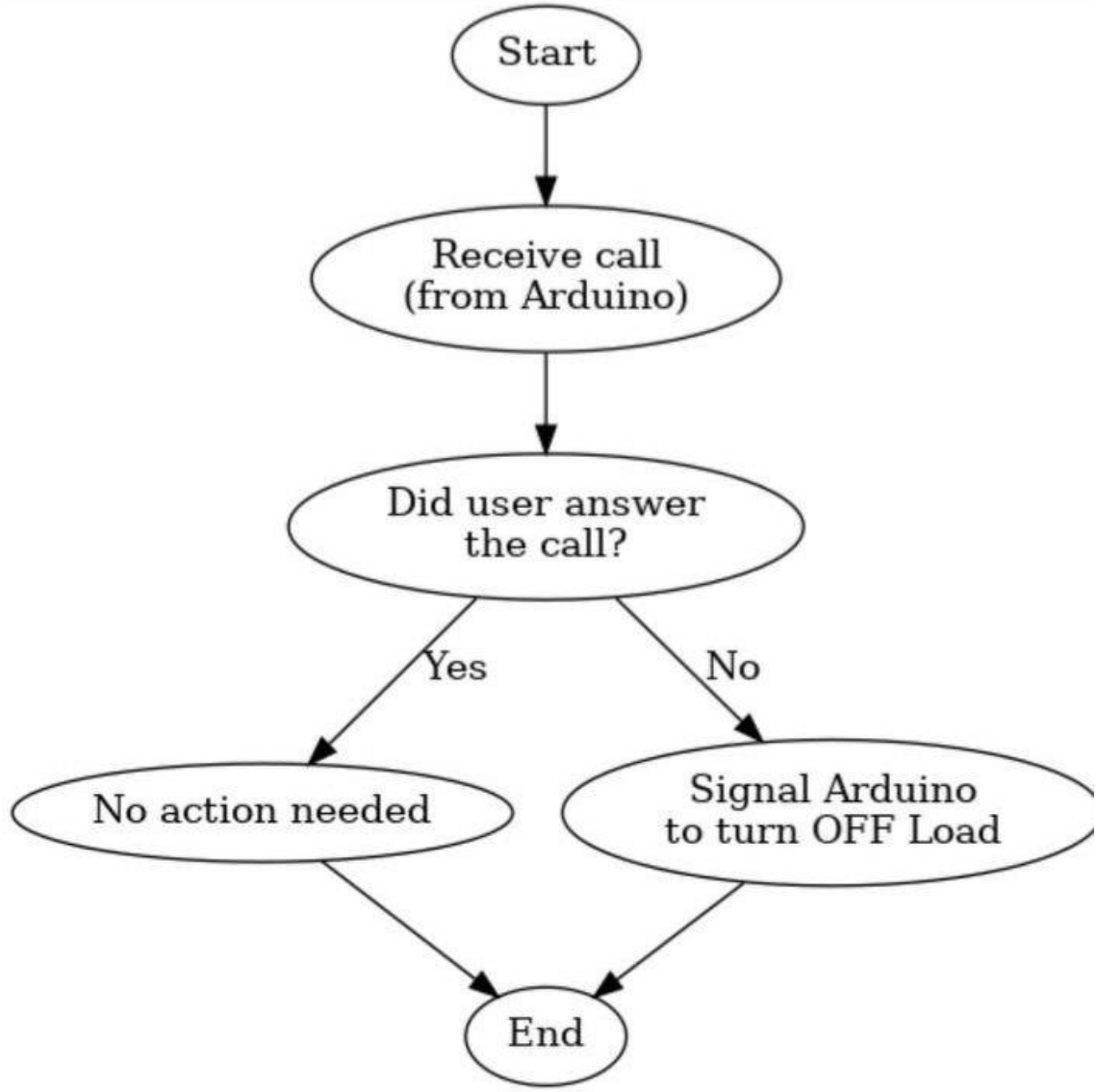
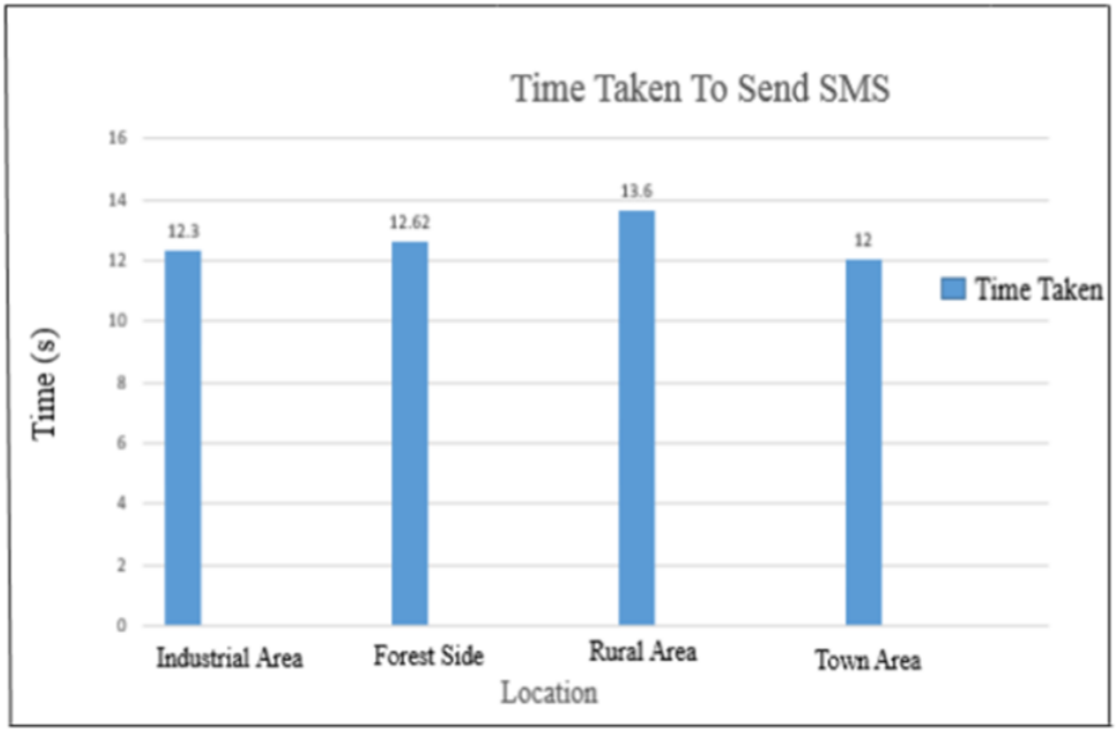


Figure 3.10. Flow chart for the function of the receiving part of the smart meter



Fiqere 3.11.Variation of Time taken with the location

Time taken to send SMS or calling has been collected from 4 different strengths of signal places to measure the efficiency of the system as shown in Figure 3.11. Each place collects4 different data to calculate the average time taken for SMS or call to be send to the particular location. Rural area requires more time, which is 13.6 sec to send SMS oe call compared to other location. This is because ,rural areas normally covered with weak signal compared to other location. While, there residential area near to the town only takes 12 sec which is less than other due to the high strength signal. In residential area near to the forest and industrial side take almost the same time to send SMS or call which is 12.3 sec and 12.62 sec respectively

3.8 Set up and connection diagrams:

As it was said earlier, the GSM alert circuit setup consists of 3 main parts: the sensor, the Arduino, which is the brain of the project and GSM modem, which sends SMS alert. Also, the system consists of LEDs, 1 breaboard , “male-male”, “male-female” and “female-female”

Fiqure 3.12 Set up and connection diagrams

3.9 Operation, Results and Discussions:

This section explains how each component of our system is connected. Various sensors and modules are integrated with the Arduino uno, each serving a specific function to ensure the proper operation. Figure 3.13 illustrates the designed system

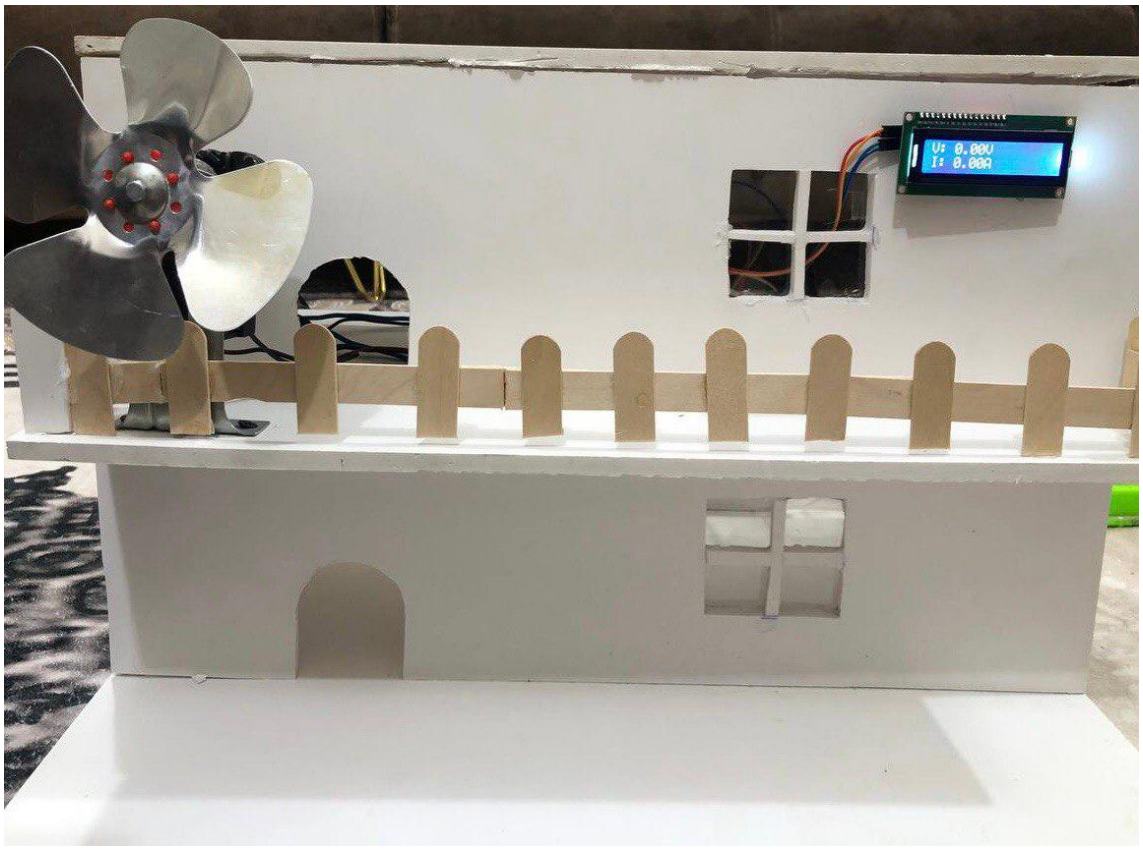


Figure 3.13 Our System Design

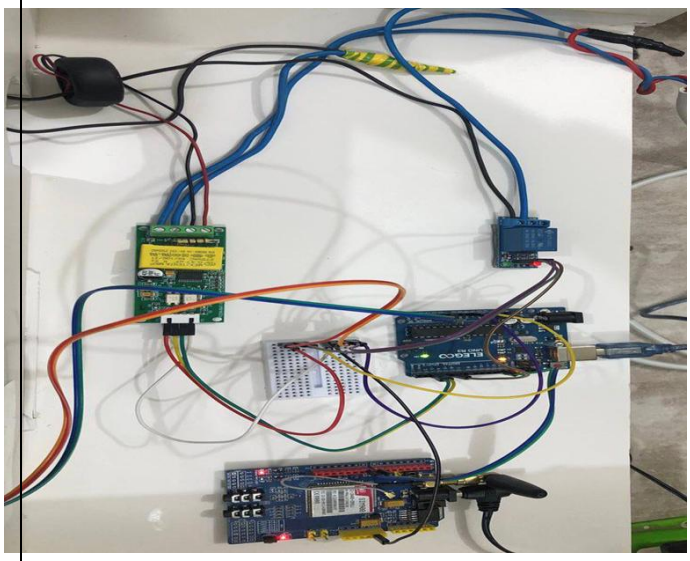


Figure (3.14) message SMS system

Fiqure 3.15 calling by sim900

Receiving SMS and calling from the system when all sensors are activated. The figure above is a complete resultof the transmitting mode of the system when the sensors have been activated. In such case the Arduino receives the signal from the sensors. After manipulating the received signals, it send sinstruction to the GSM module to notify the homeowner about each case. As a result,the mobile phone has received a message that shows the sensors have been activated instantaneously

3.10 Turn off the PIN lock:

To use the SIM card with the shield, you need to turn off the pin lock. The easiest way to do this, is to insert the SIM card in your smartphone and turn off the pin lock in the phone security settings.

In my case, I needed to go through: Settings > Advanced Settings > Security > SIM lock and turn off the lock sim card with pin..

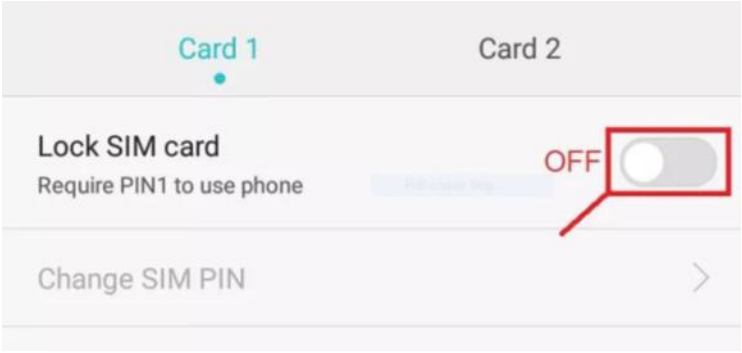


Figure 3.16: Turn off the PIN lock

Fiqure 3.17 the program used to program, the arduino

he Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards

Failed Experiments and Reasons:

During the development phase, a few experiments were conducted that did not yield the expected outcomes. These include:

1. Using Wi-Fi-based ESP32 for Telegram Notifications
Issue: Lack of reliable internet connectivity during tests caused delayed or missed alerts.
Reason: The ESP32 module depends on a stable internet connection, which was not always available in the test environment.

2. SMS Command Parsing with Delays:
Issue: The system sometimes failed to correctly interpret incoming SMS commands.
Reason: The buffer reading from SIM900 was inconsistent due to timing issues, and noise in serial communication caused message loss.

3. Continuous SMS Alert Loop:
Issue: The system kept sending SMS messages repeatedly during overload.
Reason: No flag was set to limit repeated alerts once overload was detected.

Internet was Not Used:

The decision not to use the internet in this project was primarily based on availability, reliability, and simplicity:

Availability: The project is intended to work in rural or remote areas where internet coverage is weak or unavailable.

Reliability: GSM networks (used in SIM900) are more stable for basic communication like SMS and calling, especially in emergencies.

Simplicity: Setting up mobile network-based communication (SMS/Call) requires less infrastructure and avoids Wi-Fi configuration or cloud service dependencies.

3.11 Conclusion and future work:

Modern control systems for remote monitoring of different variables are an important feature. One of the most convenient solution is GSM technology, available almost everywhere and requiring no wires. For that purpose, Arduino UNO, PZEM-004T sensor and SIM900A GSM/GPRS module were chosen. This kind of system will alert user via text message (SMS) about critical situations in the place where the solution is installed. This design has benefits, such as small size, low power consumption, low cost, high accuracy, superior anti-interference performance, and it can be real-time and easy development, human-interactive concisely and clearly. The system suitable for long distance work conditions of wireless data acquisition and transmission. After several tests, it became clear that the implementation of this project satisfies all the necessary requirements. The designed framework allows to add more sensors and other equipment's, empowering the solution and allow it's use on many other areas and problems. Disadvantage of system is necessity to replenish the balance of SIM card in module for normal operation. Solution to this problem can be the selection of the most suitable mobile phone plan, as there are many convenient plans which had offered by mobile operators. As the GSM/GPRS module SIM900A also allows a TCP/IP (internet) connection, it is possible to evolve for a solution where the control and monitoring can be done through the internet in a future. Also, this system can be adopted for mobile applications based on Android or iOS platfor…

3.12 Source Code

3.12.1 Arduino Code

Calling the libraries:

```
#include<SoftwareSerial.h>
#include<PZEM004Tv30.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
```

Test GSM Code Calling:

```
#include <SoftwareSerial.h>

// تعيين الدبابيس لتوصيل الـ SIM900
SoftwareSerial sim900(10, 11); // RX, TX

void setup() {
  // بدء الاتصال التسلسلي مع الكمبيوتر
  Serial.begin(9600);
  // بدء الاتصال التسلسلي مع وحدة SIM900
  sim900.begin(9600);

  // تأخير قبل بدء العمل
  delay(1000);

  // إرسال أمر لتأكيد الاتصال مع الشبكة
  sim900.println("AT");
  delay(1000);

  // التأكد من الرد من وحدة SIM900
  if (sim900.available()) {
    Serial.println("SIM900 is connected");
  }

  // الاتصال بالرقم
  callPhone("+XXXXXXXXXXX");  // ضع رقمك هنا
}

void callPhone(String phoneNumber) {
  sim900.print("ATD" + phoneNumber + ";\r"); // إرسال أمر الاتصال
  delay(1000);
```

```
  Serial.println("Calling " + phoneNumber);
}

void loop() {
  // هنا لأننا نرسل الاتصال مرة واحدة فقط في الـ setup.لا يوجد شيء في الـ loop
}
```

Test GSM Code SMS:

```
#include <SoftwareSerial.h>

// تعيين الدبابيس لتوصيل الـ SIM900
SoftwareSerial sim900(10, 11); // RX, TX

void setup() {
  // بدء الاتصال التسلسلي مع الكمبيوتر
  Serial.begin(9600);
  // بدء الاتصال التسلسلي مع وحدة SIM900
  sim900.begin(9600);

  // تأخير قبل بدء العمل
  delay(1000);

  // إرسال أمر لتأكيد الاتصال مع الشبكة
  sim900.println("AT");
  delay(1000);

  // التأكد من الرد من وحدة SIM900
  if (sim900.available()) {
    Serial.println("SIM900 is connected");
  }

  // إعداد الرسالة النصية
  sendSMS("+XXXXXXXXXXX", "Hello from Arduino!"); // ضع رقمك هنا
}

void sendSMS(String phoneNumber, String message) {
  sim900.print("AT+CMGF=1\r");  // ) تعيين وضع الرسائل النصية Text Mode)
  delay(1000);
```

```
  sim900.print("AT+CMGS=\"" + phoneNumber + "\"\r"); // إرسال الرقم المستهدف
  delay(1000);

  sim900.print(message); // إرسال الرسالة النصية
  delay(100);

  sim900.write(26); // ) إرسال رمز نهاية الرسالةCtrl+Z)
  delay(1000);

  Serial.println("SMS sent!");
}

void loop() {
  // هنا لأننا نرسل الرسالة مرة واحدة فقط في الـ loop لا يوجد شيء في الـ setup.
                                                                                }
```

Test Relay:

```
#include <PZEM004Tv30.h>
// تعيين الدبابيس
#define RX_PIN 10
#define TX_PIN 11
#define RELAY_PIN 8

// إعدادات الحساس
PZEM004Tv30 pzem(RX_PIN, TX_PIN);

float voltage;  // متغير لتخزين قيمة الفولطية

void setup() {
  // تهيئة الريلاي
  pinMode(RELAY_PIN, OUTPUT);
  digitalWrite(RELAY_PIN, HIGH);  // تشغيل الريلاي (التوصيل)

  // بدء الاتصال التسلسلي
  Serial.begin(9600);

  // تهيئة الحساس
  if (!pzem.begin()) {
```

```
    Serial.println("Failed to initialize PZEM-004T");
    while (1);
  }
}

void loop() {
  // قراءة الفولطية
  voltage = pzem.readVoltage();

  // عرض الفولطية في الشاشة التسلسلية
  Serial.print("Voltage: ");
  Serial.print(voltage);
  Serial.println(" V");

  // شرط فصل الحمل إذا كانت الفولطية أكبر من الحد المحدد (مثلاً ٢٤٠ V)
  if (voltage > 240.0) {
    Serial.println("Voltage too high! Turning off load...");
    digitalWrite(RELAY_PIN, LOW);  // فصل الريلاي (فصل الحمل)
  } else {
    digitalWrite(RELAY_PIN, HIGH);  // تشغيل الريلاي (تشغيل الحمل)
  }

  // الانتظار ١ ثانية قبل القراءة التالية
  delay(1000);
}
```

```
void setup() {
 المدمج كإخراجLED// تعيين دبابيس
pinMode(LED_BUILTIN, OUTPUT);
{

void loop() {
 تشغيل //LED
digitalWrite(LED_BUILTIN, HIGH);
delay(1000); // الانتظار لمدة ثانية واحدة

 إيقاف تشغيل //LED
digitalWrite(LED_BUILTIN, LOW);
delay(1000); // الانتظار لمدة ثانية واحدة
{
```

Test ArduinoUno R3:

```
void setup() {
  // المدمج كإخراج LED تعيين دبابيس
  pinMode(LED_BUILTIN, OUTPUT);
}

void loop() {
  // تشغيل LED
  digitalWrite(LED_BUILTIN, HIGH);
  delay(1000); // الانتظار لمدة ثانية واحدة

  // إيقاف تشغيل LED
  digitalWrite(LED_BUILTIN, LOW);
  delay(1000); // الانتظار لمدة ثانية واحدة
}
```

Calling when the Over Load:

```
#include <SoftwareSerial.h>
#include <PZEM004Tv30.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h>

// تعريف الاتصالات
SoftwareSerial SIM900(12, 13); // (RX, TX) لتوصيل SIM900
PZEM004Tv30 pzem(2, 3);        // (RX, TX) لتوصيل PZEM-004T
LiquidCrystal_I2C lcd(0x27, 16, 2); // عنوان I2C

#define RELAY_PIN 5
#define PHONE_NUMBER "+9647722131230"

float voltageThreshold = 250.0;
float currentThreshold = 2.0;

bool isLoadOff = false;
bool callMade = false;

void setup() {
  Serial.begin(9600);
  SIM900.begin(9600);

  pinMode(RELAY_PIN, OUTPUT);
  digitalWrite(RELAY_PIN, HIGH); // تشغيل الحمل

  lcd.init();
  lcd.backlight();
  lcd.setCursor(0, 0);
  lcd.print("System Ready");
  delay(2000);
  lcd.clear();
}

void loop() {
```

```
  float voltage = pzem.voltage();
  float current = pzem.current();

  if (isnan(voltage) || isnan(current)) {
    Serial.println("Error reading PZEM");
    lcd.setCursor(0, 0);
    lcd.print("Error PZEM");
    return;
  }

  Serial.print("Voltage: "); Serial.println(voltage);
  Serial.print("Current: "); Serial.println(current);

  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("V: "); lcd.print(voltage); lcd.print("V");
  lcd.setCursor(0, 1);
  lcd.print("I: "); lcd.print(current); lcd.print("A");

  if ((voltage > voltageThreshold || current > currentThreshold) &&
!isLoadOff && !callMade) {
    makeCall();
    callMade = true;
  }

  if (callMade && checkIfCallRejected()) {
    digitalWrite(RELAY_PIN, LOW);
    isLoadOff = true;
    callMade = false;

    Serial.println("Load turned off due to rejected call");
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Load OFF");
    lcd.setCursor(0, 1);
    lcd.print("Rejected!");
  }

  if (voltage <= voltageThreshold && current <= currentThreshold
&& isLoadOff) {
    digitalWrite(RELAY_PIN, HIGH);
    isLoadOff = false;
    callMade = false;
```

```
    Serial.println("Load turned back on");
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Load ON");
    lcd.setCursor(0, 1);
    lcd.print("Normal");
  }

  delay(1000);
}

void makeCall() {
  SIM900.println("ATD" PHONE_NUMBER ";");
  Serial.println("Calling...");
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Calling...");
}

// هذه الدالة تتحقق فقط إذا تم رفض المكالمة
bool checkIfCallRejected() {
  String response = "";

  SIM900.println("AT+CLCC");
  delay(2000);

  while (SIM900.available()) {
    response += (char)SIM900.read();
  }

  Serial.println("Response: " + response);

  // إذا لا يوجد +CLCC → تم رفضها معناها لا توجد مكالمة
  if (response.indexOf("+CLCC:") == -1) {
    Serial.println("Call was rejected!");
    return true;
  }

  return false;
}
```

SMS When the Overload:

```
#include <SoftwareSerial.h>
#include <PZEM004Tv30.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h>

// تعريف الاتصالات
SoftwareSerial SIM900(12, 13); // (RX, TX) لتوصيل SIM900
PZEM004Tv30 pzem(2, 3);        // (RX, TX) لتوصيل PZEM-004T
LiquidCrystal_I2C lcd(0x27, 16, 2); // عنوان I2C ٠ يمكن أن يكون x3F أو
٠x27

#define RELAY_PIN 5
#define PHONE_NUMBER "+9647722131230"

// حدود الفولتية والتيار
float voltageThreshold = 250.0;
float currentThreshold = 2.0;
bool isLoadOff = false;

void setup() {
  Serial.begin(9600);
  SIM900.begin(9600);

  pinMode(RELAY_PIN, OUTPUT);
  digitalWrite(RELAY_PIN, HIGH); // تشغيل الحمل افتراضيًا

  lcd.init();
  lcd.backlight();
  lcd.setCursor(0, 0);
  lcd.print("System Ready");
  delay(2000);
  lcd.clear();
}

void loop() {
  float voltage = pzem.voltage();
  float current = pzem.current();
```

```
  if (isnan(voltage) || isnan(current)) {
    Serial.println("Error reading PZEM");
    lcd.setCursor(0, 0);
    lcd.print("Error PZEM");
    return;
  }

  Serial.print("Voltage: "); Serial.println(voltage);
  Serial.print("Current: "); Serial.println(current);

  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("V: "); lcd.print(voltage); lcd.print("V");
  lcd.setCursor(0, 1);
  lcd.print("I: "); lcd.print(current); lcd.print("A");

  // التحقق من تجاوز الحدود
  if ((voltage > voltageThreshold || current > currentThreshold) &&
!isLoadOff) {
    sendSMS(voltage, current);
    Serial.println("Overload detected! Waiting 15s...");
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Overload!!");
    lcd.setCursor(0, 1);
    lcd.print("Wait 15s...");
    delay(15000);

    digitalWrite(RELAY_PIN, LOW); // إطفاء الحمل
    isLoadOff = true;
    Serial.println("Load turned off automatically.");
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Load OFF");
  }

  // إعادة التشغيل إذا عادت القيم طبيعية
  if (voltage <= voltageThreshold && current <= currentThreshold
&& isLoadOff) {
    digitalWrite(RELAY_PIN, HIGH);
    isLoadOff = false;
    Serial.println("Load turned back on");
    lcd.clear();
```

```
    lcd.setCursor(0, 0);
    lcd.print("Load ON");
    lcd.setCursor(0, 1);
    lcd.print("Normal");
  }

  delay(1000);
}

// إرسال رسالة SMS عند حدوث الحمل الزائد
void sendSMS(float voltage, float current) {
  SIM900.println("AT+CMGF=1");
  delay(1000);
  SIM900.print("AT+CMGS=\"");
  SIM900.print(PHONE_NUMBER);
  SIM900.println("\"");
  delay(1000);
  SIM900.print("Overload detected!\n");
  SIM900.print("Voltage: "); SIM900.print(voltage); SIM900.println("
V");
  SIM900.print("Current: "); SIM900.print(current);
SIM900.println(" A");
  delay(1000);
  SIM900.write(26); // Ctrl+Z
  delay(5000);
  Serial.println("SMS Sent with Voltage & Current Data");
}
```

3.13 Cost table for the project:

Electronic widget	Numbers	Cost of one
Arduino Uno R3	1	12,000
SIM900(GSM)	1	22,000
PZEM_004T	2	12,000
Relay	4	1,250
Breadboard	1	12,500
20cm_cable (Male to female)	1	2,000
10cm_cable (Male to Maie)	2	15,000

Chapter 4

Results and Discussion

4.1 Results

The project successfully achieved its main goal of protecting home appliances from high voltage and current by implementing an automated remote monitoring and control system. The key results are as follows:

1. **Voltage and Current Monitoring**:

The PZEM-004T sensor accurately measured voltage and current values in real time and transmitted them to the Arduino UNO R3.

The system was programmed to detect abnormal increases beyond predefined thresholds (voltage > 220V or current exceeding a safe limit).

2. **Automatic Load Disconnection:**

When high voltage or current was detected the Arduino sent a signal to the single relay which immediately disconnected the load (motor) to prevent damage.

3. **Remote Alert System:**

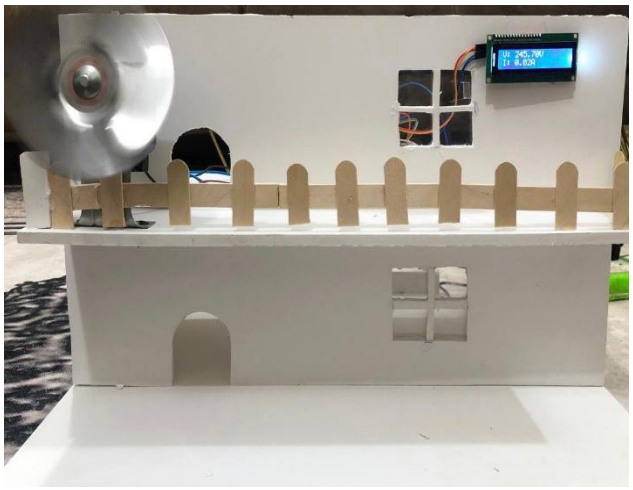
The SIM900 module successfully sent an alert call to the user's phone when an overvoltage or overcurrent situation occurred.

The system was programmed to off system automatically after 15 second after ring, serving as a notification without incurring call charges.

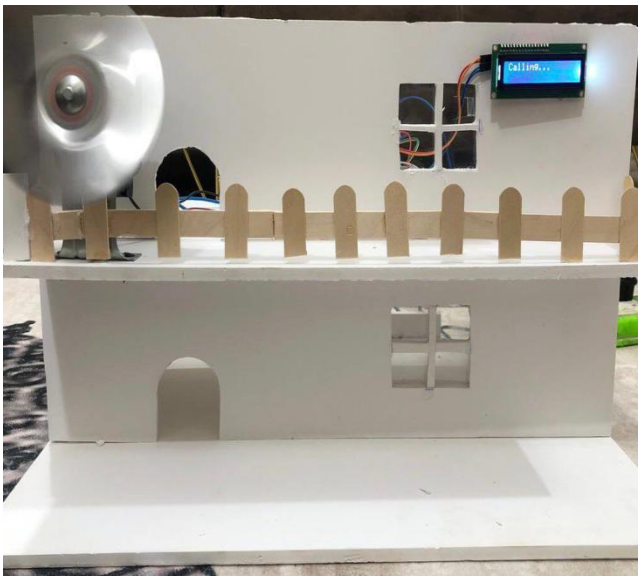
4. **LCD Display:**

The LCD screen provided real-time voltage and current readings, allowing for local monitoring.

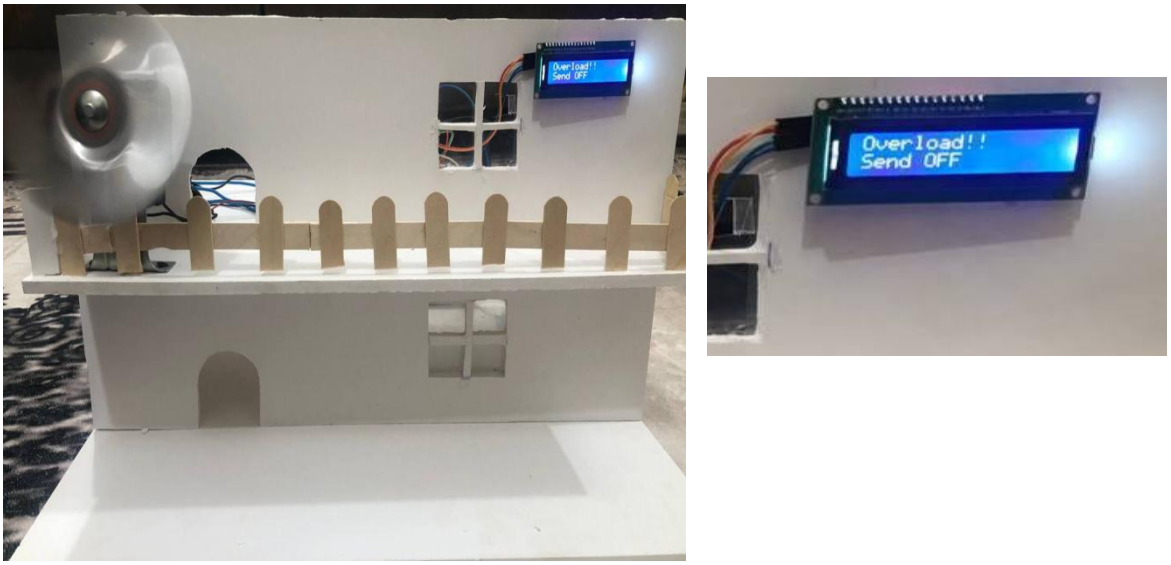
Fiqure (4.1)Display screen during system startup.



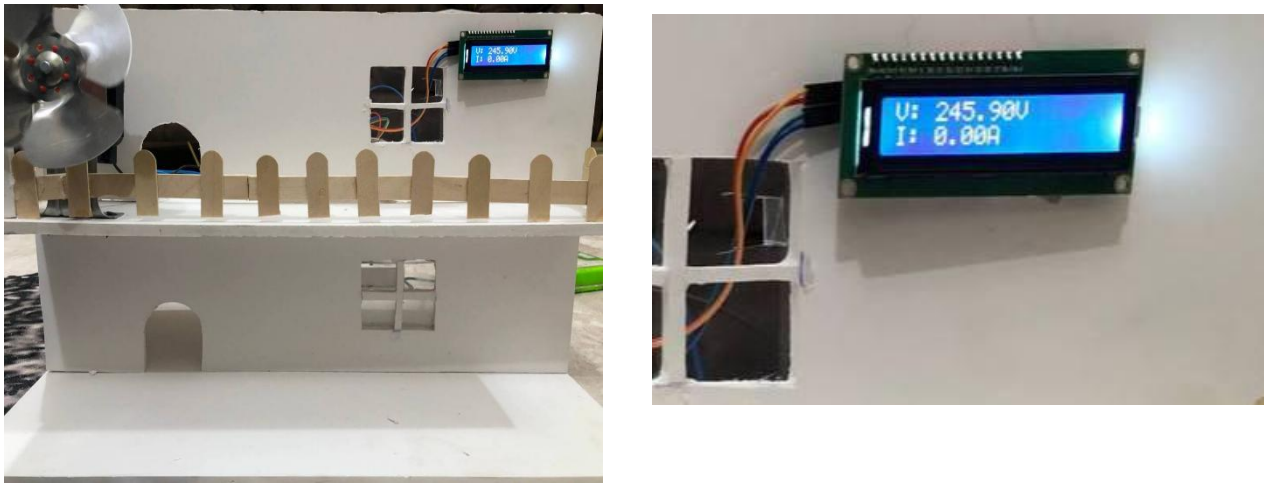
Fiqure(4.2) Display the screen while the system is operating normally.



Fiqure(4.3) Display screen during call.



Fiqure(4.4) Display screen while sending SMS message.



Fiqure(4.5) Display screen after load is off**.**

When the load is disconnected the current becomes zero but the voltage is still being measured. Reason:

When the relay turns off the load, no current flows through the circuit, so the PZEM-004T measures zero current.

However the voltage remains readable because the PZEM-004T is still connected to the power source and it continues to measure the voltage across the terminals.

4.2 Discussion

The system performed as expected demonstrating the effectiveness of using Arduino-based automation for home electrical protection. However some observations and challenges were encountered:

Response Time: The relay disconnection was nearly instantaneou ensuring quick protection.

SIM900 Limitations**:** Network dependency could be a drawback in areas with poor GSM coverage .Future improvements could include message telegram alerts alongside call notifications.

Accuracy: The PZEM-004T provided reliable measurements, but calibration may be needed for industrial-grade precision.

Expandability: Additional sensors (e.g., temperature, power consumption) could be integrated for a more comprehensive monitoring system.

Table Load Monitoring and System Response:

Voltage	Current	Condition	Response
210	1.5	Normal	Load on and lcd update
220	1.8	overvoltage	The load is turned off after the call is rejected.
200	2	overcurrent	The load is turned off after the call is rejected.
Error	erorr	Sensor failure	Desplae error(no action)

4.3Conclusion

The project successfully implemented a practical and cost-effective system for remote protection of home appliances based on real-time monitoring of voltage and current. Using the Arduino Uno, PZEM-004T sensor, relay module, and SIM900 GSM module, the system was able to detect abnormal conditions such as overvoltage or overcurrent and take immediate action by disconnecting the load and notifying the user through a phone call.
This solution not only improves safety but also gives users remote control over their electrical appliances when they are not at home, making it especially useful in areas where Internet connectivity may be limited or unavailable.

Future Development:

In future iterations, the system could be enhanced by integrating Internet of Things (IoT) features, allowing data to be sent to a cloud platform for remote monitoring through a mobile app or web interface. Additional features like support for multiple users, logging of historical data, automatic reconnection logic, and even voice call interaction could be explored to improve system functionality and user experience.

1_OR CODE (Remote Monitoring and Control of Voltage and Current and calling)

Fiqure(4.6) OR CODE Remote Monitoring and Control of Voltage and Current and calling

2_ **OR CODE** Remote Monitoring and Control of Voltage and Current and sent sms.

Fiqure(4.7) OR CODE Remote Monitoring and Control of Voltage and Current and sent sms.

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