

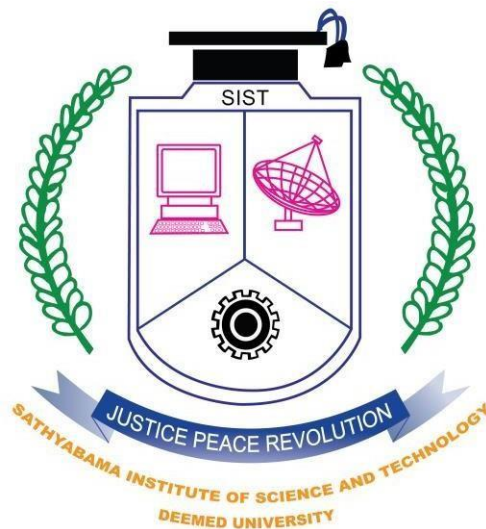
PREPAID ENERGY METER AUTO CUT-OFF AND POWER THEFT TRACKING

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering Degree in
Electrical and Electronics Engineering

by

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**DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
SCHOOL OF ELECTRICAL AND ELECTRONICS ENGINEERING**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

APRIL 2023



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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **VIJAYA RAAGHAVAN S (Reg. No. 39140063)** and **SRINATH G (Reg. No. 39140056)** who carried out the project entitled “**PREPAID ENERGY METER AUTO CUT-OFF AND POWER THEFT TRACKING**” under our supervision from December 2019 to April 2020.

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DECLARATION

We **VIJAYA RAAGHAVAN** (Reg. No. 39140063) and **SRINATH G** (Reg. No. 39140056) hereby declare that the Project Report entitled “**PREPAID ENERGY METER AUTO CUT-OFF AND POWER THEFT TRACKING**” done by us under the guidance of **Dr. SUNDERSINGH JEBASELLAN.S.D** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electrical and Electronics Engineering.

1.

2.

DATE:

PLACE:

SIGNATURE OF THE CANDIDATES

ACKNOWLEDGEMENT

We are pleased to acknowledge our sincere thanks to Board of Management of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. We are grateful to them.

We convey our thanks to **Dr. N. M. Nandhita., Dean, School of Electrical and Electronics Engineering** and **Dr. V. SIVACHIDAMBARANATHAN, Head of the Department, Dept. of Electrical and Electronics Engineering** for providing us necessary support and details at the right time during the progressive reviews.

We would like to express our sincere and deep sense of gratitude to our Project Guide **Mr Dr. SUNDARSINGH JEBASELLAN S.D** for her valuable guidance, suggestions and constant encouragement paved way for the successful completion of our project work.

We wish to express our thanks to all Teaching and Non-teaching staff members of the Department of Electrical and Electronics Engineering who were helpful in many ways for the completion of the project.

ABSTRACT

The IoT-based prepaid energy meter with auto cut-off and power theft tracking is a state-of-the-art solution that leverages the power of the Internet of Things (IoT) to revolutionize the way electricity is managed and consumed. The system enables consumers to prepay for their electricity usage, ensuring that only the amount paid for is consumed and eliminating the need for monthly bills. The system is equipped with advanced features such as auto cut-off, which disconnects power supply when the prepaid balance runs out, and power theft tracking, which detects and tracks instances of power theft. The system is built using cutting-edge technologies such as microcontrollers, wireless communication modules, and sensors, which enable real-time monitoring and control of electricity usage. The IoT-based prepaid energy meter provides numerous benefits, such as reducing electricity theft, improving revenue collection, and promoting energy conservation. The system is user-friendly, easy to install, and can be seamlessly integrated with existing electricity infrastructure. Moreover, the system allows consumers to monitor their electricity usage in real-time, enabling them to make informed decisions about their energy consumption. In conclusion, the IoT-based prepaid energy meter with auto cut-off and power theft tracking is a game-changer in the energy management industry, offering a cost-effective and efficient solution for managing electricity consumption and preventing power theft. It is an excellent example of how the Internet of Things is transforming traditional systems into smart, connected ones.

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CHAPTER 1

INTRODUCTION

1.1 GENERAL INTRODUCTION

Nowadays, the electrical energy monitoring system that has been used is by installing conventional electrical measuring devices on the electrical circuit. The time complicated interlocking and operation controlling requirements involved in Energy Management, which lead to necessity of automation of the undergoing process. In this respect, Energy Management automation, which is the creation of a highly reliable, self-healing power system that rapidly responds to real time events with appropriate actions, ensures to maintain uninterrupted power services to the end users with smart monitoring and maintaining of databases.

Then it is necessary to design a system that can be used for monitoring electricity consumption using the IoT concept in real-time and long-distance.

IoT is also identified as an enabler for machine-to machine, human-to-human and human-with-environment interactions. The Internet of things (IoT) concept enables us to attach the traditional day-to-day devices with one another over the internet. The devices connected through the IoT concept can be analyzed remotely. The IoT concept provides the essential infrastructure and opportunities to make a connection between the physical world and computer-based systems . The concept has been gaining importance with more and more wireless devices that are increasing rapidly within the market. Hardware devices are connected with one another over the web(Internet).

The ESP-8266 Wi-Fi module used in the system provides connectivity with the internet in the system. Nowadays the demand for electricity is increasing at a constant rate in the population and is being utilized for various purposes viz, agriculture, industries, household purposes, hospitals, etc. So, it is becoming more and more complicated to handle electricity maintenance and requirements. Therefore there's an instantaneous requirement to save lots of the maximum amount of

electricity as possible. As the demand from the newer generations of population for electricity is increasing so along with it the technology improvement is needed. The proposed system provides a 180 degree technical curve to the traditional energy meters using IoT technology. Also, there are other issues that we've dealt with like power theft which successively generate economic loss to the Country. Monitoring, Optimized power usage and reduction of power wastage are the main objectives that lie ahead of a far system.

A energy meter based on new technology using a Wi-Fi system that has three major objectives. They are: i. To provide automated load energy reading over an immediate basis. ii. To use the electricity in an optimized manner and very cost effective. iii. Reduce power wastage. The system basically can be monitored through the consumer end. The data from the system is displayed on a webpage that can be accessed by the consumer.

1.2 MOTIVATION FOR SELECTION OF THIS PROJECT

IoT-based system is in charge of providing knowledge from an environment to an nonexpert user. IoT-based system can be used in different environments, so it needs to be able to address many heterogeneous devices. Thus, a major concern within developing an IoT-based system is how to handle the interaction with the heterogeneous devices for non-expert users. This concern can be addressed by a middleware layer between devices and non-expert users. This layer is responsible to hide the diversity of devices from the user perspective, and provides access transparency to the devices for the end users. The idea of creating abstractions of devices been addressed in the literature. The middleware we found in the literature can provide satisfaction by facilitating the interaction with devices, but they do not support low-level device configuration .

1.3 OVERVIEW

The Arduino microcontroller is an easy to use yet powerful single board computer that has gained considerable traction in the hobby and professional market. The Arduino is open-source, which means hardware is reasonably priced and

development software is free. This guide is for students in ME 2011, or students anywhere who are confronting the Arduino for the first time. For advanced Arduino users, prowl the web; there are lots of resources. This guide covers the Arduino Uno board (Spark fun DEV-09950, \$29.95), a good choice for students and educators. With the Arduino board, you can write programs and create interface circuits to read switches and other sensors, and to control motors and lights with very little effort. Many of the pictures and drawings in this guide were taken from the documentation on the This is what the Arduino board looks like. The Duemilanove board features an Atmel ATmega328 microcontroller operating at 5 V with 2 Kb of RAM, 32 Kb of flash memory for storing programs and 1 Kb of EEPROM for storing parameters. The clock speed is 16 MHz, which translates to about executing about 300,000 lines of C source code per second. The board has 14 digital I/O pins and 6 analog input pins. There is a USB connector for talking to the host computer and a DC power jack for connecting an external 6-20 V power source, for example a 9 V battery, when running a program while not connected to the host computer. Headers are provided for interfacing to the I/O pins using 22 g solid wire or header connectors.

The Arduino programming language is a simplified version of C/C++. If you know C, programming the Arduino will be familiar. If you do not know C, no need to worry as only a few commands are needed to perform useful functions.

An important feature of the Arduino is that you can create a control program on the host PC, download it to the Arduino and it will run automatically. Remove the USB cable connection to the PC, and the program will still run from the top each time you push the reset button. Remove the battery and put the Arduino board in a closet for six months. When you reconnect the battery, the last program you stored will run. This means that you connect the board to the host PC to develop and debug your program, but once that is done, you no longer need the PC to run the program.

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, 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.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

CHAPTER 2

LITERATURE SURVEY

2.1 INTRODUCTION

A literature survey on "Hybrid Energy Source Based Landsman Converter for AC/DC Micro Grid" would involve a critical analysis of scholarly literature on the design and performance of hybrid energy sources in the context of AC/DC microgrid systems. The Landsman converter is a key component in these systems, and its design plays a critical role in the performance of the overall system. The literature survey would explore the existing research and theoretical frameworks related to hybrid energy sources, Landsman converter design, and microgrid system integration. The survey would also identify gaps in the existing literature and areas for further research in this field. Some of the key areas that would be covered in this survey could include the use of renewable energy sources such as solar, wind, and hydroelectric power, energy storage technologies, power electronics, and control systems. By conducting a comprehensive literature survey, researchers can develop a better understanding of the current state of knowledge in this field, identify key trends and debates, and establish a foundation for their own research on hybrid energy source-based Landsman converters for AC/DC microgrids.

2.2 MAJOR FINDINGS FROM LITERATURE SURVEY

IoT Based Smart Energy Meter [1] Vishal Kumar, [2] Tanishq Sharma, [3] Abu Farhan [1][2][3] Undergraduate Student, Dept. of Electronics & Communication Engg., IIMT College of Engineering, Greater Noida Vol 8, Issue 9, September 2021

The term "INTERNET" refers to the vast category of applications and protocols built on top of sophisticated and interconnected computer networks, serving billions of users everywhere in the world in 24/7 fashion.[1] We all realize that electricity energy meters are installed in everyone's house or offices to count the electricity consumption based on traditional technology. At the end of each month, many folk get worried about the high electricity bill and that we need to check out the energy

meter once in a while. But what if we can monitor our electricity use from anywhere in the world just using our smartphones? It sounds crazy but It is possible. So in this project we are designing a smart energy meter where we can monitor our appliances' load consumption in real-time. Here we are building an IoT-based Project of Energy Meter where we are using an esp8266 wi-fi module to connect our energy meter with the internet. Through this device, it will become easier to control all our devices as per the power they are consuming and have control over money.

In this paper, we described a low-cost real-time IOT based energy management system as proposed[4]. It is conceived as part of a distributed system that measures the main power system quantities and gives the possibility to manage the whole power plant. An integrated Web Server allows the gathering of the statistics of power consumptions, power quality and is in position to interface devices for load displacement. The device is characterized by quick access to the data and the combination of a smart meter and digital communication capability allows local and remote access. In this way, it is possible to manage the power consumption by the electrical appliances and also check the amount of power consumed by our appliances in terms of money. The power system resulted in an overall reduction in energy consumption and costs. Approach for energy saving in Smart Grids using Smart In this paper, described the worldwide energy demand is increasing and hence necessity measures need to be taken to reduce the energy wastage with proper metering infrastructure in the buildings. Arduino UNO uses ATMEGA-328P microcontroller and this controller comes preloaded with a Arduino UNO bootloader. The aim of this work is to realize real time pricing. This solution is economical and eco-friendly. Presently electronics energy measurement is continuously replacing existing technology of electro-mechanical meters especially in China and India. By the year 2004, digital meters started replacing electromechanical meters in Singapore. A wireless digital energy meter would definitely offer greater convenience to the meter reading task. Wi-Fi technology is chosen as a possible wireless solution to the present issue. In this paper, we present the planning, design and implementation for the Wi-Fi-enabled energy meter and also overcome the problems with traditional energy meters. The energy reader can collect the energy consumption reading from the energy meter wirelessly based on Wi-Fi technology. This paper describes Arduino uno Microcontroller based design and implementation

of energy meter using IoT concept. The proposed system design eliminates the human involvement in Electricity maintenance. The Buyer must buy the usage of electricity on schedule, just in case that he couldn't pay, the electricity transmission can be turned off autonomously from the distant server. The user can monitor the energy consumption in units from a 16*2 LCD. An IoT based real time energy measurement and actuating framework is proposed and may be easily integrated with home monitoring systems. The Wi-Fi unit performs the IoT operation by sending energy meter data to the cloud which may be accessed and displayed on an LCD screen.

The smart electricity meter using a Wi-Fi module can be easily described in two parts. The first part being the physical part and the second one being the Webpage. It consists of ESP 8266 Wi-Fi module, current sensor (ACS712), 16*2 display, and power supply. Block Diagram The device is characterized by easy access to the data and therefore the combination of a smart meter and digital communication capability allows local and remote access. In this way, it is possible to manage the power consumption by the electrical appliances and also check the amount of power consumed by our appliances in terms of money. Block diagram of the system IV.

HARDWARE IMPLEMENTATIONS

Current sensor The ACS712® is a fully integrated hall-effect based linear current sensor that provides economical and precise solutions for AC or DC current sensing in industrial, commercial, and communications systems. The device package allows for quick implementation by the customer. The device isn't intended for automotive applications. It is simply put forth as a current sensor that uses its conductor to calculate and measure the quantity of current applied in any electrical device. This device consists of a precise, low offset, linear Hall circuit with a copper conduction path located near the surface of the die. The current flows through the inbuilt hall sensor circuit in its IC. The hall effect sensor detects the incoming through its magnetic field generation. Once detected, the hall effect sensor generates a voltage proportional to its magnetic field that's then used to measure the amount of current. A precise, proportional voltage is provided by the low-offset, chopper-stabilized Bi CMOS Hall IC, which is programmed for accuracy after packaging. The interior resistance of this conductive path is 1.2 mΩ typical, providing low power loss.

ESP8266 is a Wi-Fi enabled system on chip (SoC) module developed by Espressif system. It is frequently used for development of IoT (Internet of Things) embedded

applications. It employs a 32-bit RISC CPU supported by the Ten silica Xtensa L106 running at 80 MHz (or overclocked to 160 MHz). It consists of a 64 KB boot ROM, 64 KB instruction RAM and 96 KB data RAM. External non-volatile storage is often accessed through SPI. ESP8266 module advantage is a low-cost standalone wireless transceiver that can be used for end-point IoT developments. To communicate with the ESP8266 module, the microcontroller must use a group of commands. Microcontroller communicates with the ESP8266-01 module using UART having specified Baud rate. LCD (Liquid crystal display) screen is an electronic display module and finds a huge range of applications. 16*2 display means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in the 5*7 -pixel matrix also has 11, 12, 13 and 14 pins of the display that are used as data pins for Arduino interfacing. These displays are mainly preferred for multi-segment Light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc

The proposed system can be used to display load energy usage reading in terms of Watts along with money drawn by the devices. The data would be accessed by each and every user from anywhere in the world. Ubidots.com is one such webpage which takes the help of the MathWorks MATLAB analytics to present the device information in a more detailed analysis in both description and visualization. Ubidots.com provides the user to add any number of channels to at least one account and in each account information are fed into 8 fields. An account may be assigned at least one division of an area and n channels are often created to a set of n meters within the locality. The analytics can be viewed by both the consumer and service provide.

Smart Energy Meter and Monitoring System using IoT Naziya Sulthana^{1*} Students, Dept. of E&TE Sri Siddhartha Institute of Technology Tumakuru, India Rashmi N2 Students, Dept. of E&TE Sri Siddhartha Institute of Technology Tumakuru, India Prakyathi N Y3 Students, Dept. of E&TE Sri Siddhartha Institute of Technology Tumakuru, India Bhavana S4 Students, Dept. of E&TE Sri Siddhartha Institute of Technology Tumakuru, India K B Shiva Kumar⁵ Professor, Dept. of E&TE Sri Siddhartha Institute of Technology Tumakuru, India NCETESFT - 2020 Conference Proceeding.

The effort of collecting electricity utility meter reading. Internet of Things (IoT) present an efficient and coeffective to transfer the information of energy consumer wirelessly as well as it provides to detect the usage of the electricity the main intention of this project is measure electricity consumption in home appliances and generate it's bill automatically using IoT. The energy grid needs to be implemented in a distributed topology that can dynamically absorb different energy sources. IoT can be utilized for various applications of the smart grid with distributed energy plant meter, energy generation and energy consumption meter smart meter, energy demand side management and various area of energy production.

Anitha et al., [1] proposed “Smart energy meter surveillance using IoT” about IoT, internet of things as an emerging field and IoT based devices have created a revolution in electronics and IT. The foremost objective of this project is to create awareness about energy consumption and. efficient use of home appliances for energy savings. Due to manual work, existing electricity billing system has major drawbacks. This system will give the information on meter reading, power cut when power consumption exceeds beyond the specified limit using IoT. The Arduino esp8266 micro controller is programmed toper form the objectives with the help of GSM module. It is proposed to overcome all the disadvantages in the already existing energy meter. All the details are sent to the consumer’s mobile through the IoT and the GSM module and it is also displayed in the LCD. It is a time savings and it helps to eliminate the human interference using IoT. Devadhanishini et al., [2] “Smart Power Monitoring Using IoT” that energy Consumption is the very important and challenging issue. Automatic Electrical Energy meter is used in large electric energy distribution system. The integration of the Arduino WIFI and SMS provides the system as Smart Power Monitoring system. Smart energy meter provides data for optimization and lessthe power consumption. This system also includes a motion sensor such that if there is no human in house or house it will automatically turn off the power supply. Mohammed Hosseiu et al., [3] presented a paper titled “Design and implementation of smart meter using IoT” describing the growth of IoT and digital technology. The future energy grid needs to be implemented in a distributed topology that can dynamically absorb different energy sources. IoT can be utilized for various applications of the smart grid consisting power consumption, smart meter, electric power demand side management and various area of energy production. In this

paper, the Smart Energy Metering(SEM) is explained as the main purpose of SEM is necessary for collecting information on energy consumption of household appliances and monitor the environmental parameters and provide the required services to home users. Himanshu K Patel et al., demonstrated “Arduino based smart energy meter” that removes human intervention in meter readings and bill generation thereby reducing the error that usually causes in India. The system consists the provision of sending an SMS to user for update on energy consumption along with final bill generation along with the freedom of reload via SMS. The disconnection of power supply on demand or due to pending dues was implemented using a relay. The system employs GSM for bidirectional communication. Bibek Kanti Barman, et al., proposed “smart meter using IoT” on efficient energy utilization plays a very vital role for the development of smart grid in power system. Hence proper monitoring and controlling of power consumption is a main priority of the smart grid. The energy meter has many problems associated to it and one of the key problems is there is no full duplex communication to solve this problem, a smart energy meter is proposed based on Internet of Things. The smart energy meter controls and calculate the consumption of energy using ESP 8266 12E, a Wi-Fi module and send it to the cloud from where the consumer or customer can observe the reading. Therefore, energy examine has been by the consumer becomes much easier and controllable. This system also helps in detecting energy loss. Thus, this smart meter helps in home automation using IoT. Garrab et al., proposed AMR approach for energy saving in Smart Grids using Smart Meter and partial Power Line Communication” on the raising demand of energy. Smart meters are one of the proposed solutions for the Smart Grid. In this article, an AMR solution which gives detailed end-to-end application. It is based on an energy meter with low-power microcontrollerMSP430FE423A and the Power Line Communication standards. The microcontroller includes an energy metering module ESP430CEI. Landi et al., presented "ARM-based Energy management system using smart meter and Web server about a low-cost real-time ARM-based energy management system. An integrated Web Server helps to collect the statistics of energy consumptions, power quality and is to interface devices for load displacement. The device is used to access the information. In this way it is possible to manage the power consumption of the power system leading to a consumption of power. Koay et al., explained "Design and implementation of Bluetooth energy meter" described around the year 2004,

digital meter has started to replace the electromechanical meters in Singapore. A wireless digital power meter would offer greater convenience to the meter reading task. Bluetooth technology is a possible wireless solution to this issue. The power reader can collect the power consumption reading from the energy meter wirelessly based on Bluetooth. Two methods that can retrieve the meter reading with little human intervention, are added and implemented in the targeted applications, they are Automatic meter reading(AMR) and the Automatic polling mechanism(APM). Some commercial applications are applied for the Bluetooth-enabled energy meter.

III. PROPOSED METHODOLOGY The smart energy meter monitoring system is shown in figure 1. The block diagram consists of Arduino, energy meter, WIFI module and IoT, Relay and transformer. Fig.1 Smart energy meter Energy meter used here is clamp energy meter .230V AC mains is the input given to the transformer and AC mains is converted to low voltage. Energy meter measures the live current, voltage and power in terms of KW-h. Microcontroller reads these parameters and send it to the cloud. NodeMCU is a Wi-Fi device which has a microcontroller in it. This connects the local router through IoT. The status of these parameters can be obtained through mobile or laptop. WIFI is used for data communication. WIFI is configured with Arduino. The Data from the Energy meter is sent to Arduino and to WIFI module and it reaches the users mobile phone. In this system the user can switch on/off the mains or home appliances from their Android smart phone app. The WIFI module trans and receives the data from cloud and sends to Arduino and the Arduino controls the relay to switch on and off the circuit of the home.

A. Transformer
Selecting a suitable transformer is of great importance. The current rating and the secondary voltage of transformer is a key factor. The current rating of the Transformer depends on the current needed for the load to be driven. The input voltage to the 7805 IC should be at least 2 volt greater than the required 2 volt output; therefore it requires an input voltage at least close to 7V. So, a 6-0-6V transformer with current rating of 500mA is use.

IoT Based Smart Energy Meter Birendrakumar Sahani¹, Tejashree Ravi², Akibjaved Tamboli³, Ranjeet Pisal⁴ ¹Birendrakumar Sahani, ²Tejashree Ravi ³Akibjaved Tamboli, ⁴Professor R.S. Pisal Dept. of Electronics & Telecommunication Engineering, SPVP's S.B. Patil College of Engineering, SPPU, Indapur International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056

Volume: 04 Issue: 04 | Apr -2017.-We can see a person standing in front of our house from electricity board, whose duty is to read the energy meter and handover the bills to the owner of that house every month. This is nothing but meter reading. According to that reading we have to pay the bills. The main drawback of this system is that person has to go area by area and he has to read the meter of every house and handover the bills. Many times errors like extra bill amount, or notification from electric board even though the bills are paid are common errors. To overcome this drawback we have come up with an idea which will eliminate the third party between the consumer and service provider, even the errors will be overcome. In this paper the idea of smart energy meter using IoT and Arduino have been introduced. In this method we are using Arduino because it is energy efficient i.e. it consumes less power, it is fastest and has two UARTS. In this paper, energy meters which are already installed at our houses are not replaced, but a small modification on the already installed meters can change the existing meters into smart meters. The use of GSM module provides a feature of notification through SMS. One can easily access the meter working through web page that we designed. Current reading with cost can be seen on web page. Automatic ON & OFF of meter is possible. Threshold value setting and sending of notification is the additional task that we are performing)

When the various appliances of the household consume energy the energy meter reads the reading continuously and this consumed load can be seen on meter.

- We can see that the LED on meter continuously blinks which counts the meter reading. Based on
- The blinking, the units are counted. Normally, 3200 blinks is one unit.
- In our project we are trying to develop, a system in which Arduino Uno act as main controller, which continuously monitor energy meter.
- As per the blinking of LED on energy meter the Arduino will measure the unit consumption.
- The measured reading with the calculation of the cost will be continuously displayed on web page that we have designed.
- Threshold value can be set on webpage with the help of Wi-Fi, as per the consumer's requirement. When the consumer's reading will be near about to the set threshold value it will send a notification value to the consumer.
- This threshold value notification will increase the awareness amongst the consumer about the energy.

- When the consumer gets the notification he can visit the webpage and change the threshold value.
- If the consumer is not aware with the threshold notification, then the meter will automatically get off. Then the consumer has to visit the webpage again and increment the threshold value. By the incrementation, the meter will automatically get ON.
- Finally the overall monthly bill with cost will be sent to customer as well as service provider in the form of text at first day of every month.

2.3 EXISTING BLOCK DIAGRAM AND EXPLANATION

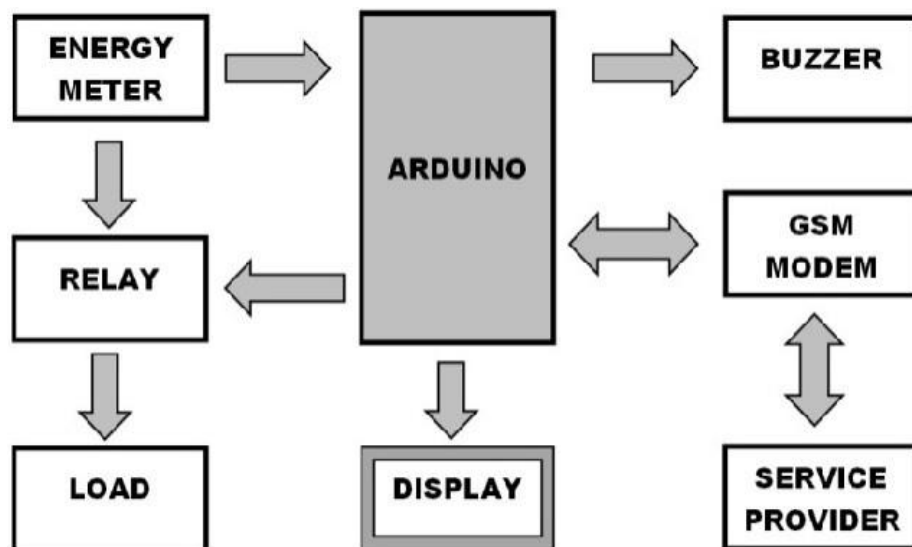


Fig 2.1 Existing Block diagram

It represents our proposed 'IoT BASED SMART ENERGY METER' system

ENERGY METER: Energy meter or watt-hour meter is an electrical instrument that measures the amount of electrical energy used by the consumers. Utilities is one of the electrical departments, which install these instruments at every place like homes, industries, organizations, commercial buildings to charge for the electricity consumption by loads such as lights, fans, refrigerators and other home appliances. Energy meter measures the rapid voltage and currents, calculate their product and give instantaneous power. This power is integrated over a time interval, which gives the energy utilized over that time period.

ARDUINO UNO(ATMEGA 328): Arduino board is the heart of our system. Entire functioning of system depends on this board. Arduino reacts to the 5v supply given by opto-coupler and keeps on counting the supply and then calculates the power consumed and also the cost. This data, it continuously stores on webpage, so that users can visit any time and check their consumption. It even reacts accordingly as per programed, to the situations like message sending during threshold value etc.

3.4 MAX 232: We are using MAX 232 for serial communication with the components that are GSM module and Wi-Fi module MAX232 is used to provide TTL to the components as per the requirement. GSM needs TTL so it is connected to Arduino through MAX232. Some Wi-Fi module doesn't require TTL because it's already build in it and some may require based on its working.

3.5 GSM MODULE (SIM900): GSM stands for Global System for Mobile communication. It is widely used mobile communication modem system in the world. GSM is an open and digital cellular technology used for transmitting mobile voice and data services operates at the 850MHZ, 900MHZ, 1800MHZ, 1900MHZ frequency bands. It has ability to carry 64kbps to 120Mbps of data rates. In our system GSM is used to send the notification of threshold reaching to consumer and for sending message of total consumption of unit with cost to the service provider and consumer.

3.6 Wi-Fi MODULE (ESP8266): Wi-Fi stands for Wireless Fidelity. We are using Wi-Fi which acts as heart for IoT. Through Wi-Fi the consumer can set changes in threshold value, he can ON and OFF the energy meter. Time to time the readings of units and cost are displayed on webpage. Consumer can accesses the Arduino board and meter with help of WiFi.

3.7 WEBPAGE (HTML): We designed webpage for operating Arduino and Energy Meter with the help of HTML. HTML stands for Hypertext Markup Language. It is a standard markup language for creating web pages and web applications with Cascading Style Sheets (CSS) and JAVA scripts it forms a triad of cornerstone technologies for World Wide Web. Web browser receives HTML documents from a Webserver or from local storage and render them into multimedia web pages. HTML describes the structure of web page semantically and originally included cues for the appearance of the document. HTML elements are the building blocks of HTML pages.

IoT based smart energy meter monitoring, theft detection and disconnection
Prof. Sandhya Shinde¹ , Mrs. Yogesh Yadav² , Ms. Pratiksha Zapake³ , Ms. Bharti Sontakke

The IoT based smart energy meter is based on Arduino. In this system we reduce the human participation in electrical energy maintenance. The theft of the electricity increases the costs paid by customer. Hence this system is used for the detection of theft. The Arduino checks the main meter and sub meter reading. If the difference between the main meter and sub meter is occurred then that theft has occurred message will be display on the LCD display and also display on the thingspeak. Customer can be access the thingspeak from anyplace. By using the consumer number it can be access on the globe at the anytime.

In this paper, we are explaining a technique of electricity energy meter reading based on IoT concept. This design implements the energy meter using the IoT concept. This whole procedure based on the Arduino. The internet of things is the internet operational of physical devices which permits object to exchange data in the above system energy meter is connected to the internet by using IoT. So there is a method to track their energy consumption time to time for consumer so that they can control their use as they plan. This system is suitable for consumer and supply. This method eliminates man power during this connection and disconnection upload. It plays a vital role to inform supplier about any theft that is happening in the sensor.

•LCD display •RELAY Arduino UNO Arduino UNO is a single board microcontroller. It construct the digital devices and control objects in a physical world. IOT ESP8266 The Internet of things(IoT) is the network of devices, vehicles, and other objects embedded with electronics, software, sensors, and internetwork connection which support objects to collect and interchange data. Each thing is individually specialized through its embedded system but is able to internal operate within the current Internet communications. CT SENSOR The CT sensor connect to an Arduino, the CT sensor output wants to be condition so it connect the input requirements of the analog input of Arduino, that is a positive voltage 0v and the ADC reference voltage.(The above Arduino board working at 5v and of the EmonTx working at 3.3v.)

Enhanced Smart Energy Meter using IOT Niharika Banerjee, Preety Manna, K. Surendhirababu, K. Venkatasubramani International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-8, Issue-1S4, June 2019.

In our day to day life electricity plays a vital role. India has power generating capacity of 334.4 gigawatt as of January 2018. The primary energy consumption of India is the 3rd biggest after China and U.S.A with 5.6% of the global share in 2018. The main objective of this project is to make people aware about the power consumption in our day to day life so that we can save energy. There will be a particular peak value set in the system and if the power consumption exceeds the particular value set, then the alarm will start buzzing. And also, the project will give notification about the power theft, power cut and overloading by using PIC16F877A micro-controller and a GSM module (Global System for Mobile Communication). The advantage of this system is that it reduces human dependency, labour and it helps in bringing awareness about the usage of energy in household and private sectors.

The energy meter presented before are time consuming, and needs a lot of human labour. The presented model is fast, effective and it gives out various information regarding the consumption of power units in the demanded amount of time lapse. The various information about power consumption (in units), power theft, overloading, power-cut can be seen in the LCD and also in the costumer's respective mobile phones using the GSM module. This system will also be helpful in controlling the electricity power which is supplied to their home by switching the power supply On or Off with the use of their mobile phones from a long distance from their respective home. The new system will also enable users to get the pre-intimidation of the power shutting down detail from the electricity board office.

The proposed systems greatest advantage over any other energy meters are the major different applications which link the costumers with the knowledge of any aspect of their power consumption and notification alarms with the use of the IOT which can be seen in their respective mobile phones. A special ID is set for each of the energy meters which are linked with the costumer's mobile numbers. Thus, each

of the information about the energy usage and notifications can be sent easily and directly to the costumers with the use of the GSM module. From this, we can also reduce the wastage of the energy, as we can monitor the usage of the consumption of energy with respect to the needed time period. Alert and Notification System using IOT In the present electricity billing system, there has been cases of fraud which increases the charges which are collected by almost the double part of the original billing amount. Thus, with the frequent notification system, the costumer will be well informed and aware about the actual usage of the energy and direct billing payment could be done through the e-payment. Also, the costumer can set a primary peak value of the energy to consumed in a particular period of time. If the consumed energy gets more than the given peak limit, the notification will be shown in the LCD, also an alarm would be present in the registered mobile phones. This receiving and transmission of the data can be done with use of the GSM module SIM900A.

2.4 DISADVANTAGES OF EXISTING SYSTEM

1. The system fails if there is no network because without a network the device can't send SMS.
2. Requires fixed GSM number.
3. Interference.
4. High Cost.
5. Some materials may create Signal problem.
6. Overheating reading (fail to read).

2.5 STANDARD

The IEEE standard adapted for this project are IEEE 1646-2018, IEEE 1888-2011, IEEE 2030.5-2018, IEEE 1377-2012 and IEEE 1547-2018.

IEEE 1646-2018: This standard specifies the requirements and test methods for prepaid distribution systems, including prepaid energy meters, automatic cutoff functions, and power theft tracking mechanisms, as I mentioned in my previous response.

IEEE 1888-2011: This standard provides guidelines for the design, installation, and operation of advanced metering infrastructure (AMI) systems, including prepaid energy meters. It covers topics such as communication protocols, security requirements, and data management.

IEEE 2030.5-2018: This standard defines the communication interface between electric vehicle (EV) charging systems and the electric power system, including prepaid energy meters. It specifies the protocols for exchanging information on energy consumption, prices, and other relevant data.

IEEE 1377-2012: This standard provides guidelines for the installation and testing of revenue metering systems, including prepaid energy meters. It covers topics such as accuracy, stability, and reliability of measurement, as well as installation requirements and testing procedures.

IEEE 1547-2018: This standard provides technical requirements for interconnecting distributed energy resources (DERs) with the electric power system, including prepaid energy meters. It covers topics such as voltage regulation, power quality, and islanding protection.

2.5.1 TERMINOLOGY

IEEE 1646-2018 is a standard that specifies the requirements and test methods for prepaid distribution systems, including prepaid energy meters, automatic cutoff functions, and power theft tracking mechanisms. The standard covers a range of technical specifications and testing procedures that are necessary to ensure the safe and reliable operation of prepaid distribution systems.

Prepaid energy meters are a key component of these systems, allowing consumers to prepay for their electricity usage and better manage their energy consumption. Automatic cutoff functions are also important, as they can prevent overuse or unauthorized usage of electricity, which can help to ensure that the energy supply is fairly distributed among customers. Power theft tracking mechanisms are designed to detect and prevent illegal tampering with the prepaid meters, which is an important consideration for the effective operation of prepaid distribution systems.

Overall, adherence to IEEE 1646-2018 can help to ensure the quality, reliability, and safety of prepaid distribution systems, including the prepaid energy meters that are used to manage electricity consumption.

IEEE 1888-2011 is a standard that provides guidelines for the design, installation, and operation of advanced metering infrastructure (AMI) systems, which includes prepaid energy meters. These systems are designed to provide real-time data on energy usage and support two-way communication between utilities and customers, allowing for more efficient and accurate billing and better management of energy usage.

The standard covers a range of topics related to AMI systems, including communication protocols, security requirements, and data management. It provides guidance on selecting appropriate communication technologies and protocols to ensure reliable and efficient data transmission, as well as guidance on securing the data and protecting against potential cybersecurity threats.

Additionally, IEEE 1888-2011 covers the management of data collected by the AMI systems, including guidelines for data storage, processing, and analysis. Adherence to this standard can help ensure the reliable and secure operation of AMI systems, including prepaid energy meters, and promote the efficient use of energy resources.

IEEE 2030.5-2018 is a standard that defines the communication interface between electric vehicle (EV) charging systems and the electric power system, which includes prepaid energy meters. The standard specifies the protocols for exchanging information on energy consumption, prices, and other relevant data between the EV charging systems and the electric power system.

Prepaid energy meters play an important role in the communication interface between EV charging systems and the electric power system, as they enable real-time measurement and tracking of energy consumption by EVs. The standard provides guidance on how to integrate prepaid energy meters into the overall communication interface and how to ensure that the data exchanged is accurate and reliable.

By providing a common communication interface between EV charging systems and the electric power system, IEEE 2030.5-2018 can help to promote the integration of renewable energy sources and the efficient use of energy resources. It can also facilitate the implementation of demand response programs and other innovative energy management strategies.

IEEE 1377-2012 is a standard that provides guidelines for the installation and testing of revenue metering systems, which includes prepaid energy meters. The standard covers a range of technical specifications and testing procedures that are necessary to ensure the accuracy, stability, and reliability of measurement for revenue metering systems.

The standard includes guidelines for the installation of revenue metering systems,

including requirements for the selection of equipment, location of equipment, and installation procedures. It also covers testing procedures for revenue metering systems, including requirements for initial testing, periodic testing, and testing following maintenance or repairs.

Prepaid energy meters are a key component of revenue metering systems, as they enable real-time measurement and tracking of energy consumption by customers. Adherence to IEEE 1377-2012 can help to ensure the quality, accuracy, and reliability of revenue metering systems, including the prepaid energy meters that are used to manage electricity consumption.

IEEE 1547-2018 is a standard that provides technical requirements for interconnecting distributed energy resources (DERs) with the electric power system, including prepaid energy meters. The standard covers a range of topics related to the interconnection of DERs, including voltage regulation, power quality, and islanding protection.

Prepaid energy meters play an important role in the interconnection of DERs, as they enable real-time measurement and tracking of energy consumption by customers who generate their own electricity using solar panels or other renewable energy sources. The standard provides guidance on how to integrate prepaid energy meters into the overall DER interconnection system, including requirements for voltage regulation, power quality, and protection against islanding.

Adherence to IEEE 1547-2018 can help to ensure the safe, reliable, and efficient integration of DERs with the electric power system, including the use of prepaid energy meters to manage electricity consumption. It can also help to promote the deployment of renewable energy sources and the efficient use of energy resources.

2.6 PROBLEM STATEMENT

The problem statement for implementing a prepaid energy meter with an auto cutoff feature and power thief tracking using IoT technology can be stated as follows:

Many households and businesses are facing challenges with energy management, particularly in terms of high electricity bills and energy theft. Traditional energy meters often do not provide real-time information on energy usage and do not have the ability to automatically disconnect electricity supply when a customer's prepaid balance is exhausted. This can lead to unpaid bills and energy theft, resulting in significant financial losses for energy providers and customers.

To address this problem, there is a need for an advanced energy metering system that integrates IoT technology to provide real-time energy usage monitoring, prepaid energy billing, automatic disconnection of supply on prepaid balance exhaustion, and power theft detection. This system should be cost-effective, user-friendly, and capable of remotely controlling and monitoring energy usage, ensuring accurate billing, and preventing unauthorized access to electricity supply.

Therefore, the problem statement is to develop an IoT-based prepaid energy metering system with auto cutoff feature and power thief tracking to address the challenges of energy management, reduce energy theft, and provide a cost-effective, reliable, and user-friendly solution for energy providers and customers

2.7 TRADE OFF

The tradeoff for implementing a prepaid energy meter with an auto cutoff feature and power thief tracking is primarily related to the cost of the system versus the potential benefits it provides.

On the one hand, a prepaid energy meter with an auto cutoff feature can help ensure that customers are more mindful of their energy usage and are more likely to conserve energy. This can lead to reduced energy consumption, which can help conserve resources and reduce the carbon footprint. Additionally, the auto cutoff feature can prevent customers from accumulating large unpaid bills, which can help reduce the financial burden on energy providers.

On the other hand, implementing a prepaid energy meter with an auto cutoff feature and power thief tracking can be expensive and may require significant investment in hardware and software systems. There may also be some resistance from customers who may find the new system to be inconvenient or difficult to use. Additionally, implementing such a system requires careful planning and monitoring to ensure that it is functioning properly and not causing unintended consequences.

Overall, the tradeoff between implementing a prepaid energy meter with an auto cutoff feature and power thief tracking is that it can provide significant benefits in terms of energy conservation and financial stability, but it may require significant investment and careful planning to implement effectively.

CHAPTER 3

AIM AND SCOPE OF THE PRESENT INVESTIGATION

3.1 INTRODUCTION

The aim is that the meter is used to monitor units consumed and transmit the units as well as cost charged over the internet using wifi connection. This allows user to easily check the energy usage along with the cost charged online using a simple web application.

Identifying any number of objects at various scales and in various poses. Accidents that result in death are the most common cause of death. Furthermore, these mishaps are unpredictable, and they can happen anytime, at any moment. As human beings, we should strive to save people's lives and prevent injuries. With these facts in mind, the aim of this project is to provide safe driving advice to those on the road and emergency care to those who have been involved in an accident. Weather conditions, collision manner, surface condition, light condition, speed, drunk driving, and other factors were all taken into account and investigated. Data analysis can be used to make safer driving recommendations and lower the accident rate.

3.2 OBJECTIVES

1. To provide a simple way to detect an electrical power theft without any human interface.
2. To indicate exact zone and distribution line on which unauthorized tapping is done in real time.

3. To determine transmission line faults. To maximize revenue generation by the power utility companies.
4. Its cost is less as compare to other present system.

3.3 SCOPE OF THE PROJECT

Using this method, excessive speeding and unintentional accidents in constrained places are effectively reduced. With current technology, there is no autonomous speed limits in the car, necessitating further research and vehicle speed optimization in order to minimise accidents. Control systems in cars will allow us to increase the safety of all road users, including pedestrians and passengers.

3.4 METHODOLOGY

To implement a methodology for auto cutoff and power theft tracking, you would need to follow these general steps:

1. **Install Smart Meters:** Replace traditional analog meters with smart meters that can automatically measure and record electricity usage data.
2. **Data Collection:** Collect data from smart meters at frequent intervals, such as every 5 minutes, to accurately detect any unusual energy consumption patterns.
3. **Data Analysis:** Analyze the collected data using advanced analytics techniques, such as machine learning algorithms, to identify any anomalies or suspicious activities.
4. **Auto Cutoff:** Set up an automatic cutoff system that can disconnect the power

supply in case of any abnormal energy consumption patterns, such as sudden spikes or drops.

5. Power Theft Detection: Use data analysis to identify any unauthorized connections or electricity theft by comparing the energy consumption patterns of different households or areas.
6. Notification and Reporting: Send notifications and reports to the appropriate authorities, such as the utility provider or law enforcement agencies, about any suspected power theft or abnormal energy consumption patterns.
7. Follow-Up and Investigation: Conduct follow-up investigations to verify any suspected power theft and take appropriate action, such as disconnecting the power supply or imposing fines.

It is important to note that the exact methodology for auto cutoff and power theft tracking may vary depending on the specific needs and requirements of the system. Additionally, implementation of such a system may require expertise in data analytics, electrical engineering, and software development.

3.5 PROPOSED BLOCK DIAGRAM AND EXPLANATION

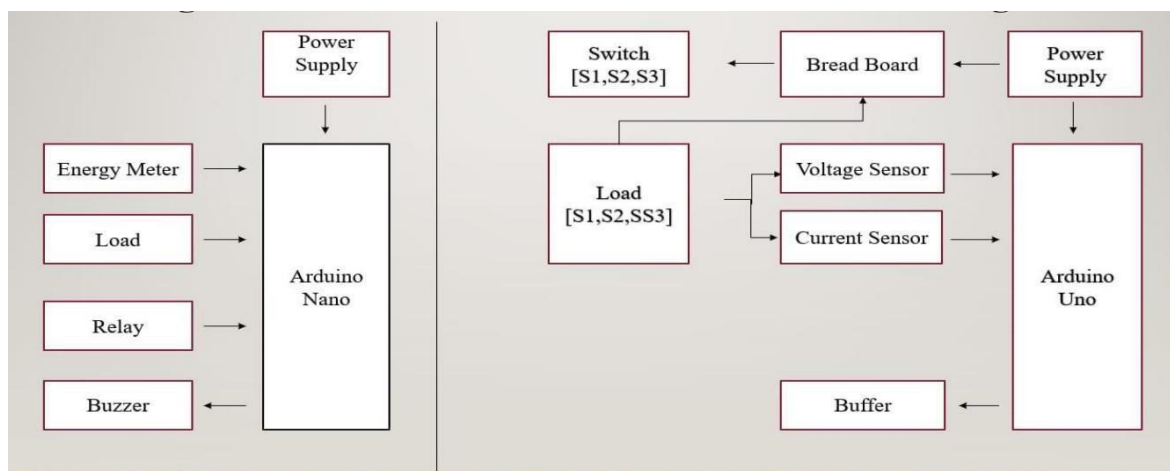


Fig 3.1 proposed Block diagram

Auto cutoff and power theft tracking are two related concepts that aim to improve the efficiency and security of electricity distribution systems.

Auto cutoff refers to a system that can automatically disconnect the power supply in case of any abnormal energy consumption patterns or power surges. This can help to prevent accidents, reduce energy wastage, and protect the electrical infrastructure from damage.

Power theft tracking, on the other hand, involves the use of data analysis techniques to identify any unauthorized connections or electricity theft. This can be done by comparing the energy consumption patterns of different households or areas, detecting any unusual spikes or drops in energy usage, or identifying any patterns of energy consumption that are inconsistent with normal usage patterns.

The goal of power theft tracking is to detect and prevent energy theft, which is a major problem in many countries around the world. Energy theft can lead to higher costs for law-abiding customers, reduce the reliability of the electrical grid, and even create safety hazards if unauthorized connections are not properly installed.

By combining auto cutoff and power theft tracking, utilities and other organizations can create a more secure and efficient electrical distribution system. By automatically disconnecting power supplies in case of abnormal energy consumption patterns, the system can prevent accidents and reduce energy wastage. By detecting and preventing power theft, the system can reduce costs and improve the reliability of the electrical grid.

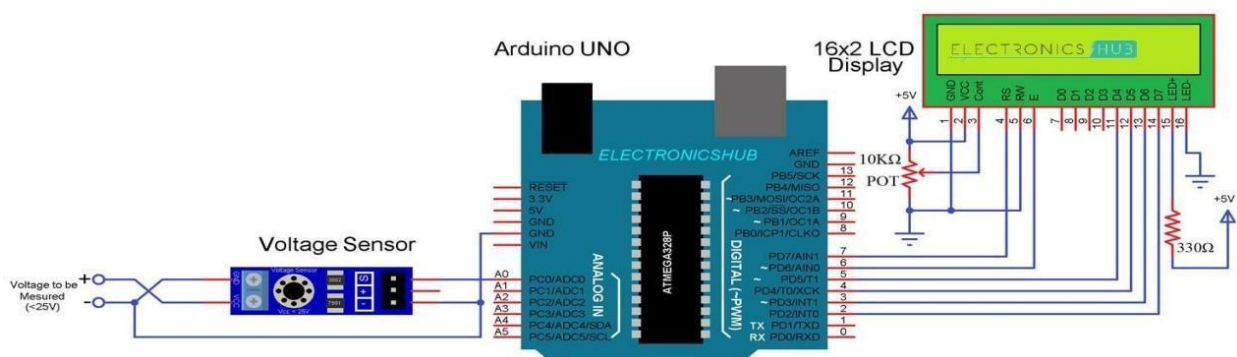


Fig 3.2 proposed circuit diagram

3.5.1 CURRENT SENSOR



Fig 3.3 current sensor

A current sensor is a device that is used to measure the flow of electrical current in a circuit. It is also known as a current transducer or current transformer. The main purpose of a current sensor is to convert the current passing through a conductor into a measurable signal that can be easily read and analyzed by an instrument or a control system.

There are different types of current sensors available in the market, including:

1. Hall Effect sensors: These sensors use the Hall Effect principle to measure the magnetic field generated by the current flowing through a conductor.
2. Rogowski coils: These are flexible coils that can be wrapped around a conductor to measure the current passing through it. They are commonly used in high-current applications.
3. Current transformers: These are magnetic devices that are used to measure high current levels in power transmission and distribution systems.

4. Shunt resistors: These are low-resistance resistors that are placed in series with a conductor to measure the current passing through it.

3.5.2 VOLTAGE SENSOR



Fig 3.4 voltage sensor

A voltage sensor is a device that is used to measure the electrical potential difference between two points in a circuit. It is also known as a voltage detector or voltmeter. The main purpose of a voltage sensor is to convert the voltage signal into a measurable signal that can be easily read and analyzed by an instrument or a control system.

There are different types of voltage sensors available in the market, including:

1. Resistive voltage dividers: These are passive devices that divide the input voltage down to a measurable level. They consist of two resistors connected in series, with the output voltage taken from the junction between them.
2. Capacitive voltage dividers: These are passive devices that divide the input

voltage down to a measurable level. They consist of two capacitors connected in series, with the output voltage taken from the junction between them.

3. Voltage-to-frequency converters: These devices convert the input voltage signal into a frequency signal, which can be easily measured and analyzed.
4. Digital voltmeters: These are electronic devices that measure the input voltage and display the results on a digital display.

3.5.3 PINS OF THE VOLTAGE SENSOR

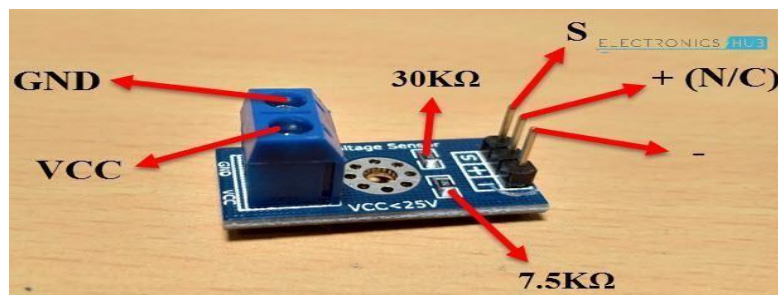


Fig 3.5 pins of voltage sensor

The number and type of pins required for a voltage sensor can vary depending on the specific sensor design and its intended application. However, here are some common configurations:

1. Two-pin voltage sensor: This type of sensor typically has two pins - one for the voltage input and the other for the ground connection. The output of the sensor is usually a voltage signal that varies proportionally with the input voltage.
2. Three-pin voltage sensor: This type of sensor includes a third pin that provides

a reference voltage to the sensor. This reference voltage can be used to improve the accuracy of the sensor's output.

3. Four-pin voltage sensor: This type of sensor typically includes two additional pins for power supply connections. These pins may be used to power the sensor, or to power external components that are connected to the sensor.

3.5.4 SCHEMATIC OF VOLTAGE SENSOR

Now, let us talk about the important thing about the voltage sensor: its schematic. The Voltage

Sensor is basically a Voltage Divider consisting of two resistors with resistances of $30\text{K}\Omega$ and $7.5\text{K}\Omega$ i.e. a 5 to 1 voltage divider.

3.6 ADVANTAGES OF PROPOSED SYSTEM

1. Improved safety,
2. Reduced costs,
3. Increased reliability, and better resource management.

3.7 APPLICATION

Applications of Auto Cutoff:

1. **Residential and Commercial Buildings:** Auto cutoff systems can be installed in residential and commercial buildings to prevent electrical accidents and reduce energy wastage.
2. **Industrial Facilities:** Auto cutoff systems can be used in industrial facilities to protect the electrical infrastructure from power surges and other types of electrical disturbances.

3. Renewable Energy Systems: Auto cutoff systems can be used in renewable energy systems such as solar or wind power plants to protect the electrical grid from fluctuations in energy production.

4. Electric Vehicles: Auto cutoff systems can be used in electric vehicles to prevent electrical accidents and protect the vehicle's battery from damage.

Applications of Power Theft Tracking:

1. Utility Companies: Power theft tracking systems can be used by utility companies to detect and prevent energy theft, which can result in significant financial losses.

2. Government Agencies: Power theft tracking systems can be used by government agencies to monitor energy consumption and detect any unauthorized connections or energy theft.

3. Law Enforcement: Power theft tracking systems can be used by law enforcement agencies to investigate cases of energy theft and prosecute offenders.

4. Energy Audits: Power theft tracking systems can be used by energy auditors to identify areas of high energy consumption and detect any energy losses in the distribution network.

Overall, auto cutoff and power theft tracking systems have a wide range of applications in different industries and settings, and can help to improve the efficiency, reliability, and security of electrical distribution systems.

CHAPTER 4

HARDWARE DESCRIPTION

4.1 INTRODUCTION

The hardware components used in auto cutoff and power thefttracking systems can include smart meters, disconnect switches, sensors, data analytics software, communication networks, and physical inspection tools. These components work together to create a secure, efficient, and reliable electrical distribution system.

4.2 HARDWARE COMPONENTS

The hardware components of modern electronic systems are made up of a variety of intricate components that work together to perform a specific task. These components include Arduino UNO, [Buy Here](#) Voltage Sensor Module (for < 25V), 16×2 LCD Display, 10KΩ Potentiometer, 330Ω Resistor, Connecting Wires and Breadboard. The interplay of these hardware components is a complex process that requires careful design and implementation to ensure optimal system performance.

4.2.1 CIRCUIT DESIGN

First, connect the “S” and “-” pins of the Voltage Sensor to A0 (Analog Input) and GND of Arduino respectively. Then connect the external voltage pins (voltage to be measured) to the screw terminal (check for polarity).

Coming to the LCD, Digital I/O Pins 7 and 6 of Arduino UNO are connected to RS and E while the Pins 5 through 2 of Arduino UNO are connected to D4 through D7 respectively.

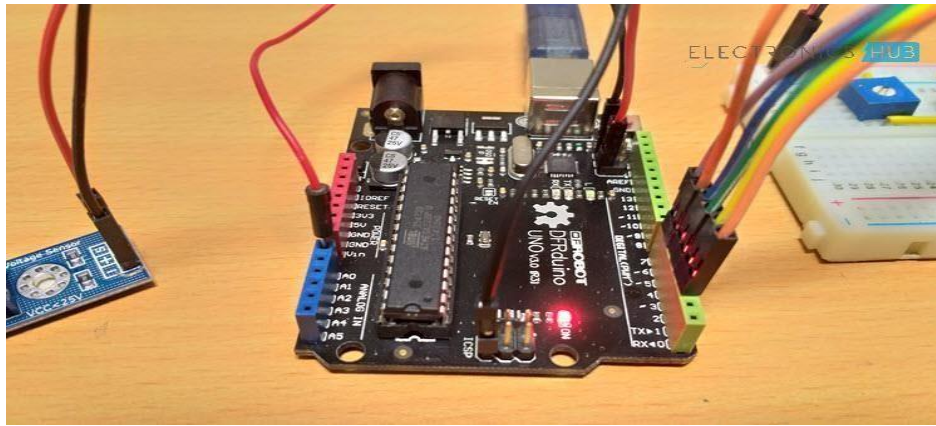


Fig 4.1 arduino connections

4.2.2 Working

I think the working of the project might be understood by now. Since the Voltage Sensor module is basically a voltage divider circuit, you can calculate input voltage using the formula

$$V_{in} = V_{out} * (R2 / (R1 + R2))$$

Here $R1 = 30000$, $R2 = 7500$ and V_{out} can be calculated from Analog Input of Arduino by using $V_{out} = (\text{analogvalue} * 5 / 1024)$.

I have implemented the same in the code. When I connected a 12V external supply as input to the Voltage Sensor, the calculated voltage is 11.94V, which is accurate enough.

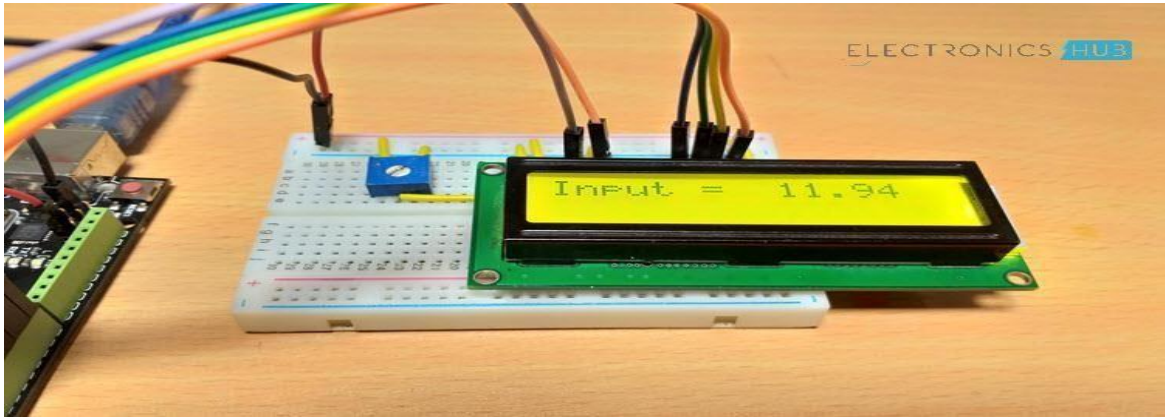


Fig 4.2 lcd connection

4.2.3 IOT

The structure of this chapter is the following: Section 1.1 defines the motivation for this work. Section 1.2 shows the research objectives and questions. Section 1.3 presents the steps required to achieve our objectives. Section 1.4 shows the structure of the report.

4.2.4 Background

The Future Internet goal is to provide an infrastructure to have an immediate access to information about the physical world and its objects. Physical objects can be applicable to different application domains, such as e-health, warehouse management, etc. Each application domain may have different types of physical devices. Each physical device can have its own specifications, which is required to use in order to interact with it.

To achieve the future Internet goal, a layered vision is required that can facilitate data access. Internet of Things (IoT) is a vision that aims to integrate the virtual world of information to the real world of devices through a layered architecture. The term „Internet of Things“ consists of two words, namely Internet and Things.

Internet refers to the global network infrastructure with scalable, configurable capabilities based on interoperable and standard communication protocols. Things

are physical objects or devices, or virtual objects, devices or information, which have identities, physical attributes and virtual personalities, and use intelligent interfaces [1]. For instance, a virtual object can represent an abstract unit of sensor nodes that contains metadata to identify and discover its corresponding sensor nodes. Therefore, IoT refers to the things that can provide information from the physical environment through the Internet.

Middleware is as an interface between the hardware layer and the application layer, which is responsible for interacting with devices and information management [2]. The role of a middleware is to present a unified programming model to interact with devices. A middleware is in charge of masking the heterogeneity and distribution problems that we face when interacting with devices [3].

4.2.5 IoT definition

In this section, we explain some of the IoT definitions. Also, we explain the layered architecture for IoT.

Internet of Things (IoT) has increasingly gained attention in industry to interact with different types of devices. IoT can have influence on industry and society by integrating physical devices into information networks [8]. IoT impacts can be on different perspectives, namely for private and business users. From the perspective of a private user, IoT has effect on both working and personal fields, such as smart homes and offices, e-health and assisted living. From the aspect of a business user the impacts would be in fields such as automation and industrial manufacturing, logistics, business process management, intelligent transportation of people and goods.

IoT integrates physical things into information networks. IoT covers the overall infrastructure, including software, hardware and services, which is used to support these information networks. The integrated physical

things can exchange data about the physical properties and information that they sense in their environment. To identify devices, we can use identification technologies like for example RFID, which allow each device be uniquely identified.

International Telecommunication Union (ITU)¹ defines IoT as “A global infrastructure for the Information Society, enabling advanced services by interconnecting (physical and virtual) things based on, existing and evolving, interoperable information and communication technologies.

IoT has a layered architecture designed to answer the demands of various industries, enterprises and society. Fig. 2.1 shows a generic layered architecture for IoT that consist of five layers, which are discussed, in the following

Edge Technology layer

This is a hardware layer that consists of embedded systems, RFID tags, sensor networks and all of the other sensors in different forms. This hardware layer can perform several functions, such as collecting information from a system or an environment, processing information and supporting communication.

Access Gateway layer

This layer is concerned with data handling, and is responsible for publishing and subscribing the services that are provided by the *Things*, message routing, and hovelling the communication between platforms.

Middleware layer

This layer has some critical functionalities, such as aggregating and filtering the received data from the hardware devices, performing information discovery and providing access control to the devices for applications.

Application layer

This layer is responsible for delivering various application services. These services are provided through the middleware layer to different applications and users in IoT-

based systems.

4.2.6 PIN CONFIGURATION

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall- wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector. The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows:

- **VIN.** The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- **5V.** this pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board.
- **3V3.** A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- **GND.** Ground pins.
- **IOREF.** This pin on the Arduino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin

voltage and select the appropriate power source or enable voltage translators on the outputs for working with the 5V or 3.3V.

Memory

The ATmega328 has 32 KB (with 0.5 KB used for the bootloader).

It also has 2 KB of SRAM and 1 KB of EEPROM.

4.2.7 COMMUNICATION

Microcontrollers depend on a host computer for developing and compiling programs. The software used on the host computer is known as an integrated development environment, or IDE. For the Arduino, the development environment is based on the open source Processing platform (www.processing.org) which is described by its creators as a “programming language and environment for people who want to program images, animation, and interactions.” The Arduino programming language leverages an open source project known as Wiring (wiring.org.co). The Arduino language is based on good old- fashioned C. If you are unfamiliar with this language, don’t worry; it’s not hard to learn, and the Arduino IDE provides some feedback when you make mistakes in your programs.

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A Software Serial library allows for serial communication on any of the Uno's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation for details. For SPI communication, use the SPI library.

As you go through the list of programming statements available in the Arduino IDE (choose Help->Reference), you might think there isn't much power for doing things like running servos, operating stepper motors, reading potentiometers, or displaying text on an LCD. Like most any language based on C, the Arduino supports the notion of "libraries" code

Repositories that extend core programming functionality. Libraries let you reuse code without having to physically copy and paste it into all your programs. The standard Arduino software installation comes with several libraries you may use, and you can download others from the Arduino support pages and from third-party websites that publish Arduino library code. A good example of a library you'll use with the Robot and likely many other robot projects is Servo. This library allows you to connect one or more hobby R/C servos to the Arduino's digital I/O pins. The Servo library comes with the standard Arduino installation package Library->Servo. This adds the line

```
#include <Servo.h>
```

Which tells the Arduino IDE that you wish to include the Servo library in your sketch. With the functionality of the library now available to you, you can use its various functions to control one or more servos. For example, you can use the write function to rotate a servo to a specific position, from 0 to 180 degrees. The following code `myServo.write(90)` Moves a servo to its midpoint, or 90 degree position. Structurally, Arduino sketches are very straightforward and are pretty easy to read and understand. The Arduino program contains two main parts: `setup ()` and `loop ()`. These are programming functions that do what their names suggest: `setup ()` sets up the Arduino hardware, such as specifying which I/O lines you plan to use, and whether They are inputs or outputs. The `loop ()` function is repeated endlessly when the Arduino is operating. Arduino IDE (Integrated development environment) is used

to write the program and dump into the Arduino board.

4.2.8 NODE MCU

NodeMCU is an open-source Lua based firmware and development board specially targeted for IoT based Applications. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Espressif systems, and hardware which is based on the ESP-12 module

4.2.9 PROGRAMMING NODEMCU ESP8266 WITH ARDUINO IDE

The NodeMCU Development Board can be easily programmed with Arduino IDE since it is easy to use. Programming NodeMCU with the Arduino IDE will hardly take 5-10 minutes. All you need is the Arduino IDE, a USB cable and the NodeMCU board itself. You can check this [Getting Started Tutorial for NodeMCU](#) to prepare your Arduino IDE for NodeMCU.

NodeMCU is an open source firmware for which open source [prototyping](#) board designs are available. The name "NodeMCU" combines " [node](#)" and "MCU" ([micro-controller](#) unit).^[8] The term "NodeMCU" strictly speaking refers to the firmware rather than the associated [development kits](#). Both the firmware and prototyping board designs are [open source](#).

The firmware uses the [Lua](#) scripting language. The firmware is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266. It uses many open source projects, such as [luacjson](#)^[9] and [SPIFFS](#).^[10] Due to resource constraints, users need to select the modules relevant for their project and build a firmware tailored to their needs. Support for the 32-bit [ESP32](#) has also been implemented.

The prototyping hardware typically used is a circuit board functioning as a [dual in-line package](#) (DIP) which integrates a USB controller with a smaller surface-mounted board containing the MCU and antenna. The choice of the DIP format allows for easy prototyping on [breadboards](#). The design was initially based on the

ESP-12 module of the ESP8266, which is a Wi-Fi SoC integrated with a Tensilica Xtensa LX106 core, widely used in IoT applicants.

4.2.10 History

NodeMCU was created shortly after the ESP8266 came out. On December 30, 2013, Espressif Systems began production of the ESP8266.

NodeMCU started on 13 Oct 2015, when Hong committed the first file of nodemcu-firmware to GitHub.^[12] Two months later, the project expanded to include an open-hardware platform when developer Huang R committed the gerber file of an ESP8266 board, named devkit v0.9.^[13] Later that month, Tuan PM ported MQTT client library from Contiki to the ESP8266 SoC platform,^[14] and committed to NodeMCU project, then NodeMCU was able to support the MQTT IoT protocol, using Lua to access the MQTT broker. Another important update was made on 30 Jan 2015, when Devsaurus ported the u8glib^[15] to the NodeMCU project,^[16] enabling NodeMCU to easily drive LCD, Screen, OLED, even VGA displays.

In the summer of 2015 the original creators abandoned the firmware project and a group of independent contributors took over. By the summer of 2016 the NodeMCU included more than 40 different modules.

4.2.11 ESP8266 ARDUINO CORE



Fig 4.3 arduino

As Arduino.cc began developing new MCU boards based on non-AVR processors like the ARM/SAM MCU and used in the Arduino Due, they needed to modify the Arduino IDE so that it would be relatively easy to change the IDE to support alternate toolchains to allow Arduino C/C++ to be compiled for these new processors. They did this with the introduction of the Board Manager and the SAM Core. A "core" is the collection of software components required by the Board Manager and the Arduino IDE to compile an Arduino C/C++ source file for the target MCU's machine language. Some ESP8266 enthusiasts developed an Arduino core for the ESP8266 WiFi SoC, popularly called the "ESP8266 Core for the Arduino IDE".^[17] This has become a leading software development platform for the various ESP8266-based modules and development boards, including NodeMCUs. NodeMCU is an open-source LUA based firmware developed for the ESP8266 wifi chip. By exploring functionality with the ESP8266 chip, NodeMCU firmware comes with the ESP8266 Development board/kit i.e. NodeMCU Development board.

4.2.12 NODEMCU DEVELOPMENT BOARD/KIT

Since NodeMCU is an open-source platform, its hardware design is open for edit/modify/build. NodeMCU Dev Kit/board consist of ESP8266 wifi enabled chip. The ESP8266 is a low-cost Wi-Fi chip developed by Espressif Systems with TCP/IP protocol. For more information about ESP8266, you can refer to the ESP8266 WiFi Module. There is Version2 (V2) available for NodeMCU Dev Kit i.e. NodeMCU Development Board v1.0 (Version2), which usually comes in black colored PCB.

How to start with NodeMCU?

NodeMCU Development board is featured with wifi capability, analog pin, digital pins, and serial communication protocols. To get started with using NodeMCU for IoT applications first we need to know about how to write/download NodeMCU firmware in NodeMCU Development Boards. And before that where this NodeMCU firmware will get as per our requirement. There are online NodeMCU custom builds available using which we can easily get our custom NodeMCU firmware as per our requirement. To know more about how to build custom NodeMCU firmware online and download it refer to [Getting started with NodeMCU](#).

How to write codes for NodeMCU?

After setting up ESP8266 with Node-MCU firmware, let's see the IDE (Integrated Development Environment) required for the development of NodeMCU.

4.2.13 NODEMCU WITH ARDUINO IDE

Here is another way of developing NodeMCU with a well-known IDE i.e. Arduino IDE. We can also develop applications on NodeMCU using the Arduino development environment. This makes it easy for Arduino developers than learning a

new language and IDE for NodeMCU.

For more information about how to write Arduino sketch for NodeMCU refer to [Getting started with NodeMCU using Arduino IDE](#)

4.2.14 NODEMCU ESP8266 SPECIFICATIONS & FEATURES

- Microcontroller: Tensilica 32-bit RISC CPU Xtensa LX106
- Operating Voltage: 3.3V
- Input Voltage: 7-12V
- Digital I/O Pins (DIO): 16
- Analog Input Pins (ADC): 1
- UARTs: 1
- SPIs: 1
- I2Cs: 1
- Flash Memory: 4 MB
- SRAM: 64 KB
- Clock Speed: 80 MHz
- USB-TTL based on CP2102 is included onboard, Enabling Plug n Play
- PCB Antenna
- Small Sized module to fit smartly inside your IoT projects.

4.3 HARDWARE KIT AND EXPLANATION

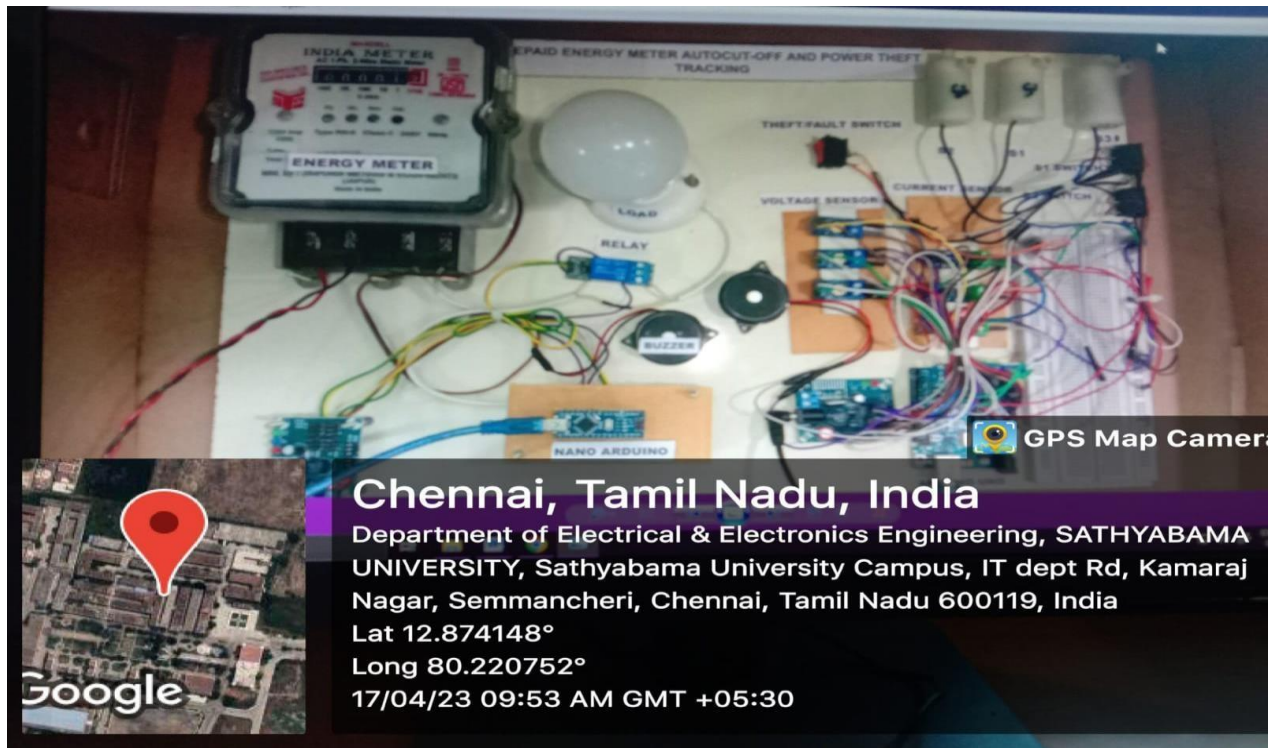


Fig 4.4 hardware kit

4.3.1 ARDUINO UNO AND ITS PROGRAMMING

Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board.

Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be standalone, or they can be communicate

with software running on your computer. The boards can be assembled by hand or purchased preassembled; the open-source IDE can be downloaded for free.

The Arduino programming language is an implementation of Wiring, a similar physical computing platform, which is based on the Processing multimedia programming environment.

4.3.2 ARDUINO SOFTWARE

1. Open Arduino IDE as shown below

Open Arduino IDE

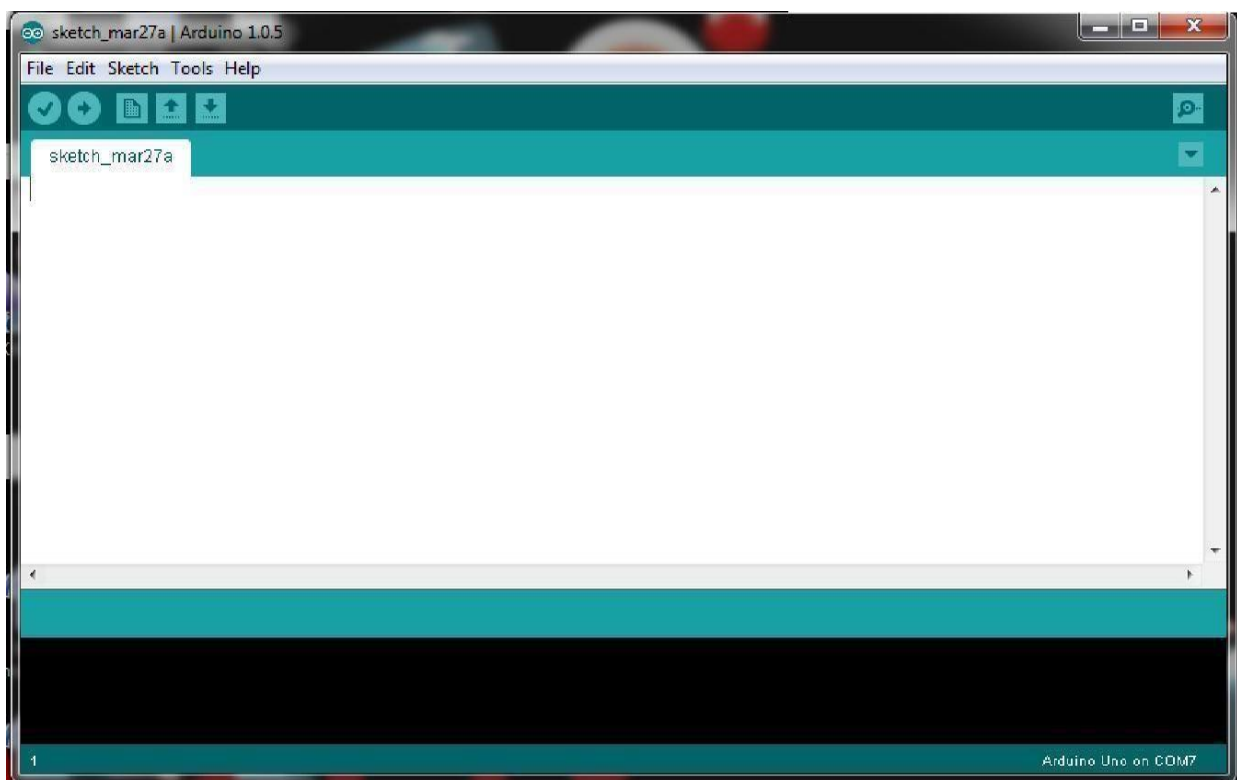


Fig 4.5 open arduino

2. Select the COM Port from tool

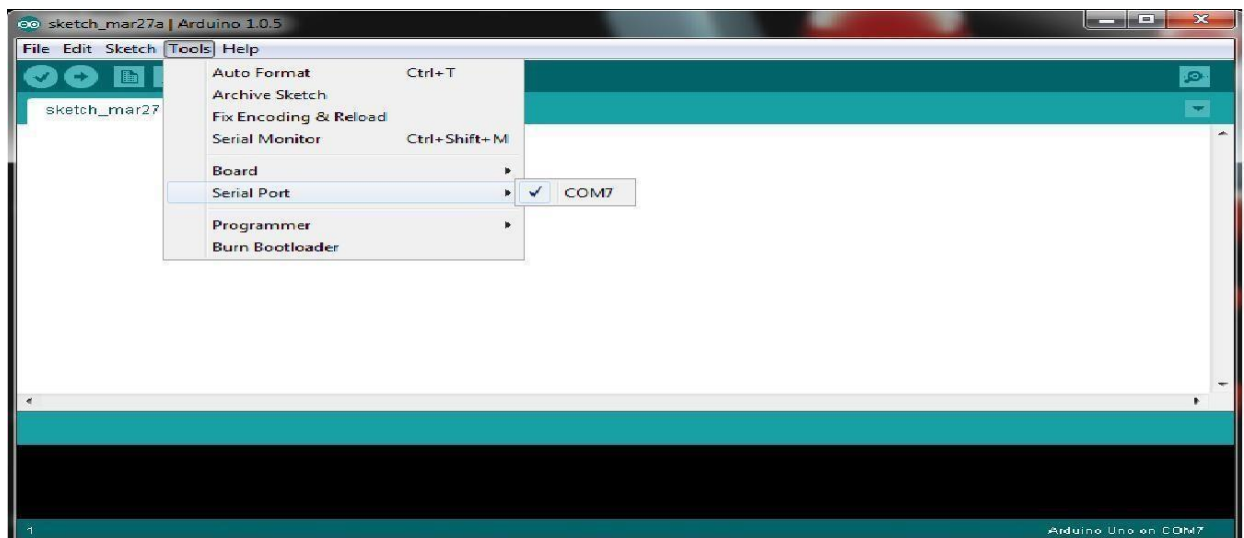


Fig 4.6 open COM port

3. Select the required Arduino board from Tools as shown below

Select the required Arduino board

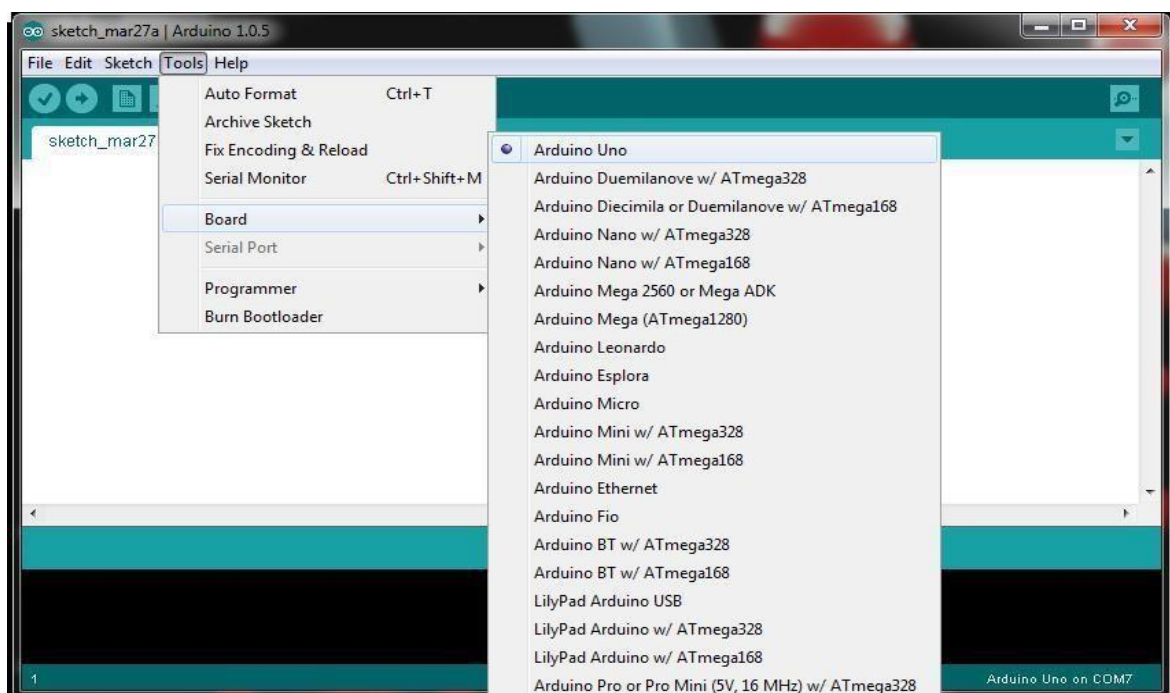


Fig 4.7 open arduino board

CHAPTER 5

RESULT/DISCUSSION AND PERFORMANCE ANALYSIS

5.1 SIMULATION

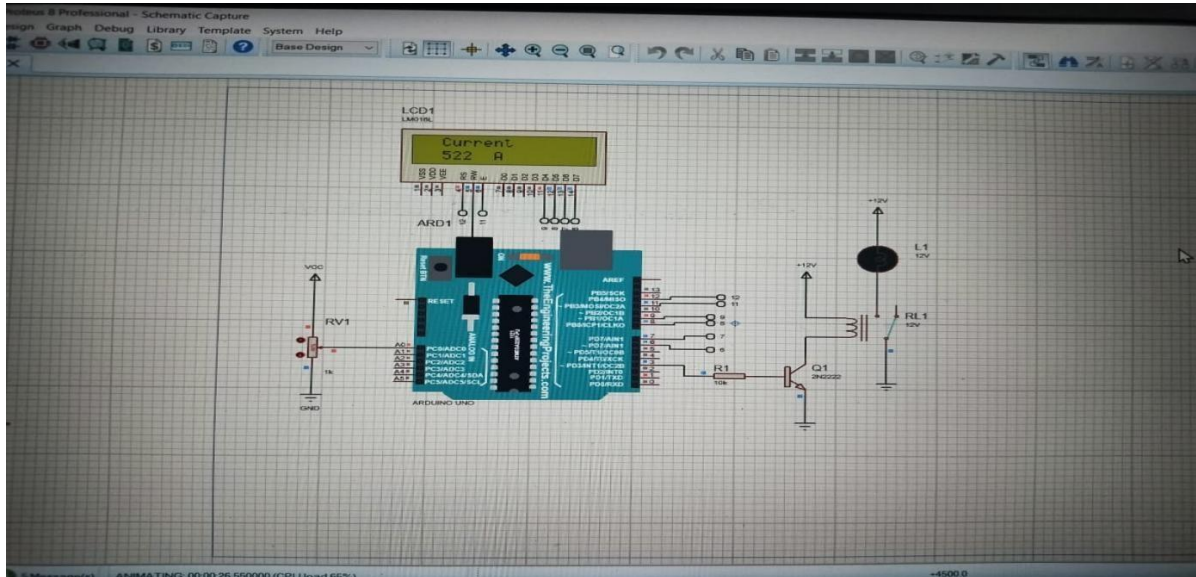


Fig 5.1 simulation

5.2 OUTPUT 1

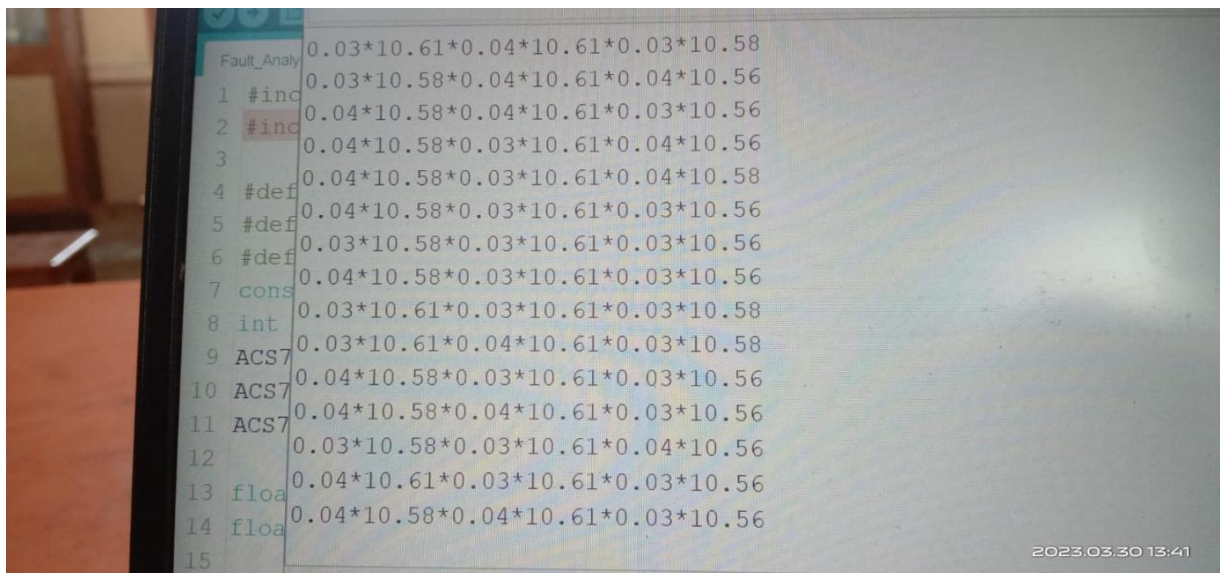


Fig 5.2 output 1

5.3 OUTPUT 2

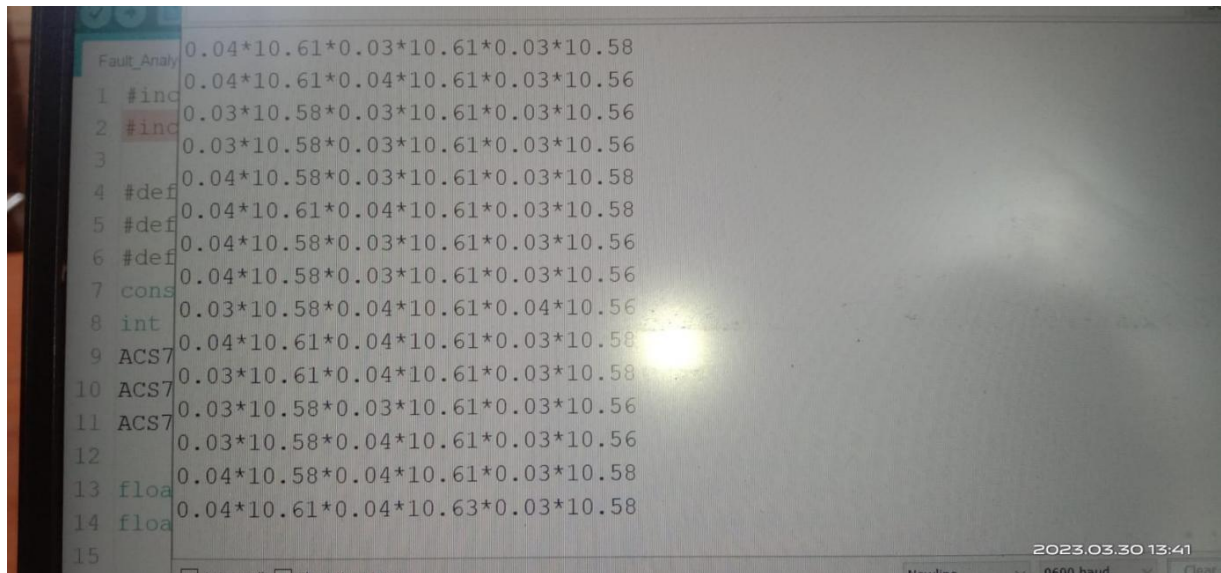


Fig 5.3 output 2

5.4 INPUT AND OUTPUT

Each of the 14 digital pins on the Uno can be used as an input or output, using `pinMode()`, `digital Write( )`, and `digital Read( )` functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kohms. In addition, some pins have specialized functions:

Serial: 0 (RX) and 1 (TX). Used to receive (RX) and Trans mit (TX) TTL serial data.

These pins are connected to the corresponding pins of the ATmega8U2 USB-to- TTL Serial chip.

External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attach Interrupt ()

function for details.

PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analog Write () function.

SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.

LED: 13. There is a built- in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Uno has 6 analog inputs, labeled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analog Reference () function. Additionally, some pins have specialized functionality:

TWI: A4 or SDA pin and A5 or SCL pin. Support TWI communication using the Wire library.

There are a couple of other pins on the board:

AREF. Reference voltage for the analog inputs. Used with analog Reference ().

Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board

CHAPTER 6

SUMMARY AND CONCLUSION

6.1 SUMMARY

In summary, auto cut off is a safety mechanism used to prevent overloading or short circuits in the electrical system, while power theft tracking is a system used to monitor and detect instances of electricity theft. Together, these technologies can improve the efficiency and safety of the electrical distribution system by reducing the risk of overloading and preventing losses due to theft. They are particularly important in areas where electricity theft is common and can have a significant impact on the financial viability of the system.

6.2 CONCLUSION

In conclusion, the use of auto cut off and power theft tracking technologies is crucial for ensuring the efficient and safe operation of the electricity distribution system. By preventing overloading and detecting instances of electricity theft, these technologies can help to minimize the financial losses associated with electricity theft and prevent potential safety hazards. As such, they are essential tools for maintaining a reliable and sustainable energy infrastructure, particularly in areas where electricity theft is prevalent.

6.3 RESULT

Energy Monitoring using IOT is a very innovative application of the internet of things which plays a vital role in upcoming years. It is used to control home appliances remotely over the cloud from anywhere in the world. In the proposed project current sensor is used to sense the current and display it on the web using IoT. The system updates the information every 4 to 3 seconds because it has some delay due to the relay module connecting with the appliances to make the appliances home automated. An attempt has been made to make a practical model of 'IoT Based Smart Energy Meter.' The propagated model is used to calculate the energy consumption of the household, and even make the energy unit reading to be handy.

6.6 REFERENCES

- [1] Anitha.k ,prathik, “Smart Energy Meter surveillance Using IoT” ,Institute of Electrical and Electronics Engineers(IEEE), 2019.
- [2] Devadhanishini, et.al” “Smart Power Monitoring Using IoT”5th International Conference on Advanced Computing & Communication Systems (ICACCS) 2019.
- [3] Mohammad Hossein Yaghmaee Design and Implementation of an Internet of Things Based Smart Energy Metering” 6th IEEE International Conference on Smart Energy Grid Engineering 2018.
- [4] Himanshu kpatel “arduino based smart energy meter” 2nd Int'l Conf. on Electrical Engineering and Information &Communication Technology (ICEEICT) 2018.
- [5] “Bibek Kanti Barman, et.al” proposed paper “smart meter using IoT” department of international electronics and electrical engineering (IEEE) 2017.
- [6] Garrab.A, Bouallegue.A, Ben Abdullah, A new AMR approach for energy savings in Smart Grids using Smart meter and partial power line communication”, IEEE First International Conference on ICICS,vol 3, pp. March 2012.
- [7] Landi,c.: Dipt. Di Ing.dell”Inf, SecondaUniv di Napoli,Aversa,Italy; Merola p.”ARMbased energy management system using smart meter and Web server”,IEEEinstrumentation and measurement technology conference binjing, pp.1-5 may 2011.
- [8] B. S. Koay, S. S. Cheah, Y. H. Sng, P. H. Chong, P. Shum, Y. C. Tong, X. Y. Wang, Y. X. Zuo and H. W. Kuek, "Design and implementation of Bluetooth energy meter", IEEE Proceedings of the 4th International Joint Conference of the ICICS, vol. 3, pp. 1474-1477, Dec,2003.
- [9] N. Fathima, A. Ahammed, R. Banu, B.D. Parameshachari, and N.M. Naik, “Optimized neighbor discovery in Internet of Things (IoT),” In Proc. of

International Conference on Electrical, Electronics, Communication,
Computer, and Optimization Techniques (ICEECOT)