

Real Time Electricity Energy Meter Based On IOT

Submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in Electronics and Communication Engineering

By

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

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INSTITUTE OF SCIENCE AND TECHNOLOGY

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **Gavvala Nivas** (Reg. No. 39130139) and **Immadi Surya Gangadhar** (Reg. No. 3913019) who carried out the project entitled **"REAL TIME ELECTRICITY ENERGY METER BASED ON IOT"** under our supervision from November 2022 to April 2023.

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DECLARATION

We, **Gavvala Nivas** (Reg. No. 39130139) and **Immadi Surya Gangadhar** (Reg. No. 3913019) who carried out the project entitled “**REAL TIME ELECTRICITY ENERGY METER BASED ON IOT**” done by us under the guidance of **Dr.A.SAHAYA ANSELIN NISHA M.E., Ph.D.** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electronics and Communication Engineering.

DATE : 20/04/2023

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1. 

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ABSTRACT

The project is designed for consumption of electricity bill. As Electricity energy meters are installed in houses or offices to measure the electricity consumption. By this project monitoring our electricity can be done and can be used from anywhere in the world and receive an SMS/E-mail when your energy consumption reaches to a threshold value. In this project we are going to make a Smart Electricity Energy meter using Arduino and ESP8266 Wi-Fi module which not only sends you a SMS/Email of your electricity Bill but also can monitor the energy uses anytime from anywhere in the world. Here Current Sensor ACS712 is used to measure energy consumption. It is used to monitor units consumed and transmit the units and cost charged over the internet using WIFI connection.

This allows users to check the energy usage along with the cost charged online using a simple web application. Thus, the energy meter monitoring system allows user to effectively monitor electricity meter readings and check the billing online with ease. 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. Extra bill amount, or notification from electric board even though the bills are paid are common errors. To overcome this an idea is used which will eliminate the third party between the consumer and service provider, and the errors will be minimized. This system also helps to detect power theft. So, this smart meter helps with home automation using IoT and enabling wireless.

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CHAPTER 1

INTRODUCTION

The vision of the internet of Things (iot) portrays a future wherever a several regular items or interconnected through a world system. They gather and offer information of themselves and their surroundings to allow across the board recognition, investigation, improvement, and the board. Up to this point this was basically a dream, anyway as of late this has gradually formed into a reality Consistently diminishing costs, measurements, and vitality necessities of little gadgets to unpretentiously experience their environment. Many devices use low-energy communication technology to send those measurements to other, more powerful components, such as Bluetooth gateways, mobile phones, or WIFI hotspots. Devices unit of measurement more and more incorporation long range wireless technologies like existing 2G and 3G networks. Local edge processors, hubs, or web services successively analyse and method IOT sensing element knowledge to make new data, which may be won't to act back on the atmosphere through actuators. In short, the iot is seen as a huge cyber-physical management loop.

The power consumption in home using Arduino (smart home metering), Smart meter is an electronic device that records consumption of electric energy of every home appliances and communicates the information to the electric supplier for monitoring and billing. Smart meters generally record energy hourly or additional often, and report a minimum of daily. Smart meters enable twoway communication between the meter and the consumer (user). Such as the complicated metering infrastructure (AMI) is much differ from automatic meter reading (AMR) because it allows two-way communication between the meter and also the provider. Communications from the meter to the use by network that to be wireless.

1.1 Over View

Smart meters improve your awareness of energy consumption. By changing behavioural habits and informing decisions to buy more energy efficient appliances there

is less pressure on the electricity grid. Smart Energy GB estimate a 24% decrease in emissions from homes and businesses. The objective of this system is to monitor the amount of electricity consumed. The distributor and the consumer both will be benefitted by eventually reducing the total Power consumption. The already existing system is having lot of complexities in before that they are all using to measure the ac current using current transformer. A current transformer can only sense current down to some minimum frequency below which gain falls off rapidly. A current transformer can't sense a fixed current. If you are measuring current of something that is inherently AC, like the power line, then a current transformer can be appropriate. If you really need to sense DC current, then you can't use a current transformer and also now the proposed system is full of difference compared to the existing system.

1.2 Aim Of The Project

Monitor and controlling of the power consumption can be easily done by the Arduino and NodeMCU microcontrollers. We are proposed the project to give the notification to the consumer side how much power they consumed depend upon the units once the units is reach above 50 automatically give the notification to the consumer side. And depend upon the consumption load will be disconnect. If in our we have 4 loads, the power consumption is greater than the 70 % one load will disconnect, 80 % 2 nd load , 90% 3 rd load and final. And also we can monitor the water tank in our home by using water flow sensor. By this sensor we can calculates the how much of water in the tank, if water content is low automatically gives the indication through the Ubidots and send the alerts message on Gmail or SMS. And the power consumption is monitor and control by user from anywhere in the world.

CHAPTER 2

LITERATURE SURVEY

Chih-Hung Wu, Yu-Wei Huang proposed **Design of a wireless ARM-based automatic meter reading and control system** . In This paper implements a wireless ARM-based automatic meter reading and control system (WAMRCS) for distribution automation[1]. The WAMRCS is designed based on a 32-bit ARM microprocessor to deal with power data processing and relay control. In order to provide a cost-effective, wireless, always-connected, two-way data link between utility company and WAMRCS, the WAMRCS sends information of utility usage, power quality and outage alarm to utility company via GPRS network. Compared with analog utility meter reading by manpower, WAMRCS is more accurate, reliable, cost-effective, quick and free from man-made errors. It can provide extra capabilities such as distribution automation, load management and time-of-use rate.

Bo Chen; Mingguang Wu, Shuai Yao, Ni Binbin, (2006) proposed **“ZigBee Technology and its Application on Wireless Meter-Reading System”**[2]. ZigBee technology is a new standard in wireless personal area after bluetooth. After an introduction to this technology, a new wireless meter-reading system based on ZigBee protocol is presented. This system, which is comprised of ZigBee network and database management system, has many important advantages such as low cost, low power consumption, and low data rate.

Himshekhar Das, L.C.Saikia proposed **“GSM Enabled Smart Energy Meter and Automation of Home Appliances”**[5]. Electrical utilities are suffering from huge losses due to power theft, inadequate usage of energy, unpaid bills, distorted power quality. Many viable solutions are proposed out of which smart energy metering, energy

management system and smart home automation are some that seems to be potent enough. These technologies are presently used by developed countries. Under meter data acquisition system of Restructured Accelerated Power Development and Reform program (R-APDRP) scheme in the year 2009-10, India plans to develop Advanced Metering Infrastructure (AMI). But no effort has been made to develop an economic model for the customers which would play a key role in better acceptance of the scheme. In this paper, a smart energy system for the residential customers is developed and a smart switch board which can curtail the need to upgrade to smart appliances to make the system more economic. Further, a Virtual Instrumentation has been developed which can be operate in any computer to function as In Home Display (IHD) for Energy Management System (EMS)

Ofoegbu Osita Edward proposed **“An Energy Meter Reader with Load Control Capacity and Secure Switching Using a Password Based Relay Circuit”**[6]. Energy conservation and its efficient utilization has been a subject of discourse amongst numerous stakeholders since the industrial age. Advancements in information technology tools thus provides a solution to automating the process of electricity metering as well as remote load control alternatives. This paper thus presents an energy meter reader implemented with a microcontroller based logic methodology fused with a building automation system to implement remote load control by home owners using SMS from a GSM phone. A password based relay circuit was incorporated to ensure secure switching by the user. The system when deployed can enable users query and set energy consumption rates remotely so as to reduce the cost on final consumers as well as conserve energy.

Yingying Cheng, Huaxiao Yang, Ji Xiao, Xingzhe Hou proposed **“Running State Evaluation Of Electric Energy Meter”**[7]. The measuring accuracy of electric energy meter is not only related to the normal operation of power system, but also related to the vital interests of users. So the appropriate evaluation of its running state is

particularly important. In this paper, according to its working principle and running characteristics, various influence factors of its operating error are summarized. Combining the online and offline information and taking the actual running environment of power grid into consideration, the evaluation index are selected to build a comprehensive running state evaluation index system based on the environment, importance and reliability, which can provide theoretical reference for the current electric energy metering device management.

Sahana M N, Anjana S, Ankith S, K Natarajan, K R Shobha proposed “**Home energy management leveraging open IoT protocol stack**” [8]. The demand for energy is ever increasing thanks to population growth and industrial development. Efficient energy management at home will be possible provided there is an increased awareness among consumers on their consumption patterns and effective use of their appliances. In India, utility companies continue to gather much of the energy utilization data manually and the automation in home energy metering is yet to be achieved as the smart meter adoption is still in its early stages. While addressing automation in home energy management, it is important to consider solutions that meet country-specific needs like energy costs, fair billing, electricity thefts, system scalability and reliability. In this paper, we present a prototype implementation for home energy management and control, leveraging Internet of Things protocol stack comprising emerging IETF standards such as 6Lo WPAN, RPL and CoAP. The open standards based approach enables seamless integration of the appliances at home to the existing internet infrastructure making remote monitoring, control and data collection over the web possible. Further, enabling IPv6 connectivity to the energy meter leads to better integration of the Data Management Systems of utilities unlike some of the existing proprietary solutions. In our IoT based and IPv6 network connected system, we have a PV panel to generate electricity for DC appliances apart from the main 230V AC supply. Considering the fact that energy supply from renewable sources is intermittent, we provide users with an option of choosing either of the energy sources over the internet. Wireless node based on CC2538 System-on-Chip is interfaced with an energy meter connected to the main AC supply, providing 2 way communications between the utility and

the consumer over the internet. The sensor nodes are also used to measure the power consumed by the DC appliances and remote actuation control. Further, a timing based approach is provided for consumers to "turn on" appliances at preset time periods. All the data collected by the sensor nodes are communicated in real time over the internet to the utility and consumer via a border router.

Luigi Martirano, Matteo Manganelli, Danilo Sbordone proposed "**Design and classification of smart metering systems for the energy diagnosis of buildings**"[9]. At present, buildings account for a great share of energy consumption. It is well known that building automation control systems allow for increasing opportunities of improvement in the performance of buildings, with respect to e.g. energy performance and indoor comfort. As system within a building become more and more complex, buildings can be regarded not merely as a load but as a smart micro grid, with the possibility of actively interacting with a smart grid. In the depicted context, metering is essential for assessing the performance of management and detecting improvement opportunities. The scope of the present work is to propose a best practice for the implementation of smart metering systems in buildings and a practical methodology to classify the systems. In the present work, a novel classification protocol is devised; an existing metering system is then evaluated and an improved metering system is proposed. The proposed protocol rates the system performance via a set of weighted indicators -according to positioning of meters, measured data, system architecture, data visualization and monitored loads -, then calculates an overall grade. The protocol is tested on an existing metering system in an educational building. The metering system returns a poor rating and a number of flaws are detected thanks to the benchmark protocol. An improved metering system is then proposed which fixes existing flaws and returns a much better grade. In conclusion, the designed classification protocol allowed diagnosing an existing metering system and pinpointing improvement opportunities and it can be a useful practice in diagnostics or design of smart metering systems.

J. Widmer, Landis proposed " Billing metering using sampled values according IEC 61850-9-2 for substations"[10]. Substations - linking the transmission network (Super Grid) and the distribution network (Smart Grids) - will play a crucial role in the future extension of the energy network. The IEC 61850 standards suite is the most promising collection of standards for the design of substation communication and automation systems and has become accepted by utilities. Up to now there were no metering devices for billing according to IEC 61850 available on the market. Sampled values according to IEC 61850-9-2 can be used as input for high precision metering. The meter as "cash-generator" in substations stores and transfers the billing values to the data acquisition system to support the billing process. The established standards for meters and data acquisition are DLMS/COSM. Further, DLMS/COSEM and IEC 61850 are based on similar structures with object models. To prove the suitability of this new metering solution based on sampled values installations are placed in substations in parallel to conventional metering solutions. Leading substation suppliers presented at CIGRE 2012 a new generation of substations with sampled values for voltage and current instead of conventional instrument transformers. Since 2012 several substations using sampled values as input for all devices were introduced worldwide. The results from thus installations are very encouraging.

Dr.G.joga Rao,G.S.N.M Venkatesh proposed Simulation of an Automatic Meter Reading System for Smart Metering by using ASK/OOK Modulation in Rural Smart Micro-grids[12]. Smart grids are electric power grids that are more efficient and reliable. These are playing an essential role in modern world. Smart grids, which include a variety of operational and energy measures including smart appliances, smart meters and energy efficiency sources. The important aspects of the smart grids are the electrical power conditioning, production control and distribution of electricity. The smart grids are not only focused on elimination of black- and brown-outs, but also on making the grid greener and more efficient, and therefore less costly. Now a day the research exercise on these smart grids involves the development in the field of Smart Metering. The inexpensiveness, simple and easy to spread out qualities lie in Power Line Communications (PLC) which made

them to use in electrical power grids. This paper presents a scheme of Automatic Meter Reading Systems for Smart Metering network with PLC technology using ASK/OOK'S modulation in rural smart micro-grids. PLC with AMR systems used in power delivery system can monitor and record illegal electricity usage by detecting system which may be additionally added in present network. The PLC with AMR Systems can reduce the illegal usage of electricity and theft in rural areas. Fast and Reliable meter reading collection with less error can be achieved with AMR Systems which eliminates the necessity of physically reading the meters. In this paper, the proposed scheme for Smart Metering has been simulated in MATLAB/SIMULINK software and results are presented successfully.

CHAPTER 3

SYSTEM DESIGN

3.1 Existing System

The already existing system is having lot of complexities in before that they are all using to measure the ac current using current transformer. A current transformer can only sense current down to some minimum frequency below which gain falls off rapidly. A current transformer can't sense a fixed current [3]. If you are measuring current of something that is inherently AC, like the power line, then a current transformer can be appropriate. If you really need to sense DC current, then you can't use a current transformer. The Disadvantages of the existing system is

- There's no guarantee you'll save money.
- A smart meter will only help you save money if you use it to monitor your energy use and make a positive decision to cut back.
- Excessive monitoring. ...
- Your meter might not stay smart if you switch suppliers.

3.2 Proposed System

In this proposed system we can easily monitor and controlling the power consumption by the Arduino and NodeMCU microcontrollers. We are proposed the project to give the notification to the consumer side how much power they consumed depend upon the units once the units is reach above 50 automatically give the notification to the consumer side. And depend upon the consumption load will be disconnect. If in our we have 4 loads, the power consumption is greater than the 70 % one load will disconnect, 80 % 2 nd load , 90% 3 rd load and final. And also we can monitor the water tank in our home by using water flow sensor. By this sensor we can calculates the how much of water in the tank, if water content is low automatically

gives the indication through the Ubidots and send the alerts message on Gmail or SMS. And the power consumption is monitor and control by user from anywhere in the world. The Advantages of this proposed system is .

- Continuously monitoring
- Current sensor senses the AC and DC current
- Control the appliance at anywhere in the world

3.3 Block Diagram

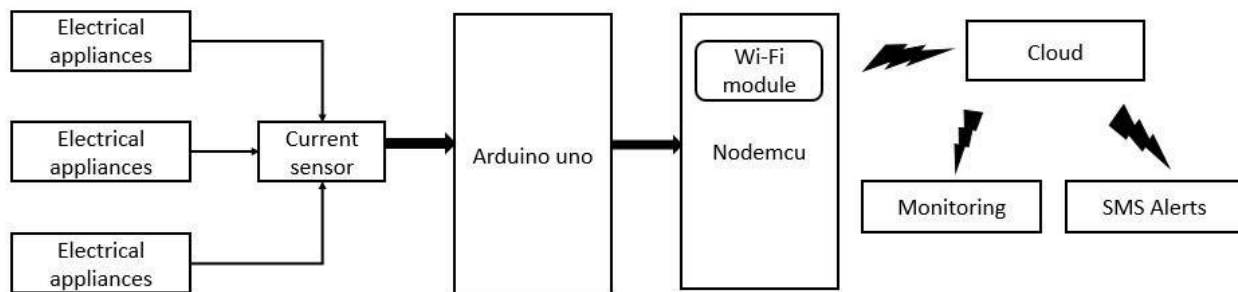


FIG 3.1 Block Diagram

The Hardware used in the system is :

- Arduino UNO
- NodeMCU
- Current sensor
- Electrical appliances (loads)

The Software used in the system is :

- ArduinoIDE
- Embedded C
- Ubidots explorer

3.4 Methodology

Monitoring and keeping tracking of your electricity consumption for verification is a tedious task today since you need to go to meter reading room and take down readings. Well it is important to know if you are charged accordingly so the need is quite certain. Well we automate the system by allowing users to monitor energy meter readings over the internet. Our proposed system uses energy meter with microcontroller system to monitor energy usage using a meter.

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. Thus the energy meter monitoring system allows user to effectively monitor electricity meter readings and check the billing online with ease.

It is a NodeMCU and Arduino based system. The block diagram consists of Arduino, energy meter, WIFI module and IoT, Relay and transformer. 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.

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.

3.5 Objective

- The IoT is used to Turn on/off the household appliances using relay and Arduino interfacing. The objective of this system is to monitor the amount of electricity consumed.
- The distributor and the consumer both will be benefitted by eventually reducing the total Power consumption.

CHAPTER 4

HARDWARE EXPLANATION

4.1 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 stand-alone, 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.

Arduino Uno:

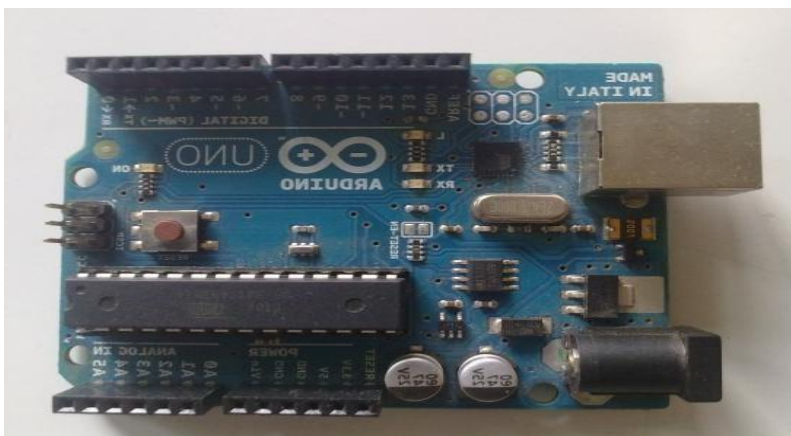


FIG 4.1 ARDUINO UNO

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 Aurdino

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.

4.2 NODE MCU

NodeMCU is an open source IoT platform.^{[4][5]} It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module.^{[6][7]} The term "NodeMCU" by default refers to the firmware rather than the development kits. The firmware uses the Lua scripting language. It 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^[8] and SPIFFS

NodeMCU was created shortly after the ESP8266 came out. On December 30, 2013, Espressif Systems^[6] began production of the ESP8266.^[10] The ESP8266 is a Wi-Fi SoC integrated with a Tensilica Xtensa LX106 core,^[citation needed] widely used in IoT applications (see related projects). NodeMCU started on 13 Oct 2014, when Hong committed the first file of nodemcu-firmware to GitHub.

Two months later, the project expanded to include an openhardware platform when developer Huang R committed the gerber file of an ESP8266 board, named devkit v0.9. Later that month, Tuan PM ported MQTT client library from Contiki to the ESP8266 SoC platform,^[13] 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 to NodeMCU project, enabling NodeMCU to easily drive LCD, Screen, OLED, even VGA displays.

In summer 2015 the creators abandoned the firmware project and a group of independent contributors took over. By summer 2016 the NodeMCU included more than 40 different modules. Due to resource constraints users need to select the modules relevant for their project and build a firmware tailored to their needs.

4.3 ESP8266 Arduino Core

As Arduino.cc began developing new MCU boards based on nonAVR 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".^[16] 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 ESP8266 Wi-Fi chip. By exploring functionality with ESP8266 chip, NodeMCU firmware comes with ESP8266 Development board/kit i.e. NodeMCU Development board.

4.3.1 NodeMCU Development Board/kit v0.9 (Version1)

Since NodeMCU is open source platform, their 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 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.



FIG 4.2 NODE MCU(Version1)

4.3.2 NodeMCU Development Board/kit v1.0 (Version2)

For more information about NodeMCU Boards available in market refer NodeMCU Development Boards

NodeMCU Dev Kit has **Arduino like** Analog (i.e. A0) and Digital (D0-D8) pins on its board.

It supports serial communication protocols i.e. UART, SPI, I2C etc.

Using such serial protocols we can connect it with serial devices like I2C enabled LCD display, Magnetometer HMC5883, MPU-6050 Gyro meter + Accelerometer, RTC chips, GPS modules, touch screen displays, SD cards etc.

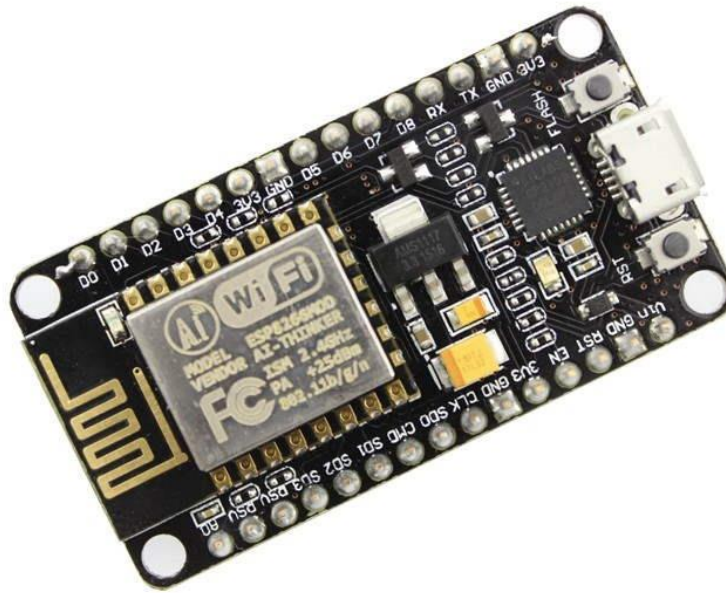


FIG 4.3 NODE MCU (Version 2)

This is how NODEMCU start, the NodeMCU Development board is featured with wifi capability, analog pin, digital pins and serial communication protocols.

To get start 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 is 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 [Getting started with NodeMCU](#)

How the codes are written in NODEMCU. Here is the process , after setting up ESP8266 with Node-MCU firmware, let's see the IDE (Integrated Development Environment) required for development of NodeMCU.

The NodeMCU is uses ESPlorer IDE .In this Lua scripts are generally used to code the NodeMCU. Lua is an open source, lightweight, embeddable scripting language built on top of C programming language.

For more information about how to write Lua script for NodeMCU refer [Getting started with NodeMCU using ESPlorerIDE](#)

Here is another way of developing NodeMCU with a well-known IDE i.e. Arduino IDE. We can also develop applications on NodeMCU using Arduino development environment. This makes easy for Arduino developers than learning new language and IDE for NodeMCU. For more information about how to write Arduino sketch for NodeMCU refer [Getting started with NodeMCU using ArduinoIDE](#)

4.4 ACS712 Current Sensor

Have you ever stopped and wonder the amount of current each of your electrical appliances require? Well, it's a tedious process to know it all but that's where the functionality of a current sensor comes to play. With different devices having different current requirements, if a wrong amount of current is fed to them, it may result in severe circumstances (overloading, etc.).

Hence, it's necessary for one to monitor the required current for applications, and that's when people turn to a current sensor to do the job, notably the ACS712 AC/DC Current sensor.

The ACS712 is a fully integrated, hall effect-based linear current sensor with 2.1kVRMS voltage isolation and a integrated low-resistance current conductor.

Technical terms aside, it's simply put forth as a current sensor that uses its conductor to calculate and measure the amount of current applied.



FIG 4.4 ACS712 Current Sensor

The features of ACS712 include:

- 80kHz bandwidth
- 66 to 185 mV/A output sensitivity
- Low-noise analog signal path
- Device bandwidth is set via the new FILTER pin
- 1.2 m Ω internal conductor resistance • Total output error of 1.5% at $T_A = 25^{\circ}\text{C}$
- Stable output offset voltage.
- Near zero magnetic hysteresis

For more information on ACS712 pinout, schematics, and circuit diagram, you can download ACS712 datasheet .

Now that we've had an idea of what the ACS712 is capable of, we'll take a look at its working principle. Well, when it comes to how a current sensor works, it can either be done through direct or indirect sensing. For the ACS712, it uses indirect sensing.

- For current sensors that work by direct sensing, ohm's law is being applied to measure the drop in voltage when flowing current is detected.

The common list of applications are :

- Motor speed control in motor control circuits
- Electrical load detection and management
- Switched-mode power supplies (SMPS)
- Protection for over-current

The Alternatives of ACS712 is :

Grove – 10A DC Current Sensor (ACS725)

With some users of the ACS712 not recommending it as your current sensor option due to its low sensitivity and bad linearity, we've come forth to provide our alternative recommendation; the Grove – 10A DC Current Sensor that's based on ACS725!

Based on the ACS725, this DC current sensor module is an economical and precise solution to your current sensing needs with capabilities of measuring up to 10A of DC current with a base sensitivity of 264mV/A!

When drawing comparisons to the ACS712, the Grove – 10A DC Current Sensor (ACS725) has the following performance advantages:

- Higher-bandwidth; 120KHz compared to 80kHz of the ACS712

- Higher sensitivity; 264mV/A compared to 66 – 185mV/A of the ACS712

Grove-interface; Easy plug-and-play pairing with your Arduino/Raspberry Pi Board instead of having to solder and use breadboards

4.5.LCD Display

Liquid crystal displays (LCDs) have materials which combine the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an ordered form similar to a crystal.

An LCD consists of two glass panels, with the liquid crystal material sandwiched in between them. The inner surface of the glass plates are coated with transparent electrodes which define the character, symbols or patterns to be displayed. Polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules to maintain a defined orientation angle.

The built-in controller IC has the following features:

- Correspond to high speed MPU interface (2MHz)
- 80 x 8 bit display RAM (80 Characters max)
- 9,920 bit character generator ROM for a total of 240 character fonts. 208 character fonts (5 x 8 dots) 32 character fonts (5 x 10 dots)
- 64 x 8 bit character generator RAM 8 character generator RAM 8 character fonts (5 x 8 dots) 4 character fonts (5 x 10 dots)
- Programmable duty cycles
 - 1/8 – for one line of 5 x 8 dots with cursor
 - 1/11 – for one line of 5 x 10 dots with cursor

1/16 – for one line of 5 x 8 dots with cursor

➤ Wide range of instruction functions display clear, cursor home, display on/off, cursor on/off, display character blink, cursor shift, display shift.

Functional description of the controller IC Registers:

The controller IC has two 8 bit registers, an instruction register (IR) and a data register (DR). The IR stores the instruction codes and address information for display data RAM (DD RAM) and character generator RAM (CG RAM). The IR can be written, but not read by the MPU.

The DR temporally stores data to be written to /read from the DD RAM or CG RAM. The data written to DR by the MPU, is automatically written to the DD RAM or CG RAM as an internal operation.

When an address code is written to IR, the data is automatically transferred from the DD RAM or CG RAM to the DR. data transfer between the MPU is then completed when the MPU reads the DR. likewise, for the next MPU read of the DR, data in DD RAM or CG RAM at the address is sent to the DR automatically. Similarly, for the MPU write of the DR, the next DD RAM or CG RAM address is selected for the write operation.

The dot-matrix liquid crystal display controller and driver LSI displays alphanumeric, Japanese kana characters, and symbols. It can be configured to drive a dot-matrix liquid crystal display under the control of a 4- or 8-bit microprocessor. Since all the functions such as display RAM, character generator, and liquid crystal driver, required for driving a dot-matrix liquid crystal display are internally provided on one chip, a minimal system can be interfaced with this controller/driver.

4.5.1 LCD Block Diagram

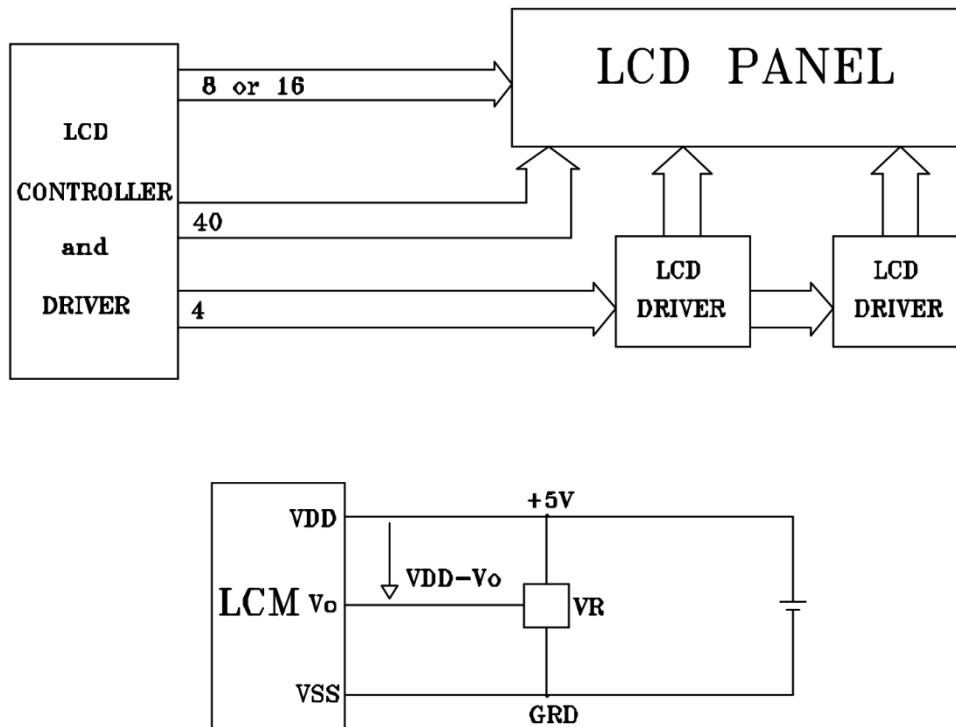


FIG 4.5 LCD BLOCK DIAGRAM

- VDD-V_o: LCD DRIVING VOLTAGE
- VR: 10K-20K

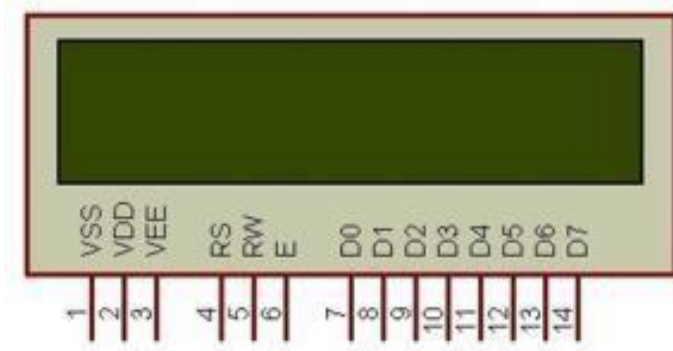


FIG 4.6 LCD

Absolute Maximum Ratings

Item	Symbol	Min	Max	Unit
Power Voltage	VDD - VSS	0	7.0	V
Input Voltage	V _{in}	V _{SS}	VDD	
Operating Temperature Range	TOP	0	+50	T
Storage Temperature Range	T _{ST}	-20	+60	

FIG 4.7 LCD Absolute Ratings

4.6 IOT (Internet Of Things)

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].

4.6.1 Motivation

IoT-based system is in charge of providing knowledge from an environment to an non-expert 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.

4.6.2 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 [10].

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”

Internet of Things-Architecture ² (IoT-A) defines it as “The idea of a globally interconnected continuum of devices, objects and things in general emerged with the RFID technology, and this concept has considerably been extended to the current vision that envisages a plethora of heterogeneous objects interacting with the physical environment.”[12]

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:[13]

Edge Technology layer 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 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 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 is responsible for delivering various application services. These services are provided through the middleware layer to different applications and users in IoT-based systems. The application services can be used in different industries such as, logistics, retail, healthcare, etc.

CHAPTER 5

RESULT AND DISCUSSION

As Electricity energy meters are installed in houses or offices to measure the electricity consumption. By this project we can monitor our electricity uses from anywhere in the world and receive an SMS/E-mail when your energy consumption reaches to a threshold value. It is used to monitor units consumed and transmit the units and cost charged over the internet using WIFI connection. This allows users to check the energy usage along with the cost charged online using a simple web application.

5.1 Working

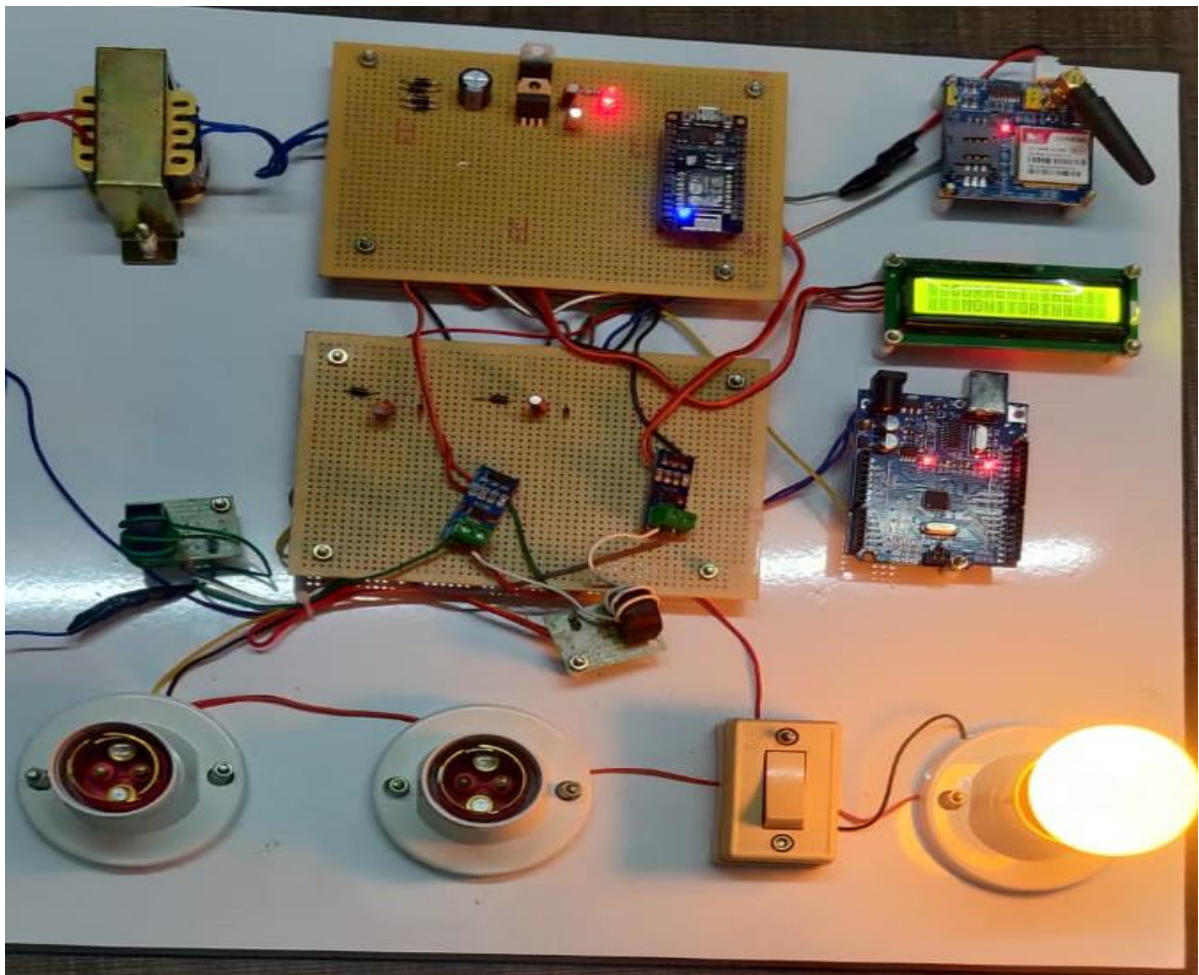


FIG 5.1 Circuit Connections

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. 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.

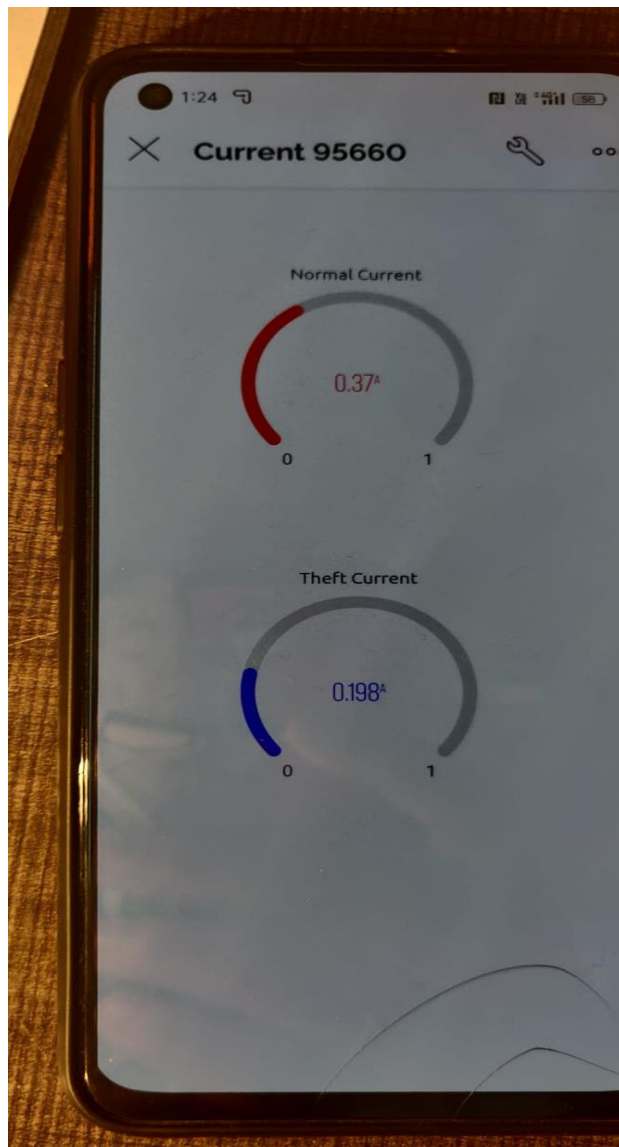


FIG 5.2 App Interface

The IoT is used to Turn on/off the household appliances using relay and Arduino interfacing. The objective of this system is to monitor the amount of electricity consumed. The distributor and the consumer both will be benefitted by eventually reducing the total Power consumption.

CHAPTER 6

CONCLUSION

6.1 Conclusion

The proposed system is able to reduce the sufferings of the customer and make users concern about the excessive consumption of electricity as well as faulty devices at home. Through this system, customers can easily view total pulse, total units and total costs of electricity. The system is easily readable and reliable. The data stored in the cloud has great importance in future energy meter data mining. In a large sense, energy distribution company such as DPDC able to observe the pattern of consumption of an area. Consequently, this observation can help in load distribution in a certain area.

6.2 Future Work

For future enhancement we can implement it without transformer. It makes work easy and we can also develop an application that automatically check the no of units we used and the certain amount is being detected from the registered account.

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APPENDICES

A) SOURCE CODE

```
#include <LiquidCrystal.h>

const int buttonPin = 8;

int buttonState = 0;    // variable for reading the pushbutton status

LiquidCrystal lcd(12, 11, 5, 4, 3, 2);

void setup() {
  pinMode(buttonPin, INPUT);
  lcd.begin(16, 2);
  Serial.begin(9600);
  analogWrite(9,75);
}

void loop() {
  buttonState = digitalRead(buttonPin);

  if (buttonState == HIGH) {
    Serial.println("Source voltage = 214V");
    Serial.println("Source current = 0.271A");
    Serial.println("Source power = 57.7");
    Serial.println("");
    delay(500);
    Serial.println("Load voltage = 214V");
    Serial.println("Load current = 0.128A");
    Serial.println("Load power = 27.1");
```

```

Serial.println("");
delay(500);
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("POWER THEFT HAS");
lcd.setCursor(2, 1);
lcd.print("BEEN OCCURED");
Serial.println("POWER THEFT HAS BEEN OCCURED");
    Serial.println("");
}

```

```

else {
    Serial.println("Source voltage = 214V");
    Serial.println("Source current = 0.131A");
    Serial.println("Source power = 27.8");
    Serial.println("");
    delay(500);
    Serial.println("Load voltage = 214V");
    Serial.println("Load current = 0.124A");
    Serial.println("Load power = 25.6");
    Serial.println("");
    delay(500);
    lcd.clear();
    lcd.setCursor(4, 0);
    lcd.print("SMART EB");
}
}

```

B) SCREENSHOTS

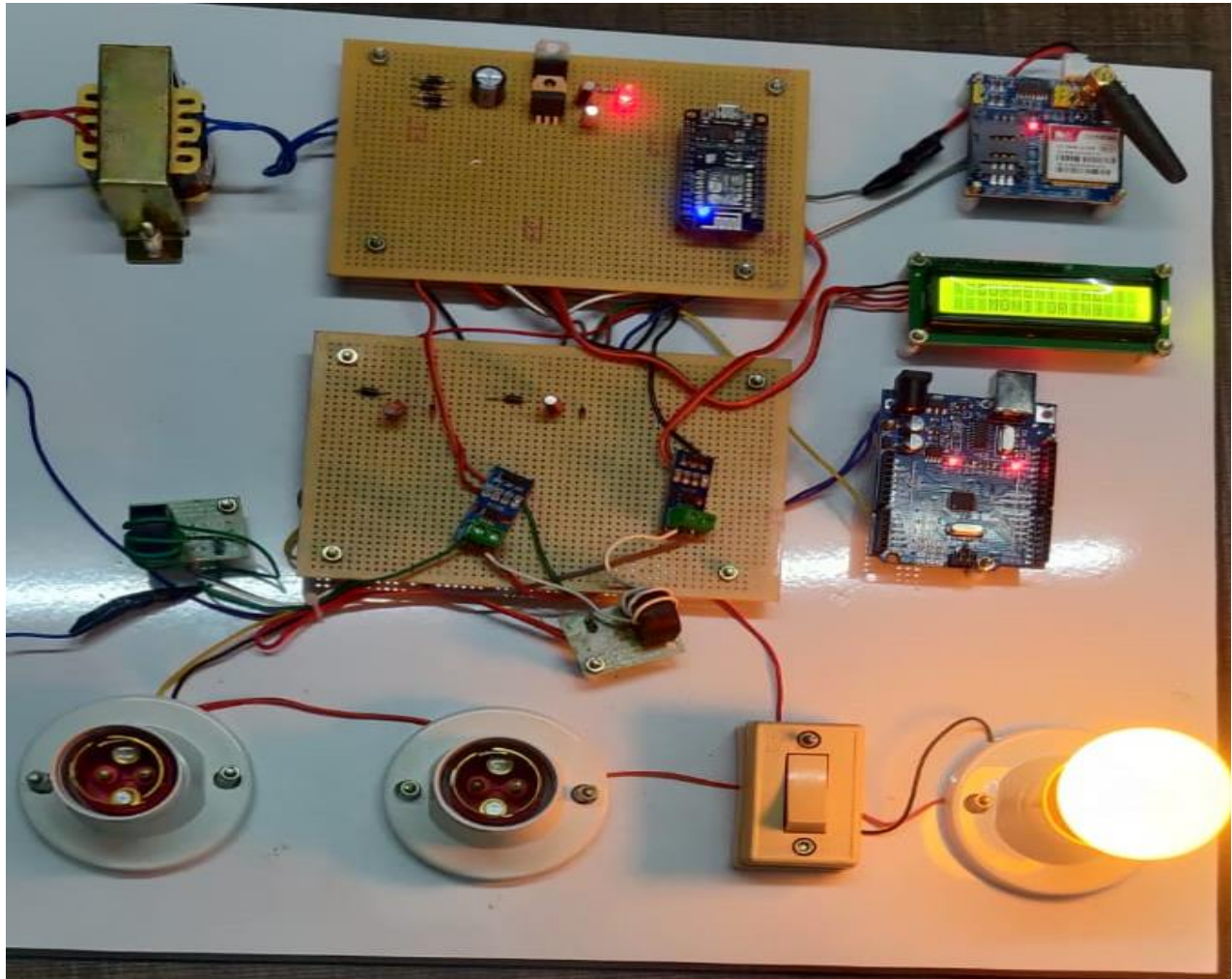


FIG B.1 Circuit Connections

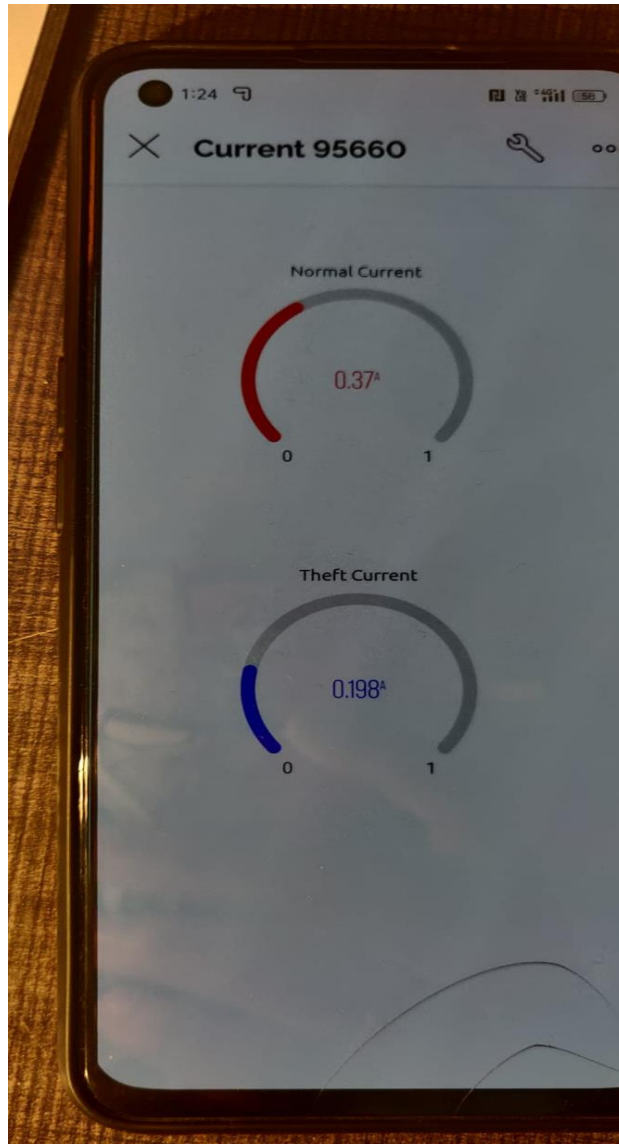


FIG B.2 App Interface

C) Research Paper

Real time Electricity Energy Meter based on IOT

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Abstract: The project is designed for consumption of electricity bill. Electrical energy meters are put in homes and businesses to track how much electricity is used. With the help of this project, you can keep tabs on your electricity usage from anywhere in the globe and get an SMS or email when it crosses a certain level. In this project, we'll use an Arduino and ESP8266 Wi-Fi module to create a smart electrical energy meter that can track your energy consumption at anytime from anywhere in the globe and send you an SMS or email with your power bill attached. To gauge energy usage, we were using a Current Sensor ACS712. It is employed to keep track of the quantity consumed and to transmit the quantity consumed and the price billed digitally via a WIFI connection. Users may utilize a straightforward web application to examine their online energy use and cost. Because of this, customers of the energy meter monitoring system may easily follow electricity meter readings and check their invoices online. The biggest flaw with this approach is that a person must visit each residence individually to read the meter and hand over the invoices. Errors are frequently made, including extra bill amounts and notifications from the power board notwithstanding paid payments. In order to solve this, we have come up with a solution that would do away with the middleman between the customer and the service provider, minimizing mistakes.

This technology helps in the detection of energy theft. As the result, this smart meter supports wireless and IoT-based home automation.

Keywords: Energy meter, Node MCU, current sensor, Arduino.

I. INTRODUCTION

The Internet of Things (IoT) envisions a world in which commonplace things are linked by a worldwide network. To enable extensive monitoring, analysis, improvement, and management, these things gather and communicate data about themselves and their environment. While this was previously only a pipe dream, it is now gradually becoming a reality because to the dropping costs, sizes, and energy needs of tiny devices that interact with their surroundings. Data is sent from these devices to more potent parts like Bluetooth gateways, cell phones, or WIFI hotspots via low-power communication protocols. Integration is being done more and more with long-range wireless technologies, including the present 2G and 3G networks. The data from IoT sensors is subsequently analyzed and processed by edge processors, hubs, or web services to generate new information. This may be used to alter the surroundings through actuators. To summarize, the Internet of Things is considered as a vast cyberphysical control loop.

A smart metre may be used to track the amount of power used by a smart house that is powered by an Arduino. This electronic gadget tracks the energy use of all household appliances and transmits the data to the electricity provider for billing and monitoring. At least once a day, if not more often, energy use is generally recorded by smart meters, which also allow

the meter and the consumer to communicate in both directions. The advanced metering infrastructure (AMI) varies from automatic meter reading in that it enables two-way connectivity between the meter and the supplier (AMR). There are frequently wireless communications between the meter and the consumer.

II.RELATED WORK

Your knowledge of energy use is increased by smart meters. There is less strain on the power system via altering behavioral patterns and influencing choices to purchase more energy-efficient products. According to Smart Energy GB, emissions from households and companies will decline by 24%. This system's goal is to keep track of how much power is used. The ultimate reduction in overall Electricity usage will be advantageous to both the distributor and the customer. Before, everyone used to use a current transformer to measure the ac current, adding to the complexity of the already existing system. Only a certain minimum frequency below which gain rapidly decreases can a current transformer detect current. A fixed current cannot be detected by a current transformer. A current transformer can be used to measure the current of an object that is intrinsically AC, such as a power line. A current transformer cannot be used to detect DC current if it is truly necessary, and the suggested method differs greatly from the current one in several ways. The power consumption of the Arduino and Nodemcu microcontrollers is easily observable and manageable. We have a project that would notify the consumer side of how much power they used based on the units; once the units hit a threshold of 50, the message would be sent to them automatically. And the load will be disconnected depending on usage. If our four loads each consume more power than 70%, one load will be disconnected, followed by two loads that consume 80% and three loads that consume 90% of our power. Also, we may use a water flow sensor to keep an eye on our home's water tank. By using this

sensor, we can determine how much water is in the tank. If there is insufficient water, an automatic warning is sent via Ubidots and an alert message is sent by Gmail or SMS. Also, users may monitor and manage power use from anywhere in the world.

III.EXISTING SYSTEM

The already existing system is having lot of complexities in before that they are all using to measure the ac current using current transformer. Only currents below a certain minimum frequency, below which gain rapidly decreases, may be detected by a current transformer. A fixed current cannot be detected by a current transformer. A current transformer can be used to measure the current of an object that is intrinsically AC, such as a power line. You cannot utilize a current transformer if you actually need to detect DC current.

IV.PROPOSED SYSTEM

In this proposed system we can easily monitor and controlling the power consumption by the Arduino and Nodemcu microcontrollers. We have a project that would notify the consumer side of how much power they used based on the units; once the units hit a threshold of 50, the message would be sent to them automatically. And the load will be disconnected depending on usage. If our four loads each consume more power than 70%, one load will be disconnected, followed by two loads that consume 80% and three loads that consume 90% of our power. Also, we may use a water flow sensor to keep an eye on our home's water tank. By this sensor we can calculate the how much of water in the tank, if water content is low automatically gives the indication through the Ubidots and send the alerts message on Gmail or SMS. Also, users may monitor and manage their power use from anywhere in the globe.

V.SYSTEM DESIGN

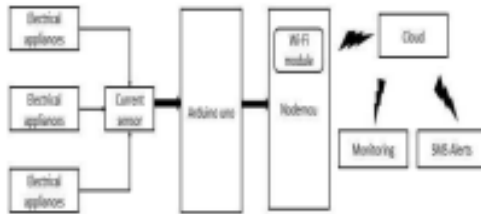


FIG1. SYSTEM DESIGN

5.1 Arduino Uno and its Programming

With Arduino, you can create devices that really can sense and manage the physical surroundings better than your windows machine. A basic microcontroller board serves as the foundation of a physical computer ecosystem that is accessible and has a software development sandbox.

By using switches or sensors as inputs and a variety of lights, motors, and other physical outputs as controls, Arduino can be used to create interactive objects. equipment that users may make use of to do different tasks. Arduino projects have two communication options: they may operate alone or they can connect to computer software. The boards can be manually put together or purchased already put together, and the open-source IDE is free to download. The Handling multimodal programming environment serves as the foundation for the Wiring physical software platform, is comparable to the Processing environment in which the Arduino programming language is implemented.

ArduinoUno:

Fig 3.2 ARDUINO UNO

The Arduino Uno board (Spark fun DEV-09950, \$29.95) is covered in this guide. It is a fantastic option for instructors and students. You may develop programmers and connect circuits using the Arduino board to easily take a look at buttons and other sensors, operate motors, and control lighting. Some of the photos and illustrations in this article were sourced from the Arduino datasheet book.

The Duemilanove board has a microcontroller from Atmel called the ATmega328 that runs at 5 V, has 2 Kb of RAM, One kilobyte of EEPROM and 32 kilobytes of flash memory are used to store settings and programmers, respectively. At a clock speed of 16 MHz, It is possible to execute 300,000 lines of C language source code per second will execute. The board has fourteen digital I/O pins and six analogue input pins. A DC power jack and a USB connection are provided for connecting to a host computer and running programmers when it is not attached, respectively. Headers are available for attaching either 22 g solid wire or header connectors to the I/O pins. In order to work with Arduino, the C/C++ programming language has been compressed. If you are proficient in C, you can programmer the Arduino. As just a few instructions are needed to do relevant tasks, you shouldn't worry if you don't know C. One of the important features of the Arduino is the ability to create control programmers on the host PC, download them to the Arduino, and have them run automatically. The programmer will still launch from the top if you press and hold the reset button while the USB cord is attached to the PC. The Arduino board should be placed in a closet without a battery during the course of six months. When the battery is reconnected, the most recent software you saved will launch. In other words, After developing and testing your software on the board using the host computer, you may run the programmed without the PC.

5.2 .ACS712 Current Sensor:



Have you ever paused to consider how much current your various electrical devices need? It's laborious to learn everything, but that is where the current sensor's usefulness comes in. Different devices have varying current requirements, thus if the incorrect amount of current is delivered to them, it might lead to dire conditions (overloading, etc.). As a result, it's vital to keep track of the required current for applications. People use current sensors to do this, particularly the ACS712 AC/DC Current sensor.

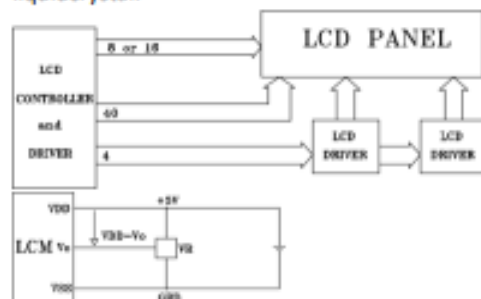
The properties of Comprehensive integration includes a hall effect-based linear current sensor, an integrated

low-resistance current conductor, and 2.1kVRMS volt isolation the list ACS712 is a versatile device. With all technical jargon out of the way, its function is simple to compute and determine the quantity of applied current utilizing its conductor. The characteristics of current sensor is 80kHz bandwidth, 66 to 185 mV/A output sensitivity, Low-noise analog signal path, Device bandwidth is set via the new FILTERpin, 1.2 mΩ internal conductor resistance,

Total output error of 1.5% at TA = 25°C

5.3 Interfacing LCD

Materials that have the qualities of both liquids and crystals are used in liquid crystal displays (LCDs). They lack a specific melting point; instead, they have a range of temperatures where the molecules are practically as mobile as they would be in a liquid yet are structured in a manner resembling crystals. An LCD is made of two glass panels with a liquid crystal material sandwiched in between. The projection of letters, symbols, or patterns is controlled by applying transparent electrodes to the inside surface of the glass plates. The liquid crystal particles then maintain a certain orientation angle as a result of the placement of polymeric layers between the conductors as well as the liquid crystal.



VI.RESULT AND DISCUSSION

This technique helps to control energy use, and avoiding energy waste is important. It measures energy uses the energy meter IOT idea and is designed and implemented using NodeMCU and Arduino. The suggested system includes a meter reading system that is intended to communicate the reading to a specific server while continually

monitoring the meter reading. It is always possible to access this information from any location across the globe.

VII.CONCLUSION

The suggested approach has the ability to lessen users' pains and raise their awareness of excessive power use and malfunctioning household appliances. Customers may simply monitor total pulse, total units, and total power expenses with this technology. The system is trustworthy and simple to read. Future data mining on energy metres will be heavily reliant on the cloud-stored data. In a broad sense, an energy distribution firm like DPDC is able to track a region's consumption trends. As a result, this discovery can aid with load distribution in a certain region.

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