DESIGN AND IMPLEMENTATION OF INTERNET OF THINGS BASED SMART ENERGY MONITORING AND CONTROLLING SYSTEM

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PROJECT SUBMITTED IN FULFILMENT FOR THE DEGREE OF
B. SC. IN COMPUTER SCIENCE AND ENGINEERING

INTERNATIONAL ISLAMIC UNIVERSITY CHITTAGONG

DECLARATION

By this I/We announce that the work in this project is my own, except for quotes and summaries properly recognized.

29 May 2021

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I/We declare hereby that we have read this project and I/he think this project is appropriate for the B degree award in terms of reach and consistency in B.Sc. in Computer Science and Engineering.

29 May 2021

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ACKNOWLEDGMENT

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Authors

ABSTRACT

With the expansion and expansion of the national economy and the power system, the reliability of a balanced power system became more important. This is the reason for the development of the metering system. Voltage, current, energy, and cost of energy usage are all measured. Initialization takes a few seconds, and then the voltage and current are monitored. The microcontroller then does a power estimation (watt). The energy rating in kilowatt-hours is then computed, as is the load used per unit cost. The microcontroller then output an LCD display. Every two minutes, the microcontroller sent SMS to the mobile distributor through IoT, which included the entire cost of the unit and unit. Additionally, reset the previous data. It begins counting units from the beginning. Previously, the electromagnet series was triggered by the current flowing via the current coil. Because the shunt magnetic coil is connected directly to the supply, it conducts current proportional to the shunt voltage. The pressure spindle is the technical word for this spindle. This method is inefficient in comparison to digital ones. Additionally, there is no option for IoT monitoring. The design and implementation of an embedded load monitoring system are shown in this project. Through the use of a single chip CPU and sensors, the online monitoring system is integrated with IoT. This system includes a current sensor and a voltage sensor, and the data may be accessed through the Internet of Things.

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CHAPTER I

INTRODUCTION

1.1 BACKGROUND

To help a nation for achieving economic progress, the power industry has a significant role. Due to heavy consumption government is facing a serious issue like power deficit. Computing an electrical bill has become a simple method .For this energy wasting and the bill-manipulating cost is reduced. Because of the rapid growth in energy consumption the developing nations power suppliers are facing a great difficulty. Several difficulties like inefficient use of energy, inadequate dependability, a large manpower and increased costs due to bill manipulation has created by conventional energy systems. Modern distributors are offering marvelous services as well as supplying consumers with current data on their energy meter to satisfy the customers .This system propose an energy-based IOT system to address this problem. Real time voltage, current, watt hour, and billing for consumer notation are shown on a 16x2 LCD display. A variable rheostat is used instead of a regular wattmeter to calibrate the proposed wattmeter as the proposed wattmeter's value is nonlinear compared to standard wattmeters. A cheap Microcontroller may be used to accurately calculate voltage, current, and watt-hour. An inexpensive IOT module can be used to tell distributors about how much power is being consumed, along with regular invoicing. This Proposed Energy meter is exactly matched with the recorded voltage and current from a multi-meter.

1.2 PROBLEM STATEMENT

A critical issue has arisen in developing countries like Bangladesh is energy deficit. Proper administration of power use is really hard without reducing power deficiency, billing and customers satisfaction all being managed at the same time. Customers are nowadays seeking for better service, more accuracy in calculation of energy and direct access to relevant data. Though there are several limitations of electromechanical meters, the ones we use today have other shortcomings such as inaccurate measurement and lack of configurability. They feature a multitude of moving components that are especially susceptible to wear over time, especially as a result of changes in operation temperature and conditions. In this scenario, greater service and great accuracy rely on improved metering.

1.3 PROJECT OBJECTIVE

The main objectives of this project are given below.

- To design a circuit for measuring voltage, current.
- To show the result in LCD Display & send the result in consumers mobile.
- To design an IoT panel for data reading from internet.

1.4 REPORT OUTLINE

In the process of design and development, five chapters have been discussed. In chronological order, the chapters and their contents are as follows:

- Chapter 1 introduces the project and explains the aim, motivation, and goals.
- In chapter 2, we're doing a literature review. This project's previous work is mentioned in this chapter.
- This chapter is about methodology. Every single aspect of this project is covered in detail in this chapter.
- The installation of the system, as well as the outcomes, are addressed in Chapter 4.
- Finally, the project's conclusion has been extensively explored in chapter 5. The project's limitations, its advantages, and its future development have all been examined in relation to this issue.

CHAPTER II

LITERATURE REVIEW

2. 1 INTRODUCTION

Now–a-days to measure the overall success of a nation, the best parameter is the usage of that nation's energy. In case of measuring the energy, energy consumption has to occur first. In 1870 the most common source of energy was gas lights. Gas meters were used to calculate the amount of energy that was utilized. Last decade, the energy metering process has seen major progression. Despite Edison's DC electrochemical meter being quite time-consuming to read, it was not widely adopted.

2.2 SCOPE OF THE PROJECT

At present accessible meters follow the theory initially applied in Blathy's meters in 1889, this concept was developed by Blathy in 1889. In typical electricity meter, the kilowatt-hour (kWh) is the unit of measurement. All readings must be read just once within the billing period. There is a chance of mistake in the process hence it requires human interaction. Due to heavy usage of electricity, the history and development of energy meters expanded back to the 1880s. While the period of gas lamps also had the energy metering system. where the amount of energy spent per home was determined, the period of electrical lights also began with a measuring system to quantify the amount of energy used per family. Gas light was replaced by electric light due to widespread usage of electricity in the late 1880s because of its lumens and lower cost. New metering technique for consumption were needed. DC ampere-hours charge values were stored on the DC meters. DC meters were insufficient over time. Then, there were electrochemical and electrolytic meters invented by Edison. Though it worked but the electrochemical meters were a massive task to read because of their complexity. IoT-based system installation is thus necessary in this sector.

2.3 REVIEW OF PREVIOUS WORKS

Few of the previous work based on Smart Metering System has described below.

2.3.1 Arduino Based Energy Meter Using GSM

With the help of bilateral communication and controlling of load this system is managed to bring smartness [1]. One of the finest advantages of this system is that it can make a good communication between the distributors and the users. The proposed system reads the 3200 blinks per kilowatt-hour of an existing metering system, during the installation process it get implemented and the metering system in use is the only way to change it. Microcontroller is connected LDR sensor and an amplifying circuit which receives input signal. The system now waits for the output value of RTC, which main task is to interrupt the microcontroller and allows the device to connect to a GSM module that provides the user and server updates.

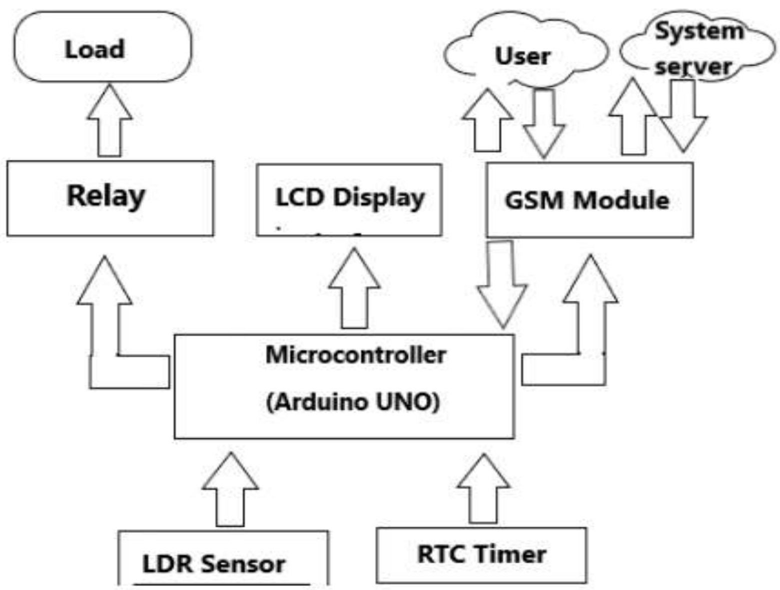


Fig. 2. 1 Arduino Based Energy Meter Using GSM [1]

If the user want to know further information or terminate the power supply for a certain period of time, they have to send a text message to the GSM module which work as a trigger. The user may also use the server for the same task. Data can be divided in several ways. Coaxial cables or fiber optics can be used for wired technologies along with GSM, Wi-Fi, or Zigbee technology, wireless solutions such as GSM, Wi-Fi, or Zigbee can be used [2][3][4][5]. If user unable to pay his bill in time, users supplies will be disconnected and unplugged from relay [6]. This proposed system has LED blinking and energy consumption like conventional meter. In order to claim the accuracy of the system, the system's function were evaluated under different circumstance and the result were compared with the readings that was collected from the traditional meter. The aim of this system is to build a user-friendly billing system to reduce human err. LDR is used to calculate the amount of energy utilized in the system. In order to have bidirectional communication, the system uses GSM, while timer displays the true. This system allow users to monitor their usage with less effort. This system is beneficial for the user because it sent an email that informs them of consumption. User can unplug the load from the supply by sending a simple email

2.3.2 Design and Implementation of an Internet of Things Based Energy Metering

This proposed system inaugurate Smart Energy Monitoring (SEM). In residential and industrial buildings this system can be used to measure how much energy electrical devices using and to employ controls on those equipment [7]. Using a different method it sent data like consumption, power line characteristics, result to a central server. It's possible to warn consumer’s consumption patterns based on the information gathered. In normal and non-peak hours, the system can control electrical equipment and shut it down if required. The system is also able to monitor and record other data like temperature, humidity, light, and the potential for leakage of harmful gases. This system is well-designed to notify customers of their usage and the current price of energy. The SEM system depicted in Fig. 1 has three key parts: sensor nodes, a gateway, and a server. Sensor nodes report their information to Gateways and Gateways use Internet connections such as ADSL modems or 3G/4G/LTE networks to connect to the Internet. Each component is described. An Android HTTP Gateway has been built. The Gateway handles all of the sensor node configuration and gathers the sensor data using the standardized API RESTful instructions. The sensor data will stored on the selected server and will be available for recover even after the project has terminated. The Gateway use an unique API key for each customer to communicate with the Server. This API key is utilized for the security and authentication process. Gateway will use this API key in the messages every time. In AP mode, the sensor node can be accessed through the IP address 192. 168. 4. 1. The gateway connects to the AP and programs it from the beginning. The sensor node can join the network SSID and password by connecting to the Gateway's local WiFi network. At the end of this process sensor node can join the network using local WiFi. Once they've joined to the Wi-Fi network, the Gateway allows the sensor nodes to communicate with each other. This web service was built on top of the Android service functionality.

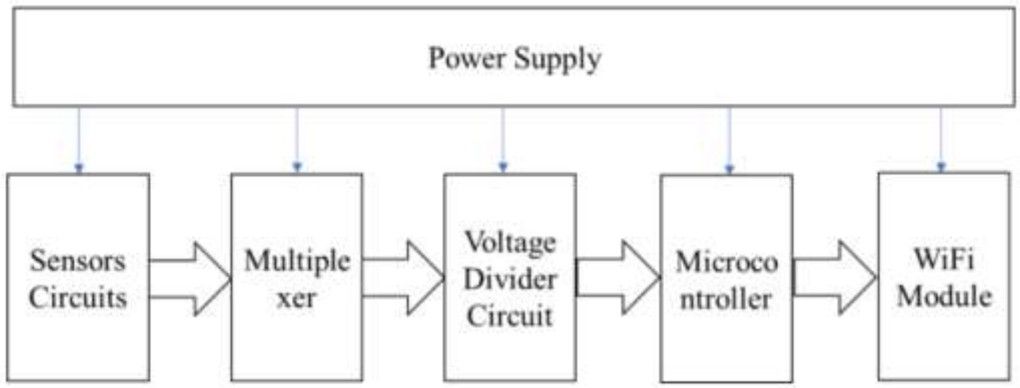


Fig. 2.2 Design and Implementation of an Internet of Things Based Energy Metering [7]

For android application, web server is one of the components that continuously run in the background of the android OS. Android will immediately restart it if the web server stops. To create the web server in the Android Gateway, they utilized the Nano HTTPD package. If you need to extract information from the HTTP message and deliver the response as a http message to the client, you may use this renowned library. The Nano HTTP/HTTPD server is a lightweight HTTP server that has a BSD-style license. It also used as a software library in software development. This system has a DHT22 temperature/humidity sensor, a MQ-5 gas sensor, a light sensor, a current sensor, a 5 V relay, and an MCU/Wi-Fi controller which has been deployed in order to gather client home information. To create the home gateway on a Raspberry Pi 3 running Raspbian with JavaFX which runs on a JavaFX platform using a Raspberry Pi. This system also have an SCT current sensor aiming to assess the entire power consumption of consumers. In this system, we see a way to protect the AMI network to avoid major disaster. Additionally, since the system is gathering energy consumption and other metrics, numerous smart grid applications may be designed and implemented, including Demand Response, AMI, and Energy Management System.

2.3.3 Smart Energy Meter Surveillance Using IoT

In this system, a unique ID is assign for every single energy meter. And this unique id is connected with the consumer's unique mobile ID [8]. The load consumption of each metervis sent to the control station via web server and other information like billing and power cut are sent from the control station to the user's energy meter. It is shown data on the LCD screen how much energy is consumed every day

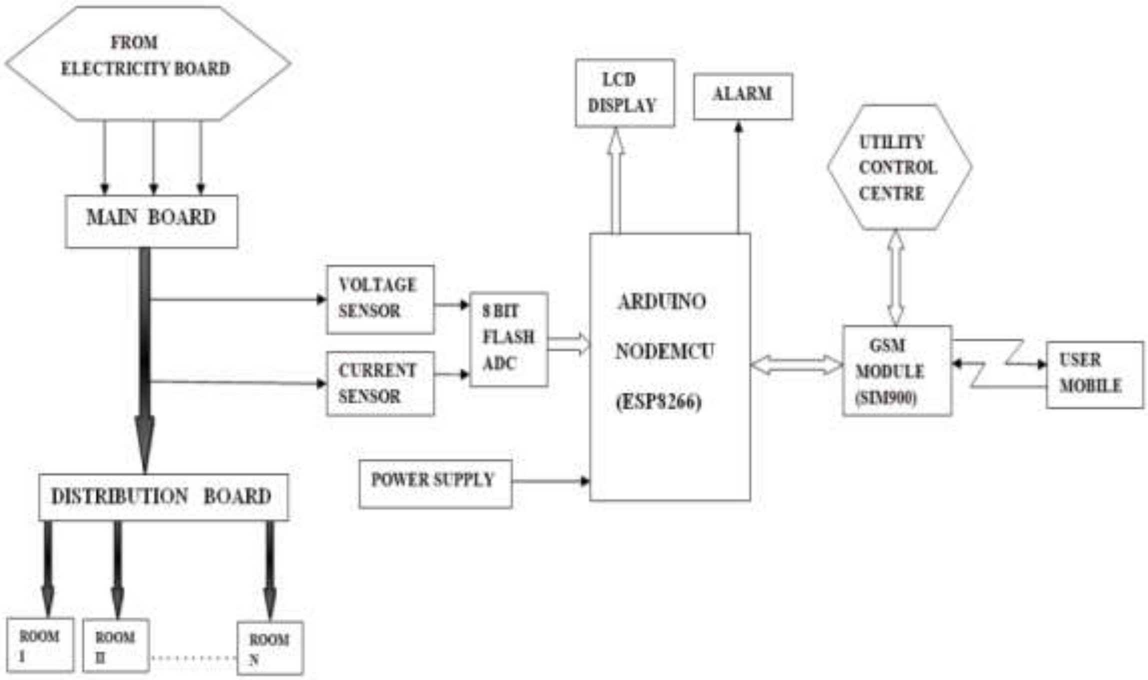


Fig 2.3 Smart Energy Meter Surveillance Using IoT [8]

With the IoT module, the customer's electricity usage is billed to them monthly through the GSM module. Customers get notifications of their energy bills through text messages. User can pay their bill using any web browser. This eliminating the manual process to collect the reading. Without electricity healthcare, industrial and public sectors faced major problem. It is important to be alert for hospitals, industrial and customers in advance. Power termination information are sent to the consumer’s mobile ID through EB web server. Data is also shown on the LCD display whenever an alert is triggered. An alarm is used to alert consumer’s that a new message has been received. But it is a time consuming process. This system need less human effort and also a time saving system. This proposed system supplies energy consumption information on a daily basis, payment and billing information by means of IoT, pre-caution notification of power cut alert of high consumption, an alert system if the energy consumption exceeds the critical limit. A recommended solution is being suggested to eliminate human involvement in order to gather readings on a monthly basis and to avoid technical issues with payment. The consumption data and other information are sent to the customer by the energy board section. To notify customers who do not pay their bills on time, deploy IoT. An alert message will be sent to the consumer’s mobile if they don't pay their bill on time or use exceeds limit that user set. Also, when inhabitants are out of station, the electricity supply may be shut off with a message to saving energy.

2.3.4 Wireless IoT based Metering System for Energy Efficient Smart Cites

The proposed IoT-based metering system is aimed to support intelligent city development and reduce energy consumption. The major goal of this is to prevent exceeds power usage which is rapidly increasing [9]. It's main benefit is that it has solution which user faced using the old meters, including inaccurate readings from the analog electromechanical meter. The conventional meter which use as post- paid has no sense of billing. It only guarantees that customers will get power supplies, except during blackouts. Advantages for both utility providers and customers may be found in prepaid meters. From the utility perspective, it reduces many issues like delays, wrong meter reading, billing mistakes. It inspire customers to consume less energy, helps customers to avoid shut offs by cutting off their accounts after zero credits [9]. This system uses the pre-payment metering. The following images depict the whole system design, which includes the components and construction components for each unit block. The detecting unit has a voltage transformer and a current sensor linked to the main supply. This transformer used 240 volts to 6 volts one step-down transformer. Current sensor which measured the current traveling through a single wire by using SCT-013-000 non-intrusive sensor, the current sensor had two clips: one for either the live or neutral current [10].

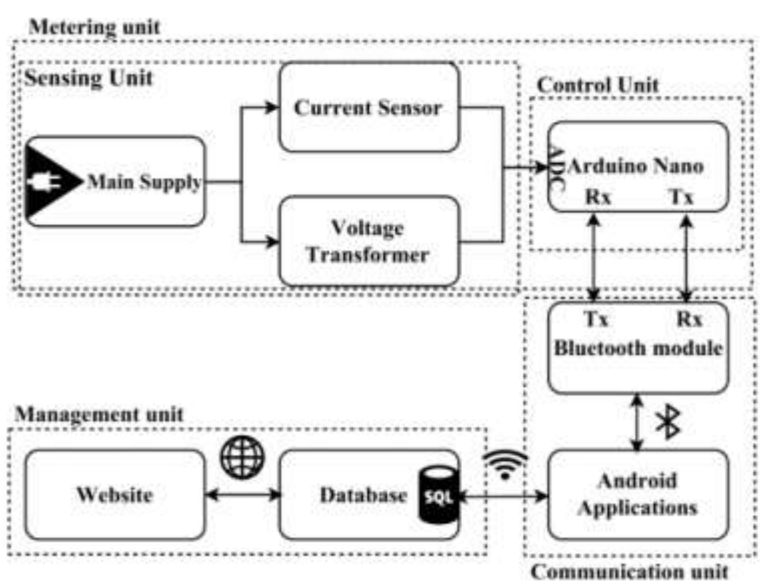


Fig 2.4 Wireless IoT based Metering System for Energy Efficient Smart Cites [9]

To acquire an estimate of current, a burden resistor is connected to the two terminals of the sensor while connected to an Arduino or other microcontroller. In addition, reading of both component are carried over to the next unit for processing. The control unit is composed of the ATmega328 microcontroller, which is based on the Arduino Nano microcontroller. Data which collected from sensing unit are carried as an input to the built in ADC in the microcontroller. Once data processing is done it turn kilowatt hours into kilowatt hours of electricity. It also count the available balance and the units. The below computations were done: Using equations (1) and (2) it compute the initial calibration values for the current and voltage as 0. 707, 1024 is the maximum reading from Arduino input ports and 36 is the burden resistance value for the current sensor. In order to compute the current value of the supply that the microcontroller reads from a 200-sample loop is used that maximum and lowest values from the analog pins on the sensor. According to equation, the current is determined as given in the following formula (3).

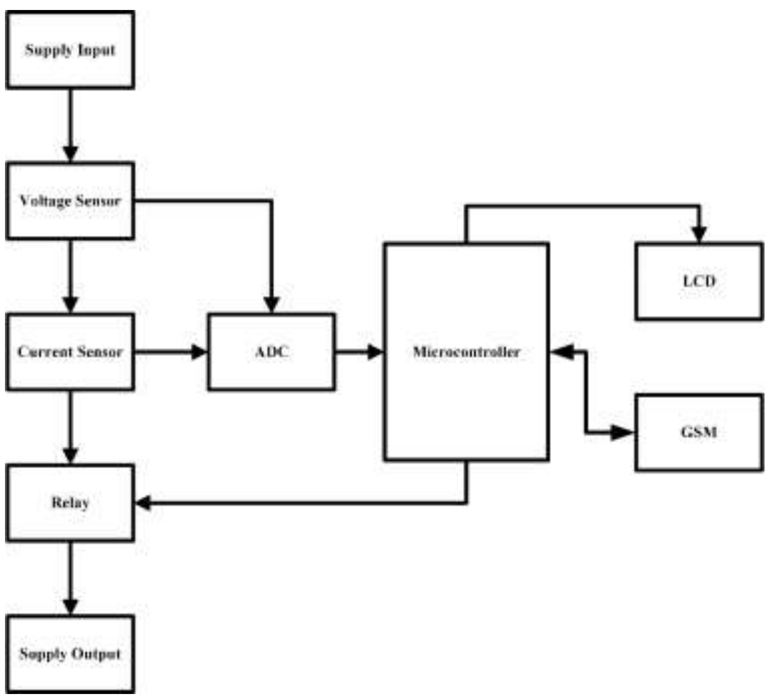


Fig 2.5 Design and development of GSM Based Energy Meter

Taking calculated value of voltage that reading from analog pin of microcontroller also shown in equation using software function called analogRead (). The control unit's key feature is established communication between the Android application and the control unit. The HC-05 Bluetooth module and the Android application make up this composed. The module is connecteded to the control unit and serially connected to the metering system. When a Bluetooth device is paired with the Arduino Nano, its Tx and Rx are attached to digital pins 0 and 1 on the Nano.

2.3.5 Design and development of GSM Based Energy Meter

To completed this project, the author use an ATmega8L microcontroller paired with a GSM module. To measure and detect the voltage and current supply of the input a potential and current transformer has been used in this system. Authors have set up two sensor pins with analog pins. The LCD shown all the on the screen. In this system, To tracking data securely, each meter has a unique identification number. Another handy method is to utilize the SIM card number as individual identification numbers. Author has configured the device by using step down transformer for reliable power source. Then the power source has been rectified to DC using diode and then it brought down to certain level for on boared usage. Current transformer is installed in series with the power source, while another is installed in parallel. The current sensor and potential transformer both get the data from the usage and store it when the user connects to the system. Wattage is calculated by taking measurements of voltage and current, then multiplying the result with an ideal power factor to find the amount of watt age used. All the data tracked by this system is shown on the LCD. The authors has connected the GSM with the microcontroller using logic converter.

CHAPTER III

METHODOLOGY

3.1 INTRODUCTION

In order to complete a project, hardware is more significant than everything else. Hardware part is really quite tough. In this project we will discuss about the hardware their usage in this chapter. One will get to know about the importance of using the components and how they serve this project at the conclusion of this chapter.

3.2 LIST OF COMPONENTS

- ESP 32
- ACS712 Current Sensor
- LCD
- I2C Adapter
- Relay
- Step Down Transformer
- Diode
- Capacitor
- Voltage Regulator

3.3 ESP 32

The ESP32 is a little wireless chip with 4MB of flash memory. Complete TCP/IP stack and microcontroller functionality are available in this low-cost Wi-Fi microchip from Espressif Systems. By using TCP, this module links microcontroller to a Wi-Fi network and enables them to use Hayes-style command to connect to a TCP/IP network.

3.3.1 Features of ESP 32

- The following characteristics of ESP 32 have been described:
- Eleven digital input/output ports

- one analog input
- USB micro port
- Power plug, with power input from 9-24V.
- Arduino-compatible

Fig 3.1 ESP 32 [10]

Table 3.1 describes the pin description of the ESP 32.

Table 3.1 Pin Description of ESP 32

Pin	Function
TX	TXD
RX	RXD
A0	Analog Input, max 3.3V input
D0	I/O
D1	I/O, SCL
D2	I/O, SDA
D3	I/O, 10K Pull-up
D4	I/O, 10k Pull-up, BUILTIN_LED
D5	I/O, SCK
D6	I/O, MISO
D7	I/O, MOSI
D8	I/O, 10k Pull-down, SS
G	Ground
5V	5V
3V3	3.3V
RST	Reset

3.4 ACS712 CURRENT SENSOR

This current-sensing IC is bi-directional and Hall effect. Current flows through the IC and as a result the IC is ineffectual to detect any voltage. This is a breakout board for the integrated Hall Effect current sensor, which includes an ACS712 converter chip. Both AC and DC transmissions can be done by measuring current sensor with great accuracy. The signal and copper traces are quite thick to survive an electrical overload. The calculation of an analog voltage output signal from ACS712 changes linearly with current. It needs a 5V power supply for VCC, as well as two filter capacitors.

Fig 3.2 ACS712 Current Sensor Module [11]

Table 3.2 represents the summary of ACS712 Current Sensor.

Table 3.2 Summary of ACS712 Current Sensor

Parameter Name	**Value**
Supply Voltage	4.5-5.5V
Supply Current	10mA
Current Measurement Range	30A
Output	Bi-directional Analog Voltage
Sensitivity	66 mV/A

3.5 STEP DOWN TRANSFORMER

A transformer is an electrical device that connects two or more circuits via electromagnetic induction. When the transformer's current varies, so does the magnetic field, and hence the voltage applied to the second coil. When two coils are placed within close proximity to one other, a magnetic field is created between them and this field may transmit power between the two coils A law known as Coulomb's law of induction was developed by Charles-Augustin de Coulomb in 1831, which describes the magnetic induction effect. Transformers are used to adjust or regulate the various voltages that are used in electrical power settings. A step-down transformer was utilized in this project where main coil inputs were set to 220 volts and the secondary coil outputs were set to 12 volts. This transformer steps down the voltage needed to activate various motors, solenoid valves, and hot guns that have been employed in this project.

3.6 LCD DISPLAY

LCD screens are very popular everywhere nowadays. In many devices, like calculators, computers, cell phones, and watches have the display. LCD stands for liquid crystal display.. 16×2 LCD displays are a fairly popular DIY and circuit board module.

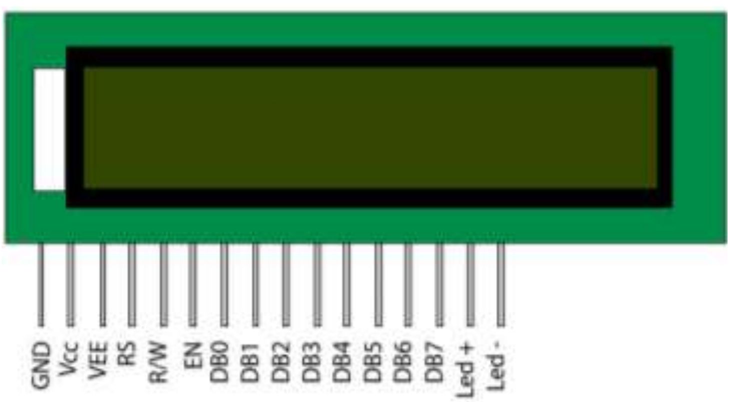


Fig 3.3 16x2 LCD Display [12]

Pinout of an LCD display is seen in Figure 3.3. The 16×2 displays one line of text with sixteen characters per line. This LCD has a character display that is 5 × 7 pixels in size.

Table 3.3 represents the summary of 16x2 LCD Display.

Table 3.3 Summary of 16x2 LCD Display

Pin No.	Description	Name
1	Ground (0V)	Ground
2	Supply voltage (5V)	Vcc
3	Contrast adjustment	V_0/ V_{ee}
4	Low for command register, high for data register	RS (Register select)
5	Low to write; High to read.	RE (Read/Write)
6	When low use as output device, when high use as input device. Generally grounded it.	E (Enable)
7	8-bit Data Pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Back light Vcc (5V)	Led+
16	Backlight Ground (0V)	Led-

3.7 I2C LCD ADAPTER

Converting a parallel-based 16 x 2 character LCD display into a serial i2C LCD that can be operated with only two wires is the serial I2C LCD display adaptor. The PCF8574 I/O expander acts as an adapter that utilizes I2C protocol to interface with Arduino or any other microcontroller. A total of 8 LCD displays may be linked to the same two wire I2C bus with each board having a separate address. A0, A1, and A2 are i2C pins that may be modified to 0X20~0X27 by soldering.

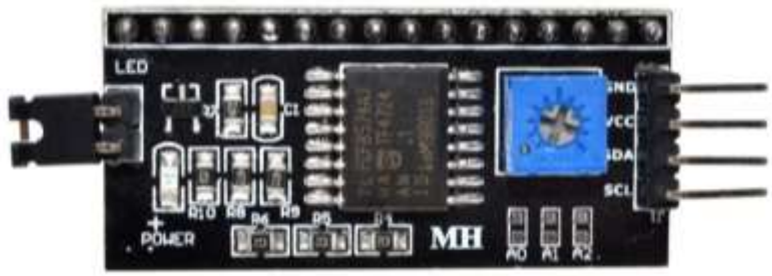


Fig 3.4 I2C LCD Adapter Module [13]

Features of I2C LCD Adapter

- One wire controls the character LCD display's 16x2 character LCD display.
- A maximum of eight LCD screens linked through I2C cables .
- The Arduino board is easy to operate and allows fast prototyping.
- Which is compatible with LCD display panels with 16 x 2 characters per line.
- You will find a 16-pin male header connection with a soldering tip on it .
- contrast is controlled using a potentiometer that is installed on the motherboard
- To control the backlight, just adjust the jumper on the circuit board.
- 5V DC voltage power source

3.8 RELAY

A relay is an electrically operated switch. in mechanical relays Electromagnets are used. Solid-state relays can also be used . In many applications, a relay controls a circuit using a distinct low-power signal, such as to activate circuits separately. Relays are electromechanical switches that open and shut circuits. Relays off and on connections in another circuit to operate an electrical circuit. The relay contact is shown in a relay schematic to be open when the relay is unenergized. There is a closed contact when the relay is not electrified, if the relay contact is Normally Closed (NC). Once you provide electrical current to the contacts or not, they will be in a different state. A single pulse of power is being used to move the relay contacts in one way. To move them back, use a different, redirected pulse of power. Input pulses that are applied more than once have no impact. Latching relays are used in situations where there should be no disruption in power transfer after latching has occurred.

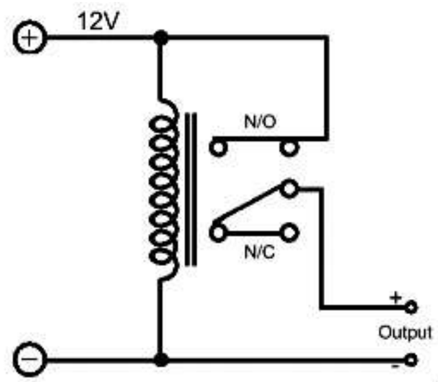


Fig 3.5 Internal Structure of a Relay [14]

3.9 DIODE

A diode is a component that enables current flow exclusively in one direction. Diode only terminates current flow in the reverse direction, but it has a restricted reverse voltage range before breakdown. Breakdown occurs when the reverse voltage reaches this level. The diode operates the circuit like a valve in electronic and electrical systems. P-N junction is the most basic kind of diode and in forward bias it acts as an ideal short circuit while in reverse bias it acts as an ideal open circuit. Besides a basic P-N junction diode, other varieties of diodes use various underlying concepts, although they all have the same result. So, diodes may perform as a simple circuit for converting AC to DC. That is why they may also be termed as a rectifier. A diode sign, with an arrow that points toward conventional current flow is seen here. The forward voltage is applied when P-N junction diode is in forward-biased, meaning that the p-type side of the junction is connected to the positive terminal and the negative terminal of the source is connected to the n-type side. Potential exists across the intersection. This barrier potential is in the opposite direction as the forward voltage applied. Silicon diode has a voltage of 0.7 volts. Germanium diodes have a voltage of 0.3V. When the voltage supplied to the forward-biased, diode is greater than the forward-biased voltage. Then Current will flow and the diode will be shorted. As a result, no additional voltage drop will occur between the junction and the positive voltage and the external resistance connected in series with the diode. The diode will begin conducting, once the voltage provided to the diode exceeds the barrier voltage or forward voltage of the junction.

Fig 3.6 Diode Symbol and Polarity [15]

3.10 CAPACITOR

Electric charge is stored in a capacitor. Capacitors are constructed from two closely spaced conductors (typically plates) separated by a dielectric substance. When linked to a power source, the plates gather electric charge. Positive charge builds on one plate and negative charge on the other. Capacitance is the amount of electric charge that is held in the capacitor at one Volt of voltage. Farads is the unit of capacitance (F). A capacitor disconnects DC circuits' current and shorts AC circuits' current. Capacitors are passive components. They neither create nor use energy.

Fig 3.7 Polarity of a Capacitor [16]

Plate-I is in a state of positivity in relation to Plate 2 at that instance. In steady state, the current tries to flow from the positive plate of the battery to the negative plate of the capacitor but this is blocked because of the presence of an insulating substance. The capacitor attracts an electric field. Over time, positive plate becomes more positive with each charging cycle, while negative plate becomes more negative. When the capacitor's capacitance equals the voltage, it retains the maximum charge. This charge period of this capacitor is referred to as "discharging time".

3.11 VOLTAGE REGULATOR

A voltage regulator is an integrated circuit (IC) that produces a set fixed voltage output regardless of the amount of current going through the load or voltage applied to the input. For the sake of keeping this project minimal, we will mostly discuss the linear regulator. A linear voltage regulator keeps the output voltage constant by continuously altering the resistance, while accounting for variations in both input and load. This project requires a 5V and a 12V power source. The 7805 and 7812 voltage regulators are required to achieve these voltage levels. Positive supply consists of the number 78, and output voltage levels must be met with the digits 05, 12. The L78xx three terminal positive regulator series is in stock.

3.12 BLOCK DIAGRAM

As shown in Figure 3.12, the general block design of this project is laid up in three main blocks. We utilized an ESP32 to connect all the devices in this project. Three current sensors and a voltage divider have been utilized to measure the load current and AC voltage. To see all of the findings on the display, a 16x2 LCD monitor was used. For particular conditions, a 6-channel SPDT relay has been used.

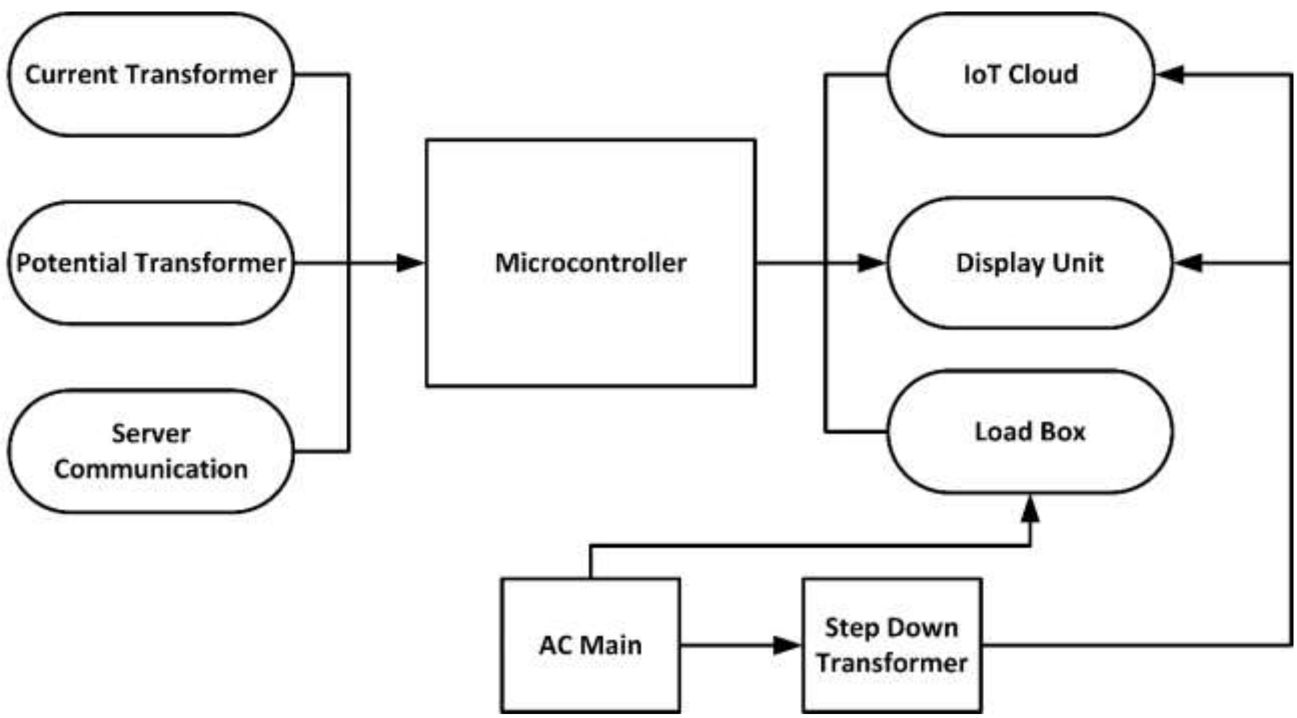


Fig 3.8 Block Diagram of the System

3.13 CIRCUIT DIAGRAM

The circuit includes all the components that have been interconnected using ESP 32. We've taken use of the analog pins to get the sensor information. The current sensor, which measures the entire current of the circuit, is utilized to measure the current we have utilized. Sensors are currently interfaced with the D34, D35, and D32 GPIO pins of the ESP32. We have created a voltage divider circuit using the winding of a step-down transformer to determine the voltage. Voltage divider circuit output been linked to the D33 GPIO pin on ESP32. The display has been utilized to show all the data on the screen, thanks to a 16x2 LCD. This display has been connected to the I2C bus by means of an I2C Module. Every single component in the circuit that has been utilized is powered by an LM2576 regulator that is programmed to deliver a consistent 5V power supply. Electromagnetic relays are being used to link the various loads together.

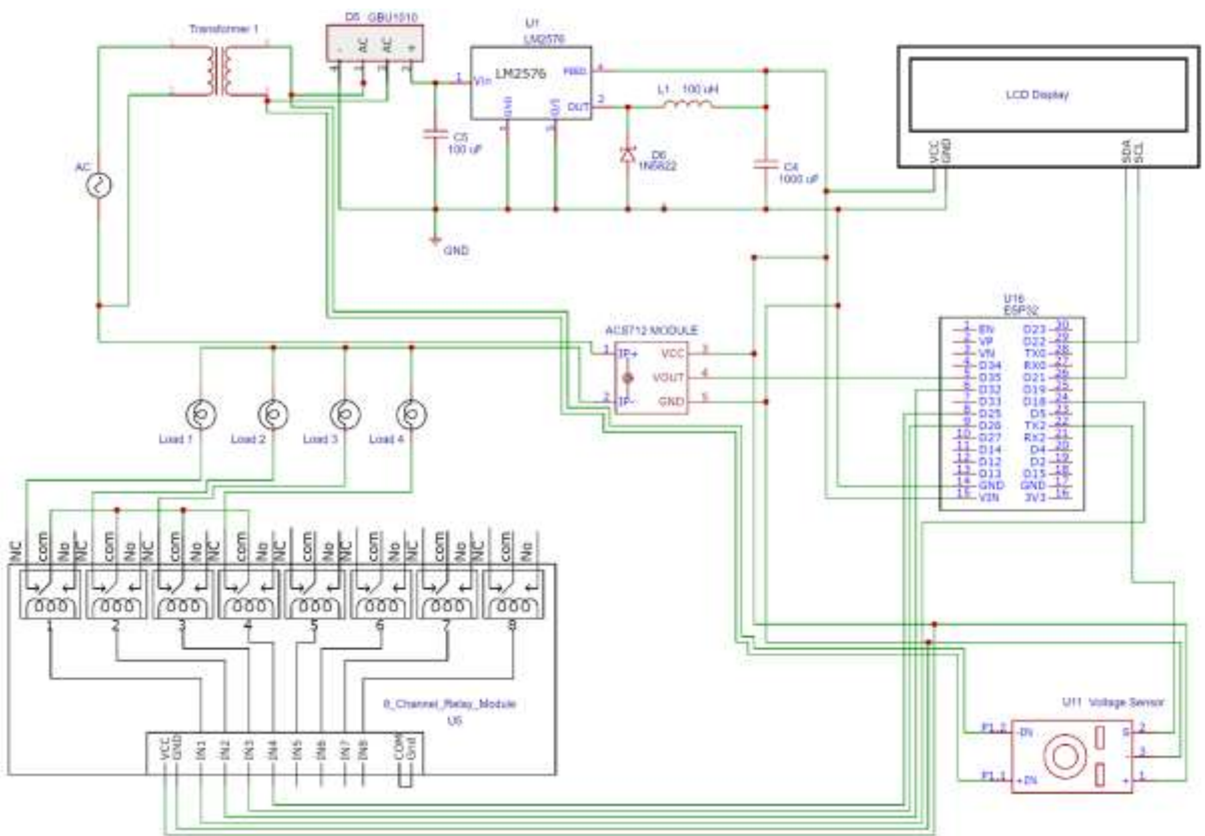


Fig 3.9 Circuit Diagram of the System

3.14 PROGRAMMING

The programming of this whole has system has described in brief below.

3.14.1 Library Files

- Wire.h: This library allows communicating with I2C devices. Arduino communicate with I2C devices through the SDA (data line) and SCL (clock line) pin.
- LiquidCrystal_I2C.h: This library allows an Arduino board to control Liquid Crystal Displays (LCDs) based on the Hitachi HD44780 chipset. The library works with in either 4- or 8-bit mode.

3.14.2 Functions

- void setup(): The void keyword is used only in function declaration. It returns no information to the function from it was called. The setup function initializes variables, pin modes, start using library etc. The setup function will only run once, after each power up.
- void loop(): This function is used for running main program over and over again. This helps continuous execution of certain program simultaneously.
- Serial.begin(9600): Serial.begin(9600) doesn’t actually print anything. Rather it initializes the serial connection at 9600 bits per second. Both sides of the serial connection (i.e. the Arduino and computer) need to be set to use the same speed serial connection in order to get any sort of intelligible data.

3.15 FLOW CHART

The full system's flowchart may be shown in Figure 3.10. This flowchart shows the whole of this project's setup and procedural processes. The first time a user accesses the system, the introduction message appears. This is going to offer a brief introduction of our project's topics. Everything has been initialized and defined. In the setup function, the state of the input output pins is indicated. After the program has executed setup, it will begin performing the loop function. Here we have defined a number of user-defined functions inside the system. This has been recorded in Figure 3.11. Analog voltage values are sent to the microcontroller, which converts the values into a readable form before they are sent to the user. To precisely measure voltage, we averaged 20 findings and found a consistent number. Fig 3.12 illustrates the reading sub process, which is then launched. the current measurement made with the ACS712 current sensor gives proportional current value.

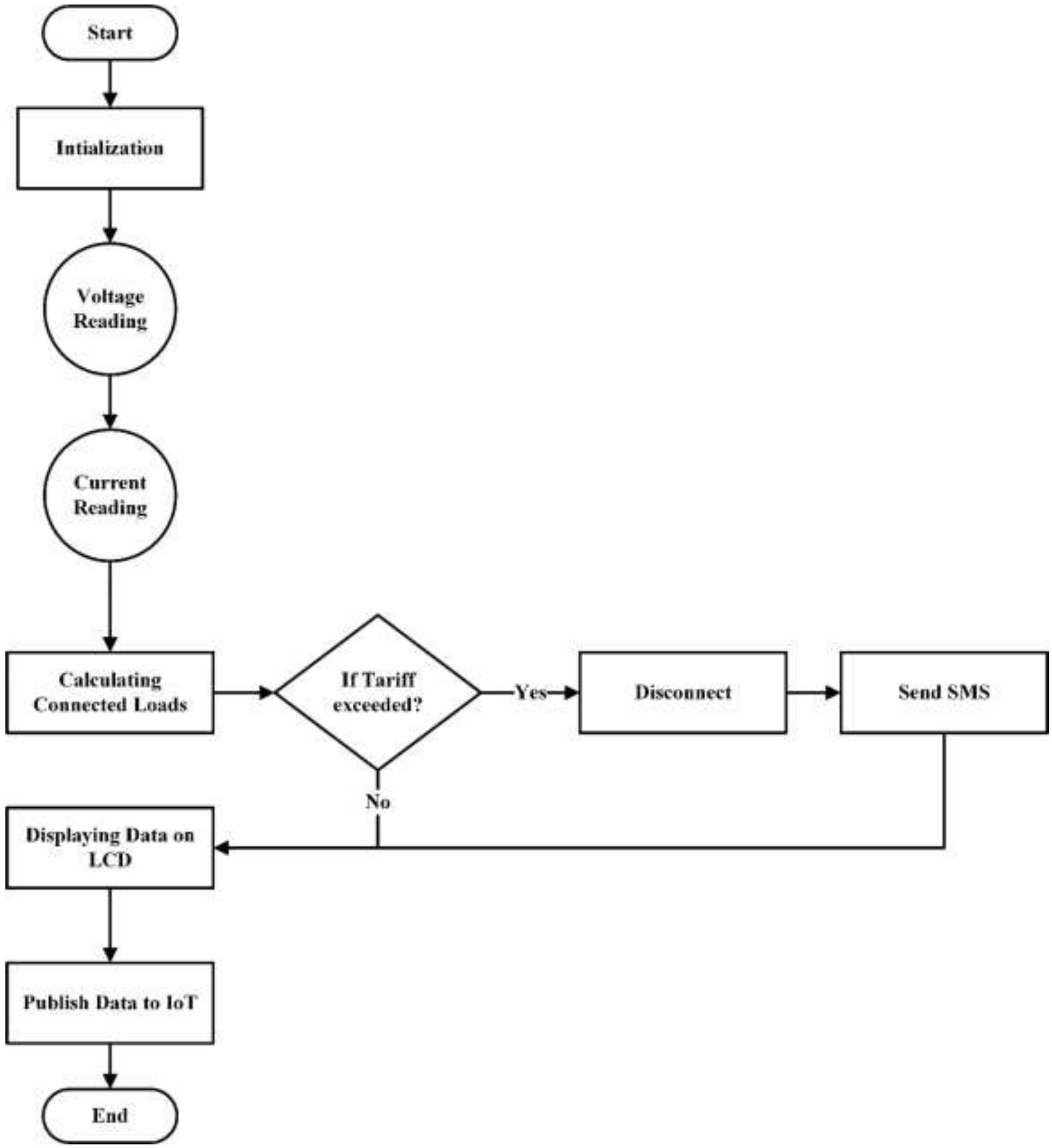


Fig 3.10 Overall Flow Chart

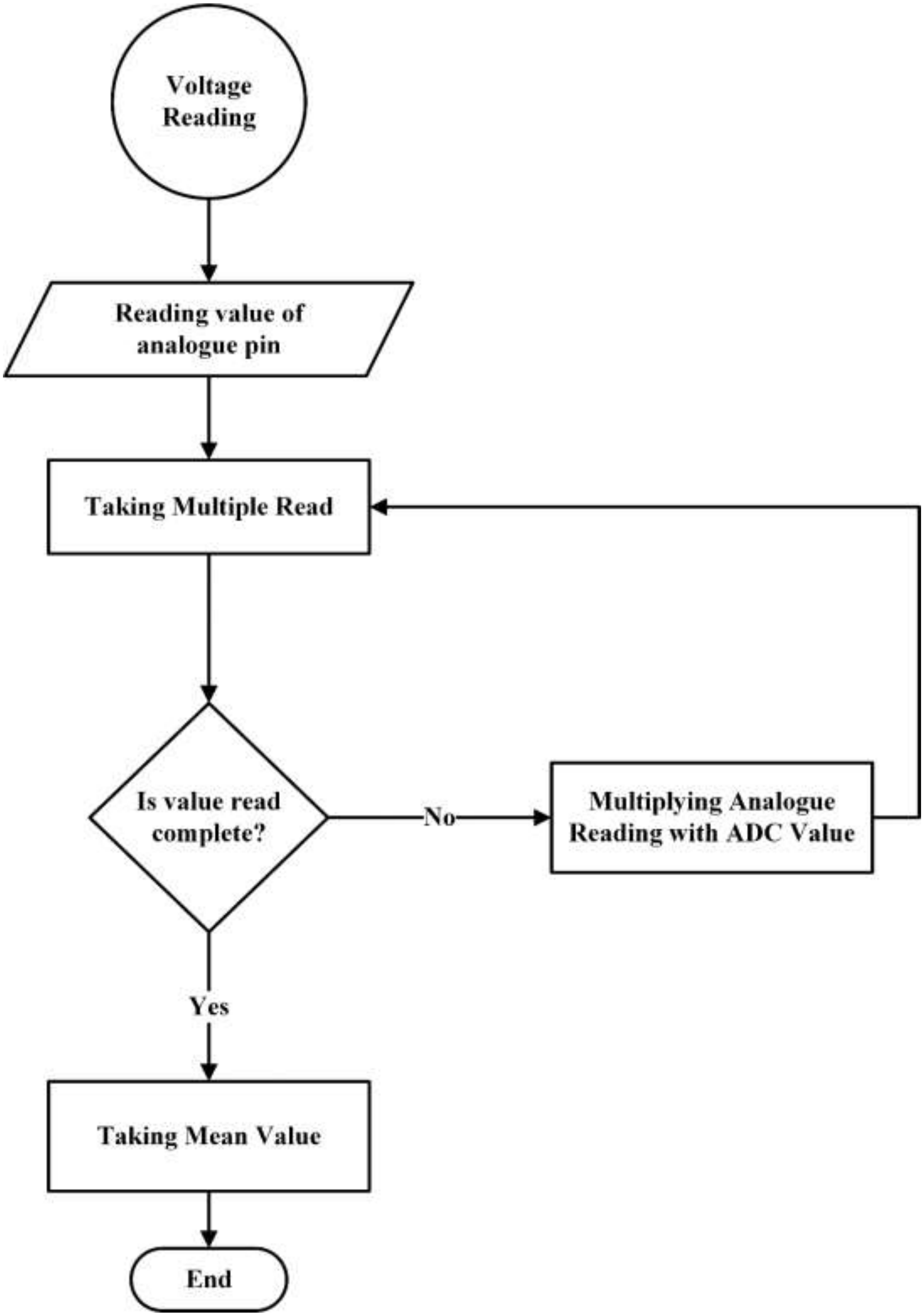


Fig 3.11 Reading Voltage Flow Chart

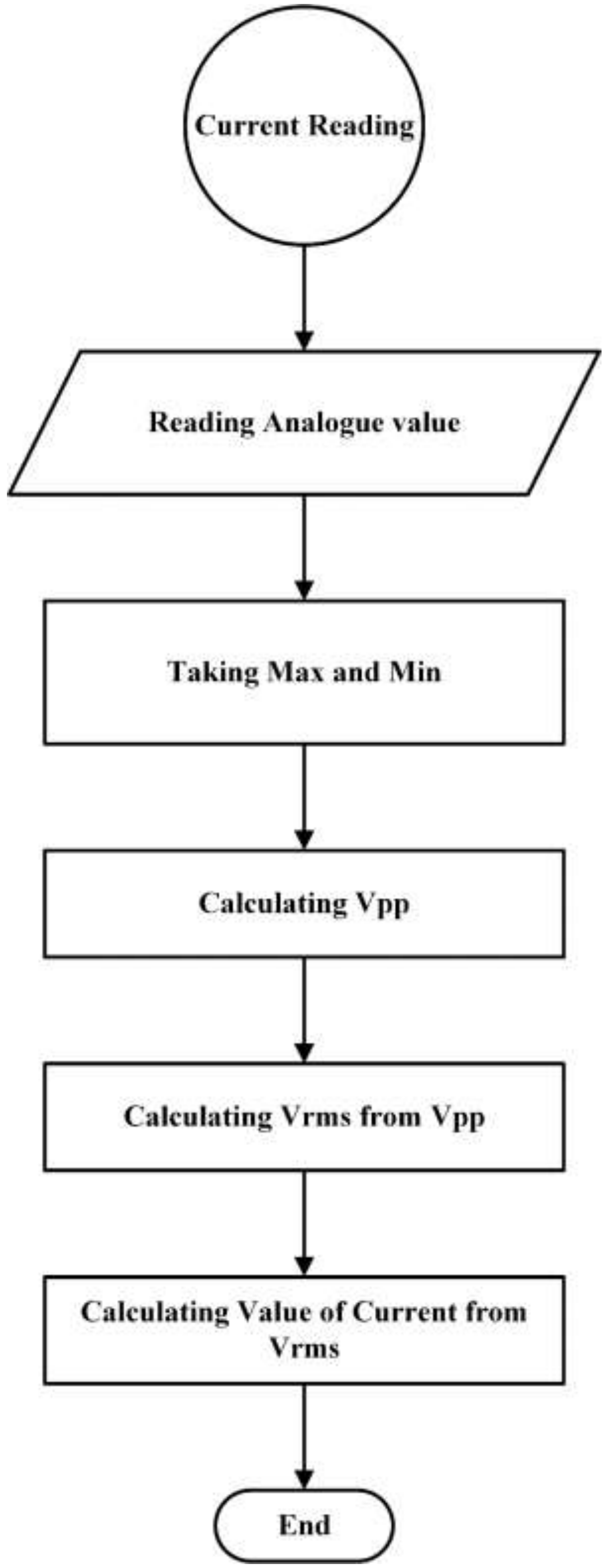


Fig 3.12 Reading Current Flow Chart

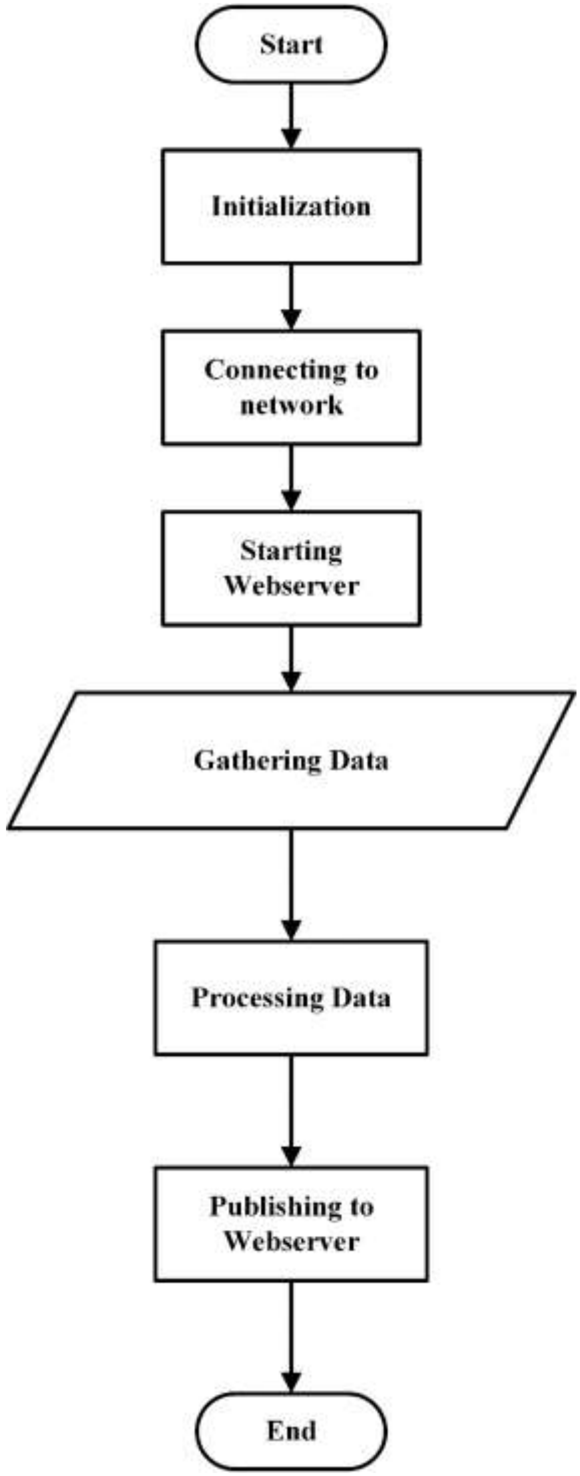


Fig 3.13 IoT Flow Chart

After having evaluated these numbers, the system shuts off the output section and displays the failure on the display as well as sending an alert to the IoT. The app launches a webserver and connects to a network device both on its local machine and on the specified network. A user may examine the IoT panel data real-time by going to the network device's host address. The measured length of the line is one ADC channel away. The current value is estimated by taking a reading using the current value sensors. To get the average RMS current, take many samples and use RMS formula to obtain RMS current. Then, record the result.

3.16 SUMMARY

Many conventional system has designed in the past, where no IoT and automation were introduced. Here we have proposed the methodology having both IoT and remote controlling options.

CHAPTER IV

RESULT AND DISCUSSION

4.1 INTRODUCTION

The entire result of this project has been described in this chapter. Hardware component of this project are shown in the image given below. The results of the suggested unit's comparison with a conventional wattmeter have been used to do a curve analysis. We claim that, our proposed meter is far better than compared to other meters.

4.2 PROJECT OVERVIEW

In Fig. 4.1, you can see the whole scenario of this project . We controlled the loads by using a 6 channel Relay. We have used a current sensor to monitor the current, and a potential transformer to detect the voltage.

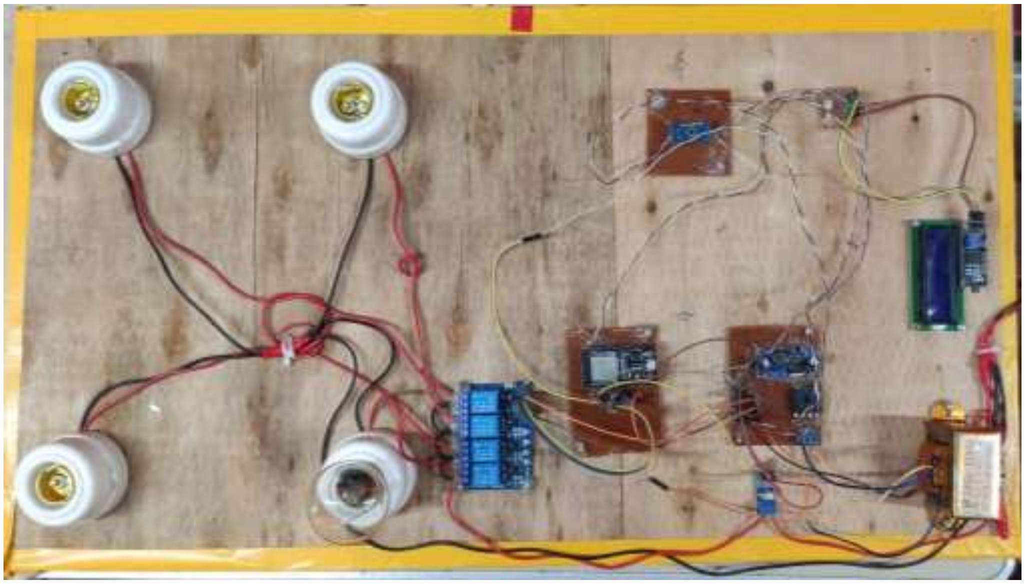
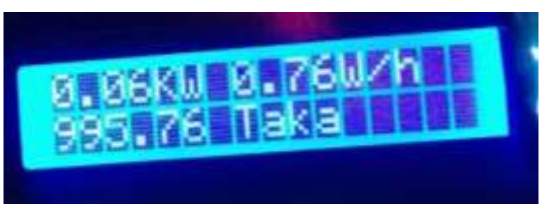


Fig 4.1 Overview of the Project

The power has provided using a voltage regulator and all the peripherals are controlled by using an ESP32.

4.3 RESULT

In this segment, we have showed all result that we have got from our project.

 **Fig 4.2** Introductory Message on System Boot	 **Fig 4.3** Introductory Message on System Boot
 **Fig 4.4** Showing Project Title	 **Fig 4.5** Showing Device Status
 **Fig 4.6** Showing Device Status	 **Fig 4.7** Showing Device Status After connecting loads
 **Fig 4.8** Showing Device Status	

Voltage, current, energy rating and cost are the result of the project. The value of energy consumption and unit cost has sent to users by a IOT module as a notification. Here, we observe output for different value of load and we calculate that our energy meter accuracy is 97.17%.

Fig 4.9 Load Controlling Panel

Table 4.2: Output Observations

Obs.	Voltage (V)		Current (A)		Power (Watt)	
	Practical	Measured	Practical	Measured	Practical	Measured
1	204	218	0.37	0.35	200	204
2	209	217	0.64	0.66	400	410
3	203	213	0.74	0.74	600	615
4	214	215	1.00	1.01	800	821
5	212	215	1.34	1.34	1000	1034
6	202	219	1.60	1.65	1200	1241

Table 4.3 Load Predictions

Balance Condition	Predication at Full Load (Approximately)
Less than 100	21 days
Less than 70	17 days
Less than 40	10 days
Less than 10	2 days

CHAPTER V

CONCLUSION AND FUTURE WORK

5.1 CONCLUSION

The outlook and assembly of the project have been supervised carefully and dealt with. This task was most hardest due to the combination from the lower voltage digital components, like the ESP32 microcontroller the actual LCD screen and additional IoT section with the primary line. Because of hard work, patience and effort eventually make it become successful.

5.2 CONTRIBUTION OF THIS SYSTEM

Within prior function, Arduino microcontroller and GSM were mostly used altogether. Arduino panel and IoT functionality is usually lacking in earlier IoT panel method. Several method were listed an easy web panel that monitors energy use in this project. In additional words, this is a user friendly and interactive system.

5.3 FUTURE IMPROVEMENT

Though we have contributed some work but we need to done some improvement. These are given below:

- It will collect all the messages received by customers through a centralized Smart Wattmeter.
- How much power is generating and distributing.

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