A Project report on

SMART PREPAID ENERGY METER

Submitted in partial fulfillment of the requirements
for the degree of

Bachelor of Technology
in
Electrical Engineering

Submitted by

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2022-2023

D E C L A R A T I O N

We hereby declare that, the work reported in this project report entitled **‘Smart Prepaid Energy Meter**’ which is being submitted in partial fulfilment of the requirements for the award of the Degree of Bachelor of Technology in Electrical Engineering from Annasaheb Dange College of Engineering & Technology, Ashta has not been submitted to any University or Institution for the award of any degree.

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C E R T I F I C A T E

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as the record of the project work carried out by them, is accepted as the Project Report in partial fulfilment of the requirements for the award of degree of Bachelor of Technology in Electrical Engineering from Annasaheb Dange College of Engineering & Technology, Ashta, during the academic year 2022- 2023

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ABSTRACT

This study is specifically focused to developed a Smart Prepaid Energy Meter system which would be able to address some of the challenges currently available in the metering system in India. In the currently working system electricity meter reading for electricity usage and billing is done by human workers from home to home and building to building. There are some drawbacks such as electricity bill error due to human mistake in billing calculations. There is another problem regarding with electricity is electricity theft.

Power utilities in different countries especially in developing countries like India are incurring huge losses due to electricity theft. In this proposed system smart energy meter installed at consumer house. Consumer unit and server are equipped with GSM module which facilitates bidirectional communication between two ends using GSM infrastructure. Consumer can easily recharge their energy meter by sending a number to the server using SMS. The purpose of this project model is used to control electricity theft and it also reduces human error and helps to retrieve the real time meter value via GSM and send it to customer mobile phone through GSM. In case of theft detection this proposed system can measure to control meter bypassing and tampering. The bidirectional GSM communication using SMS ensure the effectiveness of these measures it can send an alert to the energy supplier or server in case of power theft at the customer side and cut off the supply automatically. Legal action against dishonest customer can also be taken in this system

Keywords – Smart Meter, Prepaid System, Prepayment, Theft Detection, Alert Provision.

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CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION

In a growing nation like India, supplying power is extremely difficult. Therefore, it is crucial to manage electricity use. A home, business, or machine's electrical energy production, consumption, or supply can all be measured by an energy meter, an electronic gadget. For the continuation of content life, electricity is a crucial necessity. For proper use, it must be used extremely carefully. However, despite the fact that we have requested additional electricity in a number of locations throughout our nation, many of them still lack it. We still aren't able to estimate our precise needs, and the prevailing power is still in place, therefore our distribution strategies are also somewhat to blame for this. The services provided by power providers, on the other hand, are not well received by customers. The process involves taking meter readings manually by appointing an employee, then processing that reading for costing and generating the bill. Therefore, most of the time consumers have complaint regarding with errors in the electricity bill. With this we can monitor meter and track the electric energy meter to check if any fault is there or not. Here we cannot avoid the any mistake or error in this process as manual operation is done.

Power utilities in various nations, particularly in developing nations like India, detect significant losses as a result of electricity theft. Energy theft results in significant financial loss. Electricity theft includes bypassing meters to steal electricity, tampering with meters to indicate low readings, unusual billing practices, and unpaid bills. To manage the quantity of energy supplied only based on the prepaid amount, the project's goal is to create and deploy a smart prepaid energy meter system. Customers can use the power supply in accordance with their available recharge, which can be topped up, thanks to this technology.

The phrase "First Pay First Served" is used when referring to the smart prepaid energy meter system. This system implemented with the Arduino uno and ESP 8266 wi-fi module is used which is provided for uploading data to the cloud. Consumers who use the IoT-based prepaid energy meter will monitor their real-time energy usage in the web database, as well as manage their whole device from the web database. To make it easier, the number of units required can also be charged in that database. As a result, the user can see how many units have been consumed and how many units remain. By using their user

ID, consumers can conveniently recharge their energy meter in the database. The service provider will have complete leverage over the customer side thanks to bidirectional IOT connectivity. When consumers pay for electricity before using it, electricity can only be created once. After the payment, the recharge is turned on, allowing the consumer to use the electricity and the load to be linked to the system. The electricity will be shut off immediately once the recharge is finished. Customers must reload their energy meters and pay for service before using the electricity. The amount of electricity used by the user can be effectively controlled using an energy meter system. Consumers that use power can purchase a predetermined amount of recharge to use it just as needed. As a result, all customers will use less energy and be more careful and responsible. This smart prepaid energy meter system provides the block rate as per the MSEB system. This is the best feature provided by this system. To prevent electricity theft, this project suggests a sophisticated prepaid energy metering system. Electricity theft can be significantly minimized by combining the new steps with the prepaid metering system. There is electricity can be stolen: by circumventing the energy meter and by messing with it. CT is connected in series with phase and neutral in order to build this system. The current differential between phase and neutral will reveal information regarding theft when a consumer tries to steal by shorting the electricity phase wire. The voltage difference between the input and output when the customer tries to bypass by shorting both the phase and neutral will determine whether or not a theft happened. As a result, information concerning the discovery of electricity theft will be communicated to the consumer as well as the appropriate party.

1.2 PROBLEM STATEMENT

Digital energy meters have a number of benefits, just like the present or existing system, but there are constantly chances for innovation or modification in different instruments for the convenience of consumers and suppliers. The following are the issues with those energy meters that need to be fixed:

- For energy meter and other related functions like paying bills, a sizable workforceis needed.
- In existing system meter reading is taken by an employee so there are possibilitieslike error in the energy meter reading.
- Time and labour consuming.
- A mistake in billing brought on by the meter reader’s negligence during meter reading and occasionally inaccurate billing estimate.
- If consumer uses a post-paid billing system, they must wait in line for an hour to paytheir bills.
- Consumers are not required to pay their bills on schedule.
- When there are areas, additional steps for disconnections and reconnections are required.
- Unnecessary use of electricity.

1.3 PROJECT OBJECTIVES

The objectives for the smart prepaid energy meter system can be summarized as follows:

- To create a SPEMS that only uses the prepaid amount to regulate the energy supply.
- To offer a system that can lower the costs and loads associated with setting up thesystem utilizing the suggested energy solution.
- To apply to get the concept of “First Pay First Serve”.
- To save time using an energy meter by only reloads prepaid.
- To provide access of energy meter from anywhere and anytime i.e., remotely operated.

- To provide prepaid system which help to reduce manual efforts and save the time.
- To give protection against theft of electricity by bypassing or meter tempering.
- To provide real time monitoring of consumption of electricity.
- To provide different notification to consumers like recharge alert, theft alert.
- To provide the billing services as per the MSEB i.e., consumer can charge withblock rate tariff.

1.4 PROJECT SCOPE

The development of the smart prepaid energy meter system has two aspects that arenecessary to address the difficulties mentioned. The relevant levels are:

1. Supplier

- In charge of designing the rechargeable system that modifies the access system's validity and turns on the lighting.
- Charged with keeping track of all access the information for each transaction.

2. Consumer

- The ability to prepay for the energy.
- Has access to the transactions' statuses after the amount.
- Has the ability to assess energy consumption balance.

1.5 EXPECTED OUTCOME

- This method enables consumers to manage and regulate their energy consumptionbased solely on their pre-paid balance.
- The system is responsible to ensure all the computed data in smart prepaid energy meter system are updated.
- Assists in lowering the cost and load associated with installing the system and implementing the suggested energy solution.
- Helps to detect the energy theft if consumer tries to misbehave with the system.
- This proposed system helps to provides the bidirectional communication

1.6 CHAPTER OUTLINE

Chapter 1 - Introduction: This chapter discusses about the introduction, general background of the project. Besides that, the problem statement and objectives must be accomplished. It also highlights some expected problems and how they can be solved. Theoverall chapter outline is also detailed under this chapter.

Chapter 2 - Literature Review: This chapter reviews works done in the earlier studies or researches which are related to the project smart prepaid energy meter system. The differences between prepaid and postpaid also will be discussed in this chapter. This chapter also will discuss about the importance of the electricity. Discussion on theadvantages, limitations about the project are included in this chapter. Further description about the software tools is also provided in this chapter.

Chapter 3 - System Development: This chapter discusses the methodologicaldevelopment of this project, which includes the techniques used. Flowcharts of the softwareprogramming are included. Even though this includes the software parts, but the best hardware selections are also discussed. Block diagram of proposed system and results are also included in this chapter.

Chapter 4 - Performance Analysis Results and Discussion: This chapter display the results of this project. In this chapter discuss the output of proposed system. What are the outputs are obtained from this system and what is the mechanism or theme can be set behind it. Output results with proof are mentioned in this chapter.

Chapter 5 – Conclusion and scope for future work: This chapter highlights the overall summary of this project based on the objectives and results. Problems and recommendations for future works to improve the project have also been discussed. This chapter discuss the scope for future work which indicate the modification with this system. Also, highlight applications of proposed system.

CHAPTER 2
LITERATURE SURVEY

Dinesh Yadav et al described that [1], It is widely acknowledged that the inefficient meter reading and charging framework is one of the major subsystems contributing to the significant budget loss in the power supply company. Prepaid billing or using smart energy meters instead of traditional ones for billing management could be the answer to this problem. Arduino and GSM are integrated into the proposed system, which is an improvement over the existing energy meter and allows the consumer to efficiently manage their electricity usage.

Kanwal Naz Shaikh et al [2], expressed that the data from these conventional meters is physically recorded on a month basis for billing purposes. Due to errors, this manual technique causes a variety of issues for both customers and businesses. In addition, a common problem that causes revenue loss is power theft. Prepaid smart energy meters are used to address this issue.

Abdul Ahad, Shuva Mitra et al [3], explained that in this paper, a prepaid smart energy meter system with extra features was proposed. This system automates the electric power industry. The addition of the GSM module removes technical complexity while also offering a costly substitute.

Nabil Mohammad et al [4], Specifically in developing nations like India, it was stated that electricity theft is the main issue in the power sector. In order to prevent meter tampering and bypassing, this proposed system installed smart energy meters at customer locations. These measures' effectiveness is guaranteed by the GSM bidirectional communication using SMS. Power can be disconnected and the appropriate action taken.

S. M. Lutful Kabir et al [5], This paper offers a framework for a comprehensive prepaid metering system that is based on the principle of pay first use letters. The utility has trouble fully collecting the electricity bill in developing nations. Prepaid metering is therefore growing in popularity as a means of guaranteeing early bill payment. This is based on a hierarchical data collection process that goes from the source end to the consumer end. Similar to this, commands for the meters are sent from the source end to the consumer end. Control and oversight of the prepared meters are the goals of this development. This article suggests a framework for an open-system, fully unbundled, and comprehensive prepaid metering system.

If a consumer chooses, he or she can install the meters in the proposed scheme themselves by following specific instructions. Additionally, the consumer can use mobile apps on their smartphone to monitor and manage their meters. All of the energy data from the meters connected to a distribution transformer is gathered at a single point using a PLC and then sent to the server via a GSM network. This system has been used to overcome the drawbacks of the current prepaid metering scheme and to show how the framework will do so.

Somefun T.E et al [6], As previously mentioned, one of the current sensors monitors the current used by the user's load, while the latter, put in place prior to the meter, monitors the current used by all loads. Theft is indicated when there is a discrepancy between the values read and the values. The system's ability to accurately measure load consumption and detect attempts to tamper with or bypass the energy meter were both noted. Not least of all, GSM technology was used to report all fraudulent attempts. This study aims to develop an energy meter theft and tampering detection system that can accurately measure and track the supply and distribution of power. Furthermore, it provides a remote energy management system that enables the consumer to connect or disconnect his load as desired.

A Jain et al [7], expressed as the prepaid energy meter proposed in this study functions similarly to a prepaid cell phone. An analogue to a mobile SIM card is found inside the meter. The prepaid card communicates with the electric company through a mobile communication network. When the prepaid card is no longer in balance, the contactor cuts off power to the consumer load. Using mobile communication, the power utility can remotely recharge the prepaid card in response to customer requests. Power utilities can collect electricity bills from customers before their consumption thanks to the system of a prepaid energy meter. Prepaid recharging capabilities and information sharing with the utilities regarding customer consumption details are also attributes of the prepaid meter, which is not only limited to automated meter reading (AMR). MATLAB has been used to simulate the proposed prepaid meter in a software model. The energy meter is connected to a prepaid card that can use mobile communication to communicate with the power company. In MATLAB, the concept has been executed successfully.

Abdul Sattar Saand et al [8], expressed that our suggested design, which incorporates Arduino and GSM technology, represents an improvement over conventional energy meters and allows consumers to efficiently manage their electricity usage. With the obtained results, the system performs well. The problems of unpaid bills and human error in meter readings will undoubtedly be eliminated by an earlier charging, ensuring that the utility will receive a fair amount of money. Voltage, current, and power can all be measured with digital energy. meters, but only active power can be measured with electromechanical energy meters. Digital meters use highly integrated circuits to measure energy use by capitalizing the voltage and current that give instantaneous power in watts. Electricity usage is displayed in digits on a liquid crystal display by digital metres, which are also affordable, highly accurate, and less likely to be stolen. In this scheme, consumers who have recharged their cell phone accounts send a message to smart metres over the GSM network.

M. Wassim Raad et al [9], This paper proposes a system based on smart cards, which are more and more widely acknowledged as reliable security, identification, and authorization tools. In order to reduce counterfeit fraud, financial card issuers are moving towards replacing magnetic strip cards with chip cards. An intelligent token, also known as a smart card, is a plastic card the size of a credit card that contains an integrated circuit chip. It provides computational power in addition to memory power. It was suggested to use a safe smart card-based electronic payment system for internet-based pre-paid electricity. The proposed system also has the unique ability to access the company server remotely without the additional cost of a PC thanks to the use of an input-based controller. The transition to a true open platform multiplication smart card environment is still under construction.

Sachin Tyagi et al [10], This paper makes the case for the use of Arduino in an IoT-based smart meter. We minimize the need for human intervention in the upkeep of electrical energy with this system. Consequently, this system is also used to detect theft. The consumer number can be used to access the message that will be displayed on LCD if a theft occurs anywhere in the world at any time. It will be beneficial if they can check their consumption online from anywhere in the world because almost everyone is online 24 hours a day. With the help of the Internet of Things-based Smart Energy Meter, we can monitor our energy use online, which gives us access to real-time data on our power usage and enables us to continuously monitor it

Lahari J R et al [11], expressed that these days, each state's electrical boards send a representative to each home to read the energy meters and report their findings to the board of electricity. Based on the quantity purchased, a bill is generated. With this system, the user can monitor their power usage in real time while reducing manual lab ours. The amount of food consumed each day as well as the source's daily usage can be tracked by the consumer.

The system employs a Cleve automated procedure in place of manual labor. Thus, the coast decreases while the meter is maintained. By tracking the load and estimating the precise sources that the user is using at any given time, this system can keep track of the user's usage. Sources are used, and the corresponding readings are continuously stored in the server and relayed to the base station that controls them via the app that users can download.

Ghufran M. Jasim et al [12], This paper makes the claim that distributed energy system billing and measurement are difficult tasks with numerous issues, including the need for numerous human operators, easy tampering, and accuracy issues. This paper proposed the design and implementation of a cutting-edge and incredibly accurate single-phase smart energy meter utilizing radio frequency identification (RFID) technology and the Internet of Things (IoT). Wi-Fi technology is used to transmit information to the central control unit about energy consumption and smart meter readings.

Nitesh D. Bhavsar et al [13], expressed how labor-intensive and time-consuming the current method of billing for electricity consumption is. India's energy billing is prone to errors. A time-consuming and laborious task, generating bills by visiting each and every customer's home. Energy billing involves errors at every stage, including errors with electro-mechanical meters, human errors when recording meter readings, and errors when processing paid bills and past-due bills. When a bill is paid, it frequently appears on the subsequent bill as a balance that is still owing. The consumer's maximum demand, usage information, line losses, and power theft cannot be properly known. The operator needs to go to each customer's home to disconnect the power supply if they haven't paid their bill. These procedures are tedious and take a long time. Prepaid Power Billing Using Adaptive Meter is the suggested fully automated billing system for resolving all systemic issues. The prepaid system relies on a GSM-based method of recharging. Without physically accessing the energy metre, the recharge can be completed from any distance.

Vinayak Rangrao Patil et al [14], In this paper, it was proposed to transfer the unit online using an IoT-based prepaid energy meter. Consequently, it saves time and manpower. It will control energy consumption and reduce energy waste if consumers are only charged for the energy they actually use. Additionally, consumer-end demand theft is discovered. The energy meters used in India are either electromechanical or electronic. The system's main flaw is that a utility representative must visit each neighborhood individually to read the energy meters in each home and hand over the bills. The bill was paid by the customer, so it seems. Even when bills are paid on time, mistakes like an additional billing charge or a notification from the utility company frequently occur.

Dr.V.Ranganayaki et al [15], this proposal suggests a prepaid energy metering system that allows users to monitor how much energy they have used. In this process, each consumer device has a smart energy meter installed, and the service provider maintains a server. The IOT module is installed on both the meter and the server, allowing bidirectional communication between the two ends through the IOT interface. By using their user ID, consumers can conveniently recharge their energy meter in the database. The database of real-time power usage and prepaid energy use is addressed in this work. By using this method, the vendor will have complete oversight of the consumer's side of the transaction and will be able to monitor the system on a daily basis to ensure that no fraud is occurring. From the user to the supplier, this device can have very fast feedback.

Shivam Roy et al [16], described this It has been possible to create an IOT-based energy meter that measures power consumption and displays the results on an LCD. The virtual terminal created in PROTEUS receives the consumed power via serial communication. Because it provides an accurate accounting of units driven due to the prevention of malpractice, this project can therefore educate management about wasted time, unnecessary trips, bookkeeping, and billing. The GSM technology is used to send messages to the user about their power consumption (measured in watts), and if that consumption falls below a preset threshold, it prompts them to recharge.

CHAPTER 3
SYSTEM DEVELOPMENT

3.1 PROPOSED SYSTEM

In this proposed smart prepaid energy meter, each and every consumer is provided with a smart prepaid energy meter. In this system the Wi-Fi module is used to send and receive the data over the cloud about the electricity consumption. The figure shows the overview of proposed system.

The system consists various type of component like microcontroller (ATmega328P) which controls the operation of other components connected to it according to the instruction provided to controller, Wi-Fi module is connected to send and receive the data over cloud, current sensor-1 and current sensor-2 is used to measure the current magnitude in the incoming and outgoing terminal of the energy meter, energy metering chip (ADE7751) which is used to generate the interruption provided to microcontroller according to the status of current transformer and potential transformer, the relay is used to disconnect the load from the supply once the available balance get zero.

Here we have made the project IOT based. Consumer going to recharge the system through website which we have created prier. From that website we can see the last recharge, available balance, available units, illegal load notification and provision to recharge the system. Initially when the available balance is zero then, system will sense zero unit and that time the relay will be in off state according to instruction provided to the controller. When energy meter is recharge with X amount at that time X amount of unit will be added in existing available unit i.e., zero. Once the X amount of consumption is done, balance will get to zero and the system will cut of the load until and unless we recharge the system.

In this system we are going to show the notification of the connection of illegal load. The existed system does not have such feature to show that whether there is illegal connected not.

3.2 HARDWARE REQUIREMENT

3.2.1 ARDUINO UNO

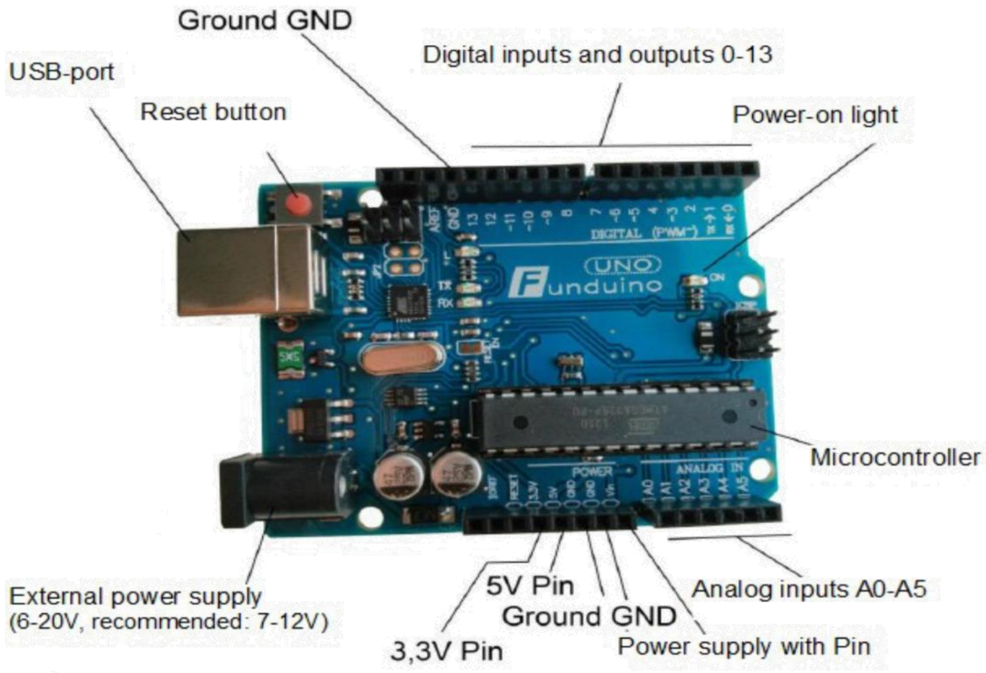


Figure 3.2.1: ATmega382p Microcontroller

The ATmega328p microcontroller, often known as the Arduino Uno, is one type of microcontroller. The Arduino Uno development board for microcontrollers is based on the 8-bit ATmega328P microcontroller. It also has additional components that support the ATmega328P MCU IC, including a voltage regulator, serial communication, and crystal oscillator. The ATmega328p microcontroller's 14 digital and 6 analogue input-output pins allow it to be connected to a wide variety of input-output devices. To write, build, and create the program's hex file, we utilize a separate Arduino IDE (Integrated Development Environment) to programmer the ATmega328p microcontroller.

3.2.1.1 COMMANDS

Using Arduino, you can connect to other microcontrollers, computers, other boards of the same kind as Arduino, or other gadgets. On the ATmega328P microcontroller, UART TTL (5 V) serial connection is supported through digital pins 0 (Rx) and 1. (Tx). The board's ATmega16U2, which computer software interprets as a virtual com port, transmits this serial communication through USB via USB. The built-in USB COM drivers are utilized by the ATmega16U2 firmware, so no additional drivers are required. However, on Windows, you require an a.inf file. The serial monitor included with the Arduino software can be used to send and receive simple text data to and from the Arduino board.

When data is being transmitted between the two RX and TX LEDs on the Arduino board, they light up. When data is transmitted via the USB-to-serial chip and USB connection to the PC, the two RX and TX LEDs on the Arduino board will flash (not for serial communication on pins 0 and 1). Guru of programming. All of the Uno's digital pins can be used for serial communication thanks to the serial library. Additionally, SPI and I2C (TWI) communication are supported by the ATmega328P. To make using the I2C bus easier, The Arduino software includes the Wire library

- (Master and slave). A serial clock is produced by employing the master device.
- SDA: Serial Data is also known as SDA. This phrase alludes to the line that the slave and master utilize to transmit and receive data. As a result, SCL is referred to as the clock line, and it is known as the data line.
- Vin: The connected ICs are managed by this modulated DC supply voltage. For the ICs on the Arduino board, it is sometimes referred to as the primary voltage. Either a positive or negative voltage value may be produced by applying the Vcc voltage to the GND pin.
- Pin 13: SCK For Serial Clock, it is an acronym. This synchronises the data flow through the use of clock pulses.

3.2.1.2 PIN CONFIGURATION

- SCL: SCL is the acronym for serial clock. The clock data is sent across the pin or line. Between the two devices, it synchronies data transportation the acronym for this. The Slave's data is retrieved from this data line's MISO pin.
- MOSI (Pin-11): Its acronym is "Master Output/Slave Input." This line is used for data transmission to the peripherals.
- SS (Pin-10): Slave Select is what it means. Slave Select is denoted by the SS (Pin- 10) symbol. The master makes use of this line. It functions as an enable line. An object can communicate with the master when the value of the Slave Select pin is set to LOW. If the value is HIGH, it disregards the master. There are now numerous SPI peripheral devices that can share the MISO, MOSI, and CLK lines.
- External Interrupts (Pin 2 and 3): Using these pins, an interrupt can be initiated

on a low value, a rising or falling edge, or a change in value.

- ICSP pins: In-Circuit Serial Programming is what it stands for. The Arduino board's firmware can be updated via these pins. The microcontroller receives firmware updates with the new functions through the ICSP header. The ICSP header has six pins in total.
- Analog Pins (A0-A5): The Arduino Uno's ADC is utilized by its six analogue pins (Analog to Digital converter). Along with serving as analogue inputs, these pins can also function as digital inputs or outputs. These pins accept analogue signals as inputs and produce values between 0 and 1023. (Since the Arduino Uno has 210 resolution or a 10-bit Analog to Digital converter). The three stages of an analogue to digital converter's functioning are sampling, quantization, and digitalization.
- Digital Pins: Pins 0 through 13 are used for digital input and output on the Arduino UNO board. Only two states can be read by an Arduino digital pin: when a voltage signal is present and when it isn't. It's common to refer to this type of input as digital, and the states are represented by the numerals HIGH and LOW, or 1 and 0. (or binary).
- PWM pins: Digital pins 3,5,6,9,10, and 11 all display the '-' symbol if you look closely. These pins also have PWM capabilities. These pins are hence referred to as PWM pins. The acronym for is PWM, or pulse width modulation. It signifies the modulation of an analogue value into a digital signal. Consider the scenario where you need a DC motor to run between 0 and 5 V at a certain analogue voltage. This is not feasible due to the MOSFET-based design of the Arduino board.
- RESET: Making use of this, reset the Arduino board. This pin will trigger a board restart if 5 V is put to it.
- I/O Reference Voltage (IOREF): Input/output reference function is provided by this pin. The microcontroller is currently functioning at a specified voltage reference. This pin is inactive when a signal is applied to it.
- GND (Ground pins): There are 5 accessible ground pins on the PCB.

3.2.1.3 FEATURES

- Runs on 5 V, thus older 5 V equipment has a cleaner interface.
- a GCC port upgrade. This wide operating range, which supports both 5V and many more contemporary components, is unique. A decent set of instructions are included.
- It can perform well in sleep mode.
- Its edge is precisely sculpted.

3.2.2 LCD DISPLAY

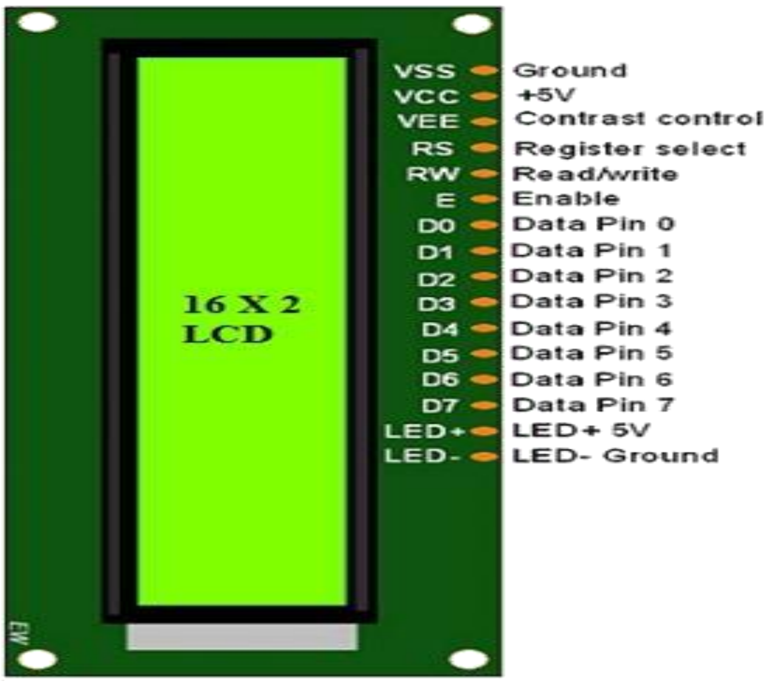


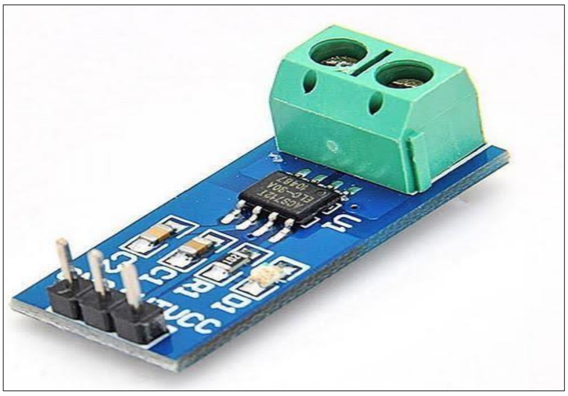
Fig 3.3.2 LCD (Liquid Crystal Display) 16x2 Display

3.2.2.1 FEATURES

- The operational voltage range for this LCD is 4.7 to 5.3 volts.
- There are two rows with a combined output of 16 characters.
- When there is no light, 1mA of current is used.
- You can make any character using a 5 by 8-pixel box.
- Alphanumeric LCDs show both letters and numbers.
- The ability of displays to operate both in 4-bit and 8-bit modes.

- There are variations of these with blue and green backlights.
- Support for both 4-bit and 8-bit modes in displays.

3.2.3 CURRENT SENSOR



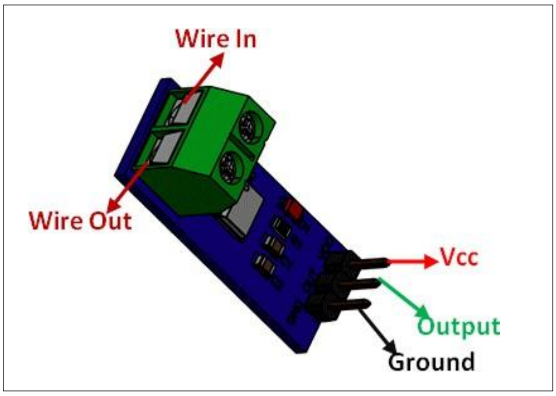


Figure 3.2.3 Current Sensor

The current applied to the conductor can be measured and calculated using the ACS712 Current Sensor without degrading the functionality of the system. Linear sensor IC with a Hall-effect base: ACS712 Current Sensor In addition to a low resistance current conductor, this IC offers 2.1kV RMS voltage isolation. A current sensor detects the flow of current through a conductor or wire and produces a signal that is proportionate to the detected current as either an analogue voltage or a digital output. The two methods of measuring current are direct sensing and indirect sensing.

Direct sensing monitors the voltage drop that occurs in a wire when current runs through it in order to detect current. A conductor that is conducting current generates a magnetic field everywhere around it. In indirect sensing, the magnetic field is computed to calculate the current using either Ampere's law or Faraday's law. Depending on the situation, the magnetic field can be located using a transformer, a hall effect sensor, or a fiberoptic current sensor.

To determine the current, the ACS712 Current Sensor employs an indirect sensing method. To keep track of current, this IC makes use of a low-offset, liner-based Hall sensor circuit. The integrated circuit, which has a copper conduction channel, has this sensor mounted on its surface. A magnetic field is created when current flows across this copper conduction line, which the Hall effect sensor can pick up on. In proportion to the magnetic field being seen, the Hall sensor, which tracks current, produces a voltage. How near the magnetic signal is to the Hall sensor will determine how accurate the device is.

A magnetic signal becomes more precise as it gets closer. Additionally, a tiny surface-mount SOIC8 packaging is offered for the ACS712 Current Sensor. This IC has current flowing from Pins 1 and 2 to Pins 3 and 4. To measure the current, this conduction path is used. It's not too difficult to implement this IC.

Since the terminals on the conduction path are electrically isolated from the IC leads, the ACS712 can be used in applications where electrical isolation is necessary. Therefore, additional isolation methods are not needed for this IC. For this IC to operate, a 5V supply voltage is required. Depending on whether AC current or DC current is present, its output voltage changes. Magnetic hysteresis is almost absent in ACS712. The conduction circuit is made up of Pins 1 through 4, and Pin 5 is used as the signal ground pin. The FILTER pin, which is located on pin 6, is used by an external capacitor to set the bandwidth. The pin for the analogue output is number seven. The pin for the power supply is number eight.

3.2.3.1 PIN CONFIGURATION

- Pin 1 (Vcc): Input voltage for common applications is +5V.
- Pin 2 (Output): Analog voltage outputs that are proportional to current
- Pin 3 (Ground): connected to the circuit's ground
- T1 (Wire in): This connection is to the wire through which current must be measured.

3.2.3.2 FEATURES

- Supply voltage is 230 Volt
- Measure Current Range: 5A~5A
- Output sensitivities between 66 and 185 mV/A.
- Low noise analogue signal pathway
- 80KHZ bandwidth
- 1.2 milliohm internal conductor resistance.

3.2.4 WIFI MODULE

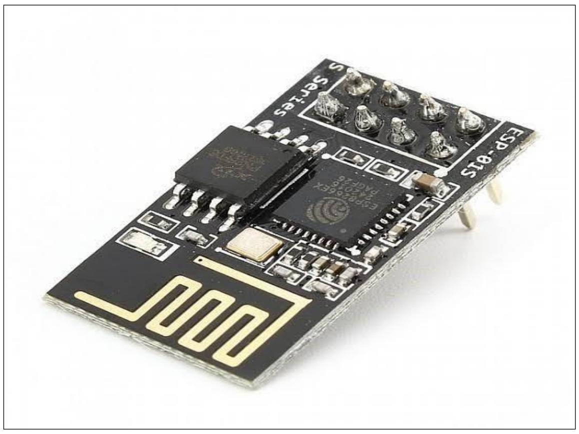


Figure 3.2.4 Wi-Fi Module ESP8266

Any microcontroller can connect to your WIFI network using the built-in TCP/IP protocol stack of the ESP8266 WIFI Module, a self-contained SOC. The ESP8266 can take over or be given responsibility for any WIFI networking tasks from another application processor. Because each ESP8266 module is pre-programmed with an AT command set firmware, you can connect it to your Arduino device and add WIFI functionality akin to a WIFI Shield. The ESP8266 module is a very affordable board with a sizable and expanding community.

With minimal runtime loading and upfront development, this module's strong on-board processing and storage capabilities enable the GPIO-based coupling of sensors and other application-specific devices Due to the high level of on-chip integration, it only requires a small amount of external circuitry, and even the front- end module is made to take up little space on the PCB. The ESP8266 can operate in

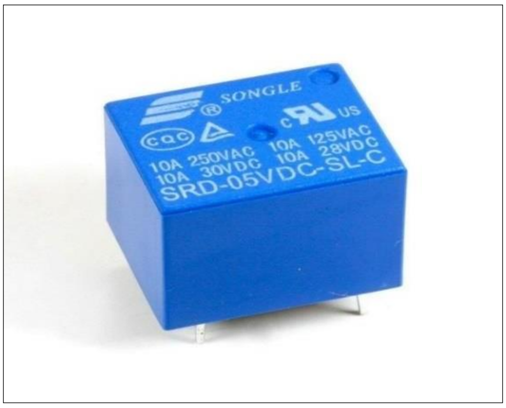
any operational environment without the need for additional RF components thanks to its built-in self-calibrating RF. Additionally supported are APSD for VoIP applications and Bluetooth coexistence interfaces.

Due to the strong community support, the ESP8266 has access to a virtually limitless amount of knowledge. The Documents section below has a number of resources for using the ESP8266, including instructions on how to use it as part of an IoT (Internet of Things) solution.

3.2.3.1 FEATURES

- 802.11 b/g/n
- Wi-Fi Direct (P2P), soft-AP
- Integrated TCP/IP protocol stack
- Integrated TR switch, balun, LNA, power amplifier and matching network
- Integrated PLLs, regulators, DCXO and power management units
- +19.5dBm output power in 802.11b mode
- Power down leakage current of <10uA
- 4MB Flash Memory
- Integrated low power 32-bit CPU could be used as application processor
- SDIO 1.1 / 2.0, SPI, UART
- STBC, 1×1 MIMO, 2×1 MIMO
- A-MPDU & A-MSDU aggregation & 0.4ms guard interval
- Wake up and transmit packets in < 2ms
- Standby power consumption of < 1.0mW (DTIM3)

3.2.5 RELAY



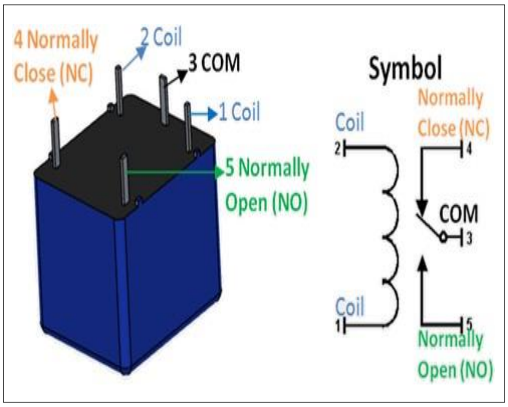


Figure 3.2.4 Relay

In electronics, relays are the most prevalent switching device. The Voltage of trigger, which is the voltage needed to activate the relay and move the contact from Common NC to Common NO, is the first of two crucial relay settings. The other parameter is the voltage & current of load, which in this case is no more than 30V and 10A for DC. It describes the highest current or voltage that the NC (Normally closed), NO (Normally open), or Common terminals of the relay can withstand.

3.2.4.1 FEATURES

- Maximum Current: 5Amps AC/DC (max).
- Maximum Voltage: 250Volts AC/30V DC.
- Standard Voltage: 12Volts
- Resistance of coil: 270Ω.
- Current in coil: 44.4mAmps
- Operating Voltage: 8.6V - 21.6V

3.2.6 OPTOCOUPLER

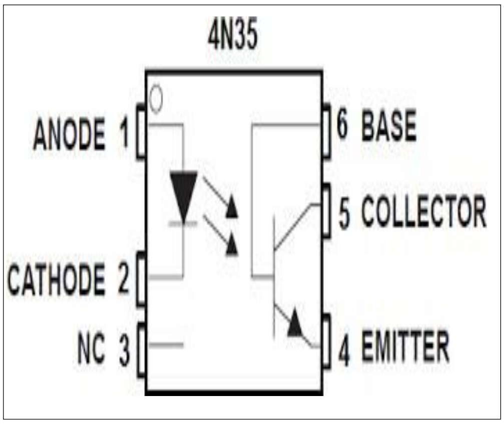


Figure 3.2.5 Figure 3.2.6 Optocoupler

The transmission of an electrical signal between two different circuits is made possible by a semiconductor device known as an optocoupler. Two elements make up an optocoupler. the LED and an infrared LED are both detected by a photosensitive device. Each component is housed in a black box with connecting pins. No matter if the incoming signal is AC or DC, the input circuit uses it to turn on the LED.

Depending on the kind of output circuit, the photosensor, the output circuit that detects light, will either produce AC or DC. In the beginning, current passes through the optocoupler, which causes the LED to emit an infrared light proportional to the amount of current flowing through the part. The photosensor is activated when light strikes it and current flows. The photosensor is also prevented from conducting when the LED's current flow is cut off.

3.2.5.1 FEATURES

- Test voltage for isolation: 5000 Vrms
- interfaces with families of common logic
- The coupling capacitance of Input-Output < 0.5pF
- Dual-in-line 6 pin package as per the industry standard

3.2.7 ENERGY METER

Figure 3.2.7 Energy Meter

The tool used to gauge the energy consumption of an electric load is referred to as a "energy meter." The energy represents the total amount of electricity used by the load at a particular moment in time. Power consumption in residential and commercial AC circuits is measured using it. The meter is less expensive and accurate.

3.3 BLOCK DAIGRAM

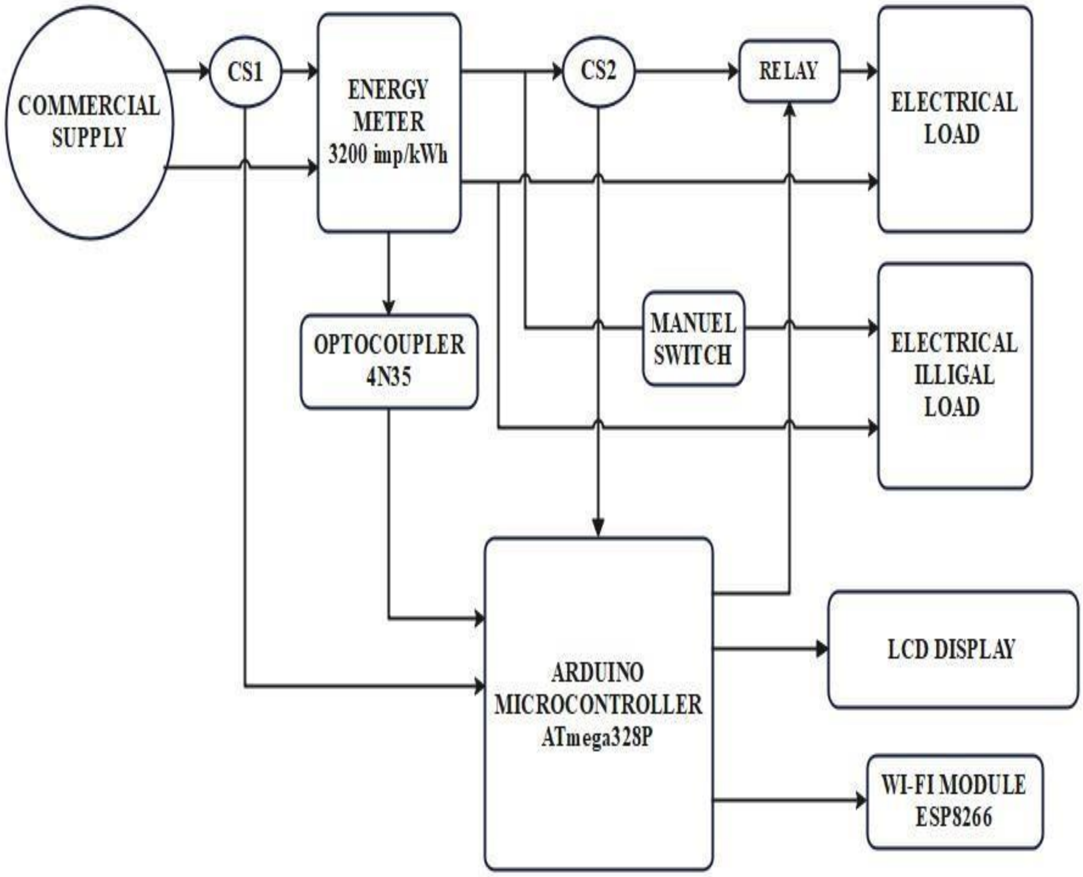


Figure 3.3 Block Diagram

Above fig shows the block diagram of out model. This block diagram consists of various blocks such as commercial load, current sensor, energy meter, relay, optocoupler, Arduino microcontroller, LCD display, Wi-Fi module, manual switch etc. The components used that system are connected properly and sequentially for the useful operation of the system. The connections of the components and the function of the blocks is explained detail further.

The commercial supply is nothing but the supply from the utility side (MSEB) which is of 230 volts. There are two current sensors namely CS1 and CS2 are used. The current sensor CS1 is connected before the energy meter. It measures the magnitude of the current which incoming to the energy meter. And the current sensor CS2 is connected after the energy meter which measures the magnitude of the current passing through the load. The energy meter is used to generate the pulses according to the consumption of electricity. If we connect the load of large power the rate of pulse generation will increase and vice versa. The optocoupler used to count the pulses generated by the energy meter. The display unit is used to show the values of both the incoming and outgoing currents measured by the current sensors CS1 and CS2. The manual switch is used to connect the illegal. Once the illegal load is connected to the energy meter, the controller will send the command to the relay to cutoff the load from the supply. The Wi-Fi module is used to upload the data to the cloud. The data to be upload is the units that are consumed by the load. The Arduino is nothing but the heart of our system. All the operation of this system is controlled by the Arduino.

In the operation of the system the supply from the utility is given to the energy meter at incoming terminals. The incoming supply is of 230 volts is given to energy meter through current sensor CS1. The measured current magnitude of incoming supply voltage is fed to the Arduino. The energy meter is designed in such a way that if it generates the pulses 3200 then it will be considered as 1 unit. In others works we can say that 3200 pulses are equivalent to 1 unit. But for this demo model we have reduced that count of pulses. The optocoupler is connected between the energy meter and the Arduino. This optocoupler is used to count the pulse rate generated by the energy meter and update the Arduino about pulse rate. The current sensor CS2 is connected to measure the magnitude of current coming out from the meter which is further fed to the load. The current sensor CS2 also update value in Arduino of current magnitude. The relay passes the supply from CS2 to Load through itself. The illegal load is connected to the outgoing terminal of the energy meter through manual switch. Once the manual switch is pressed then the system will consider as the illegal load is connected to the meter. The value of CS1 and CS2 is compared in the Arduino, if it is same then controller consider that there is no illegal load is connected to the energy meter. If the illegal load is connected to the system, the Arduino will send the command to the relay to cutoff the load from the energy meter.

As per the name of project we have made the provision of prepaid. In general, we are going to pay the electricity bill after the consumption of electrical energy. But in this system, we have to pay first then we can use the electricity. For that purpose, the system is made IOT based. We have created one website here to upload the data of electricity consumption on the cloud. The status of the system is updated on the cloud after every 10 seconds. On that website we can see the meter number, last balance, left balance in rupees, electricity bill, consumed units and the notification of theft detection illegal load. There is one block is given where we can put the amount of recharge.

For the domestic purpose the block rate tariff is used. The tariff is nothing but the rate at which the consumer is charge for the consumption of electricity. In the case of block rate tariff there are blocks of some units have made. The different block of unit is charge for the different rate. Here in the proposed system first 10 units are charged for 3rs/unit, then second 10 unit i.e., from 10-12 are charged for 5rs/unit and next 10 units i.e., from 20-30 are charged for 7rs/unit. In such a way that the billing of this proposed system is done.

3.4 CIRCUIT DIAGRAM

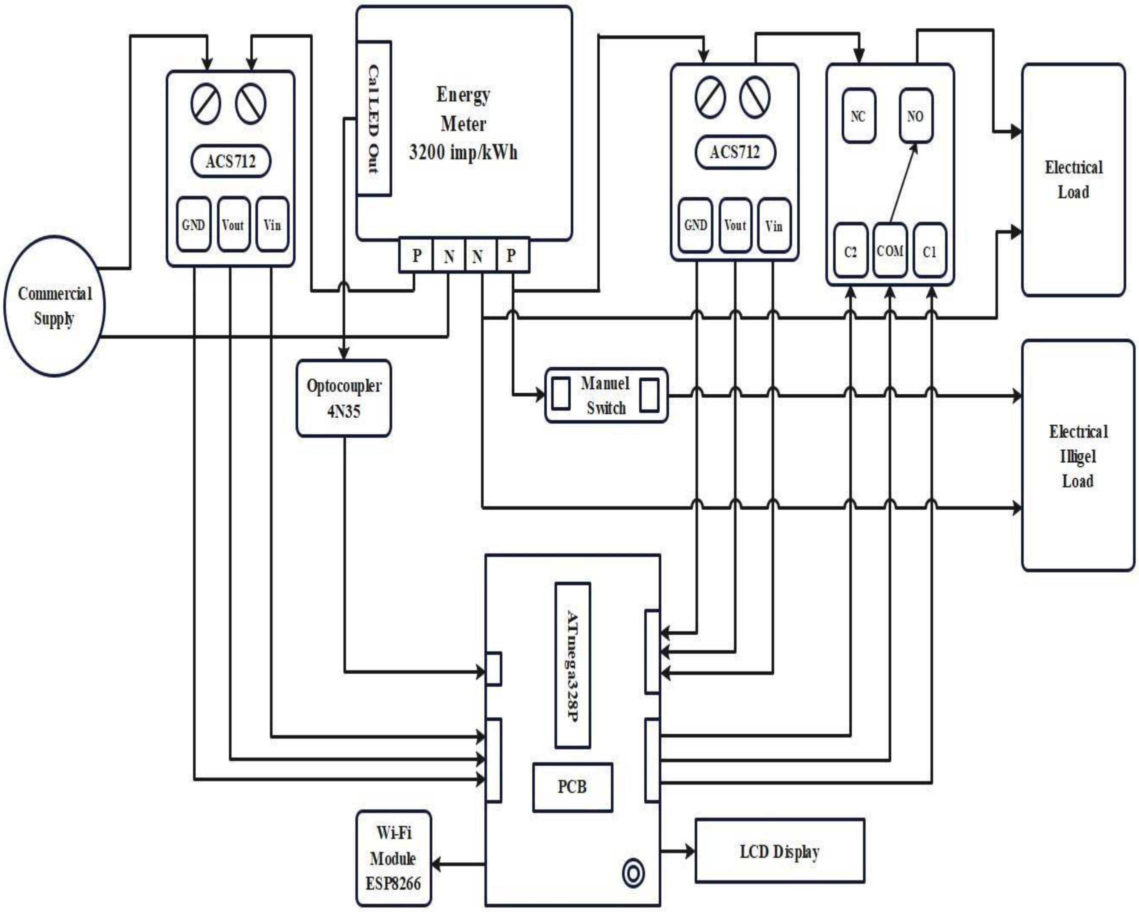


Figure 3.4 Circuit Diagram

The above figure shows the circuit diagram of Smart Prepaid Energy Meter. In which initially there is no balance when consumer recharge their meter it will be recognized by the above system through controller and instruction is send to the relay to connect supply with load a. Once recharge is done balance will starts to deduce according to pulses coming from the optocoupler. Here optocoupler is used to interface the energy meter with the system in order to detect the consumption of electricity with the help of pulses

The main function of C.S is to measure the current flowing through phase and neutral to detect the illegal load connected to system. As soon as illegal load connected to it, it will send alert to the consumer.

CHAPTER 4

RESULT AND DISCUSSION

4.1 THEORETICAL/MATHEMATICAL ANALYSIS

4.1.1 MATHEMATICAL ANALYSIS OF BILLING SYSTEM

In this system, there are two features are provided i.e., prepaid energy meter and illegal load connection. The prepaid energy system is designed according commercial billing system. I commercial billing system there are billing of electricity according to usage of units. There are different charges for unit according to consumption of unit. In commercial billing system the unit is calculated by taking difference between last consumption and current reading. As there is unique number for every consumer in commercial billing system, in this proposed system consumer has been provided with ID and password. The table below shows the billing system of electricity according to unit.

Table 4.1.1.1: Commercial Billing System

Units	0-100	101-200	201-300	301-500	500-1000	1000+
Rate/Unit	3	5	7	9	11	13

In this proposed system the concept of charge is as same as commercial billing system but in this it is designed in range of 10 units, 20 units and 20+ units for simplification purpose. The proposed system is described as below.

Table 4.1.1.2: Billing system of proposed system

Units	0-10	11-20	20+
Rate/Unit	3	5	7

As an illustration, suppose a customer recharges their energy meter with Rs. The server will then recognize it and send this information to the system with the aid of the platform. once balance has been added to the system. When it is detected by the controller, the controller will instruct the relay to turn on. Supply and load are thus connected. When a consumer uses up all of a product, the balance is reduced by 3 Rs. per unit up to 10 units. If the consumer continues to consume more than these 10 units after that, the remaining amount is deducted at a rate of 5 Rs. per unit up to a maximum of 20 units. After that, the tariff rate is 7 Rs/Unit when the consumption of energy exceeds 20 units.

4.1.2 MATHAMATICAL ANALYSIS OF ENERGY METER

Practically, 3200 imp/kWh this is the term used on plates of digital/electronic energy meter which is used for Domestic, Industrial and even for Power grid purpose. The practical energy meter has the LED on plate of energy meter which blinks with respect to the load. If LED blinks 3200 time, then it means 1 KWH is being consumed i.e., 1 unit has been consumed. This is also called energy meter constant on which units are being calculated.

- In this case voltage is kept constant i.e., 220 in Volts.
- The current flowing irrespective of load in Ampere.
- The first step is to calculate the power.

Formula,

$$P = V*I*\cos \Phi \qquad \ldots\ldots (1)$$

The unit of Power (P) is watt

Therefore, consumption of 1000 W is nothing but consumption of One unit

But in this case Power Factor Cos Φ assumed to be 1 but in practical implementation it will be calculated.

Next step is to find energy after the calculation of Power.

The electrical energy is as defined as Work done by electric charge, in Watt.

Formula,

$$E = (V*I*\cos \Phi) *t$$

$$\text{Or} \quad E = P*t \text{ .... from equation (1)}$$

Where,

V = Voltage in volts

Cos Φ = 1 (Assumed)

T = Time in hours

4.1.3 CALCULATION OF CURRENT SENSOR

Table 4.1.3: Selection of Current Sensor (ACS712)

Current Sensor	**Temperature limit**	**Optimized Range (A)**	**Sensitivity, Sens (Type) (mV/A)**
ACS712 5A	-40 to 85	± 5	185
ACS712 20A	-40 to 85	± 20	100
ACS712 30A	-40 to 85	± 30	66

From Table 4.1.3 For the current sensor ACS712, the datasheet is only saying that sensor will make output between 66mV to 185mV when 1 Ampere current is flowing through the circuit. The Response Equation of current sensor ACS712 is used to measurement of circuit The Procedure is,

- Suppose there is 500 W load. Connect 500W load the sensor and calculate the output voltage. It should between 150mV to 420mV. Note it as VD1
- Again, suppose there is 300W load and connect to another sensor. Also measure the output voltage. It should be between 90mV to 252mV. Assume it as VD2.
- For the response equation (y = mx + c) A (500, VD1), (300, VD2), C (W, VD)
- > (VD1 – VD2)/(500 – 300) = (VD1-VD)/(500 – W)
- > VD = k*W +C – This is linear equation for ACS712
- Now declare VREFERENCE as 1.1 V internal
- The ADC value become 1024 only when input is 1.1V
- Whenever input is VD, ADC value will be (1024/1.1) *VD. That is VD = (1.1/1024)
- *ADC.
- The original response equation:
- VD = k*W +c
- > (1.1/1024) *analog Read(A0) = kW + C.

From the above equation it is observed that all factors are know which will be help to compute almost correct value of present arbitrary. In addition to that as voltage value is known for domestic purpose it is usually 220V, calculation of current is become easier.

This calculated current used for detection of theft of electricity meter as well as used for prepaid part in order to reduce the units according the rate of current flowing through the meter.

4.2 PERFORMANCE ANALYSIS

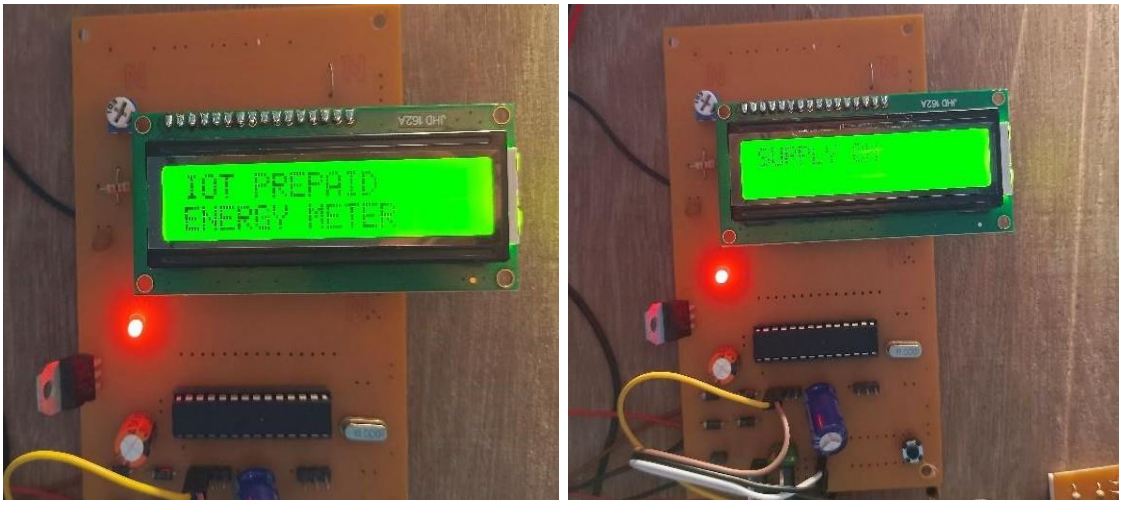


Fig 4.2.1: System Initialization

The above the figure show the initialization of system. The Wi-Fi module ESP8266 is trying establish connection with the server. From this point onward Wi-Fi module upload the data to the cloud server.

This process always on unless and until the system is in on state. This will help the system to get better connectivity without any interruption.

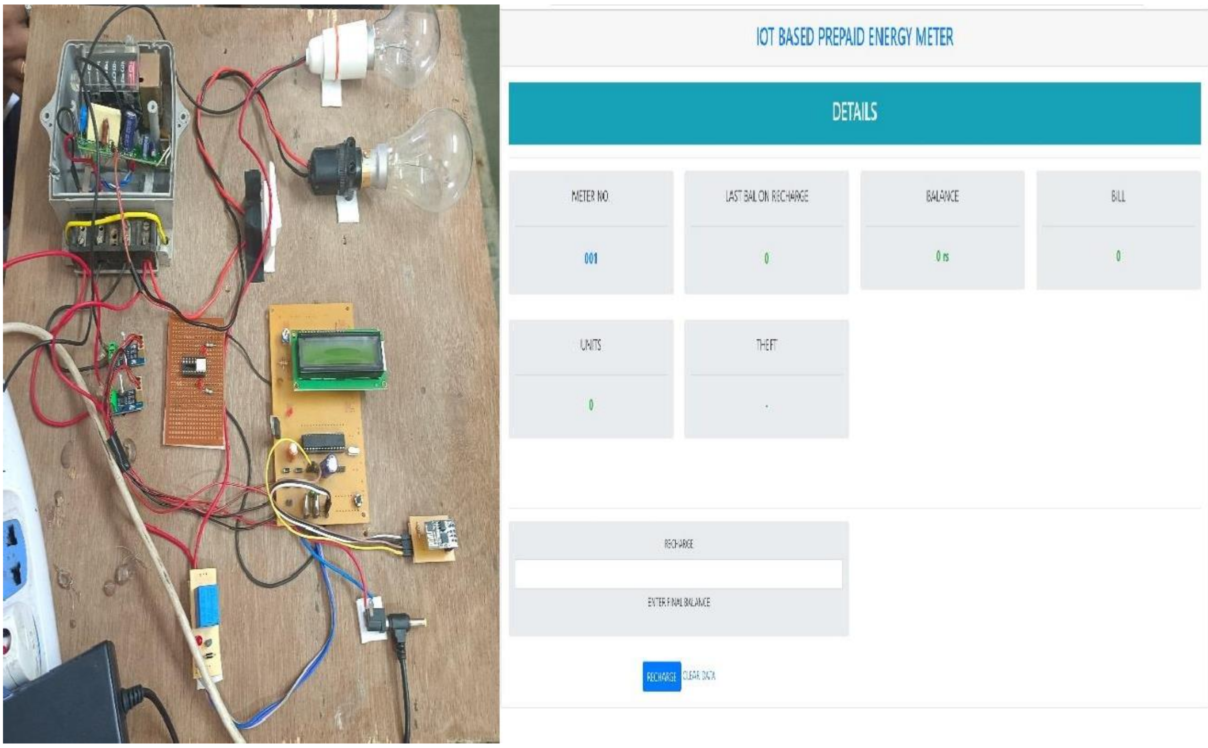


Figure 4.2.2: Unavailable Balance

In this initially it assumed that there is zero balance in the server. The above system is designed in such way that when there is balance is unavailable to the server. It will send the signal to the system in order disconnect the electrical supply.

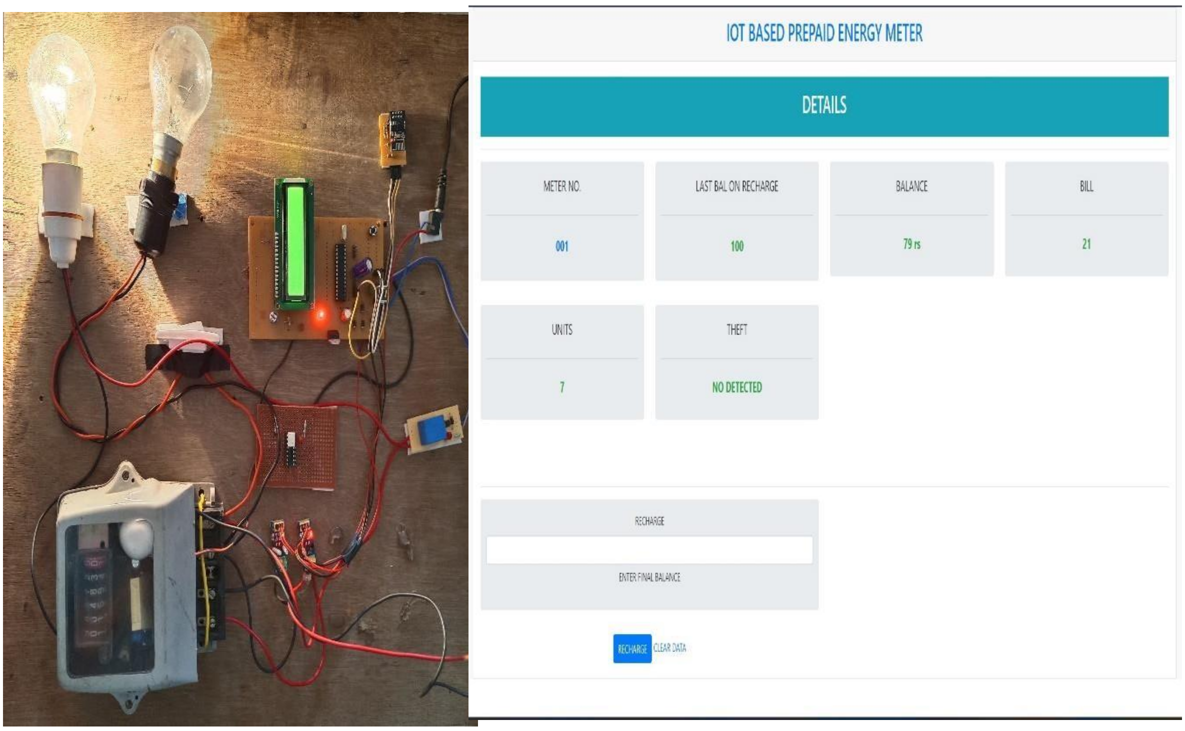


Figure 4.2.3: Billing of 10 Unit

From the above figure Last Balance on Recharge is indicate that recharge done by the consumer, Balance indicates remaining balance while consumption of electricity, Unit displays the number of units being consumed by the consumer. From unit and bill it can be seen that, the rate is 3 Rs/Unit as this billing system is described according to commercial billing system.

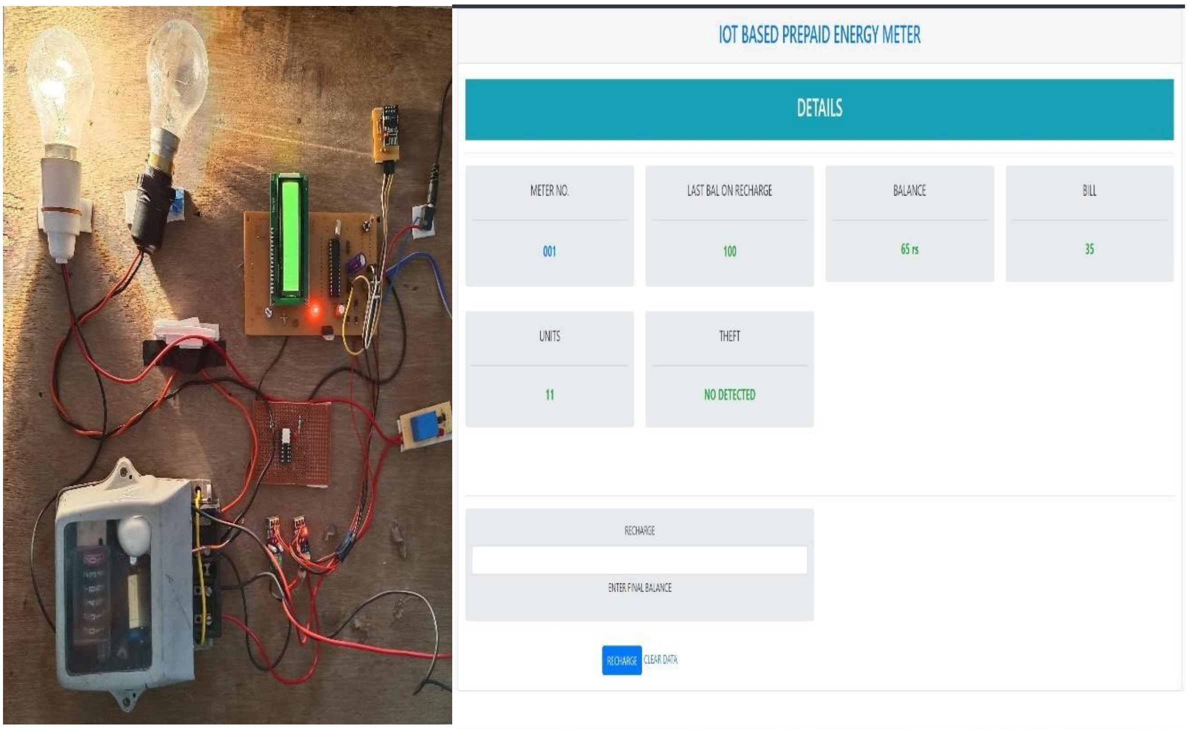
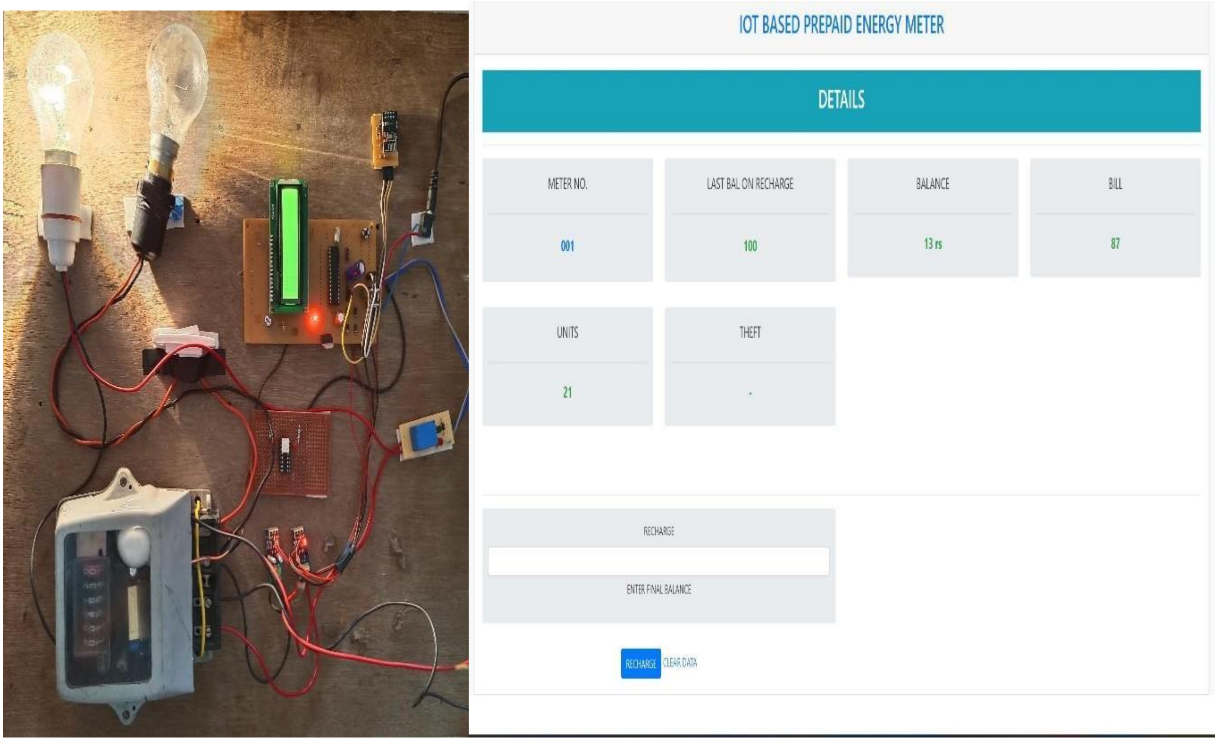


Figure 4.2.4: Billing of 20 Units

The above figure shows the billing system for 20 units. In this billing system, there are total 11 units are consumed in which the rate for the first 10 units is according to 3 Rs/Unit tariff rate meanwhile the remaining unit i.e., 1 Unit is consumed according to tariff rate of 7 Rs/unit. For the first then unit the billing is 30 Rs and for remaining it is 5 Rs. Thus, the addition of both these rates become total bill of electricity i.e., 35 Rs.



4.2.5: Billing of 20 Unit above

The above figure shows the billing system for 20 units above. In this billing system, there are total 21 units are consumed in which the rate for the first 10 units is according to 3 Rs/Unit tariff rate and next unit up to charged 20 unit is charge by 5 Rs/Unit. The remaining unit consumed above 20 unit is charged 7 Rs/Unit.

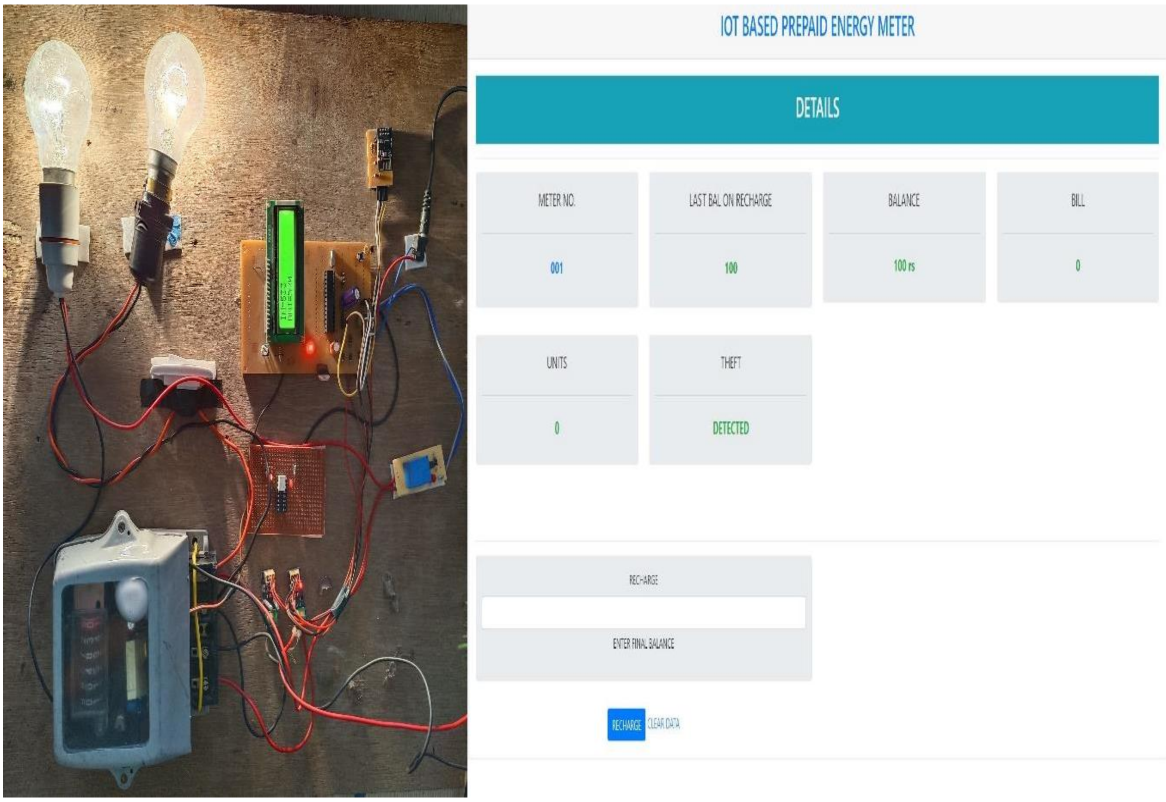


Figure 4.2.6: Theft Detection of Electricity

From the above figure it can be seen that the CT1 is connected to the input line of energy meter meanwhile the CT2 is connected to the output of the energy meter. The second bulb is connected to turn on in order to divert the current and detect the theft of electricity. This theft detection system is operated on principle of the current difference between CT1 and CT2. Once difference is occurred in it, it is as treated as there is theft of electricity. Consumer get alert by system as soon as theft is detected.

4.3 EXPERIEMENTAL ANALYSIS

Table 4.2.1: Recharge Plans as Per Commercial Billing

Sr. No.	Recharge Amount	Unit	Final Bill
1	30	0-10	30/-
2	80	11-20	80/-
3	150	21-30	150/-

The table describe the billing system of prepaid energy meter. In this plans consumer has to recharge their energy meter according to amount as mentioned in above table. These plans are made according to consumption of unit. If consumer recharge their energy meter with X amount, it will deduce balance according to rate consumption of electricity. While consuming if consumer consumed energy in between 0-10 Units then rate is 3 Rs/Unit. Again, another consumer consumed energy in between 11-20 Units then rate is 7 Rs/Units and if consumed units are above 20 Units, then rates are 7 Rs/Units.

Table 4.2.2: Consumption of Units as Per rates

Sr. No / Units	Up to 10 Units	Up to 20 Units	Above 20 Units
1	Deduce by 3 Rs/Unit	Deduce first 10 unit by 3 Rs/Unit	Deduce First 10 unit by 3 Rs/Unit
2	-	Remaining by 5 Rs/Unit	Deduce Upto 20 Units by 5 Rs/Unit
3	-	-	Remaining by 7 Rs/Unit

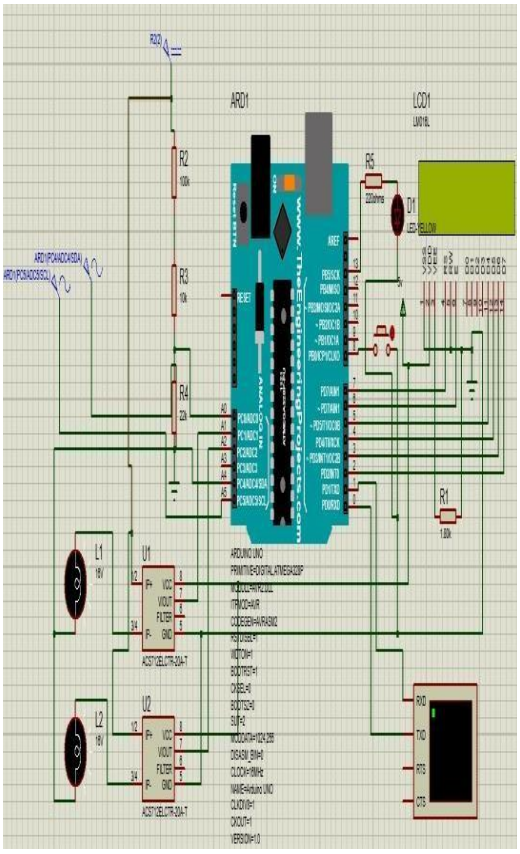
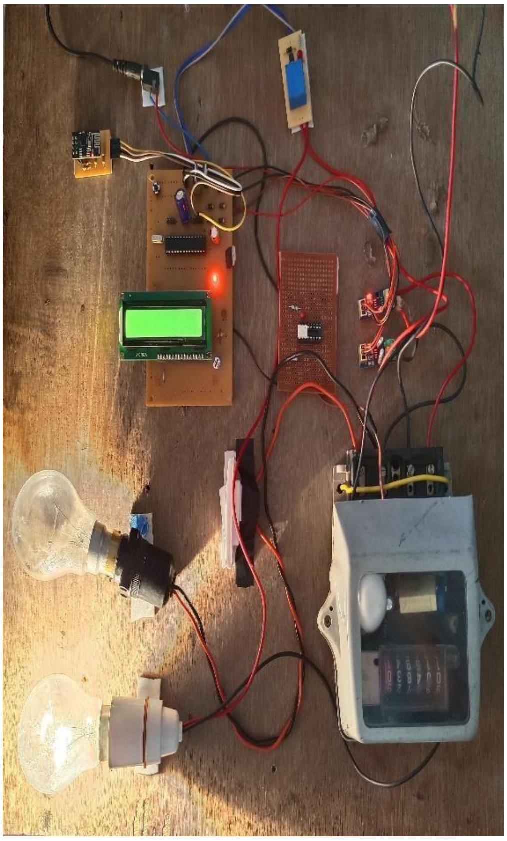
This table describe details about the prepaid energy meter's billing system. Customers who subscribe to this plan must recharge their energy meters using the amounts shown in the above table. These plans are developed in accordance with unit consumption. When a consumer adds X to their energy meter, their balance will be reduced in accordance with the rate at which they use electricity. This system is designed in such way that consumer has to recharge their system with some amount what he wants. When consumer recharge their system with some amounts then this data is sent to system from the server.

For example, if consumer recharge their energy meter with the amount of 100 Rs. Then it will be recognized by sever and it will send information to the system with the help of platform. As soon as balance get added into the system. It will be recognized by controller and it will send instruction to relay to be turn on. Thus, load connected with supply.

When consumer consuming balance deducing according to 3 Rs/Unit up to the 10 Units. After that if consumer is still consuming over these 10 units, then balance deduced according to 5 Rs/Unit up to the 20 Units. Thereafter when energy consumes over the 20 units then tariff rate is 7 Rs/Unit.

4.4 COMPARISON BETWEEN THEORATICAL AND EXPERIEMENTAL ANALYSIS

Table 4.3: Comparison Between Theoretical and Experimental Analysis

Sr. No	Theoretical Analysis	Experimental Analysis
1.		
2	IoT based prepaid system is not possible	IoT based prepaid system is possible
3	Cannot design prepaid system accordingcommercial billing	Practically it is possible to design billing system according to the commercial billing system
4	Less variation in output of current sensor	More variation in output of current sensor
5	Calculations part of mathematical modeling is easy	Calculation is little bit difficult compare to theoretical part

6	It is time consuming (depending upon no of iteration)	Usually, it is faster than the simulation process
7	It would be easier to evaluate complex system through simulation	Simplification is needed for large scale system
8	Set unit consumption up to the 5 unit only for simplification purpose	Set unit consumption according to the commercial billing system
9	In case of simulation, it is not possible to having two-way communication	In IoT based system it is possible to establish two-way communication
10	The Arduino programming language is Based on C++, mostly used and well known programming language	The programming language for IoT devices Is C and C++
11	Simulation can be faster than experimental Setup	Binary transition makes experimental setup slow

4.5 JUSTIFICATION FOR ERROR

Following are some reasons for deviation in achieving desired goal:

- The variation at the output of current sensor than limits which further create difficulty to measurement of current flowing through phase and neutral
- Sometime error occurs to establish the communication between system to
- server
- Data collection, storage, and sharing make up the majority of the Internet of Things. The existence of efficient sensors is the only thing that makes it possible. Manufacturers now have easier access to IoT due to the availability of inexpensive sensors.
- In order to share data, the sender and the receiver must be connected. This is what the internet gives IOT, making it effective and simple to use.
- Making a design that is reliable and strong is also crucial. From the modelling stage to deployment, the product's strength must be maintained.
- Manufacturers lack tests and updates necessary to compete in the production race. Today, production appears to be the primary focus of IoT manufacturers so instead of security. Products are therefore not properly tested or updated on a regular basis. IOTs are more vulnerable to hacker attacks as a result.

4.6 CONCLUSION

This chapter briefly discussed about result of project of Smart Prepaid Energy Meter. Arduino is used to design discussed in details. Setup and installation of all the is outlined systematically to ensure the effectiveness function of all components mentioned in software. These all tools required to develop Prepaid energy meter as well as Theft detection system. In addition to that the output of both of the system is displays on interface of system. Virtually it is not possible to send and receive commands from consumers to system or system to consumer. This simulation is made in such way that at one time only code can be dump either of prepaid energy meter or detection of theft of electricity

CHAPTER 5
CONCLUSION AND SCOPE FOR FUTUR WORK

5.1 CONCLUSION

This work addresses the real-time power usage database and prepaid energy use. The proposed system aims to establish the principle of energy conservation by requiring users to pay for their needs in advance according to the "pay and then use" principle. Because the electric power is cut off when the consumer's pre-filled balance runs out in this scenario, they avoid wasting energy. The proposed smart meter design has been tested with various loads and has demonstrated its worth and dependability when compared to calibrating meters, making it precise and suitable for practical applications. Without the user having a subscription to the global Internet network, Wi-Fi is used to transfer data between the meter and the control center. The control center's workers can easily navigate its interactive graphical user interface. Additionally, it effectively conveys the data from the meter. The consumer can regularly check the system by employing this technique. Less labor is needed to manage power consumption due to the straightforward feedback mechanism used in this proposal.

5.2 FUTURE SCOPE

For phase one, the simulation is done in proteus software. For phase one simulation of both detection of theft as well as prepaid part has done. In this semester the bidirectional communication between consumers and system instead of virtual terminal. In phase two practical implementation of smart prepaid energy meter system can be done with block rate tariff.

In future work focus on design and implantation of product to provide better performance and reliable services. Future work includes the software system which provides the alert message to the consumer for their low balance and misbehave with an energy meter. It includes that containing the recharge history of last few months.

5.3 APPLICATIONS

- With the help of a smart meter, you can check your electricity bills and learn more about the state of the electricity grid, which will enhance the grid's performance and the level of service you can offer to customers.
- Until the amount of the prepaid electricity bill is exhausted, this energy meter measures electricity. A warning is sent to the customer in the case of prepaid electricity meters in the event that their account balance is getting low. The meter needs to be recharged, and this alert lets them know. Manual or automatic processes are both acceptable.
- proposed meter for monitoring electrical energy consumption in a house, building, or other electrically powered object. They are employed in order to give customers accurate billing.
- Thus, using a prepaid meter enables you to save electricity, which in turn results in saving money because you'll never receive an unforeseen, excessive electricity bill! The ability to effectively manage your cash flow and allocate costs is thus one of the major benefits of prepaid electricity.

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APPENDICES

CODE

```
include <LiquidCrystal.h>

// initialize the library with the numbers of the interface pins
#include <EEPROM.h>
LiquidCrystal lcd(A1, A0, 12, 11, 10, 9);
int addr = 1;
int count = 0;          //integer for storing character of ID

char input[12];//memory for storing 12 characters of ID

const int ct1 = A5;  // Analog input pin that the potentiometer is attached to
const int ct2 = A4;  // Analog input pin that the potentiometer is attached to
int ctv1 = 0;        // value read from the pot
int ctv2 = 0;        // value output to the PWM (analog out)

const int buttonPin = 2;     // the number of the pushbutton pin
const int countp = 3;     // the number of the pushbutton pin
const int re1 = 4;     // the number of the pushbutton pin
int chk=0;
void setup()
{
  lcd.begin(16, 2);
  Serial.begin(9600);//serial communication enabling by 9600 baud rate
  pinMode(0, INPUT); //receive pin set as output
  lcd.print("IOT PREPAID");//showing name
  lcd.setCursor(0, 1);//move courser to second line
  lcd.print("ENERGY METER");//showing name
   pinMode(buttonPin, INPUT);
 pinMode(countp, INPUT);
pinMode(re1, OUTPUT);
```

```
digitalWrite(re1, LOW);
  digitalWrite(buttonPin, HIGH);
   digitalWrite(countp, HIGH);
 chk=5;
  delay(3000);
}
byte value;
String d = "unit 1 0 120";

void serialEvent() {
    // get the new byte:
    char inChar = (char)Serial.read();
    // add it to the inputString:

    // if the incoming character is a newline, set a flag so the main loop can
    // do something about it:

lcd.print("SUPPLY ON"); delay(1000);
    }
     if (inChar == 'B') {
     digitalWrite(re1, HIGH);
  lcd.clear();
lcd.print("SUPPLY OFF");
delay(1000);
    }
}
void loop()
{
  int op = 0;
  lcd.clear();
  lcd.clear();
  ctv1 = analogRead(ct1);
 ctv2 = analogRead(ct2);
```

```
   lcd.setCursor(0, 0);
lcd.print("IN=");
 lcd.print(ctv1);
   lcd.setCursor(0, 1);
lcd.print("OUT=");
lcd.print(ctv2);
      if((ctv1-ctv2)>100)
{
Serial.print("theft=DETECTED*");
delay(5000);
}
      else if((ctv2-ctv1)>100)
{
Serial.print("THEFT=DETECTED*");
delay(5000);
}
      if( digitalRead(countp)==LOW)
      {
       Serial.print("unit=1*");
        lcd.setCursor(9, 0);
lcd.print("UPLOAD.");
delay(3000);
      }
       if( digitalRead(buttonPin)==LOW)
      {
       Serial.print("theft=NO DETECTED*");
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("THEFT STS UPLOAD");
       delay(5000);
      }
```

```
int a5 = analogRead(A5);
int a4 = analogRead(A4);
  Serial.print("_");
Serial.print(a5);
Serial.print("_");
  Serial.print("_");
Serial.print(a4);
Serial.print("_*");

}
```

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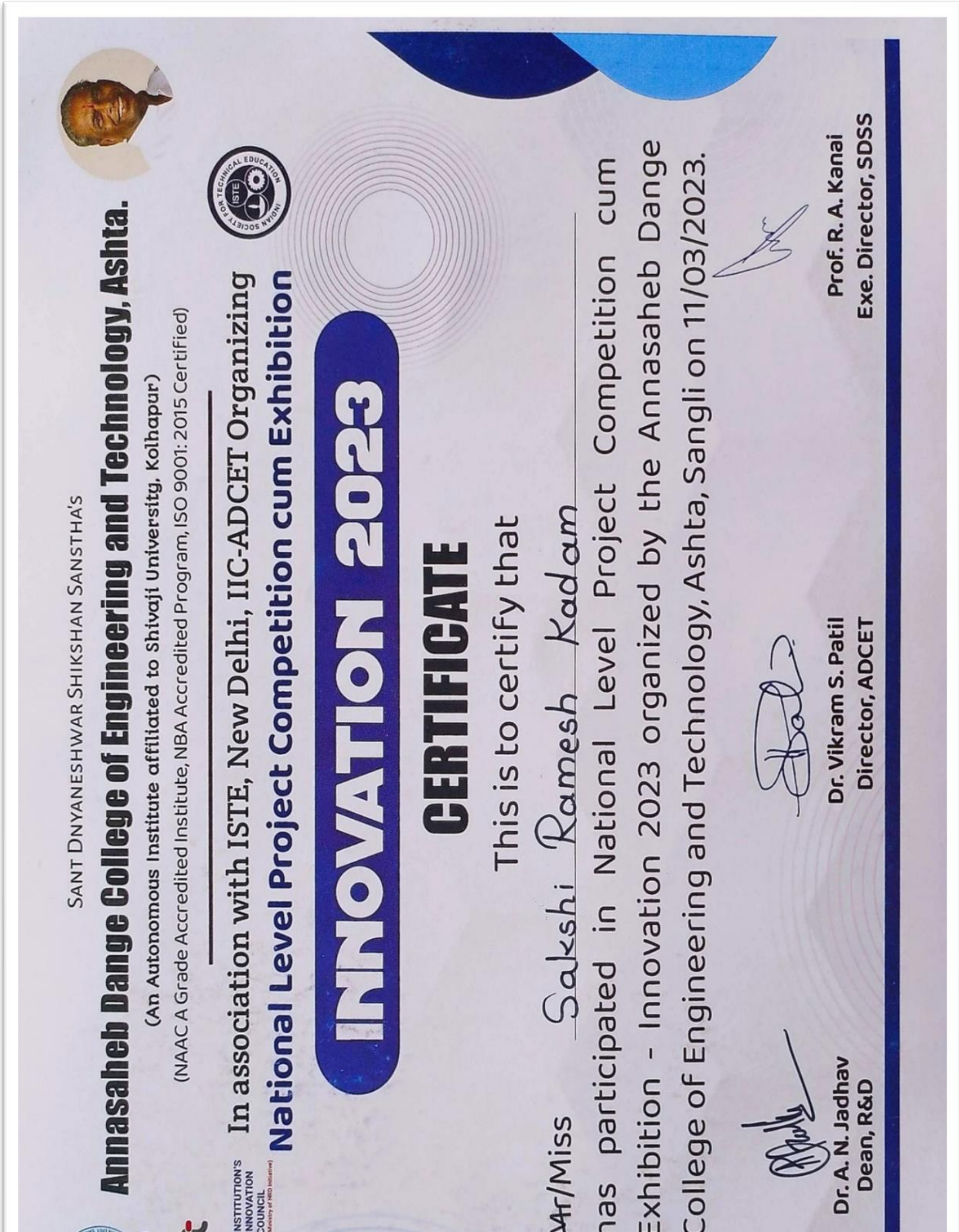

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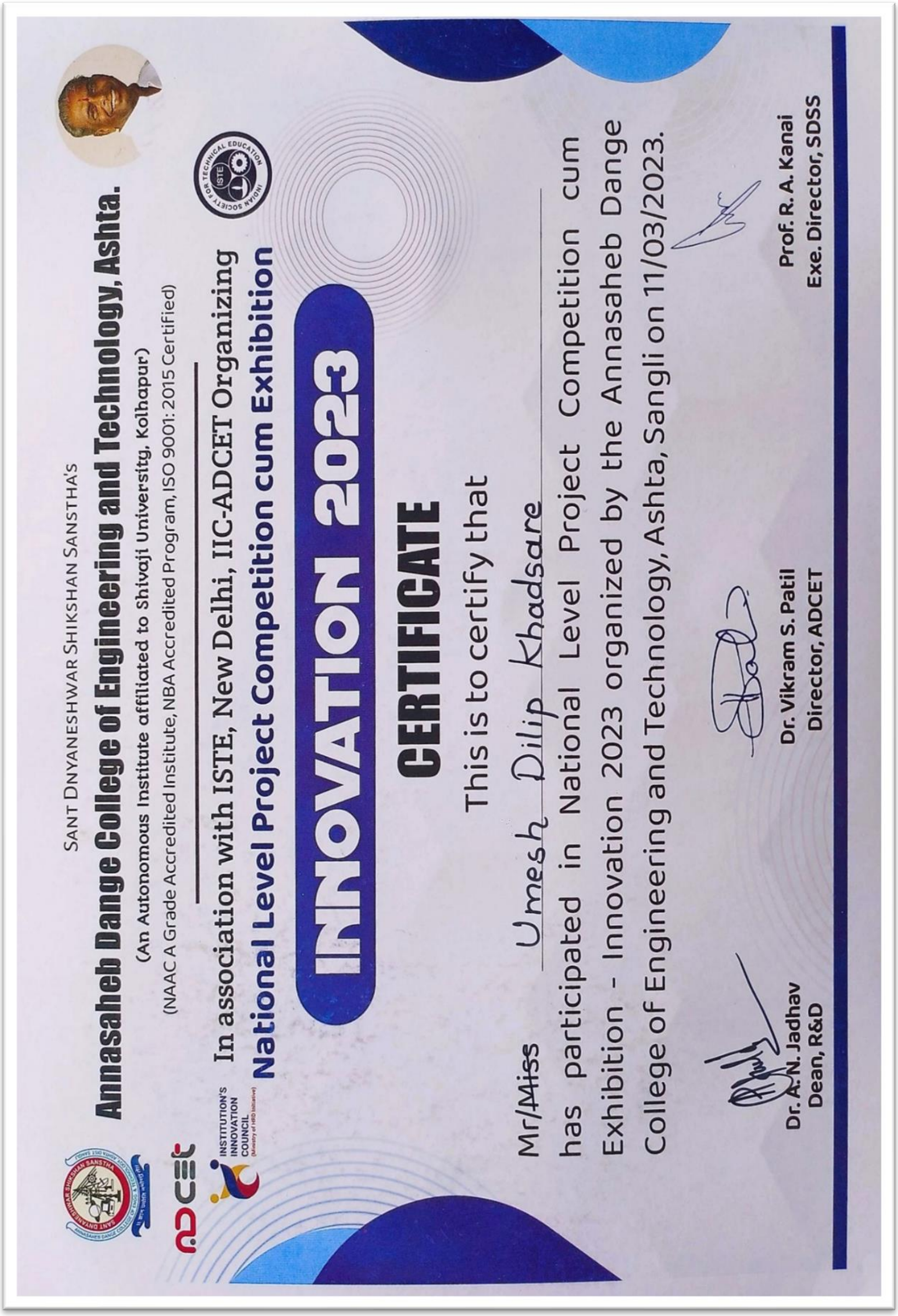

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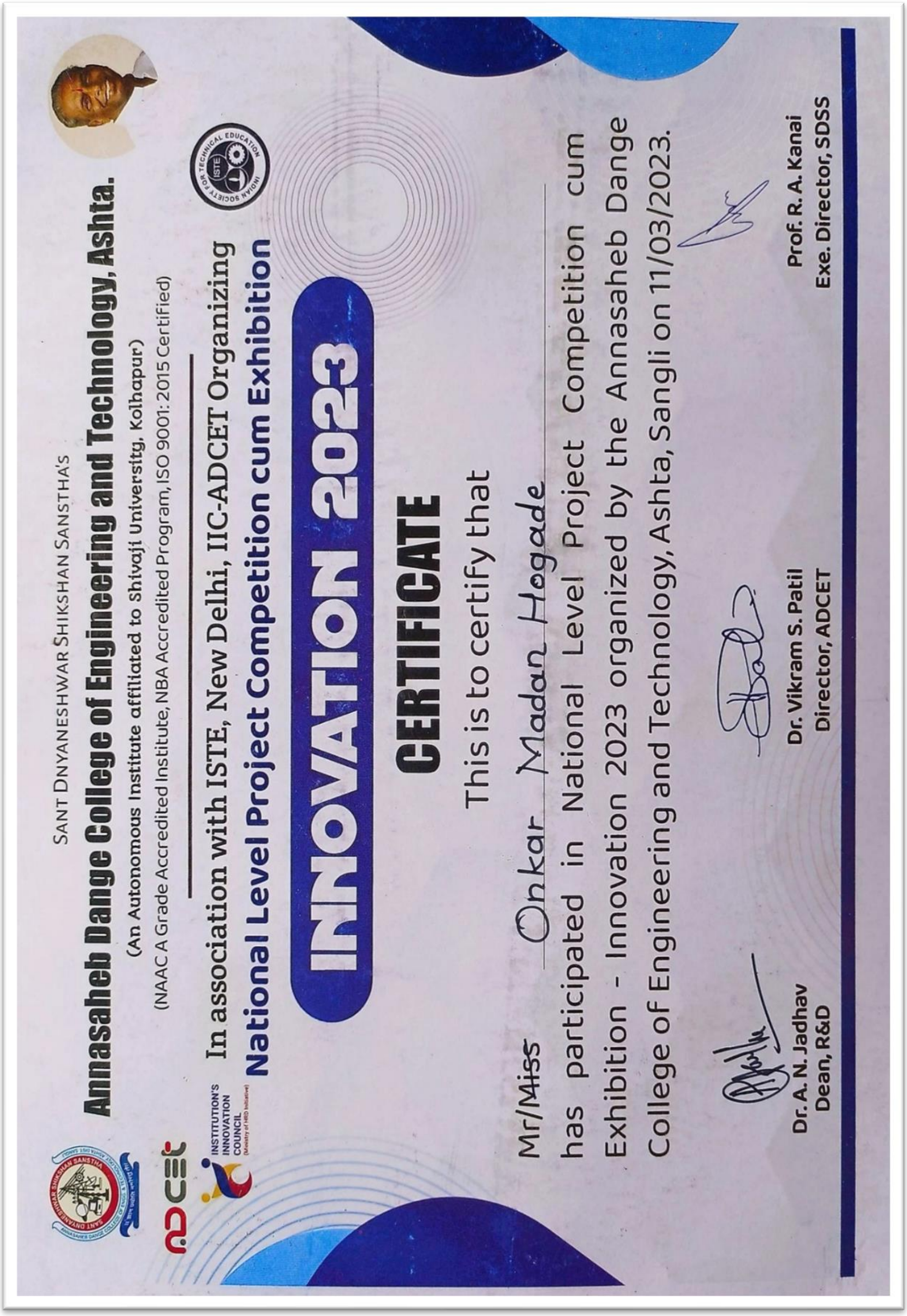
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