IOT BASED SMART ENERGY METER FOR ENERGY EFFICIENCY

A MINI PROJECT - I REPORT

Submitted by

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20EC280- MINI PROJECT 2

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

ABSTRACT

The "Smart Energy Meter" initiative intends to revolutionize residential power use monitoring by putting an inventive method into place. the precise measurement of different household loads' power usage using an energy meter. An ESP32 controller processes the data, calculating units spent and enabling effective energy management. In order to support energy saving initiatives, the system has an intelligent function that automatically switches off all loads when occupants are not present. Power statistics and real-time unit consumptions are sent to an IOT platform for remote monitoring and analysis, where they are shown on an LCD panel. Additionally, a technique for alerting consumers via email is included to warn them when power consumption begins. The "Smart Energy Meter" project provides a way to maximize energy utilization, encourage sustainability, and raise user awareness of power usage by integrating hardware and software components.

Acknowledgment

We put forth our heart and soul to thank **ALMIGHTY** for being with us all through this technical adventure.

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LIST OF FIGURES

LIST OF ABBREVATIONS

IOT	Internet Of Things
PIR	Passive infrared Sensor
LCD	Liquid Crystal Display
IC	Integrated Circuits
LoRa	Low Range
RL	Relay
SEM	Smart Energy Meter

CHAPTER 1

INTRODUCTION

Providing a comprehensive product overview is the primary goal. Information on the issues with Energy Meters is provided in this chapter. It also provides a thorough understanding of the variables influencing power and efficiency.

1.1 PROJECT OVERVIEW

Similar to oxygen and water, electricity is often overlooked in our day-to-day existence. It now plays a significant role in our modern lives as well. It is among the most significant inventions ever made. Given how many times we utilize electricity in our daily lives, its significance was evident. The majority of kitchen equipment utilize it to easily cook or clean. In contrast to the traditional method, cooking with electricity is more comfortable and convenient. Electric stoves, rice cookers, chillers, and even basic bread toasters are appliances that run on electricity. Consider how much comfort electricity brings to each and every person. Communication and entertainment are also made possible by electricity. Cinema, radio, and television all require power. Electricity is required to run most children's toys and computers. The primary energy source for modern communication devices like computers and cell phones is electricity. Electricity is necessary for schools and healthcare institutions, such as hospitals, to function effectively. In hospitals and other healthcare facilities, electricity is crucial. Among many other things, it operates incubators, ECG equipment, and X-rays.

Below figure 1.1 shows how the usage of electricity got increased in a decade. This rapid increase in usage of electricity will leads to depletion of the source eventually. Every year power used has increased by 20% . Most of the power used here is by mis

consumption there is no real time gadget for viewing or monitoring power live. This results in the increased usage of power.

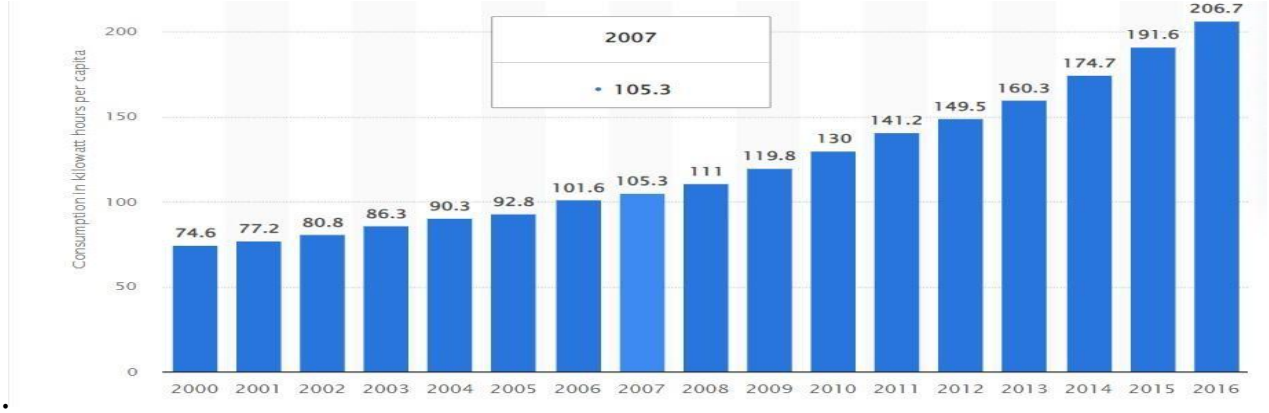


Figure 1.1 Electricity consumption over the years

CHAPTER 2

LITERATURE SURVEY

The product development process requires a large survey of existing methods and growing technology. Various literature surveys from different journals and conference paper has been studied for best results. This has been done to collect information about the dataset and electricity controlling techniques.

2.1 INTRODUCTION

The history of electricity, the unseen force that drives contemporary society, is a fascinating one, entwined with technical advancement, scientific discovery, and human inventiveness. The history of electricity is one of constant progress and change, beginning with the discovery of static electricity by prehistoric societies and continuing through the construction of complex electrical networks that span continents. Early people saw the effects of static electricity, such as lightning strikes and electric fish, thousands of years ago, marking the beginning of the history of electricity. But it wasn't until the 17th century that researchers like William Gilbert started to approach the study of electricity methodically, setting the stage for further breakthroughs. The famous kite experiment by Benjamin Franklin, which showed the link between lightning and electricity, occurred in the 18th century and was one of the turning points in the history of electricity. The knowledge of electricity as a natural phenomena that resulted from this experiment opened the door for more research and testing. The way people harnessed and used electricity was changed in the 19th century by Michael Faraday's discovery of the electric motor and Alessandro Volta's development of the electric battery.

2.2 BACKGROUND

Muhammad Aqeel, Muhammad Ali Shahzad, "Intelligent Smart Energy Meter Reading System Using Global System for Mobile Communication "Proceedings of Khwaja Fareed University of Engineering and Information Technology in 2023

Fast mechanical advancements have been made in the field of e-metering (Electronic Metering), and interest in a reliable and efficient Automatic Meter Reading (AMR) framework has grown. Conventional meter perusing approaches are replaced by a clever framework for GSM-based vitality meter reading. It gives the vitality supplier remote access to the current vitality meter. Every element's electronic vitality meter is integrated with a GSM-based remote correspondence module so that users may access their power usage remotely. The charging station is a PC that has a database on it and a GSM recipient at the other end. Periodically, live meter readings from the GSM-enabled vitality meter are transmitted back to this charging station, and these minute details are updated in a central database. After managing this information, the client is notified of the total monthly use and the outstanding amount. Therefore, compared to a typical charging framework, a GSM-based remote AMR framework is a more successful strategy. Additionally, this framework provides experts to force firms to take action against tolerant customers who make significant contributions. Following the affidavit of duty, the Intelligent Smart Energy Meter Reading System Using Global System for Mobile Communication can reconnect the control supply. Thus, we considered developing such an automated system. In order to replace the traditional reading system, this research uses a smart energy meter reading system that is based on GSM technology. In this article, the relevant Authority receives reading information by SMS from the GSM module.

Devendra M. Jaiswal , Mohan P. Thakr, " Modeling & designing of smart energy meter for smart grid applications",Internal journal of K.K. Wagh Institute Of Engineering Education And Research, 2022

The monopoly in the electrical market has almost completely disappeared thanks to privatization, which has also increased competition between various power providers. This results in the automation of power systems developing. Innovation often leads to the smart grid's adoption of a novel idea—smart meters. The distribution sector of the conventional grid is experiencing power losses, and as these losses grow, the price of energy per unit will rise. With a focus on lowering carbon footprints, a novel idea about renewable energy in the smart grid is introduced. The smart metre is simple to use and provides real-time information on energy use and cost. By guaranteeing proactive use of electrical energy and lowering carbon emissions, it decreases energy demand. In addition to implementing smart technologies, replacing traditional energy meters with intelligent ones benefits both utility companies and consumers. Automated meter reading takes the role of advance metering equipment. The first stage in implementing smart metering nationwide is installing an intelligent meter. The country's mandatory smart meter regulation has been strengthened in light of losses including tampering, harmful customer activity, and billing delays. This study presents the mathematical modeling of a single-phase smart energy meter and estimates power and energy using an energy computing chip to determine apparent, reactive, and active energy. The Proteus simulator is used to simulate a single-phase intelligent meter, and the results are shown

Muhammad Tahir, “Implementation of a smart energy meter using blockchain and Internet of Things: A step toward energy conservation ”, Sir Syed University of Engineering and Technology, 2022

The world is being impacted by the impending energy crisis.Researchers are forced to automate the power industry due to the pressing necessity to preserve energy. Among the biggest obstacles is energy conservation.A result of the Russian-Ukrainian War, Third World nations face challenges both globally and in Europe. The implementation of technologies that can stop energy loss and enable consumers to purchase and sell extra electricity is necessary. The Internet of Things, or IoT, actively contributes to energy saving in the power and electrical sectors. For effective transmission, the novel idea of smart grids is widely applied. When applied in conjunction with smart grids, blockchain technology can further minimize energy waste and promote effective use. An energy meter with blockchain and smart grid capabilities is suggested in this article. In the suggested implementation, a few microgrids with individual blockchains are displayed. A demonstration comprising many microgrids, each with its own blockchain, is the suggested implementation. In accordance with the smart contracts, the users' transactions will use energy.The emphasis is on peer-to-peer blockchain-controlled microgrid transactions. Three products of the architectural design are an Ethereum blockchain smart contract, an Android app to track and manage transactions, and a smart energy meter that may be used to trade energy with other customers

Francisco Sánchez-Sutil ,"Design and Implementation of a Smart Energy Meter Using a LoRa Network in Real Time",Internal journal of University of Jaen, 2021

Recently, there is an exponential growth in the significance of developing, deploying, and utilizing smart meters (SMs). Electrical engineers employ SMs for a wide range of purposes, from load profile analysis in homes to real-time monitoring. This progress has been aided by the application of wireless technology. The use of SMs can lead to a number of issues, including coverage and places without Internet connectivity. SMs may be installed in a variety of places, even those without Internet connectivity, thanks to LoRa (long range) technology's excellent coverage and low-power equipment. Developing an SM network that satisfies the shortcomings of existing wireless networks while adhering to the LoRa standard is the aim of this research. In the past few years, the importance of creating, implementing, and using smart meters (SMs) has increased exponentially. SMs are used by electrical engineers for a variety of tasks, including as real-time monitoring and load profile analysis in residential buildings. The use of wireless technologies has facilitated this development. Many problems, including as coverage and locations without Internet access, might arise from using SMs. SMs can be deployed in many locations, including those without Internet access, because of the outstanding coverage and low-power equipment of LoRa (long range) technology. The goal of this research is to create an SM network that complies with the LoRa standard and addresses the inadequacies of current wireless networks

SUMMARY

In conclusion, real-time monitoring, remote access and control, data analytics, demand response capabilities, and connection with renewable energy sources are just a few advantages that come with smart energy meters. Smart meters are essential to the transition to a more resilient and sustainable energy future because they give customers actionable data and facilitate more effective energy management. Large volumes of energy use data are gathered by smart meters, and these data may be examined to find patterns, abnormalities, and areas for optimization. Consumers and utility businesses may learn important information about peak demand times, trends of energy usage, and possible locations for energy-saving initiatives by utilizing data analytics. Utility firms may access and operate smart energy meters remotely. This minimizes the need for manual interventions and enhances customer service by enabling fast invoicing and meter reading procedures as well as the capability to remotely disconnect and reconnect services as needed

CHAPTER 3

METHODOLOGY AND WORKING PRINCIPLE

The product has two parts for implementing the process. The first one is the hardware part and the next is software part. The procedure, software and hardware components used in the product are explained in detail in this chapter.

3.1 PROPOSED METHOD

By adding a number of cutting-edge features targeted at improving energy management and encouraging sustainability in homes, the proposed "Smart Energy Meter" system provides a substantial improvement over the current setup. Unlike the current system's fundamental features, the suggested solution incorporates an ESP8266 controller to facilitate occupancy-based dynamic load management. This clever function minimizes energy waste and lowers electricity costs by automatically adjusting power usage by turning off non-essential loads when occupants are not present. The suggested system also includes real-time alarm mechanisms that send out emails to customers when power consumption above predetermined thresholds, allowing proactive energy management. In addition, the incorporation of IoT platforms enables the remote observation of energy consumption information, enabling individuals to monitor usage trends and make knowledgeable choices even while they are not at home. Through the implementation of sophisticated features and the resolution of the shortcomings of the current system, the suggested system provides a holistic approach to maximizing energy usage and encouraging environmentally friendly practices.

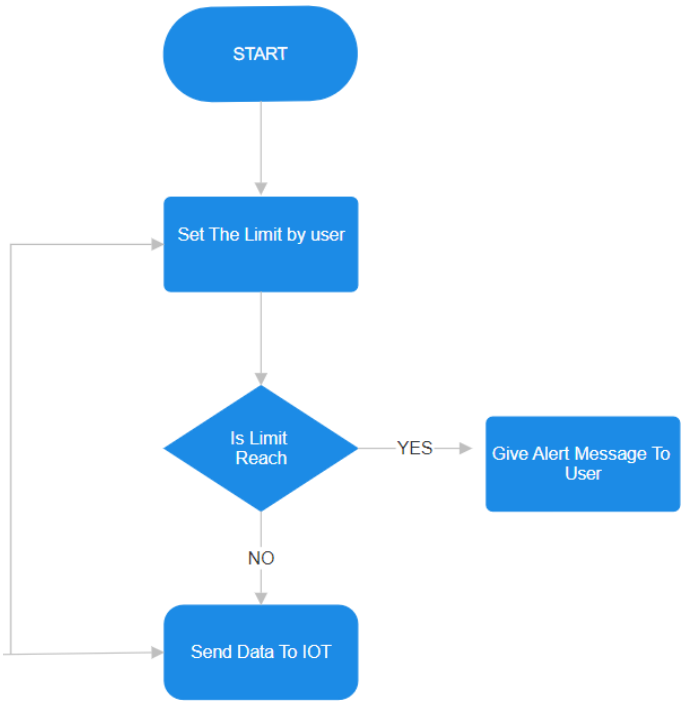


Figure 3.1 FLOW CHART

3.2 HARDWARE DESCRIPTION

3.2.1 ESP 8266 (Node MCU) :

Built on the ESP8266 WiFi module, NodeMCU is an open-source development kit and firmware. Due to its capacity to offer WiFi connectivity to a wide range of electronics applications, the ESP8266 is a highly integrated, low-cost wireless microcontroller that has become greatly popular. With the help of an intuitive programming environment and firmware, the NodeMCU project seeks to facilitate the usage of the ESP8266 module by developers and enthusiasts alike. With WiFi connection and the ability to interface with both digital and analog devices, NodeMCU v1.0 is a robust platform for developing projects. With its microcontroller capabilities, communication protocols, and programming simplicity, it's a great option for novice and seasoned developers working on wireless communication, automation, and Internet of Things applications.

Device Features:-

The ESP8266 board includes the following specifications.

Microcontroller	ESP8266
Operating Voltage	3.3V
Digital I/O Pins	11 (D0 - D10)
Analog Input Pins	1 (A0)
Clock Speed	80 MHz
Flash Memory	4 MB
Wi-Fi	802.11 b/g/n (2.4 GHz)
Wireless Range	indoor 100 meter
Operating Temperature Range	-40°C to +125°C
Input Voltage	5V (via USB or VIN pin)
Output Voltage	3.3V
Current Consumption	~80 mA (average), ~170 mA (peak)
USB-to-Serial Chip	CH340G
Programming Interface	Micro USB

GPIO Pins	PWM, I2C, SPI, and 1-Wire
Onboard Antenna	Yes
Dimensions	49.3mm x 25.5mm
Compatible IDEs	Arduino IDE, PlatformIO, NodeMCU Lua
CPU	Tensilica L106 32-bit

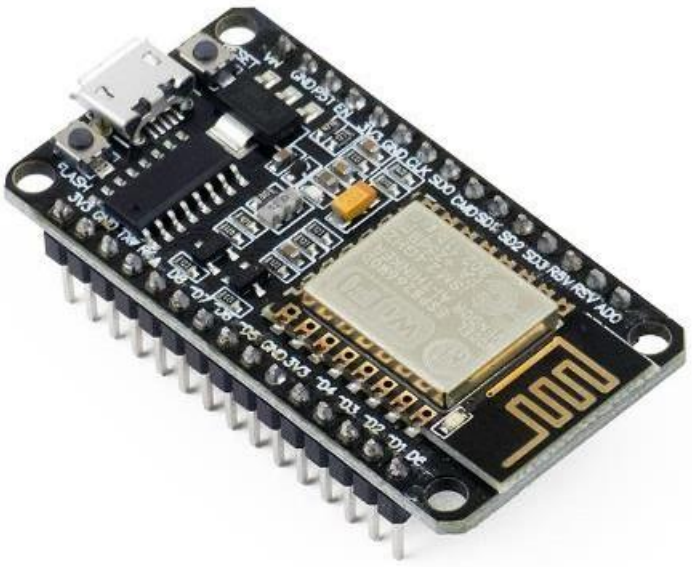


Figure 3.2 ESP8266 Microcontroller Board

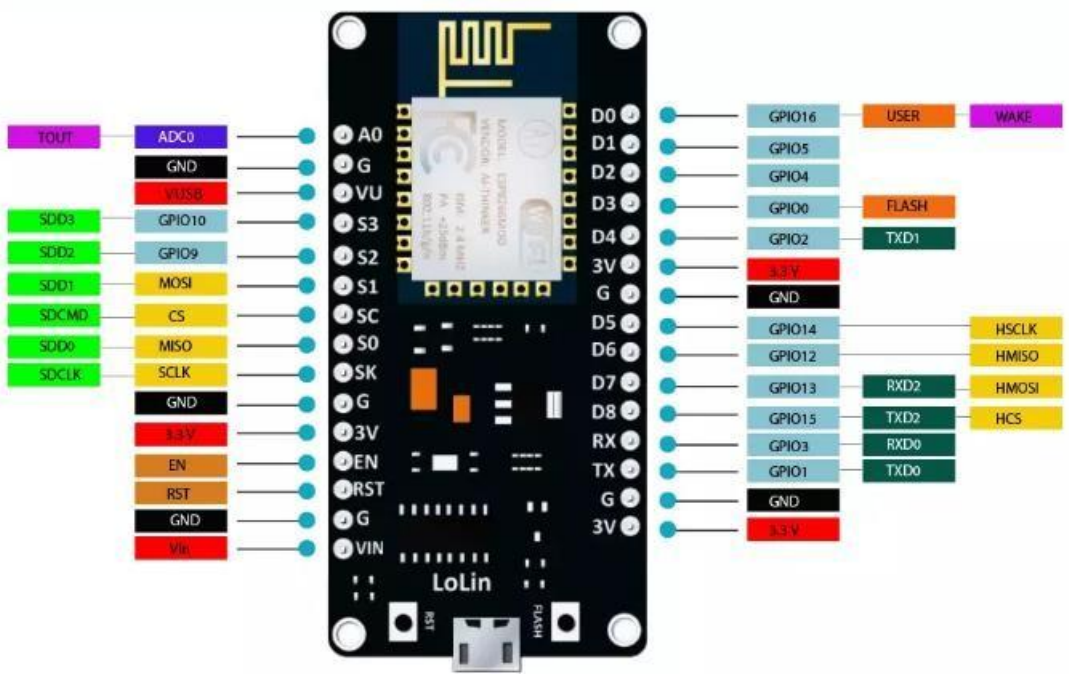


Figure 3.3 PIN DIAGRAM OF ESP8266

Pin Number	Pin Name	Alternate Name	Normally used for	Alternate purpose
1	**Ground**	-	Connected to the ground of the circuit	-
2	**TX**	GPIO – 1	Connected to Rx pin of programmer/uC to upload program	Can act as a General purpose Input/output pin when not used as TX
3	**GPIO-2**	-	General purpose Input/output pin	-
4	**CH_EN**	-	Chip Enable – Active high	-
5	**GPIO - 0**	Flash	General purpose Input/output pin	Takes module into serial programming when held low during start up
6	**Reset**	-	Resets the module	-

7	**RX**	GPIO - 3	General purpose Input/output pin	Can act as a General purpose Input/output pin when not used as RX
8	**Vcc**	-	Connect to +3.3V only	

3.2.2 5V single channel relay module:-

Relays are electromechanical switches that operate by using an electric current to open or close their contacts. A simple relay is not all that the single-channel relay module is made of; it also includes parts that facilitate switching and connections and serve as indicators to indicate if the module is powered on and whether the relay is operating.

The board module for Arduino PIC AVR DSP ARM is a 1 channel 5V relay. It is controllable by a variety of microcontrollers, including ARM, AVR, PIC, Arduino, and more. 15–20 mA of driving current are required for each, and A high current relay is installed. common interfaces that can work with microcontrollers include DC 5V / 10A and AC 250V / 10A.**Specification and Features:**

• A single channel relay board .

• Voltage at Operation (5V).

• Maximum Current (20 mA).

The current capacity of the relay contact at DC5V is 10A.

• One regular open contact and one regular closed contact.

• Increasing the relay coil with a triode drive.

• Pin for high impedance control .

• Pull-down circuit to prevent failures .

• Lamp for power supply indication .

• May regulate a range of appliances and other large-current equipment.

• Standard TTL Level (AVR, Arduino, 8051, PIC, ARM) logic controlled .

• The load area isolation trenches, control, and module comply with international safety standards.

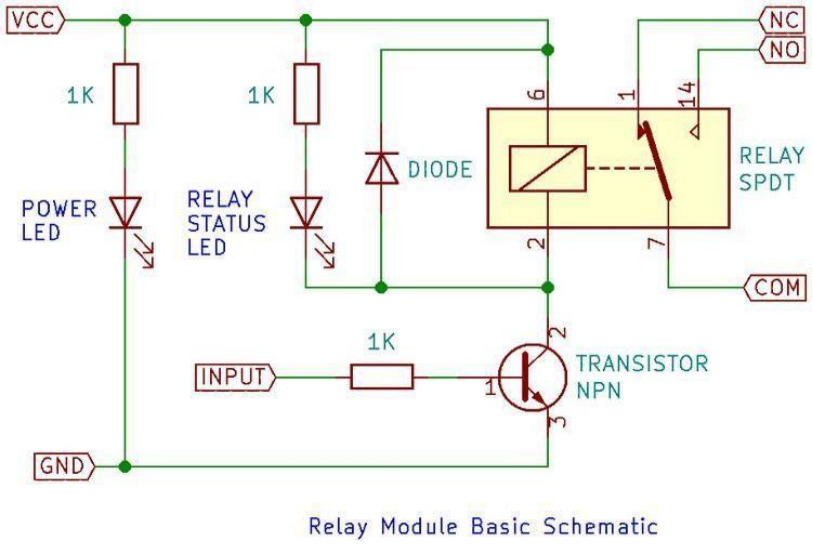


Figure 3.4 Internal circuit Diagram of 5V single channel relay module

The single-channel relay module features components that make connection and switching easier in addition to indications that show if the module is turned on and whether the relay is working, making it more than just a basic relay. The screw terminal block is

placed initially. This part of the module needs a robust connection because it is in contact with the mains. Large mains cables are easier to connect with screw terminals than with direct soldering. A voltage of at least 5V is necessary for the relay coil to be activated, as shown by the relay's component number, "05VDC," on the bottom. A voltage lower than this would prohibit the relay's contacts from closing regularly.

Additionally, there are indications for voltage and current that indicate the highest voltage and current that the relay is capable of switching. For instance, the top left marking reads "10A 250VAC," indicating that when the relay is attached to a 250V mains circuit, it can switch a maximum load of 10A. The relay can switch a maximum current of 10A DC before the contacts get broken, according to the bottom left rating, which reads "10A 30VDC." The 'relay status LED' indicates the current passing through the relay coil and illuminates when the relay is functioning. Additionally, the jumper includes an input pin that, when pushed high, turns on the relay. When an input is insufficiently current to drive a relay coil directly, the switching transistor amplifies the signal and uses the supply voltage to operate the relay coil. In this manner, a microcontroller or sensor output can be used to drive the input. When the relay is turned off, voltage spikes are avoided by the freewheeling diode. Every time the module is switched on, the power LED, which is linked to VCC, illuminates. amplifies it by driving the relay coil with the supplied voltage. In this manner, a microcontroller or sensor output can be used to drive the input. When the relay is turned off, voltage spikes are avoided by the freewheeling diode. power LED is connected to V_{CC} and turns on whenever the module is powered.

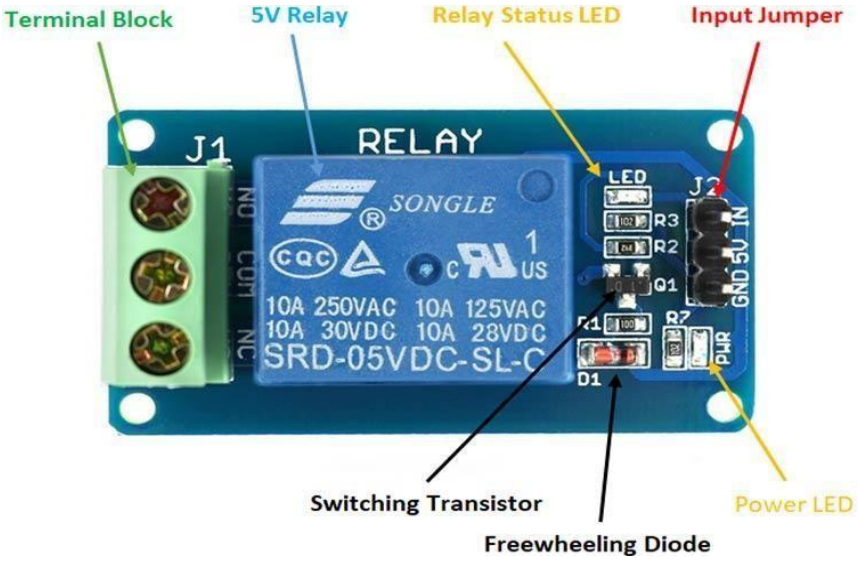


Figure 3.5 5V single channel relay module

3.2.3 PIR Sensor

An electrical device that detects infrared (IR) radiation from living things and objects that are warmer than absolute zero is called a passive infrared (PIR) sensor. PIR sensors are frequently employed in a variety of applications to detect presence, motion, and occupancy. They are especially well-liked in home automation, security systems, and lighting control. PIR sensors are temperature-sensitive and made to pick up on the relatively quick temperature variations brought on by moving heated items. They are not radiation producers; rather, they are sensors of variations in infrared radiation from their environment.

Figure 3.6 PASSIVE INFRARED RAY SENSOR

Pin Description

VCC (+): The PIR sensor receives its power supply voltage from this pin. Generally, a positive voltage source (3.3V or 5V, depending on the sensor's requirements) is connected to it.

GND (-): This pin is the ground connection and is connected to the common ground of the power supply and other circuit components.

OUT: Certain PIR sensors come with a sensitivity adjustment pin that lets you alter the sensor's sensitivity and detection range. You may alter the sensor's sensitivity to variations in infrared radiation by turning this pin.

SENSITIVITY: Certain PIR sensors come with a sensitivity adjustment pin that lets you alter the sensor's sensitivity and detection range. You may alter the sensor's sensitivity to variations in infrared radiation by turning this pin.

TIME DELAY: The time delay pin is another configurable function found in certain PIR sensors. The duration that the sensor's output remains high after motion is detected may be adjusted with this pin. This delay is frequently employed to stop short movements from setting off false alarms.

Specifications

Operating Voltage	3.3V or 5V
Operating Current	5 mA to 15 mA
Detection Range	5 meters to 12 meters

Detection Angle	90 degrees to 180 degrees
Output Voltage Levels	Low: 0V / High: 3.3V or 5V
Sensitivity	Adjustable via a potentiometer
Time Delay	5 seconds to 300 seconds
Warm-up Time	10 seconds to 60 seconds

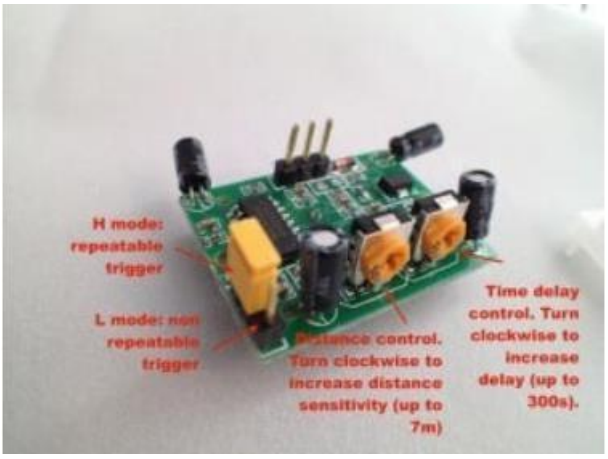


Figure 3.7 Features of PIR sensor

Working

A PIR sensor detects the heat emitted by living beings and objects. It contains a special material that generates a small electric charge when it senses a change in temperature. The sensor is divided into segments, each covering a specific area.

- **Infrared Radiation**: Depending on their temperature, all objects release a certain amount of infrared radiation. Although this radiation is invisible to the human eye, PIR sensors and other specialized sensors can detect it.

Pyroelectric Material: When temperatures change, a material known as pyroelectric material—which is utilized in PIR sensors—produces a small electrical charge.This material undergoes segmentation within the sensor.

- **Segmentation**: The segments of the pyroelectric material are exposed to incoming infrared light through the lens of the sensor. Every segment is associated with a particular region within the sensor's range of view.

- **Detection of Changes**: The temperature in the segments varies when a warm object—like a human or animal—enters the sensor's field of vision. The pyroelectric material experiences a brief production of electrical charge as a result of this temperature shift.

- **Signal Processing**: The electronics of the sensor amplify and process the electrical charges produced by the segments. The electronics of the sensor is made to recognize the quick changes in charge that the moving, heated item produces.

- **Output**: The sensor's output is activated if the variations in charge produced by the segments correspond to a predetermined pattern, signifying motion. Usually, a digital signal that oscillates between high and low levels indicates if motion has been detected.

- **Time Delay**: A time delay option is often included in PIR sensors to prevent false alerts from momentary changes in the surroundings. The sensor's output stays active for a given amount of time after motion is detected before shutting off.

3.2.4 I2C Interfaced 16x2 LCD

16x2 LCD

A 16x2 LCD (Liquid Crystal Display) is a common type of alphanumeric display module that can display two lines of text, with each line containing up to 16 characters. These displays are widely used in various electronics projects, devices, and applications for displaying information to users. Here are some details about a typical 16x2 LCD module:

Display Size: The LCD screen has 2 lines, and each line can display up to 16 characters (including letters, numbers, symbols, and spaces).

Character Size: The standard character size is typically 5x8 pixels, allowing the display of a variety of characters and symbols.

Backlight: An adjustable backlight is a common feature of 16x2 LCD modules, which helps with visibility in a variety of lighting scenarios. White, blue, green, or other colors can be used for the backlight.

Communication Interface: 16x2 LCD modules usually use the Hitachi HD44780 or a compatible controller, which is commonly interfaced with microcontrollers using a parallel interface.

Contrast Control: Many modules allow you to adjust the contrast of the characters on the screen using a built-in potentiometer.

Controller Commands: A microcontroller may send a set of commands to the HD44780 controller, which can be used to operate the display, move the pointer, clear the display, and other functions.

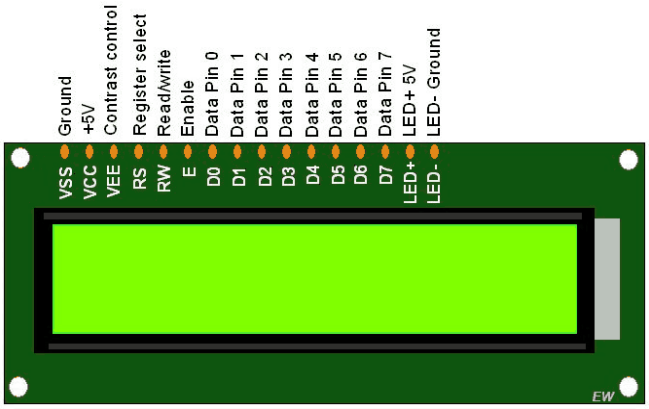


Figure 3.8 I2C INTERFACED (16 X 2) LIQUID CRYSTAL DISPLAY

Specifications

Display Size	16 characters x 2 lines.
Character Size	5x8 pixels (5 pixels wide, 8 pixels high).
Controller	HD44780
Operating Voltage	+5V
Interface:	4-bit or 8-bit / I2C/SPI
Viewing Area	2.95mm x 5.55mm
Contrast Control	potentiometer or resistor to V0
Temperature Range	0°C to 50°C
Dimensions	80mm x 36mm x 12mm (W x H x D)

Working

The working principle of a 16x2 LCD (Liquid Crystal Display) involves manipulating liquid crystals to create characters and graphics on the screen. Here's a step-by-step overview of how a typical 16x2 LCD works:

- **Initialization:** When the LCD module is powered on, the microcontroller initializes it by sending specific commands. These commands configure the display mode, cursor settings, and other parameters. The initialization process is essential for proper communication between the microcontroller and the LCD.

- **Character Generation:** The LCD has a built-in character generator ROM that contains patterns for standard ASCII characters and some custom symbols. When the microcontroller sends character data to the LCD, the LCD uses this ROM to generate the appropriate character pattern. Each character is formed by a matrix of pixels (dots) that can be turned on or off.

- **Display Data RAM (DDRAM):** The LCD has an internal memory called the Display Data RAM (DDRAM). This RAM is organized in a grid that corresponds to the rows and columns of the LCD. When you send character data to the LCD, it's stored in the DDRAM, and the cursor is automatically advanced to the next position.
- **Cursor Control:** The microcontroller can control the cursor's position on the screen. By sending cursor-related commands, the microcontroller can move the cursor to a specific location, which determines where the next character will be displayed.

- **Instruction and Data Modes:** The microcontroller communicates with the LCD using the RS (Register Select) pin. When RS is low, the LCD interprets the data on the data pins as commands. When RS is high, the data is treated as character

data. This allows the microcontroller to send commands for configuration or character data for display.

- **Enable (E) Signal:** The E (Enable) pin is used to trigger the LCD to read the data on its data pins. When the E signal transitions from high to low, the LCD reads the data present on the data pins and processes it as either a command or character data, depending on the RS pin's state.

- **Backlight Control:** Many LCD modules come with an integrated LED backlight. The backlight can be controlled using a separate connection. Connecting the backlight anode to a positive voltage supply and the cathode to ground activates the backlight.

- **Contrast Control:** The V0 pin, also known as the contrast pin, is used to control the contrast of the characters displayed on the LCD. By adjusting the voltage at this pin, you can control the darkness or lightness of the characters.

3.2.5 I2C Module

Microcontrollers and other integrated circuits frequently contain the I2C (Inter-Integrated Circuit) interface module, also known as an I2C controller or module. A data line (SDA) and a clock line (SCL) are the only two wires needed for many devices to interact with one another thanks to the synchronous, multi-master, multi-slave I2C communication protocol.

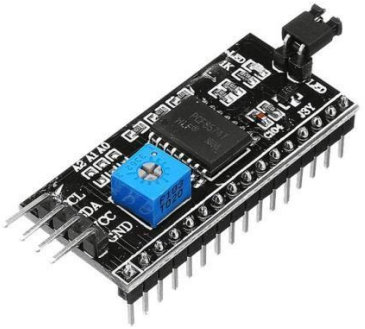


Figure 3.9 I2C MODULE

Specifications

Operating Voltage	5v
Operating Current	2mA
Communication Protocol	I2C
Dimensions	30x20 mm
Operating Frequency	400KHz to 1000Khz

Working

An I2C module that interfaces with an LCD acts as an intermediary between a microcontroller and the LCD panel. It translates the microcontroller's commands and data into a format that the LCD can understand and displays on the screen.

- **I2C Communication:** The I2C module communicates with the microcontroller using the I2C protocol. The microcontroller acts as the master device, and the I2C module acts as a slave device on the I2C bus.

- **Initialization:** The microcontroller initializes the I2C module by sending appropriate commands to configure the module for LCD communication. This includes setting up the I2C address of the LCD module, configuring display settings, and more.

- **Commands and Data:** The microcontroller sends commands and data to the I2C module over the I2C bus. These commands instruct the module to perform various actions, such as clearing the screen, setting the cursor position, displaying text or graphics, and controlling the backlight (if applicable).

- **I2C Module Processing**: Upon receiving commands and data, the I2C module processes the information. It interprets the commands and translates them into the appropriate control signals for the LCD panel.

- **LCD Control Signals:** The I2C module generates control signals that are sent to the LCD panel. These signals control aspects such as enabling or disabling the display, setting the cursor position, managing the backlight (if applicable), and more.

- **Display Data:** If the microcontroller intends to display characters, numbers, or graphics on the LCD, it sends the data to the I2C module. The module then formats this data and sends it to the LCD panel.
- **LCD Panel Display**: The LCD panel receives the control signals and display data from the I2C module. It uses the received signals to control individual pixels and segments on the screen, thereby displaying the desired content.

- **Feedback and Acknowledgment:** In some cases, the I2C module might provide feedback to the microcontroller to acknowledge successful execution of commands or data transmission. This feedback helps ensure that the microcontroller and module are in sync.

3.2.6 Energy Meter

Energy meters, also known as electricity meters, are devices used to measure the amount of electrical energy consumed in a building or facility. They are an essential part of the electrical distribution system and serve several important purposes:

Billing: Energy meters are primarily used for billing purposes. They measure the amount of electricity consumed, and this data is used to calculate the charges on your electricity bill.

Monitoring: Energy meters provide valuable data about electricity usage. This data can help consumers and utility companies track energy consumption patterns, identify potential issues, and make informed decisions about energy conservation.

Figure 3.10 Energy Meter

Electrical Specifications

Specification	**Analog Meter**	**Digital Meter**	**Smart Meter**
Voltage Rating	120/240 V	120/240 V	120/240 V or custom
Current Rating	5A or 10A	5A, 10A, 20A	5A, 10A, 20A, or higher
Frequency	50 Hz or 60 Hz	50 Hz or 60 Hz	50 Hz or 60 Hz
Accuracy Class	Class 1.0	Class 0.5 or 1.0	Class 0.2 or better
Specification	Analog Meter	Digital Meter	Smart Meter
Operating Temperature	-20°C to 50°C	-25°C to 70°C	-25°C to 70°C
Display Type	Dial or Disc	LCD or LED	LCD or LED
Pulse Output	N/A	Optional	Standard
Communication	N/A	N/A	Zigbee, Wi-Fi, Cellular
Metering Standards	Local Standards	IEC/ANSI	IEC, ANSI, Local Standards

Mechanical Specifications

Mechanical Specification	**Analog Meter**
Meter Type	Electromechanical
Dimensions (Width x Height x Depth)	4" x 4" x 2.5" (Approximate)

Mechanical Specification	Analog Meter
Enclosure Material	Plastic or Glass Cover
Display Type	Analog Dial or Disc
Weight	Typically around 0.5 kg
Mounting	Wall-mounted or Panel-mounted
Terminal Configuration	Screw-type Terminals for Wiring
Sealing	Typically Sealed to Prevent Tampering
Operating Mechanism	Mechanical Gears and Register
Dust and Water Resistance	Limited resistance to dust and moisture
Calibration Adjustments	May Require Periodic Calibration
Connection Type	Direct Wired Connection to Power Source

Working:

Current Measurement:

The "current coil" or "I coil" is a tightly wound coil of wire that forms a magnetic field when current flows through it. According to Ampere's law, a current-carrying conductor generates a magnetic field.

The number of turns in the coil and the current passing through it determine the strength of the magnetic field.

Voltage Measurement:

The "voltage coil" or "V coil" is typically a single coil or set of coils wound around a magnetic core. When voltage is applied across these coils, it induces a magnetic field. This magnetic field is directly proportional to the applied voltage, following Faraday's law of electromagnetic induction.

Electromagnetic Force:

The magnetic fields generated by the current coil and voltage coil interact. When a current flows through the I coil and voltage is applied to the V coil, their magnetic fields

combine, creating an electromagnetic force known as the Lorentz force.
The Lorentz force causes a torque on a metal disc or rotor located within the meter.

Rotating Disc:

The rotating element, often a lightweight aluminum disc, is placed in the magnetic field created by the current and voltage coils.
The Lorentz force acting on the disc causes it to rotate. The speed of rotation is directly proportional to the power being consumed by the load. This is based on the basic physics principle that work (power) is equivalent to the change in mechanical energy.

Dial Display:

The disc is mechanically linked to a system of gears and dials. As the disc rotates, it drives the gears, which, in turn, move the pointers on the dials.
Each dial represents a unit of energy, and the number of rotations made by the disc corresponds to the amount of energy consumed.

Readings:

The position of the pointers on the dials provides a visual representation of the cumulative energy consumption.
For instance, if a pointer on a dial has moved from 0 to 1, it indicates the consumption of one unit of energy, such as one kilowatt-hour (kWh).

3.4 SOFTWARE DESCRIPTION

3.4.1 Arduino software IDE:-

Message boards, text consoles, toolbars with buttons for frequently used tasks, menus, and an editor for writing code are all included in the Arduino Integrated Development Environment, also known as the Arduino Software (IDE). To upload and communicate with programs, it establishes a connection with the Arduino hardware.the

Cross-platform (Windows, macOS, and Linux) Arduino Integrated Development Environment (IDE) is a program written in C and C++ functions.On boards that are compatible with Arduino, it is used to write and upload programs. Under the GNU General Public License, version 2, the IDE's source code is made available. Coding conventions unique to the Arduino IDE are used to support the languages C and C++. A software library including numerous standard input and output operations is made available by the Arduino IDE and is derived from the Wiring project. The IDE package includes the GNU tool chain, which is also required to compile and link user-written code into an executable cyclic executive program. This code consists of only two basic functions, which are used to start the sketch and the main program loop. The program stub main() is necessary for this process.

Features

1. A straight forward, user-friendly code editor and compiler with integrated Serial.Observer/terminal .
2. Verify and checks your code for errors compiling it
3. Compiles your code and uploads it to the configured board.See uploading below for details
4. Creates a new sketch.
5. Open and presents a menu of all the sketches in your sketchbook. Clickingone will open it within the current window overwriting its content.
6. Saves your sketch
7. Opens the serial monitor.

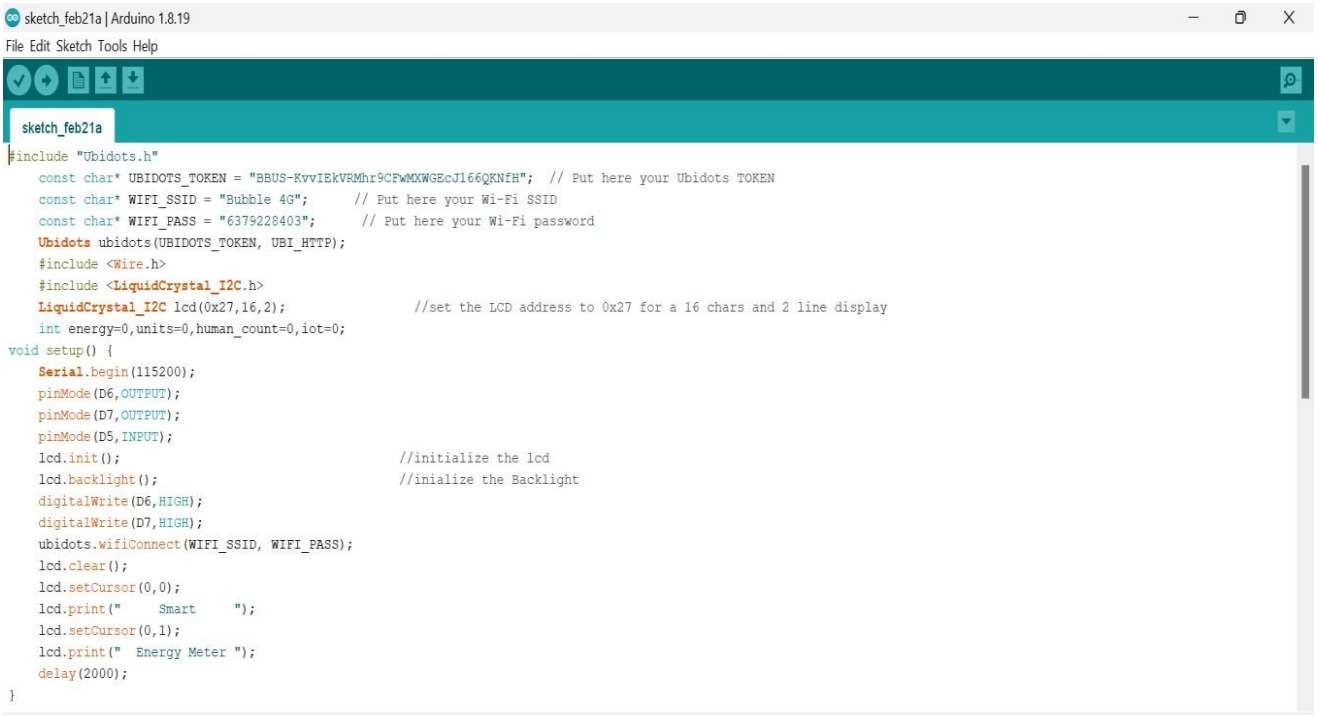


Fig 3.10 Arduino IDE coding

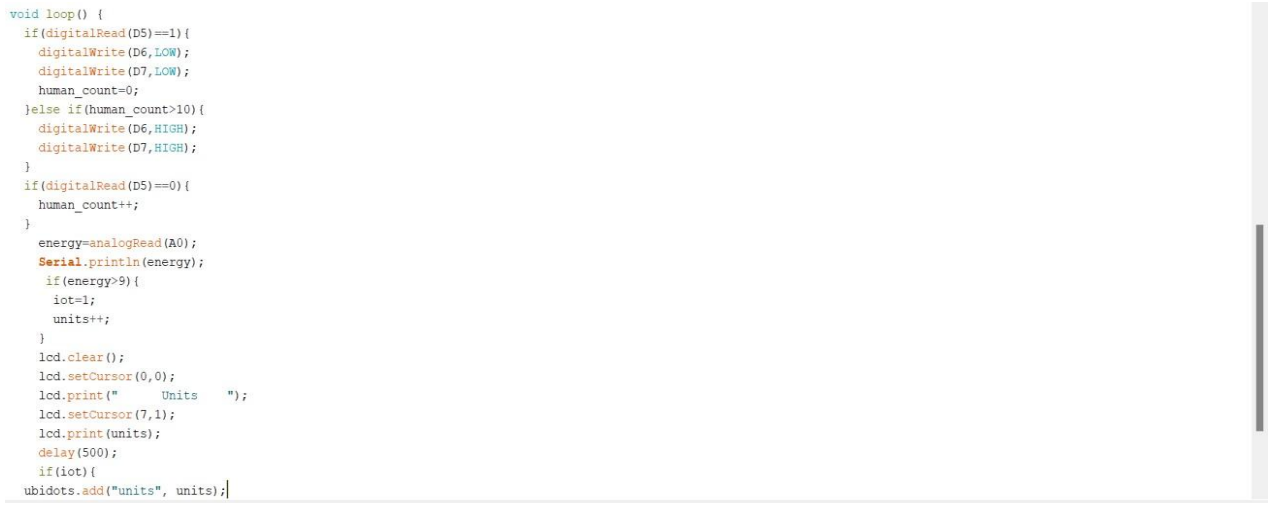


Fig 3.11Arduino IDE coding

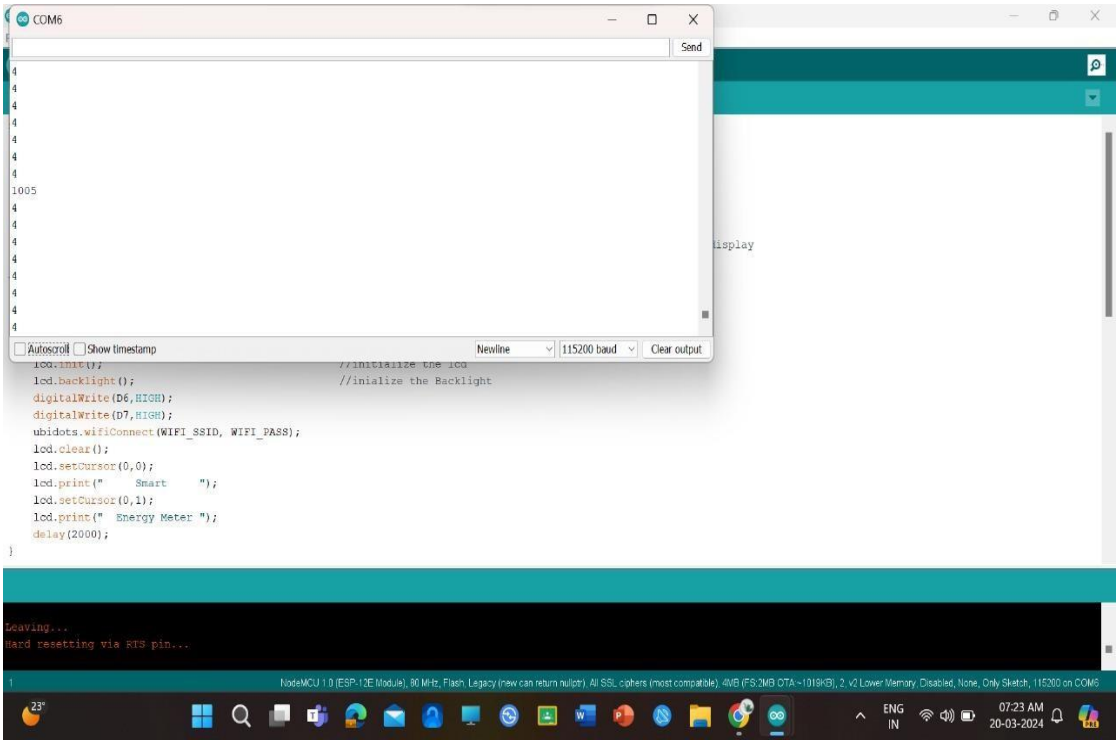


Figure 3.12 Arduino IDE coding

3.4.2 Internet of Things (UBIDOTS):

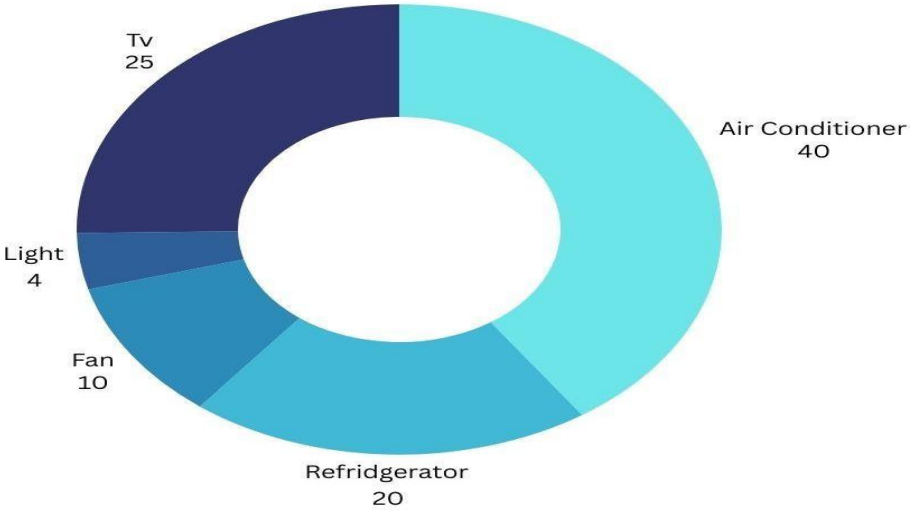
An IoT platform called Ubidots enables companies and entrepreneurs to develop and expand IoT concepts to production. Send data to the cloud from any device with an Internet connection by using the Ubidots platform. Then, using visual tools, you can unlock the value of your data and set up actions and alerts depending on your real-time data. You may read and write data to the accessible resources—data sources, variables, values, events, and insights—by using the REST API provided by Ubidots. The API requires an API Key and supports both HTTP and HTTPS.

Figure 3.13 UBIDOTS SITE

3.5 INNOVATIVENESS OF THE SOLUTION

The main divergence of the product from existing one is that, it has not only monitored the units level but also displays it through IOT. And intimates when units crossed the limit. This effortless mechanism of the Energy Meter sytem necessitates the use of modern technology in systematic monitoring of the Energy as units and facilitates in efficient usage of energy.

- **IMPACT OF THE PRODUCT**



	Home Appliances	Units
	Air Conditioner	40
	Refridgerator	20
	Fan	10
	Light	4
	Tv	25

Figure 3.15 Units consumption By Appliances

3.6 UNIQUENESS AND FEATURES

- Best Water indication system is proposed for the welfare of common people in an cost efficient way.

- The water level of the tank is monitored for 24 hours , level of the water can be identified any time by the LCD display and glowing of led bulbs by anyone in the apartment

- The main advantage is that it is automatically running in a repeated manner because of the loop programmed in the arduino coding

- Increases the water conservation and helps in water management by every individual’s in daily life.

3.6 SUMMARY

This chapter briefly illustrates the methodology followed during the implementation of the product. Microcontroller, the PIR sensor and all other components that are used for hardware implementation is explained briefly with its features. The IOT device Software that works by the program coded by the user helps in the implementation of the software part of the product.

CHAPTER 4
EXPERIMENTAL RESULTS AND DISCUSSIONS

This project has successfully overcome the overconsumption of energy in day to day life. The Electricity used can be monitored through ubidots and can set limit. Alert message will be triggered and sent to the registered mail via IOT.

4.1 RESULT OF IOT BASED SMART ENERGY METER:

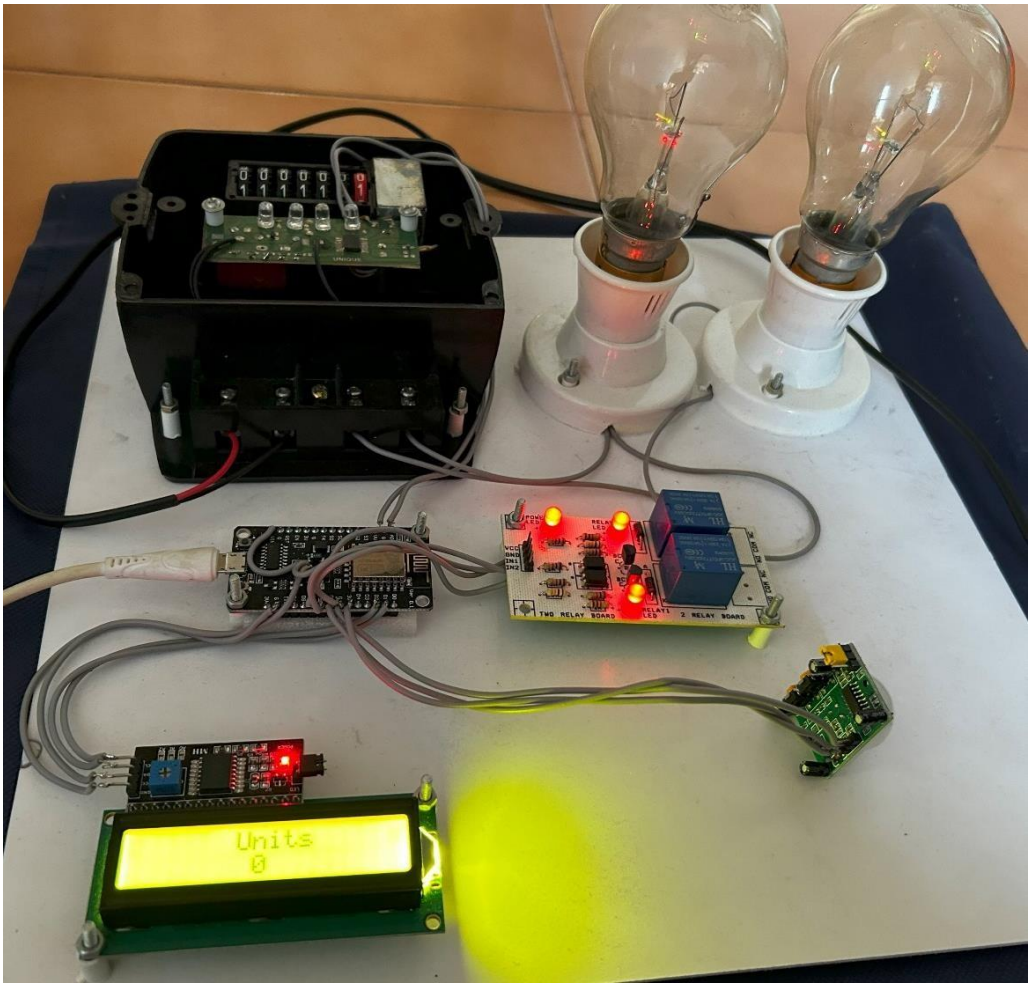


Figure 4.1 ESP8266 Connection Of Hardware Setup

Figure shows the hardware setup interfaced with ESP8266 to process the data from the sensors.

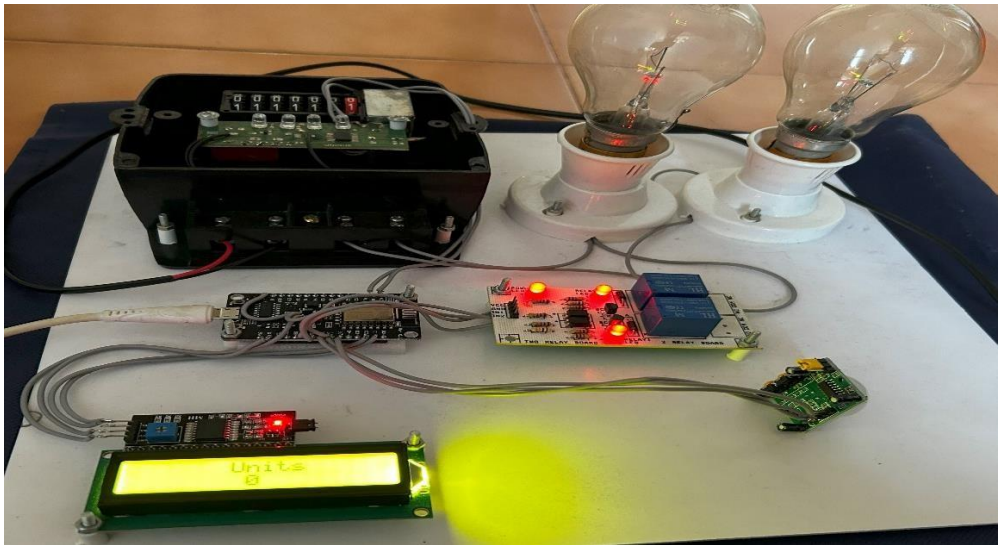


Figure 4.2 Non Triggered Stage

Figure shows that there is no people around the system and the load is not Triggered

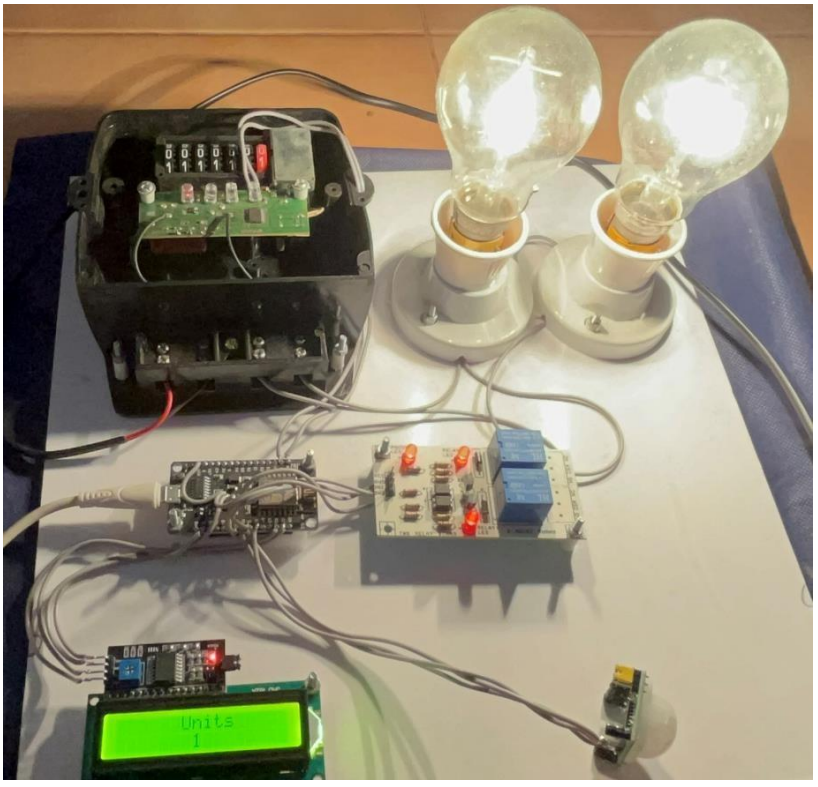


Figure 4.3 Triggered stage

Figure shows that when person enters the room the appliances triggers on automatically

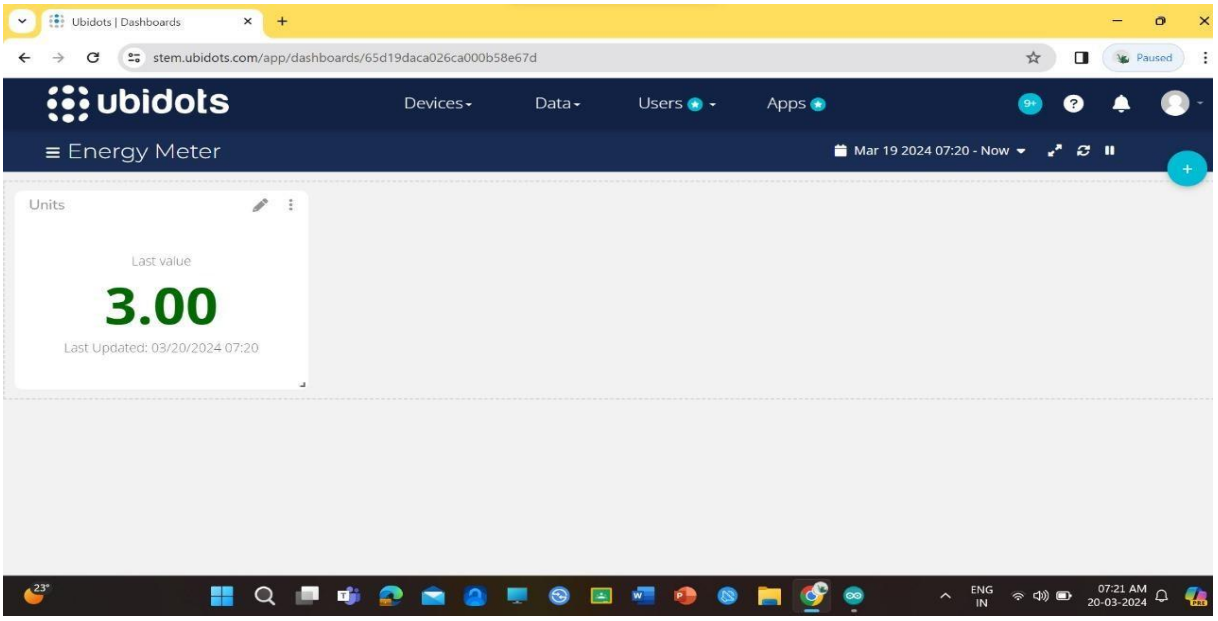


Figure 4.4 Units usage Monitored through IOT

Figure shows the live energy consumption in units through Ubidots.

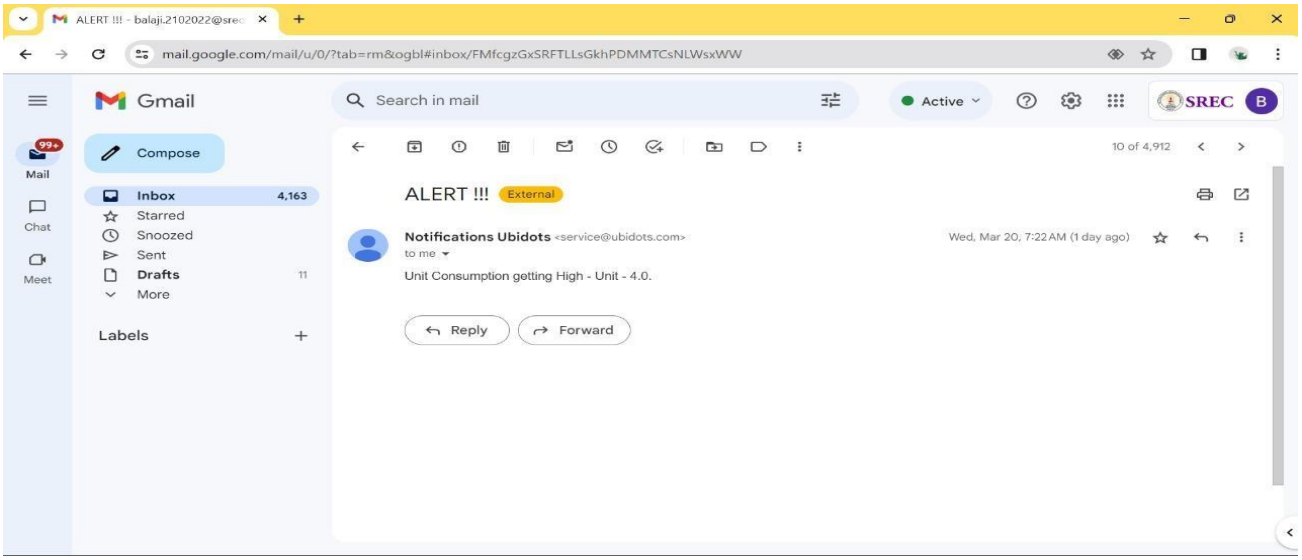


Figure 4.5 Alert message

Figure shows the automatically triggered mail when units crossed the limit set by the use

4.2 SUMMARY

The data collected from sensors are sent as live data to the software. The software process the data collected and sends alert message if units crossed the limit. The steps carried out are organized in such a way that it helps individuals in easy accessibility with both hardware and software.

CHAPTER 5
CONCLUSION AND FUTURE SCOPE

5.1 CONCLUSION

In the end, the suggested "Smart Energy Meter" system offers a revolutionary approach to managing household energy usage, overcoming the drawbacks of current systems and incorporating cutting-edge features to boost productivity and encourage sustainability. The suggested solution enables users to take proactive steps to improve their energy usage by combining real-time notifications for excessive power consumption, occupancy detection-based dynamic load control, and remote monitoring capabilities via IoT platforms. In addition to enabling significant reductions in energy waste and electricity bills, the Smart Energy Meter system promotes responsible energy consumption and helps create a more sustainable and environmentally conscious future for households globally through its innovative features and user-centric design.

5.2 FUTURE ENHANCEMENT

In Future, this System can be further developed with communication features by designing the basic level communication application that can be further installed through play store or can be designed with an alerting system by help of buzzers to alert users once the units reached their limit. This project when developed on a larger scale can be practically implemented in the Municipal Corporation of any village,town or city to reduce the Units wastage further more efficiently. This can also be implemented in individual houses in future.

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conducted on Feb 17, 2024.

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Dr.A.Grace Selvarani
HOD/CSE

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