IOT based Energy Meter and Bill Monitoring System

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<u>Declaration</u>

It is declared hereby that this project paper or any part of it has not been submitted to anywhere else for the award of any degree.

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Certification

This is to certify that this project entitled "**IOT based Energy Meter and Bill Monitoring System**" is done by the following students under my direct supervision. This project work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering, Sonargaon University (SU) in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering.

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Abstract

It is a proposed system designed to eliminate human involvement in the electricity system. IOT (Internet of things) is the network of physical things with electronics software, sensors, and connectivity to enable objects to collect and exchange data. IOT based automatic meter reading is the technology of automatic collecting data energy meter and transferring data to the server for billing process and if there is any tempering then also detectable. The internet connected to meter collect the data and display data on the LCD by which we can read and understand the things that are going on the system. Current drawn also calculated by the current Sensor that connected in series with the load will be shown on the LCD. It is difficult to manual reading and calculating bill of individually. This will help for the proper and accurate reading of billing process. By taking all these features that can be done by IOT based smart energy meter easily.

TABLE OF CONTENTS

Chapter 4: Result and Discussion

Chapter 5: Conclusion

LIST OF THE FIGURE

LIST OF TABLE

CHAPTER 1

INTRODUCTION

1.1 Introduction

To measure the amount of energy consumed by domestic, commercial and industrial user, energy meter is being used. As the population of energy consumers are gradually increasing the smart energy meter helps to ease the energy management system. The paper depicts the solution for reducing human involvement in energy management for the domestic and industrial consumers. All the data monitoring is done via a web based portal provided with a dedicated internet connection. The system has to be made in such a way that the power consumption is analyzed properly. Currently the system we use required human involvement which leads to the time consumption also, it has always been a necessity that a particular individual or person from the energy department should visit the consumer house and note down the readings and therefore errors can get introduced .So in order to overcome the stress, smart energy meter is introduced. In this work, the system uses esp8266 microcontroller because it is energy efficient hence it consumes less power. The system will combine with the energy meter which is already installed in place of residence.

The consumer can easily access the figures of energy meter through a Mobile. The distribution companies are unable to keep track of the changing maximum demand of consumers due to this consumer is facing problems like receiving due bills for the bills that have already been paid. So to overcome these problems the remedy is to keep track of the consumers load on timely basis, which will help to assure accurate billing, track maximum demand and to detect threshold value. By considering the present scenario it is important to build an efficient energy meter. The present project "IOT Base Smart energy Meter, Bill Monitoring and Load Controlling System" addresses the problem faced by both the consumers and the distribution companies.

This system make it easier for the electricity department to read the meter readings monthly without a labour work. This can be achieved by the use of esp8266 unit that continuously monitor and records the energy meter reading in its memory location. The consumers can continuously record the reading and the live meter reading can be access to the consumer on request.

1.2 Background

Automation is a demand in this era of information and communication technology where a smart control system is used to reduce or replace human operators in the industry, offices or homes to produce some goods or services. The consumer is facing problems like receiving due bills for bills that have already been paid as well as poor reliability of electricity supply and quality even if bills are paid regularly. The remedy for all these problems is to keep track of the consumers load on timely basis, which will held to assure accurate billing. Load control and monitoring system is the subset of automation system that allows us to control household appliances like light, door, fan, air-conditioner etc in an intelligent way. It also includes those of domestic activities such as home entertainment systems, houseplant and yard watering, pet feeding and the use of domestic robots. Load control and monitoring system also can provide home security and emergency systems to be activated while necessary. It helps handicapped and old aged people who will enable them to control home appliances and alert them in critical situations. It not only refers to reduce human efforts but also energy efficiency and time saving. There are different types of load control and monitoring systems in the market. They are generally proprietary and closed, expensive and not very customizable by the end user. To overcome this limitation, there are scopes of research in this area.

In this project work, a IOT based home automation and energy monitoring device has been chosen to implement. It can operate by any mobile when needed by using blynk application. A program code was being downloaded into the microcontroller. When the blynk gets any press from user it gives data signal to the microcontroller, the microcontroller then gives an output signal to the relay Module to turn ON or OFF the output. This is a very simple project work which is very cost-effective and can be used in so many places where automatic power consumption control is the main concern.

1.3 Goal of the Work

The main purpose of this project is to design and implement a IOT Base Smart energy Meter, Bill Monitoring and Load Controlling System that can be produced at a low cost with effective and competitive usage. This system is designed to be more users friendly and easy to operate at any level. The project is also been designed to be further working vision using minimum hardware at the lower level of processing. These systems are directed at specific applications.

1.4 Problem Identification

Energy meters in Bangladesh have overwhelmingly been electromechanical in nature yet are progressively their status of working capability being supplanted by more modern and precise advanced and electronic meters. A high amount of power at destinations is lost because of theft. With few changes made with present existing architecture of energy meters we can overcome the theft. As indicated by an investigation agency distributed by DPDC, Bangladesh is hoping to shrewd lattice framework to help handle a power robbery issue and enhance unwavering quality.

1.5 Project Objective

- Our objective is to design and construct a home appliances control system using android phone with a low cost and to ensure human comfort.
- Monitoring Consumed power
- Sent bill information over internet

1.6 Project Scope

In a way to achieved above objectives, this project need to be implemented as below:

- This load control and monitoring system is incorporating with esp8266microcontroller and Smartphone.
- The microcontroller is used as the heart of this Control and Monitoring System that controls the entire operations involved.
- The System is capable to operate Home Appliance and Monitor the costing.

CHAPTER 2

THEORY OF THE PROJECT

2.1 Introduction

The system architecture of the Smart energy meter output appliance can be divided into 2 main parts. They are:

- Microcontroller and
- Current Sensor

2.2 Hardware Used

- Wemos D1 R1 Microcontroller
- ACS712 Current Sensor
- Relay Module
- Transformer
- Bridge Rectifier
- Buck Converter
- LCD Display

2.3 Microcontroller

A microcontroller is a compact integrated circuit designed to govern a specific operation in an embedded system. A typical microcontroller includes a processor, memory and input/output (I/O) peripherals on a single chip. Sometimes referred to as an embedded controller or microcontroller unit (MCU), microcontrollers are found in vehicles, robots, office machines, medical devices, mobile radio transceivers, vending machines and home appliances among other devices. Microcontroller is a single chip microcomputer made through VLSI fabrication. A microcontroller also called an embedded controller because the microcontroller and its support circuits are often built into, or embedded in, the devices they control. A microcontroller is available in different word lengths like microprocessors (4bit,8bit,16bit,32bit,64bit and 128-bit microcontrollers are available today).

2.3.1 ESP8266 Microcontroller

The ESP8266 is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability produced by manufacturer Express if Systems. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands. However, at first there was almost no English-language documentation on the chip and the commands it accepted. The ESP8285 is an ESP8266 with 1 MiB of built-in flash, allowing for single-chip devices capable of connecting to Wi-Fi.

2.3.2 ESP8266 Basic microcontroller

The basic structure and block diagram of anESP8266 microcontroller is shown in the figure

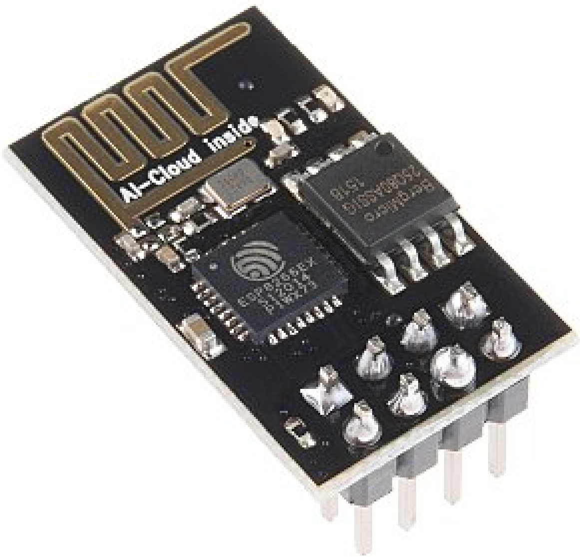

Figure 2.1: Microcontroller Structure

2.3.3 Advantages of Microcontrollers

The main advantages of microcontrollers are given.

a) Microcontrollers act as a microcomputer without any digital parts.
b) As the higher integration inside microcontroller reduces cost and size of the system.
c) Usage of a microcontroller is simple, easy to troubleshoot and system maintaining.
d) Most of the pins are programmable by the user for performing different functions.
e) Easily interface additional RAM, ROM, I/O ports.
f) Low time required for performing operations.

2.3.4 Microcontrollers Applications

Some basic applications of a microcontroller are given below.

1. Used in biomedical instruments.
2. Widely used in communication systems.
3. Used as a peripheral controller in PC.
4. Used in robotics.
5. Used in automobile fields.

2.3.5 WeMos D1 R1 Arduino Compatible ESP8266

This WeMos development board is based on the ESP8266, which is a Wi-Fi communication IC built by Espressif. At its core is a microcontroller that runs at a blazing 80 MHz and includes a built-in TCP/IP stack and transceiver, which allows for Wi-Fi communication. This low-cost option can, not only, add Wi-Fi capability to your next project, it can run it. This board is a standalone microcontroller development board that can be easily programmed using the Arduino IDE. Some of the peripherals provided by that ESP8266 include 9 GPIOs, 1 analog input, UART, SPI, and TWI/I2C, and Wi-Fi. It operates at a 3.3V logic level and it can be powered from the USB voltage or AC adapter input. The WeMos D1 uses the ESP 8266 microcontroller that is 2 x faster than an Uno, has 160Kbs of Ram compared to the 2K of an Uno and a 100x the amount of Flash memory! And each I/O pin is interruptible!

2.3.6 Technical Specs

- Supply Voltage (Vin): 5 – 15V
- Logic Voltage: 3.3V
- Wi-Fi, UART, I2C, SPI
- Digital I/Os: 9
- Analog Inputs: 1

2.3.7 Resources

- Installing ESP8266 Support in Arduino IDE
- ESP8266 Arduino Core Reference
- ESP8266 Arduino Libraries
- Over-the-Air Update/Programming
- ESP8266 Datasheet

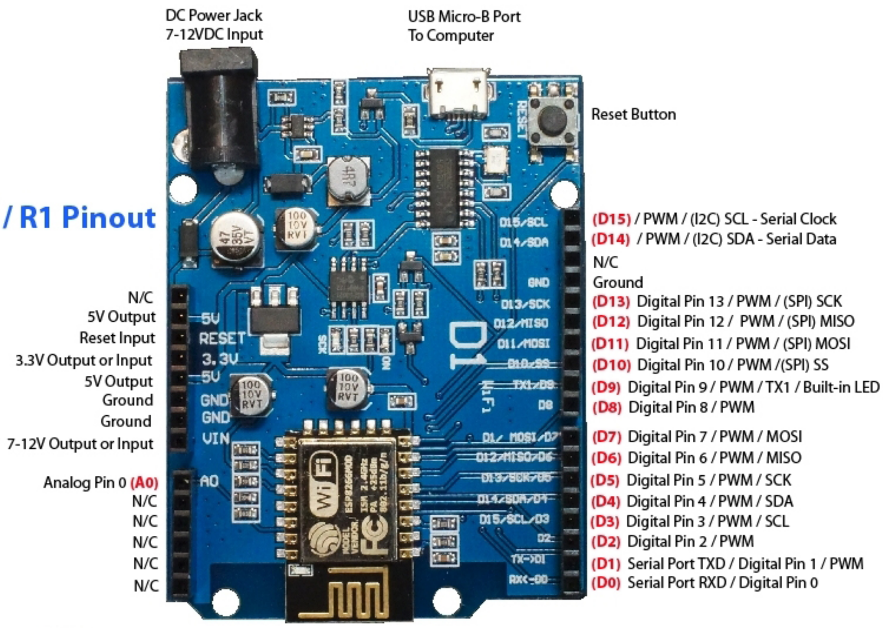

Figure 2.2: Wemos D1 R1 microcontroller

2.3.8 WeMos D1 R1 Wi-Fi ESP8266 Board

- An Arduino UNO Compatible Wi-Fi board based on ESP8266EX.
- WeMos® D1 R2 Wi-Fi ESP8266 Development Board is programmable via Arduino IDE.
- 11 digital input/output pins, all pins have interrupt/pwm/I2C/one-wire supported (except D0)
- 1 analog input (3.3V max input)
- A Micro USB connection
- A power jack, 9-24V power input.
- Compatible withArduino
- Compatible with nodemcu

2.3.8 Technical specs table chart:

Pin	Function	ESP-8266 Pin	Microcontroller	ESP-8266EX
TX	TXD	TXD	Operating Voltage	3.3V
RX	RXD	RXD	Digital I/O Pins	11
A0	Analog input, max 3.3V input	A0	Analog Input Pins	1

D0	IO	GPIO16	Clock Speed	80MHz/160MHz
D1	IO, SCL	GPIO5	FLash	4M bytes
D2	IO, SDA	GPIO4	Length	68.6mm
D3	IO,Pull-up	GPIO0	Width	53.4mm
D4	IO,pull-up, BUILTIN_LED	GPIO2	Weight	25g
D5	IO, SCK	GPIO14		
D6	IO, MISO	GPIO12		
D7	IO, MOSI	GPIO13		
D8	IO,pull-down, SS	GPIO15		
G	Gound	GND		
5V	5V	-		
3V3	3.3V	3.3V		
RST	Reset	RST		

Table 2.1: Specification Of table chart

*All IO have interrupt/pwm/I2C/one-wire supported(except D0)

Programming:

The D1 R1 has a micro USB for auto programming, alsowe can program it using OTA.

2.4 Blynk application Fundamentals

There are many apps to control the Wi-Fi communication with our smart phones. In our project we have used Blynk app for controlling our project using our smart phone. Blynk app for IOS and Android is the easiest way to build our own mobile app that work with the hardware of our choice. Blynk Library is an extension that runs on top of the hardware application. It handles all the connection routines and data exchange between our hardware, Blynk Cloud, and our project.

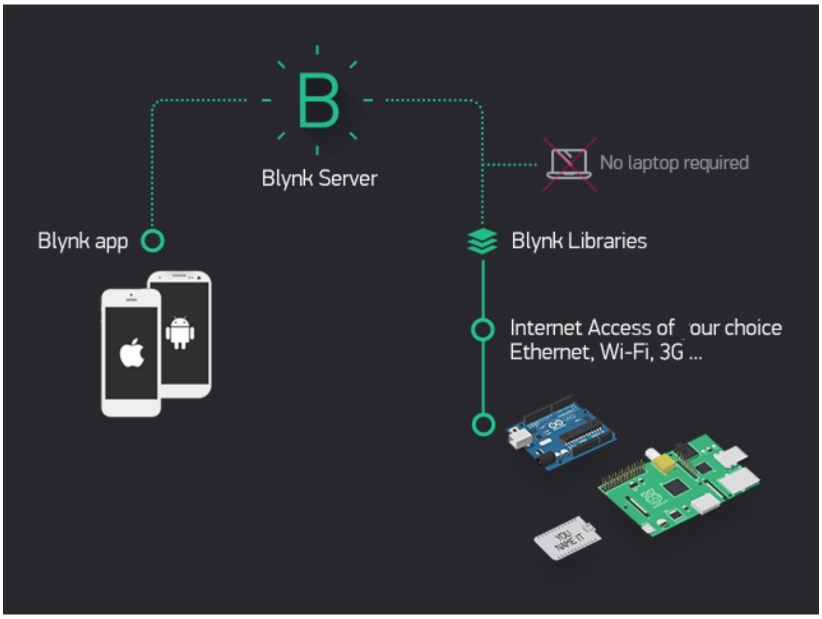

Figure 2.4: Blynk application communication feature

2.4.1 Major features

“Blynk app” It can control hardware remotely, it can display sensor data, it can store data, visualize it and do many other cool things. There are three major components in the platform: Blynk App - allows to you create amazing interfaces for our projects using various widgets.

Figure 2.5: Blynk application widget box

2.5 Current Sensor

In this project there used a current sensor for detect consumed power. Depending on consumed power we find the costing of used equipment. Here we used ACS712 Current sensor for sensing current.

The ACS712 current sensor provides economical and precise solutions for AC or DC current sensing in home, industrial, commercial, and communications systems. The device package allows for easy implementation by the customer. Typical applications include motor control, load detection and management, switched-mode power supplies, and over current fault protection.

The device consists of a precise, low-offset, linear Hall sensor circuit with a copper conduction path located near the surface of the die. Applied current flowing through this copper conduction path generates a magnetic field which is sensed by the integrated Hall IC and converted into a proportional voltage. Device accuracy is optimized through the close proximity of the magnetic signal to the Hall transducer.

Specification of Current Sensor

	5A Module	**20A Module**	**30A Module**
Supply Voltage (VCC)	5Vdc	5Vdc	5Vdc
Measurement Range	-5 to +5 Amps	-20 to +20 Amps	-30 to +30 Amps
Scale Factor	185 mV per Amp	100 mV per Amp	66 mV per Amp
Chip	ACS712ELC-05A	ACS712ELC-10A	ACS712ELC-30A

Table 2.2: Specification Of Current Sensor

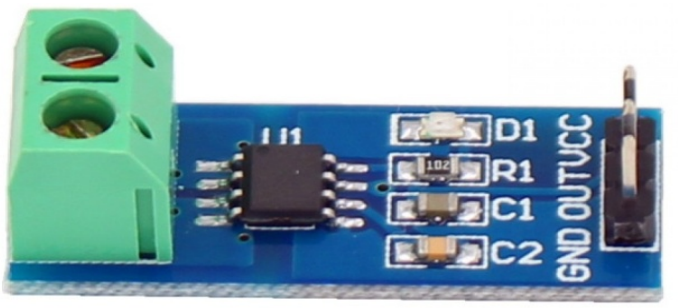

Figure 2.6: ACS712 Current Sensor

The ACS712 current sensor is based on the principle of Hall-effect, which was discovered by Dr. Edwin Hall in 1879. According to this principle, when a current carrying conductor is placed into a magnetic field, a voltage is generated across its edges perpendicular to the directions of both the current and the magnetic field. It is illustrated in the figure shown below. A thin sheet of semiconductor material (called Hall element) is carrying a current (I) and is placed into a magnetic field (B) which is perpendicular to the direction of current flow. Due to the presence of Lorentz force, the distribution of current is no more uniform across the Hall element and therefore a potential difference is created across its edges perpendicular to the directions of both the current and the field. This voltage is known Hall voltage and its typical value is in the order of few microvolt's. The Hall voltage is directly proportional to the magnitudes of I and B. So if one of them (I and B) is known, then the observed Hall voltage can be used to estimate the other.

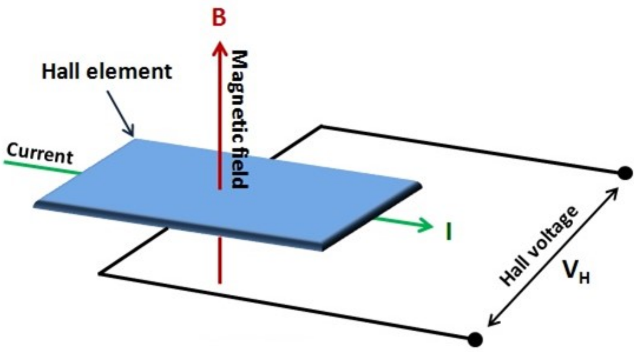

Figure 2.7: Hall Effect

2.5.1 Principle of Hall-effect

The ACS712 device is provided in a small, surface mount SOIC8 package. It consists of a precise, low-offset, linear Hall sensor circuit with a copper conduction path located near the surface of the die. When current is applied through the copper conductor, a magnetic field is generated which is sensed by the built-in Hall element. The strength of the magnetic field is proportional to the magnitude of the current through the conduction path, providing a linear relationship between the output Hall voltage and input conduction current. The on-chip signal conditioner and filter circuit stabilizes and enhances the induced Hall voltage to an appropriate level so that it could be measured through an ADC channel of a microcontroller. The pin diagram of ACS712 device and its typical application circuit is shown below. Pins 1, 2 and 3, 4 forms the copper conduction path which is used for current sensing. The internal resistance of this path is around 1.2 mOhm thus providing low power loss. As the terminals of this conduction path are electrically isolated from the sensor leads , the ACS712 device eliminates the risk of damaging the current monitoring circuit due to the high voltage on the conduction side. The electrical isolation between the conduction current and the sensor circuit also minimizes the safety concerns while dealing with high voltage systems.

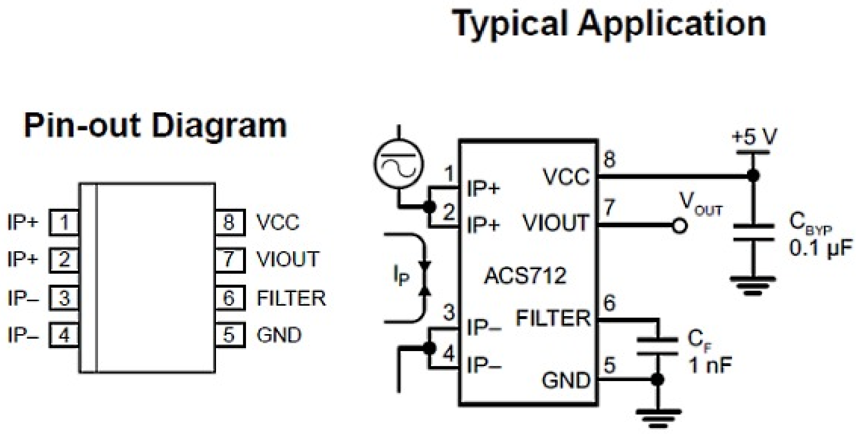

Figure 2.8: Pin diagram and a typical application circuit of ACS712

In low-frequency applications, it is often desirable to add a simple RC filter circuit at the output of the device to improve the signal-to-noise ratio. The ACS712 contains an internal resistor (RF) connected between the output of the on-chip signal amplifier and the input of the output buffer stage (shown below). The other end of the resistor is externally accessible through pin 6 (Filter). With this architecture, users can implement a simple RC filter through the addition of an external capacitor (CF) between the Filter pin and ground. It should be noted that the use of external capacitor increases the rise time of the sensor output, and therefore, sets the bandwidth of the input signal. The maximum bandwidth of the input signal is 80 KHz at zero external filter capacitor. The bandwidth decreases with increasing CF. The datasheet of ACS712 recommends to use 1 nF for CF to reduce noise under nominal conditions.

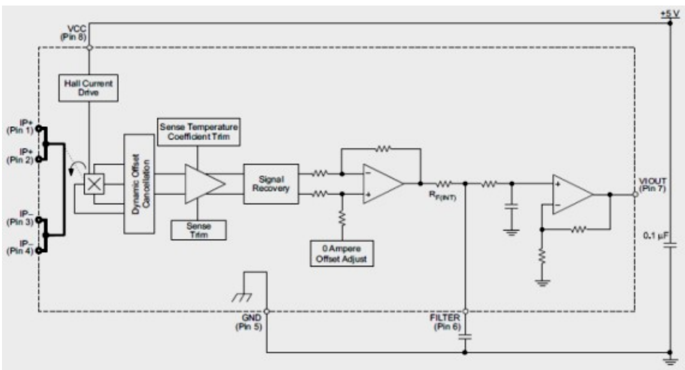

Figure 2.9: Functional block diagram of ACS712

2.5.2 Sensitivity and output of ACS712

The output of the device has positive slope when an increasing current flows through the copper conduction path (from pins 1 and 2, to pins 3 and 4). The ACS712 device comes in three variants, providing current range of±5A (ACS712-05B), ±20A (ACS712-20B), and ±30A (ACS712-30A). The ACS712-05B can measure current up to ±5A and provides output sensitivity of 185mV/A (at +5V power supply), which means for every 1A increase in the current through the conduction terminals in positive direction, the output voltage also rises by 185 mV.

The sensitivities of 20A and 30A versions are 100 mV/A and 66 mV/A, respectively. At zero current, the output voltage is half of the supply voltage (Vcc/2). It should be noted that the ACS712 provides ratio metric output, which means the zero current output and the device sensitivity are both proportional to the supply voltage, VCC. This feature is particularly useful when using the ACS712 with an analog-to-digital converter. The precision of any A/D conversion depends upon the stability of the reference voltage used in the ADC operation. In most

Microcontroller circuits, the reference voltage for A/D conversion is the supply voltage itself. So, if the supply voltage is not stable, the ADC measurements may not be precise and accurate. However, if the reference voltage of ADC is same as the supply voltage of ACS712, then the ratio metric output of ACS712 will compensate for any error in the A/D conversion due to the fluctuation in the reference voltage.

Let me explain this with an example. Suppose, an ADC chip uses Vcc = 5.0V as a reference for A/D conversion and the same supply voltage powers an ACS712 sensor chip. The analog output of the ACS712 will be digitized through the ADC chip. When there is zero current through the current sensor, the output is Vcc/2 = 2.5V. If the ADC chip is 10-bit (0-1023), it will convert the analog output from the ACS712 sensor into digital value of 512 count.
Now, if the supply voltage drifts and becomes Vcc = 4.5V, then, due to the ratio metric nature, the new output of the ACS712 sensor will be 4.5/2 = 2.25V, which will still be digitized to 512 by the ADC as its reference voltage is also lowered to 4.5V. Similarly, the sensitivity value will also be lowered by a factor of 4.5/5 = 0.9, which means if the ACS712-

05B is powered with a 4.5V supply, the sensitivity is reduced to 166.5 mV/A, instead of 185mV, A. This concludes that any fluctuation in the reference voltage will not be a source of error in the analog-to-digital conversion of the ACS712 output signals.

The curve below shows the nominal sensitivity and transfer characteristics of the ACS712-05B sensor powered with a 5.0V supply. The drift in the output is minimum for a varying operating temperature, which is attributed to an innovative chopper stabilization technique implemented on the chip.

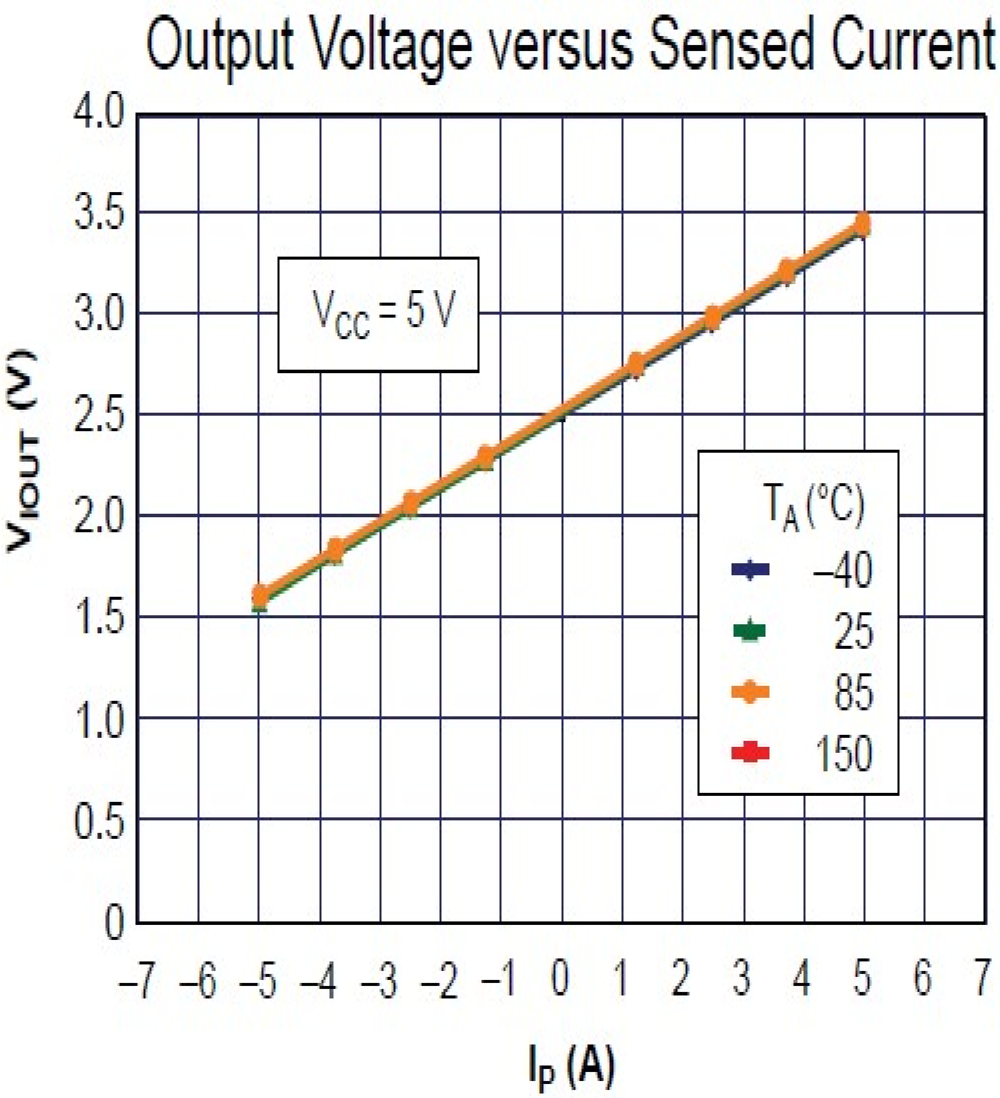

Figure 2.10: Output voltage vs. sensed current of ACS712

2.5.3 Sensor and Microcontroller connection

ACS712 current sensor reads current value passing on it, for this project we use A0 for read current.

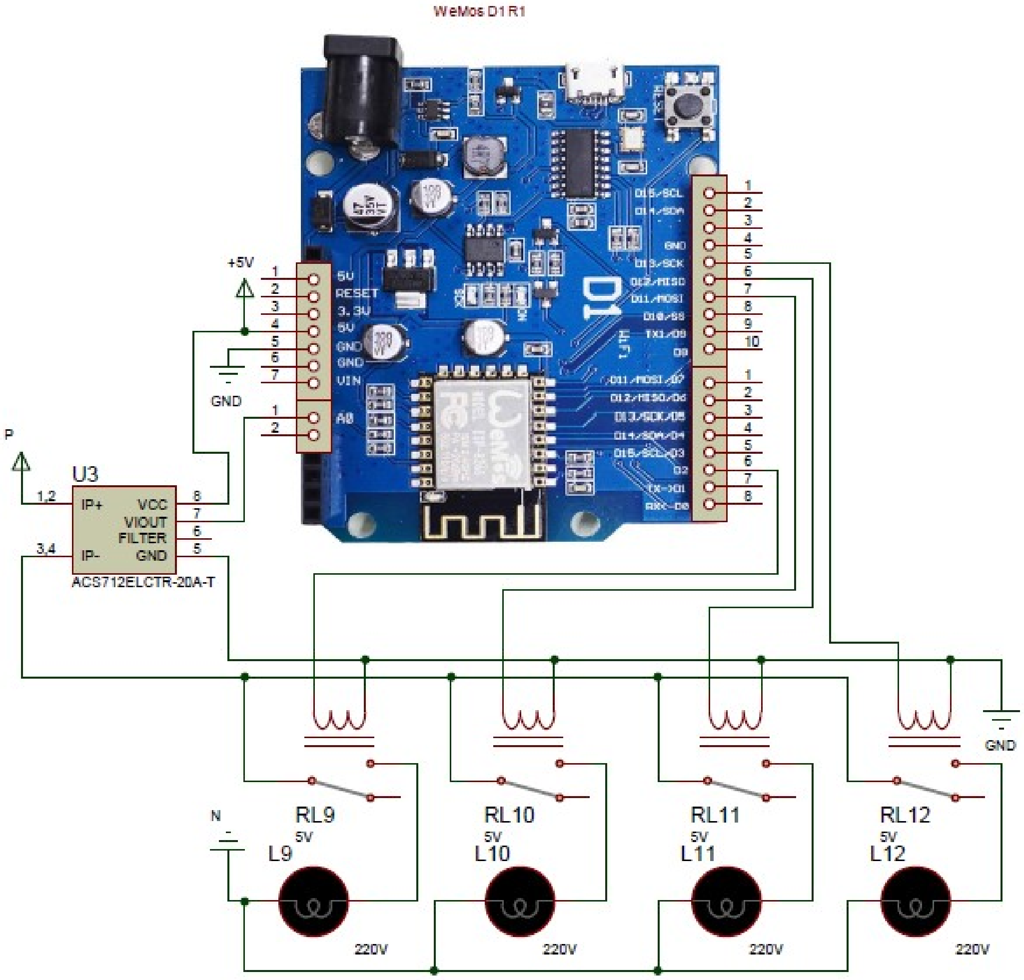

Figure 2.11: Connection of Microcontroller and ACS712

2.6 Relay switch

The Wemos D1 R1 operates at 5V it can't control these higher voltage devices directly, here we use a 4 Channel 5V Relay Module to switch the 120-240V current and use the Wemos D1 R1 to control the relay. This is a 5V 4-channel relay interface board, and each channel needs a 15-20mA driver current. It can be used to control various appliances and equipment with large current. It is equipped with high-current relays that work under AC250V 10A or DC30V 10A. It has a standard interface that can be controlled directly by microcontroller.

2.6.1 Principle

From the picture below, you can see that when the signal port is at low level, the signal light will light up and the optocoupler 817c (it transforms electrical signals by light and can isolate input and output electrical signals) will conduct, and then the transistor will conduct, the relay coil will be electrified, and the normally open contact of the relay will be closed. When the signal port is at high level, the normally closed contact of the relay will be closed. So, you can connect and disconnect the load by controlling the level of the control signal port.The SRD-05VDC-SL-C relay has three high voltage terminals (NC, C, and NO) which connect to the device you want to control. The other side has three low voltage pins (Ground, Vcc, and Signal) which connect to the Wemos D1 R1.

NC: Normally closed 120-240V terminal

NO: Normally open 120-240V terminal

C: Common terminal

Ground: Connects to the ground pin on the Arduino

5V Vcc: Connects the Wemos D1 R1 5V pin

Signal: Carries the trigger signal from the Wemos D1 R1 that activates the relay

Inside the relay is a 120-240V switch that's connected to an electromagnet. When the relay receives a HIGH signal at the signal pin, the electromagnet becomes charged and moves the contacts of the switch open or closed.

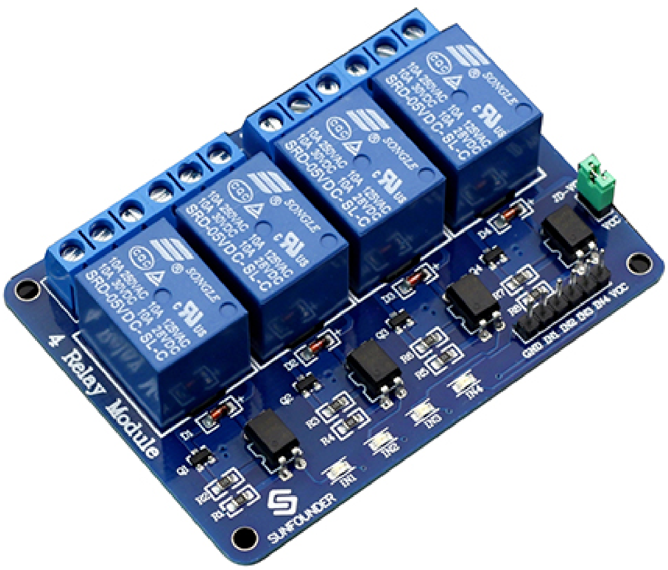

Figure 2.12: 4 Channel 5V Relay Module

2.6.2 Pin Description and Features

INPUT	OUTPUT
VCC: Positive supply voltage GND: Ground IN1--IN4: Relay control port	Connect a load, DC 30V/10A , AC 250V/10A

Features:
Size: 75mm (Length) * 55mm (Width) * 19.3mm (Height)
Weight: 61g
PCB Color: Blue

There are four fixed screw holes at each corner of the board, easy for install and fix. The diameter of the hole is 3.1mm
High quality Songle relay is used with single pole double throw, a common terminal, a normally open terminal, and a normally closed terminal

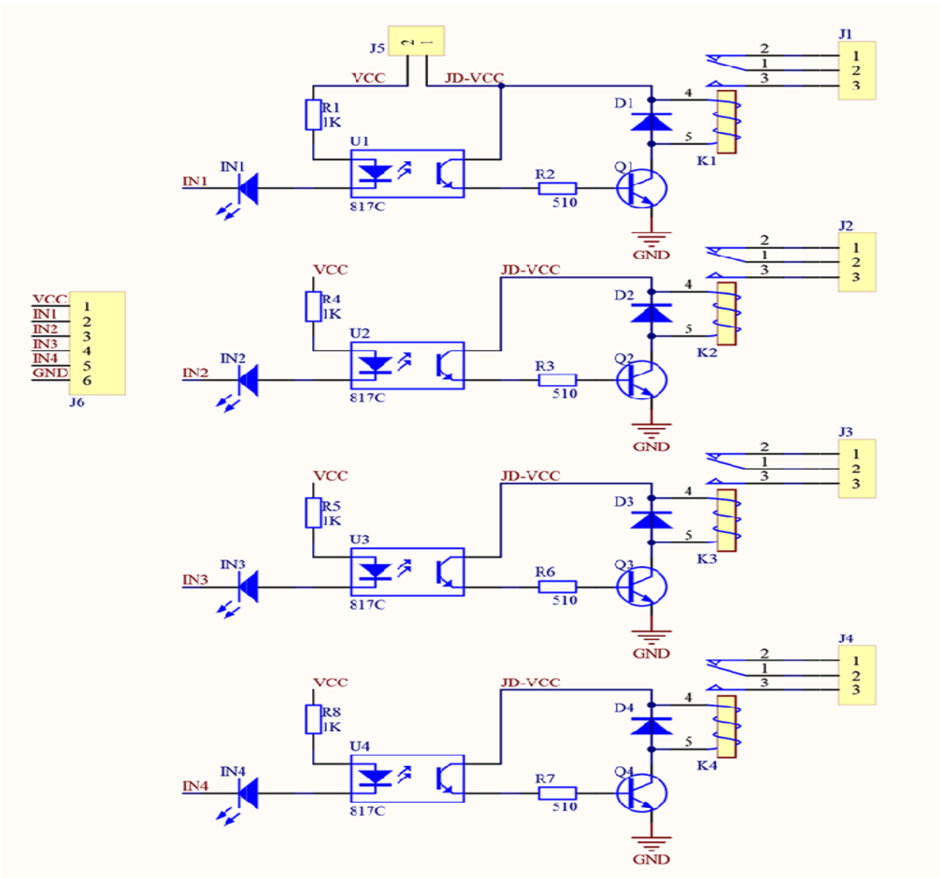

Figure 2.13: 4 Channel 5V Relay Module circuit diagram

2.7 Transformer

A transformer is a passive electrical device that transfers electrical energy between two or more circuits. A varying current in one coil of the transformer produces a varying magnetic flux, which, in turn, induces a varying electromotive force across a second coil wound around the same core. Electrical energy can be transferred between the two coils, without a metallic connection between the two circuits. Faraday's law of induction discovered in 1831 described the induced voltage effect in any coil due to changing magnetic flux encircled by the coil.

Transformers are used for increasing or decreasing the alternating voltages in electric power applications, and for coupling the stages of signal processing circuits.

Basically, transformer are two types.

1. Step up transformer
2. Step down transformer

We have used step down transformer as required for our project. Which is 220v to 12v 3000ma step down transformer.

Figure 2.14: 220v to 12V step down transformer.

2.8 Diode

A diode is a specialized electronic component with two electrodes called the anode and the cathode. Most diodes are made with semiconductor materials such as silicon, germanium, or selenium. Some diodes are comprised of metal electrodes in a chamber evacuated or filled with a pure elemental gas at low pressure. Here we used converted AC into DC using a bridge-wave rectifier that consists of four diodes

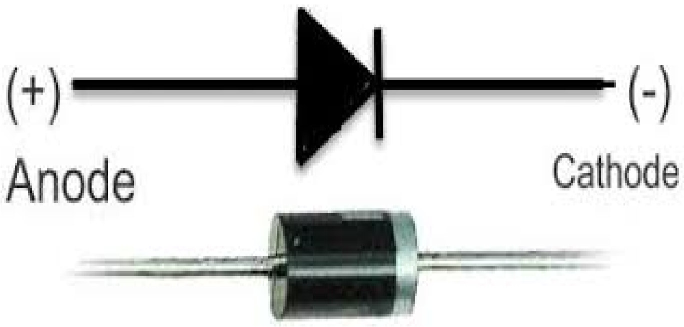

Figure 2.15: Diode symbol.

2.9 Full wave rectifier

A Full wave rectifier is a circuit arrangement which makes use of both half cycles of input alternating current (AC) and converts them to direct current (DC). ... This arrangement is known as a Bridge Rectifier. It uses the entire AC wave (Both positive and negative sections). Each diode uses 0.7v when conducting and there are always two diodes conducting.

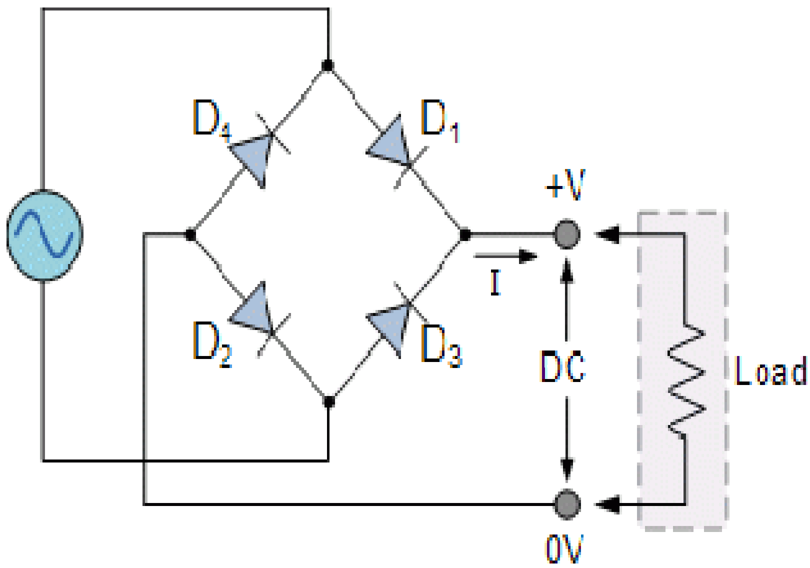

Figure 2.16: Full wave rectifier is a circuit diagram

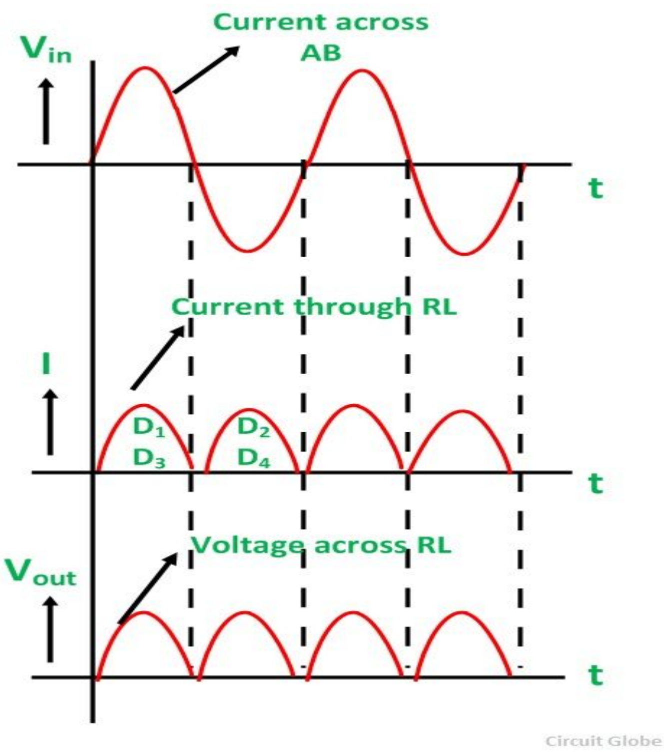

Figure 2.17: Full wave rectifier wave from

2.10 LCD Display

A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals combined with polarizers. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in color or monochrome. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and seven-segment displays, as in a digital clock. They use the same basic technology, except that arbitrary images are made from a matrix of small pixels, while other displays have larger elements. LCDs can either be normally on (positive) or off (negative), depending on the polarizer arrangement. For example, a character positive LCD with a backlight will have black lettering on a background that is the color of the backlight, and a character negative LCD will have a black background with the letters being of the same color as the backlight. Optical filters are added to white on blue LCDs to give them their characteristic appearance.

Figure 2.18: LCD Display

2.11 Buck Converter

A buck converter (step-down converter) is a DC-to-DC power converter, which steps down voltage from its input to its output. The basic operation of the buck converter has the current in an inductor controlled by two switches. In the idealised converter, all the components are considered to be perfect. Specifically, the switch and the diode have zero voltage drop when on and zero current flow when off, and the inductor has zero series resistance. Further, it is assumed that the input and output voltages do not change over the course of a cycle

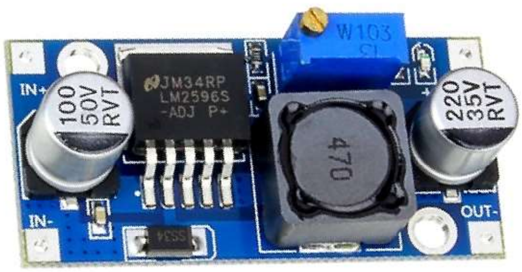

Figure 2.19: DC-DC Buck Converter

CHAPTER 3

DESIGN & FABRICATION

3.1 Introduction

In this Chapter we are going to Explain about the system Design construction through Hardware and development of software. In addition, the chapter elaborates the hardware and the software stage by stage. All the operations of hardware and software are also included in this chapter. The system design of the total project is shown in below Figure3.1 with simple block diagram.

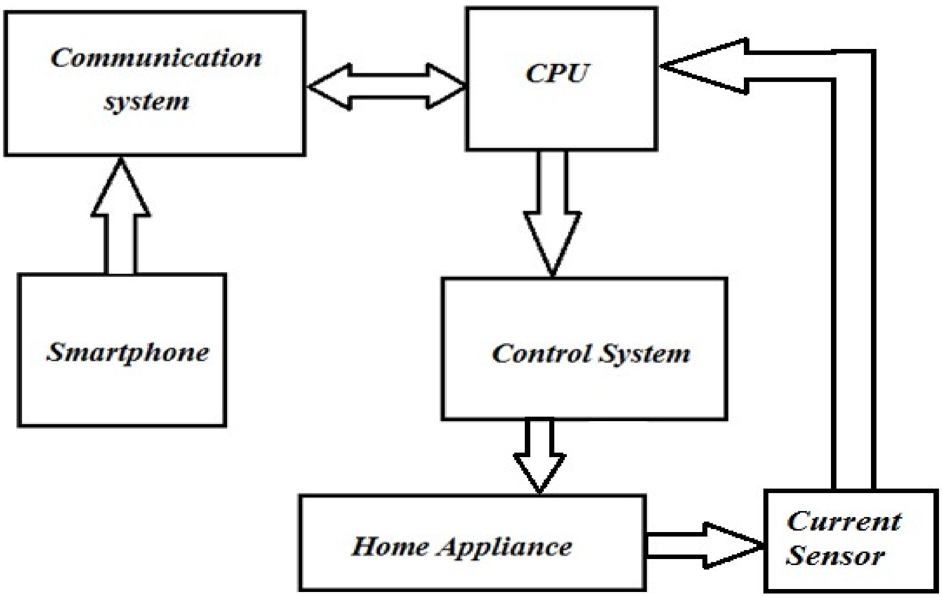

Figure 3.1: Simple Block Diagram

The proposed system uses esp8266 Processor that can process the instructions according to our requirements such as power delivered to appliances and status of devices i.e on state or off state. The control signals generated through Wi-Fi are fed to the microcontroller which will drive the appliances that are connected to ACS712 through energy meter. The same will be displayed on LCD along with the same information will send to web server about number of units consumed in terms of graph. We could able to reduce the consumption of power by switching off through Mobile application that are defined while programming the web server and IDE.

The integration of the modules are producing the system which is more or less can be divided into two phase where the first phase is the output smart Appliance system and the second phase is the monitoring the input signal. Figure 3.2 is shows the separated phase through the boxes. The microcontroller, Data Signal Converter, Relay are in the first phase of the system and Appliance output is the second phase of the system.

The load control and monitoring system can operate maximum four different types of load due to limitation of output number of pin. The Figure 3.3 shows the total Architect of the project in a complete Flowchart.

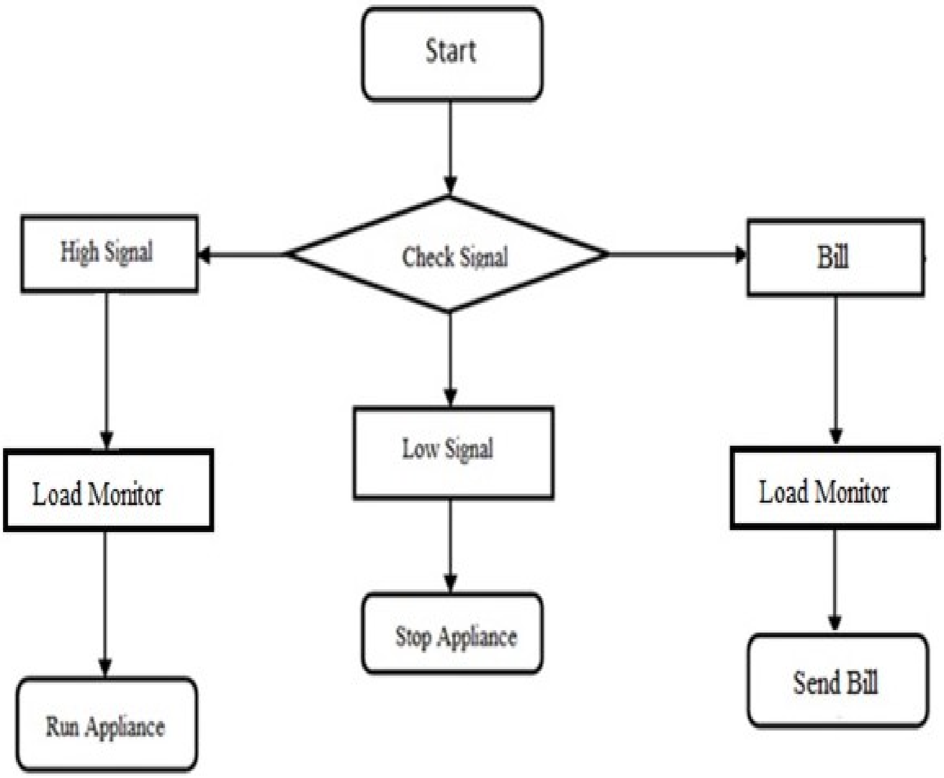

Figure 3.3: Flowchart of the Project.

3.2 System Overview

This system principally monitors electrical parameters of appliances and subsequently calculates the units consumed. As WSN's are having many advantages, here we have designed smart meters predicting the usage of power consumption. However it is low-cost, flexible, and robust system to continuously monitor and control based on consumer requirements, wifi technology for networking and communication, because it has low-power characteristics, which enable it to be widely used in home and building environments.

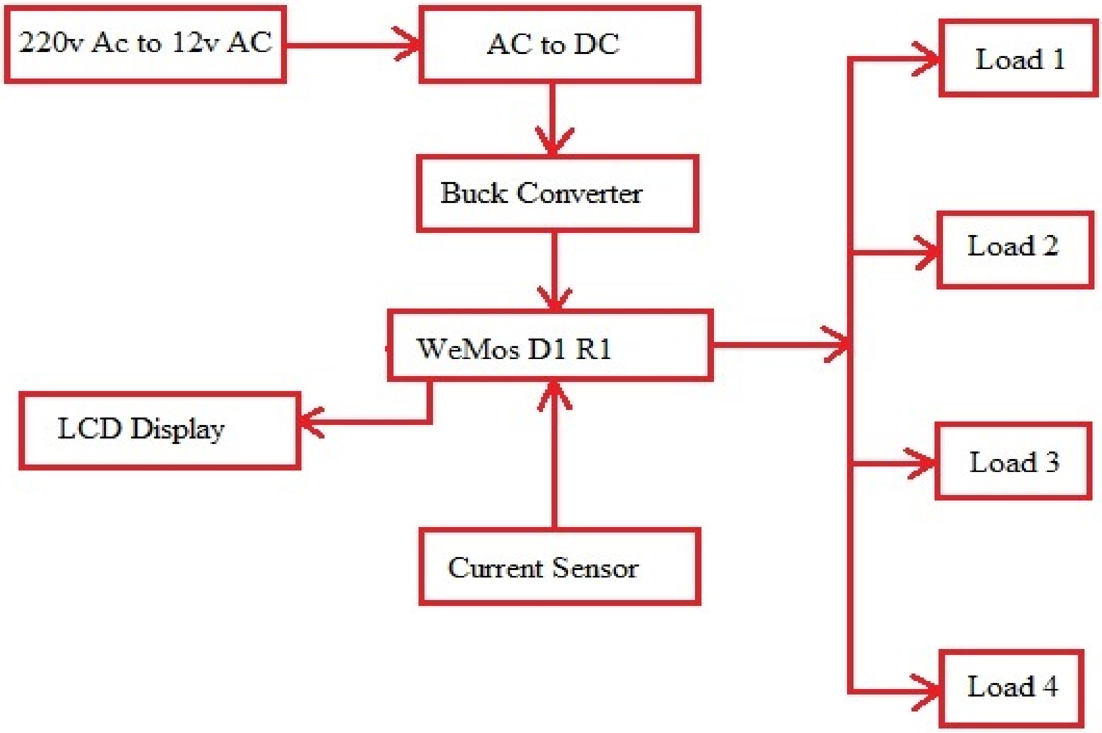

Figure 3.4: Block Diagram

Figure 3.4 describes that the system consists three main parts such as microcontroller, communication& Sensor and appliance control. The esp8266 microcontroller acts as a heart of the System. This esp8266 controls the entire operating system. The entire signal received by the WSN is then judged by the esp8266 and if there any signal from blynk application module then operate the relay for power the home appliance. There are a current sensor which monitor the current passing through it and sent the current reading to microcontroller. Microcontroller calculate the power consumption and cost and displaying it to LCD.

3.3 Operation using Arduino IDE

According to Flowchart the operation is clear that is works when data signal comes from receiver. The Microcontroller always monitors the signal comes from the blynk application. Once this code is uploading then we can check the transmitted and received signal through our computer monitor using serial monitor the process is given below

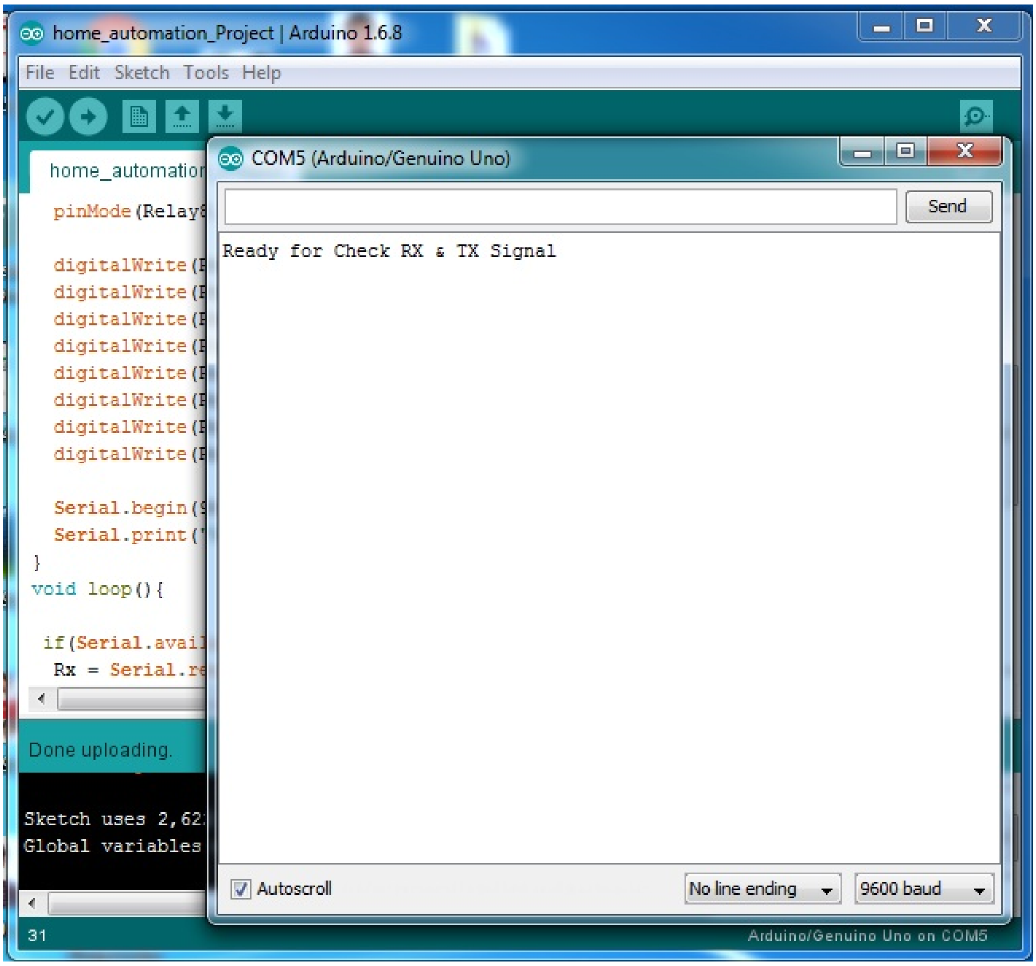

Figure 3.6: data signal check using Serial Monitor

Once the serial monitor display's "Ready for Check RX & TX Signal" then the controller is ready to transmit and receive the data signal. By input any data signal command such as ON1, ON2, ON3, ON4, after sending this data serial monitor display the associated relay is activated or deactivated.

3.4 Software Configuration

Programming software of this line follower is known as ARDUINO-IDE .This is open source programming platform. The open-source ARDUINO environment makes it easy to write code and upload it to the input/output board. Here we use ARDUINO-1.8.1 platform. To configure software we have to use ARDUINO IDE named arduino.exe To configure this programmer with computer we need a USB cable then check serial port and select the programmer from IDE platform such as,

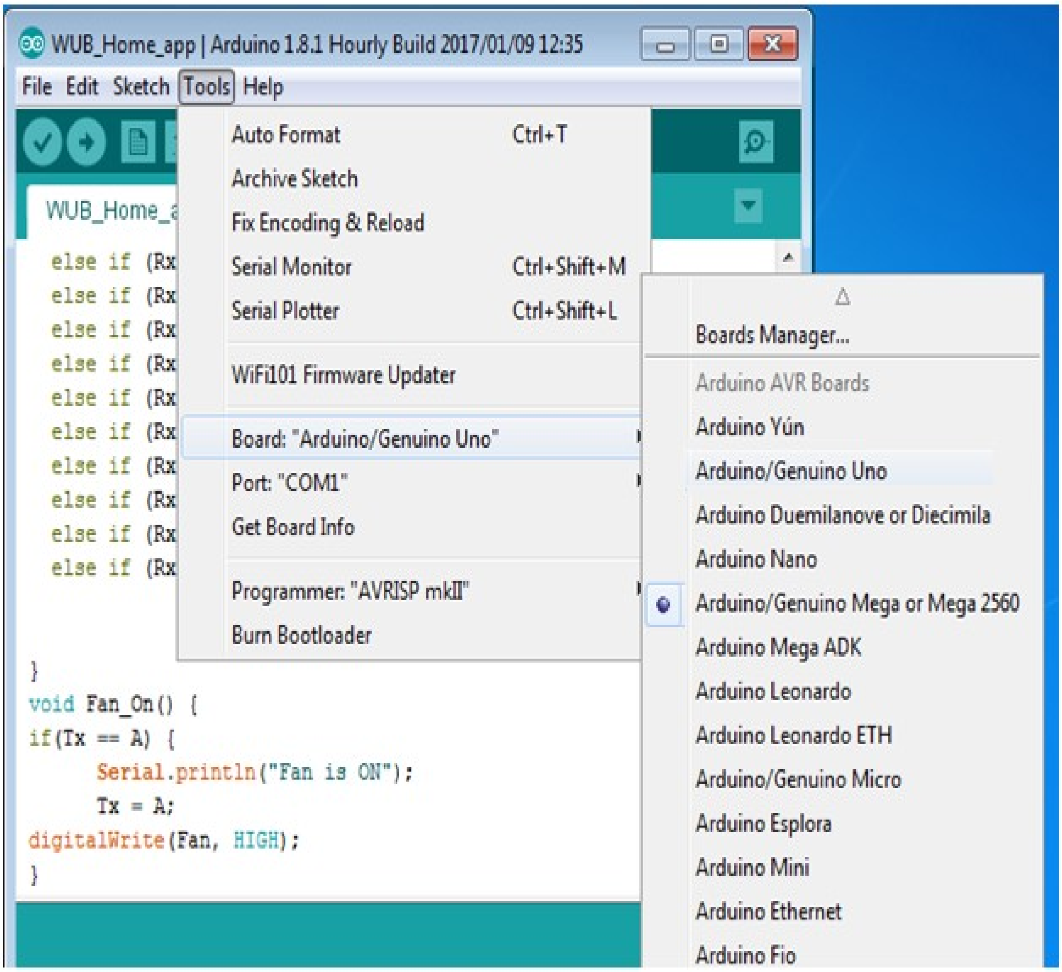

Figure 3.8: IDE Board Selection Menu

After complete configuration IDE is ready for programming. At finally upload main program to new ATMEGA2560 using IDE

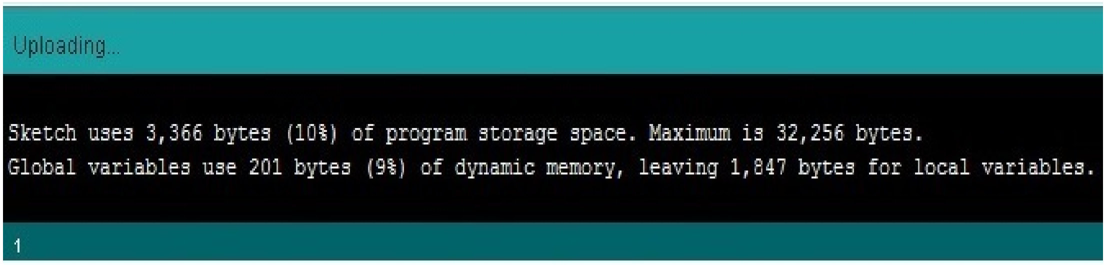

Figure 3.9: Uploading the program

When microcontroller will programmed properly a confirmation message will be show, which looks like,

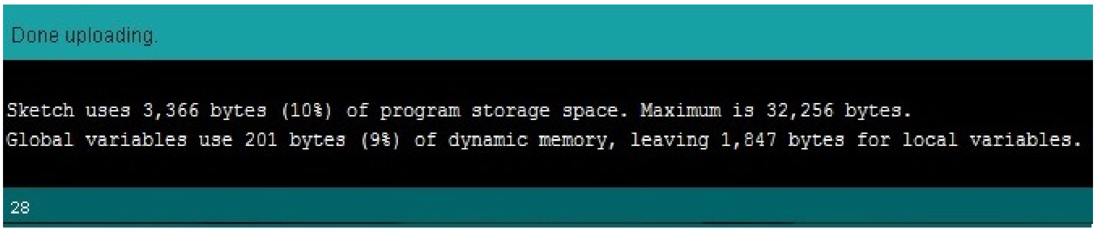

Figure 3.10: Message for upload complete

Now our WeMos D1 R1 is ready to use.

3.5 Circuit Diagram

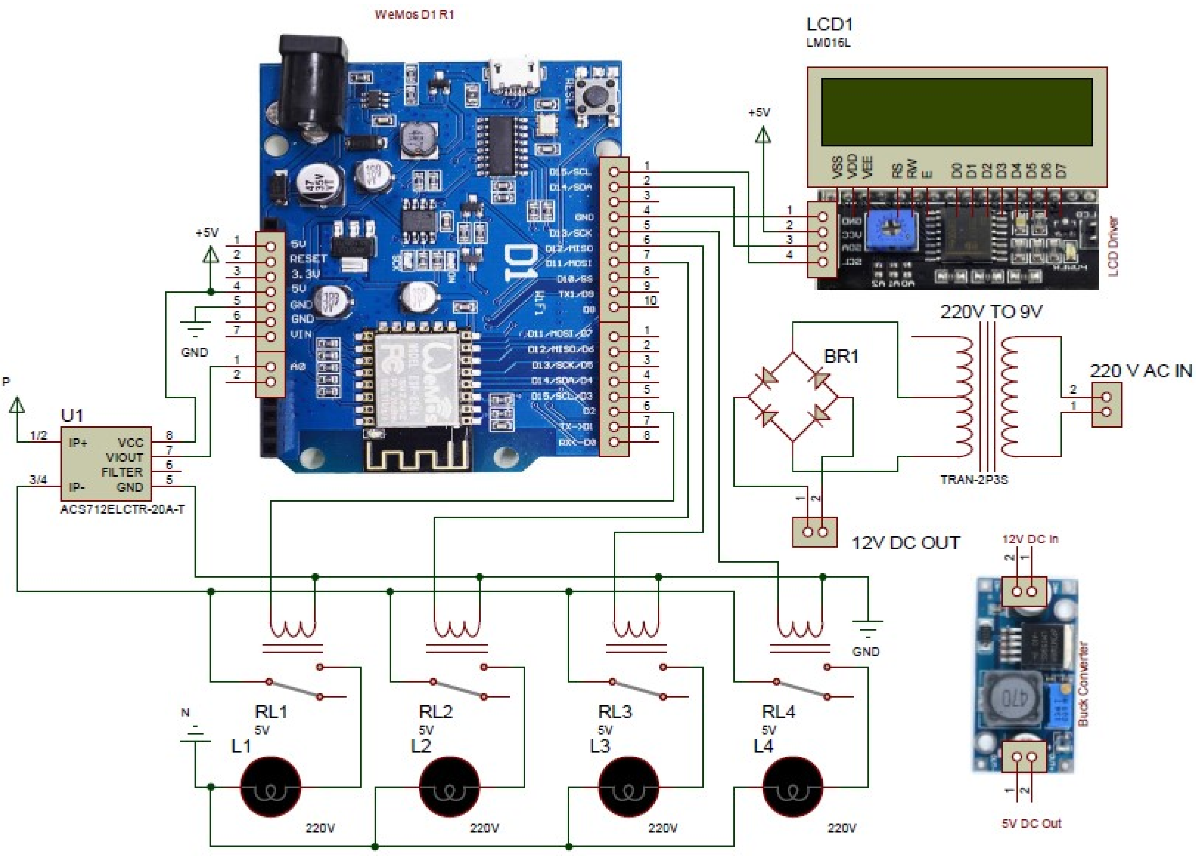

Figure 3.11: Circuit Diagram of the Project

3.6 Summarization

In this chapter all hardware and software configuration and implementation and simulation are explained properly. ARDUINO IDE is an open source platform so clear concept is necessary to work with ARDUINO IDE and ESP 8266. After study this chapter concept will be clear about ARDUINO Mega and project related all other equipment.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

The advancement of the Internet of Things has been emerging day by day. The Internet of things (IoT) revolves connection between M2M that embedded with electronics, software, sensors, actuators that assist users in monitoring and controlling devices remotely and efficiently. In the IoT based energy meter being are provided with unique identifiers with the ability to transfer data. The area of IoT has amplified from the convergence of wireless technologies, micro electro mechanical systems and the Internet.

4.2 Output Results

Output system consists of AC Load which are connected to relay for switching high voltage. Microcontroller cannot operate ac output directly but it is possible to operate high voltage using relay and a relay can be operate by our microcontroller. When Microcontroller get on signal from blynk application then it gives voltage to relay and then relay start passing the ac current and when it receive off signal from controller it stop switching AC current. When any load is connected then its consumed power and cost for consumption will display at LCD

Figure 4.1; Meter Reading on LCD

4.3 Testing using Mobile Application

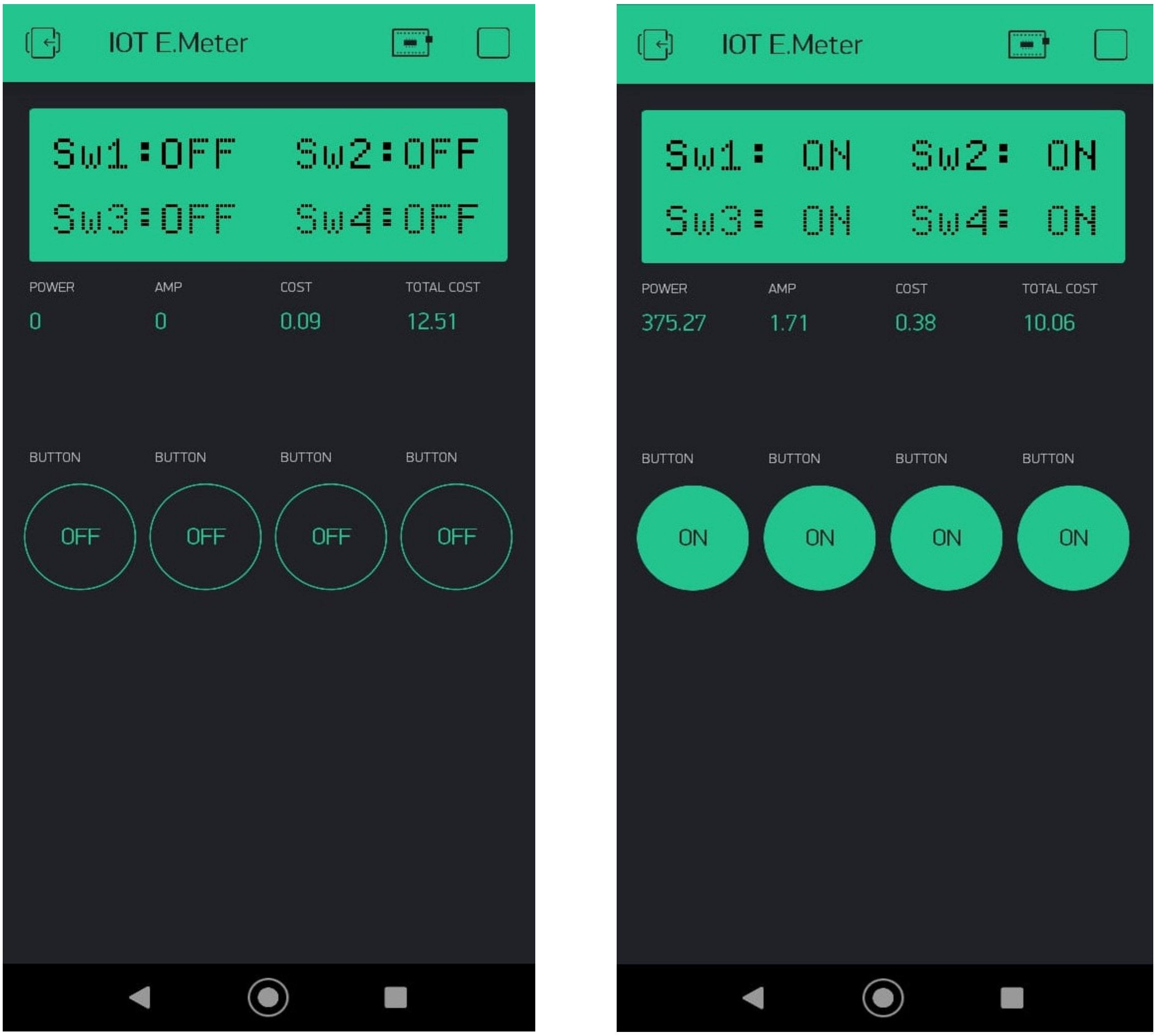

Figure 4.2: Bill Monitoring using Mobile

4.4 Costing

Costing is always a vital issue to make any project. Price of electronics is not stable for a developing country like Bangladesh, because Bangladesh never produces electronics parts but import from other developed country and during import price depends upon the stock of foreign currency. Average price of parts used in this project is given bellow,

Name	Quantity	Unit Price	Total Price
WeMos D1 R1	1	700	700
4 Ch Relay Board	1	300	400
ASC712 Current Sensor	1	180	180
LCD Display	1	150	150
LCD Display Driver	1	160	160
Bulb + Holder + Switch + Plug	1 Set	364	364
Buck Converter	1	150	150
Transformer (12V, 3A)	1	350	350
Cable, Jumper, Circuit Board	1	250	250
Base Board	1	300	300
		TOTAL COST	**3,004/- Taka**

Table 4.1: Price list of hardware used at the system

4.5 Discussion

Energy meter billing is an important part of energy distribution. Each time a person is needed from the authority to collect the reading of meter and create a bill to the consumer. But this created a problem because the manual reading needs manpower, time-consuming and may cause an error. So, smart energy meter comes for providing the facilities of automatic reading of meter and also can detect the meter tempering by sending the message with the help of IOT.

The project has met all the objectives as listed previously. The objective a low cost control system, confirm its presence by purchase controller element from local market. This project was made by WeMos D1 R1 which is based on esp8266. To indicate output there are 4 Light so that we can see the output and it ensure that the module works properly. WeMos D1 R1 output voltage and current is 5V and 40mA respectively but relay module needs 4.5-5V. Each WeMos D1 R1 pin needs to program as demand so it needs Arduino-IDE programming platform. Excellent feature of the project that is ensure human comfort by without changing someone's position. The load control and monitoring system not only reduces risk of electric shock but also ensure human comfort so that it can also be used in industry to ensure human safety.

CHAPTER 5

CONCLUSION

5.1 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 transfer via 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.

5.2 Application

This project can be use both for energy monitoring and load operate at

- Home Appliance such as microwave ovens, light, fan, television, computer, water dispensers, rice cookers etc.
- Industry appliance such as light, fan, air conditioners, security camera, start and stop any motor or generator etc.
- Commercial office appliance such as air conditioners, fan, camera etc.
- Corporate office such as light, fan, air conditioner, Computer, security system, lift, door lock, calling bell etc.
- Educational institute such as light, fan, computer, lab equipment etc.
- Hospital equipment such as dehumidifier, IPS/UPS, operates X-Ray or such type of radiation generated machine etc.

5.3 Advantage

- Easy to install
- To reduce wastage of energy.
- Prevent electricity shortage during dry seasons.
- Make every customer a self-interested guardian of the power (energy) supply.
- Real time bill monitoring

- Time reduced receiving bill.
- Fully automated
- No maintenance cost
- No need to press fire switch
- Ensure Human Safety

5.4 Limitation

- It can work only where the internet connection is available.
- This project can control up to four devices, but cannot control more than that.
- Microcontroller need to program differently if it need to use more appliance

5.6 Future Recommendation

This Load control and monitoring system can be improve by add web server to store load and bill history which may need extra payment to domain server, voice control and camera system also can develop.

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Appendix

Programming of the Project

The program is given below,

```
#include "ACS712.h"

#include <LiquidCrystal_I2C.h>
#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
char auth[] = "tiv5NlXeIHF9Qjdqygc_aiCMggb1fexp";
char ssid[] = "Little Scientist";
char pass[] = "017934097844";
int Load_1 = D2;
int Load_2 = D11;
int Load_3 = D12;
int Load_4 = D13;
BlynkTimer timer;
LiquidCrystal_I2C lcd(0x27, 16, 2);
WidgetLCD iLCD(V0);
ACS712 sensor(ACS712_20A, A0);
float cost;
float unit_price=0.001;
float total;
void setup() {
  Serial.begin(9600);

  // calibrate() method calibrates zero point of sensor,
  // It is not necessary, but may positively affect the accuracy
  // Ensure that no current flows through the sensor at this moment
  // If you are not sure that the current through the sensor will not leak during calibration -
comment out this method
  Serial.println("Calibrating... Ensure that no current flows through the sensor at this
moment");
  sensor.calibrate();
  Serial.println("Done!");
pinMode(Load_1, OUTPUT); //Set the Load_ (D8) as an output
pinMode(Load_2, OUTPUT);
pinMode(Load_3, OUTPUT);
pinMode(Load_4, OUTPUT);
digitalWrite(Load_1, HIGH);
digitalWrite(Load_2, HIGH);
digitalWrite(Load_3, HIGH);
digitalWrite(Load_4, HIGH);

lcd.init();
lcd.backlight();
lcd.clear();
```

```
lcd.setCursor(3, 0);
lcd.print("Smart IOT ");
lcd.setCursor(2 , 1);
lcd.print("Energy Meter");
delay(3000);
lcd.clear();
lcd.setCursor(0 , 1);
lcd.print("Connecting....");
Blynk.begin(auth, ssid, pass);
delay(2500);
//Blynk.virtualWrite(V0,"System Started...");
iLCD.print(0,0, "Connected      ");
lcd.setCursor(0, 1);
lcd.print("Connected      ");
delay(2500);
iLCD.print(0,0, "                    ");
iLCD.print(0,0, "Sw1:OFF");
iLCD.print(9,0, "Sw2:OFF");
iLCD.print(0,1, "Sw3:OFF");
iLCD.print(9,1, "Sw4:OFF");
lcd.clear();
}

void loop() {
  float U = 220;

  //float I = (sensor.getCurrentAC()/2);
float I = sensor.getCurrentAC();

  // To calculate the power we need voltage multiplied by current
 // float P = ((U * I)/2.2);
  float P = (U * I);
  Serial.println(String("I = ") + I + " A");
  Serial.println(String("P = ") + P + " Watts");



if (P<=70){
Blynk.virtualWrite(V2,0);
Blynk.virtualWrite(V1,0);
lcd.setCursor(0, 0);
lcd.print("Cost=");
lcd.print(total);
lcd.print("  ");
lcd.print("TK       ");
lcd.setCursor(0, 1);
lcd.print("P=");
lcd.print("0.00");
//lcd.print(" ");
```

```
lcd.setCursor(7, 1);
lcd.print("W ");
lcd.setCursor(9, 1);
lcd.print("I=");
lcd.print(0.0);
//lcd.print(" ");
lcd.print("A");



}

if (P>=70){
cost=unit_price*P;
Blynk.virtualWrite(V2,I);
Blynk.virtualWrite(V1,P);
//Blynk.virtualWrite(V3,cost);
Serial.println(cost);
total=(cost+total);
Serial.println(total);
Blynk.virtualWrite(V3,cost);
Blynk.virtualWrite(V4,total);

lcd.setCursor(0, 0);
lcd.print("Cost=");
lcd.print(total);
lcd.print("  ");
lcd.print("TK       ");
lcd.setCursor(0, 1);
lcd.print("P=");
lcd.print(P);
//lcd.print(" ");
lcd.setCursor(7, 1);
lcd.print("W ");
lcd.setCursor(9, 1);
lcd.print("I=");
lcd.print(I);
//lcd.print(" ");
lcd.print("A");
}

 Blynk.run();
timer.run();

  delay(1000);
}
```

```
BLYNK_WRITE(V5) {
int pinValue = param.asInt();

if (pinValue == 1) {
//Blynk.virtualWrite(V0,"Load_1 is ON");
iLCD.print(0,0, "Sw1: ON");
//lcd.clear();
//lcd.setCursor(0, 0);
//lcd.print("Sw1: ON");
digitalWrite(Load_1, LOW); // Turn Load_ on.
//delay(2500);
//Blynk.virtualWrite(V0," ");
  }
else {
digitalWrite(Load_1, HIGH); // Turn Load_ off.
//Blynk.virtualWrite(V0,"Load_1 is OFF");
iLCD.print(0,0, "Sw1:OFF");
//lcd.clear();
//lcd.setCursor(0, 0);
//lcd.print("Sw1:OFF");
//delay(2500);
Blynk.virtualWrite(V0," ");}}

BLYNK_WRITE(V6) {
int pinValue = param.asInt();
if (pinValue == 1) {
//Blynk.virtualWrite(V0,"Load_2 is ON");
iLCD.print(9,0, "Sw2: ON");
//lcd.clear();
//lcd.setCursor(9, 0);
//lcd.print("Sw2: ON");
digitalWrite(Load_2, LOW); // Turn Load_ on.
//delay(2500);
//Blynk.virtualWrite(V0," ");
}
else {
digitalWrite(Load_2, HIGH); // Turn Load_ off.
//Blynk.virtualWrite(V0,"Load_2 is OFF");
iLCD.print(9,0, "Sw2:OFF");
//lcd.clear();
//lcd.setCursor(9, 0);
//lcd.print("Sw2:OFF");
//delay(2500);
//Blynk.virtualWrite(V0," ");
}
}
```

```
BLYNK_WRITE(V7) {
int pinValue = param.asInt(); // Assigning incoming value from pin V3 to a variable
if (pinValue == 1) {
digitalWrite(Load_3, LOW); // Turn Load_ on.
//Blynk.virtualWrite(V0,"Load_3 is ON");
//lcd.clear();
iLCD.print(0,1, "Sw3: ON");
//lcd.setCursor(0, 1);
//lcd.print("Sw3: ON");
//delay(2500);
Blynk.virtualWrite(V0," ");}
else {
digitalWrite(Load_3, HIGH); // Turn Load_ off.
//Blynk.virtualWrite(V0,"Load_3 is OFF");
//lcd.clear();
iLCD.print(0,1, "Sw3:OFF");
//lcd.setCursor(0, 1);
//lcd.print("Sw3:OFF");
//delay(2500);
//Blynk.virtualWrite(V0," ");
}}


BLYNK_WRITE(V8) {
int pinValue = param.asInt();
if (pinValue == 1) {
digitalWrite(Load_4, LOW); // Turn Load_ on.
//Blynk.virtualWrite(V0,"Load_4 is ON");
//lcd.clear();
iLCD.print(9,1, "Sw4: ON");
//lcd.setCursor(9, 1);
//lcd.print("Sw4: ON");
//delay(2500);
//Blynk.virtualWrite(V0," ");
}
else {
digitalWrite(Load_4, HIGH); // Turn Load_ off.
//Blynk.virtualWrite(V0,"Load_4 is OFF");
//lcd.clear();
iLCD.print(9,1, "Sw4:OFF");
//lcd.setCursor(9, 1);
//lcd.print("Sw4:OFF");
//delay(2500);

}}
```