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DESIGN AND IMPLEMENTATION OF IoT BASED MONITORING AND CONTROLLING SYSTEM FOR ELECTRICAL LOAD AND RENEWABLE ENERGY SOURCE

by

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DECEMBER 2020

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A project

submitted as partial fulfilment of the requirement for the degree of

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

Department of Electrical and Electronic Engineering

INTERNATIONAL ISLAMIC UNIVERSITY CHITTAGONG

DECEMBER 2020

CERTIFICATE OF APPROVAL

The project entitled as "**DESIGN and IMPLEMENTATION of IoT BASED MONITORING and CONTROLLING SYSTEM for ELECTRICAL LOAD and RENEWABLE ENERGY SOURCE**" submitted by **Md. Mehedi Hasan**, bearing Matric ID. **ET 161070** and **Md. Rakibul Islam**, bearing Matric ID. **ET 161072** of session **Spring 2020**, to the Department of Electrical and Electronic Engineering, International Islamic University Chittagong, has been accepted as satisfactory in partial fulfilment of the requirements for the degree of Bachelor of Science in Engineering and approved for the examination held on **30th December 2020.**

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DECLARATION

It is hereby declared that this work has been done by us and no portion of the work contained in this project has been submitted elsewhere for the award of any degree or diploma.

_____

Md. Mehedi Hasan

_____

Md. Rakibul Islam

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Authors

ABSTRACT

Electricity is an important ingredient for socioeconomic development of a society. In households electricity has an impact on living standard, health, education and so many. IoT is an automated computer system, an Internet-connected entity capable of storing and transmitting data without human interaction through the WIFI network. Bangladesh has energy shortage, but renewable energy, on the other hand has tremendous promise. To satisfy the rising demand for electricity, renewable energy could be a potential solution. Among several renewable sources we integrated foot step energy from piezoelectric sensor and solar energy conversion system to operate the electrical loads. Arduino Nano is used for programming purpose. IOT is implemented to monitor real time energy usage by electrical loads in kilowatt-hour (unit) rating and calculate the cost of consumed energy. By using IOT we can also control the whole system via a website. After the connection of all the components with Arduino Nano , the power is delivered to the Arduino and simultaneously the Wi-Fi module is powered. Then a connection is established between Wi-Fi module and access point through which can upload and access the sensor value over internet. The control taken through the user are send by Arduino Nano and uploaded over the cloud server, then from the cloud server the controller retrieves the data through Wi-Fi module and performs the required action, depending on the control signal provided by the user. Hardware based system has been developed and found the system works well. However, access to it has been difficult in our countries due to different reasons, cost being one of them. This project proposes a low-cost small electrical loads controlling and monitoring system using IoT that can benefit the user . This system have features that we can use for better control and monitor the electrical loads using sensor networks and communications, real time power consumption and pricing reduced operations and management cost , increased the efficiency by saving time and reducing power loss. This project will also expand the deployment of renewable energy sources.

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CHAPTER 1

INTRODUCTION

1.1 Introduction:

The Internet of Things (IoT) is an automated computer system, an Internet-connected entity capable of storing and transmitting data without human interaction through the wifi network.

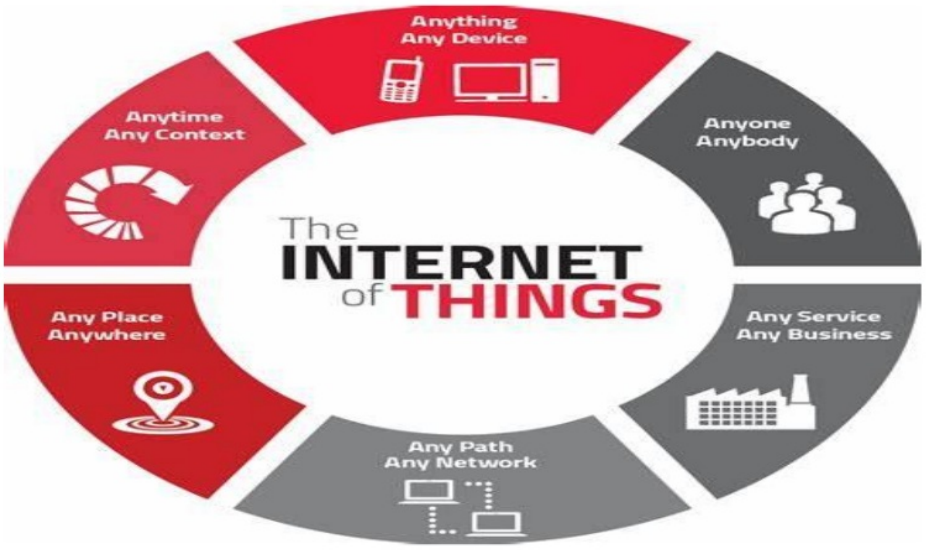

Fig 1.1 The Internet of things [1]

In addition to internet access, most recent digital and smart manufacturing developments and architecture advances emerge from the Internet of Things (IOT) to become a groundbreaking technology in the transformation of many areas of modern living. While IOT was introduced in the sense of supply chain management, it has developed into a wide range of applications such as transport, utilities, healthcare , industrial automation, construction and home automation, etc. Via IOT, smart communication with existing networks results in omnipresent, computer-sense knowledge without the assistance of human interference. Internal Things is an evolving internet-connected paradigm that

enables physical objects or things to link, interact, and communicate with each other, similar to how humans in today's world talk through the web. It links structures, sensors, And actuator software for the wider internet. Accessible in a wide variety of applications, such as energy systems, households, factories, towns, logistics, healthcare, agriculture, etc. It consists of IOT modules with distinctive names that are capable of executing tasks of remote sensing, tracking and actuation. These devices are able to communicate directly or indirectly with each other, and data collection is often carried out locally or remotely through centralized services or cloud-based applications. It is a global network on which internet protocols interconnect devices, sensors and actuators. Remember, for example, the figure below, where a computer interacts over the internet with a system consisting of a sensor. In those situations, the TCP/IP protocol is used as an internet protocol.

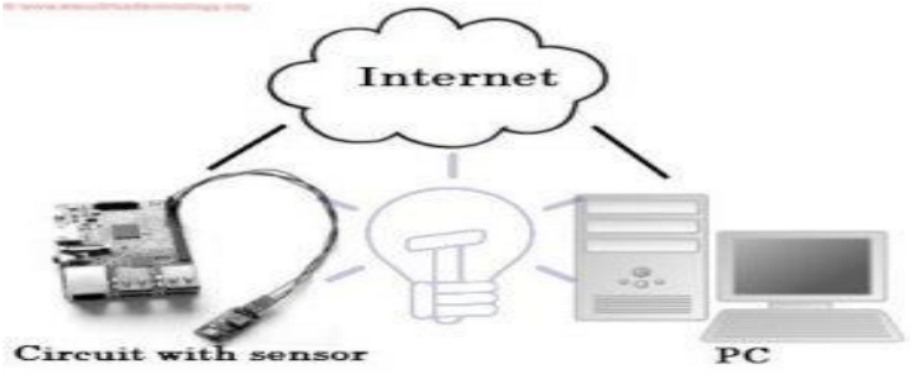

Fig. 1.2 PC and Sensor connected by IoT [1]

Without effective utilization of electricity, it is virtually difficult to eliminate power losses, ensure proper billing, and please consumers. In today's world, users of electricity are calling for improved customer support, high energy calculation precision and accurate results. Now days people are very busy and they want everything to be done by automated without the physical activity. IoT based monitoring and controlling technology could be the possible solution for the future world. In this report an IoT based monitoring and controlling system for electrical loads and renewable energy system has proposed by which a user can easily monitor and control any electrical loads . By using this system an user can easily know how much energy consumed by the loads and the real time costing of that consumed energy.

1.2 Applications of Internet of Things:

- Smart lighting by adaptation of switching based on environmental conditions.
- Wireless and internet-connected lights for Online applications and smartphone apps.
- Managing and managing smart appliances.
- Intrusion detection systems, warning devices and applications for monitoring.
- Protection devices such as identification of smoke and fumes.
- Control of home entertainment, such as recording, audio and projectors.

1.3 IT companies disrupting the energy market:

IT-based technologies that are absent from conventional power plants. This new approaches pave the way for new entrants who have not historically been connected to the energy grid. Technology firms are challenging conventional players in the energy industry in many ways. Because of micro grids, they are designing complex delivery networks to accommodate the more decentralized generation of electricity. In addition, the growth of data gathering offers many new opportunities for technology firms, such as the implementation of user-level transmission sensors and the balancing of device reserves.

Micro grid infrastructure makes residential electricity usage cheaper than purchasing from utilities. In addition, with the link to smart meters, citizens may control their electricity usage more effectively and more efficiently. [4] Nevertheless, the efficiency and stability of micro grids greatly depends on the continuous relationship between the requirements for power production, storage and load. [3] A hybrid offering integrating renewable energy sources with energy sources such as coal and gas storage demonstrates

1.4 Technical Challenges:

A small power plant faces a number of technological challenges, some of the largest being the growth, installation, and deployment of the array of different technology needed to allow cost-effective contact between both sides of the meter. One of the most noticeable changes that an embedded device faces. This method aims to organize consumer equipment, collect demand feedback and adjust household use based on a mixture of this knowledge and consumer expectations.

1.5 Motivation:

Bangladesh has energy shortage, but clean energy, on the other hand has tremendous promise. To satisfy the rising demand for electricity, our system could be a potential solution. As it can track, quantify and transmit energy automatically as per load requirements and at the same time reduce the failure of the device. By using IoT tall the electrical loads in a system can be control over a website that saves the time and reduce the maintenance cost.

1.6 Project Objectives

The objectives of this project are given below:

- To design and implement an IoT based monitoring and controlling system.
- To generate power using renewable energy source.
- To record demand management based on IoT.

1.7 Report Outline

During the design and development of this project, six chapters were covered. The following are the chapters and their contents:

- Chapter 1 is the introductory chapter that provides the outline, inspiration and goals of the project.
- Chapter 2 is an overview of literature. In this section, previous work related to this project has been addressed.
- Chapter 3 is the concept of hardware. All the components used in this project have been elaborately defined in this chapter.
- Chapter 4 is the project's device architecture. Circuit diagram, Flow map and Project Programming have been discussed in this chapter Block diagram.
- Chapter 5 is the design and outcomes of the system, Analytical verification and specification of the system.
- Chapter 6 is the summary of the project. The limitations of the project, advantages, applications and future progress were addressed.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction:

This chapter contains the background and some review of the previous works.

In today's world electricity is the most important for our living. We cannot live without the electricity in this world. For the generation of electricity there are many source available but all the source are not environment friendly and some of the source are limited and will be end in upcoming decade. But on the other hand renewable energy source is unlimited and environment friendly. Almost every country in this world has energy shortage if we can use the renewable sources to generate electricity and properly maintain the loads then this source of energy will be the possible solution for the energy crisis. In today's world we usually control the electrical loads by manually, there are many risk of accidents in this method and it is also time consuming and costly. If we use IoT system to monitor and control the electrical loads then it will be very easy for the user to control the loads easily by only a touch in the website or in an android phone. User can also monitor the consumed energy of the electrical loads in any computer or in any android device which was not possible in the conventional technology.

In Section 2, a detailed analysis of relevant research is addressed. The device model highlighting the main sections of the system is demonstrated in section 3. Along with the functional circuit diagram, Section 4 represents the experimental configuration. The consequences and discussion are contained in Section 5. Finally, this paper ends with Section 6.

Several academic projects have been carried out over the last decade and major advances have been made in the Internet of Things (IoT) technologies linked to infrastructure in the power sector. This summarizes a variety of related studies carried out on IoT technologies. The smart metering system has also been applied internationally for grid power assessment and household energy billing schemes, according to IoT technologies. Many of the programs model the design of the proposed structure in the power field. This suggested method gives ample information to the user at a remote position to assess the condition and current volume of oil in the transformer & oil circuit breaker (OCB). An

warning message with what corrective steps to be taken would be sent to the operator in any troubling situation. This device also helps the user to operate the circuit breaker and to adjust the operation of the relay plug/transformer tap.

2.2 Review of Some Previous Works:

Few of the previous work based on IoT Based Monitoring and Controlling System for Electrical Load and Renewable Energy Source has described below:

2.2.1 A smart IoT based system for monitoring and controlling the sub-station equipment electrical load:

Online surveillance and supervision of substation installations is an important topic for the power management department, which is usually accomplished manually or using expensive PLC and SCADA equipment. A smart surveillance and efficient control system for the whole sub-station equipment is highly desirable with the advent of the internet and computing age, by incorporating the Internet of Things (IoT) technology it can be accomplished . The IoT is a network of physical devices that are combined with hardware, applications, sensors, actuators and network communication that can locate, capture and share data. Via its embedded computer system, each item is individually recognizable and capable of interoperating within the current internet infrastructure. This paper recommended an IoT-based network approach to track and automate the equipment of the sub-station so that time and energy can be handled as effectively as possible. The IoT based framework enables objects to be remotely sensed or managed through current networks, providing opportunities to incorporate the real environment more deeply with computer-based systems, resulting in increased performance, precision and economic gain, with the added advantage of minimal human interference. In addition, a prototype method for evaluating the feasibility of the new model has been introduced and evaluated.

2.2.2 IoT Based Monitoring and controlling system for home automation:

The project recommends that the IOT (Internet of Things) used for tracking and managing home equipment be successfully introduced through the World Wide Web. The portable equipment is used by the home control system as a user interface. By means of Zigbee, Wi-Fi, etc which are low power networking service., home automation network can connect to zigbee and wi-fi through an Internet gateway. The main objectives of this project is to use Wi-Fi as a way of networking protocol and to monitor home appliances via smartphone or computer raspberry pi is used as a server device. Home appliances such as door lock , light and fan are operated without physical contact through simple website. An additional aspect that improves the facet of fireplace accident security is the potential to smoke the smoke in order to associate a warning message and a photo to the mobile in the case of every fireplace.

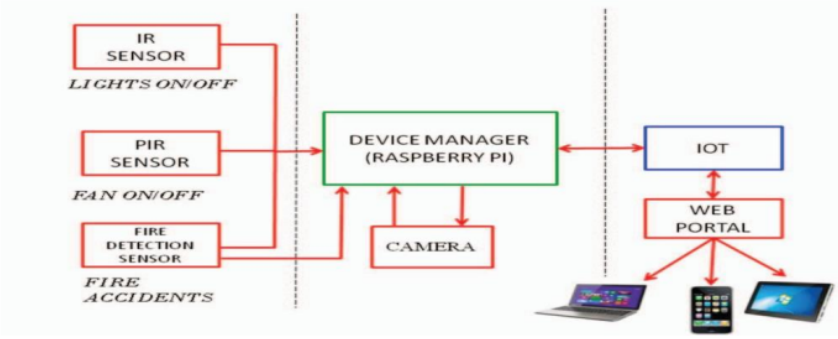

Fig 2.1 Architecture of proposed solution [37]

Server connectivity helps the user to choose the appropriate device. Contact with the server helps the user to choose the appropriate computer. The server connects with the relays that correlate. The embedded system board can also handle and run the equipment domestically if the web membership is down or the server is not up. We deliver a climbable and cost-effective Home Automation system via this. We can monitor home appliances by the use of this program. This has been applied in different areas, such as the Internet, the power switch and the graphical user interface (GUI). We can mitigate the expense of using phones and tablets. The device is ideal for operating equipment remotely. Here, using arduino and Internet of Things technologies, we have presented

the case of home control and security system exploitation. The device is ideal for tracking and managing home appliances for real-time home security. The different potential technologies will be used by internet monitoring of different household equipment, internet industrial automation and administration, machine-driven fireplace escape systems and enhancement of security issues in highly small areas.

2.2.3 IoT based real time energy monitoring system using Raspberry Pi :

This work is on IoT-based real time energy management system for the regulation and monitoring of the switchgear industry. Because of the reduced cost and very highly efficient technologies for tracking the energy usage of the business, Raspberry Pi was chosen for this function. With the Node.js programming language, the Raspberry Pi is used to gather data from current industry energy meters and store it locally, to be accessed from a laptop or cell phone via Grafana. It is considered that the tracking system is valuable for the industry to understand the day-to-day energy habits that are important to promote energy saving efforts to reduce energy usage.

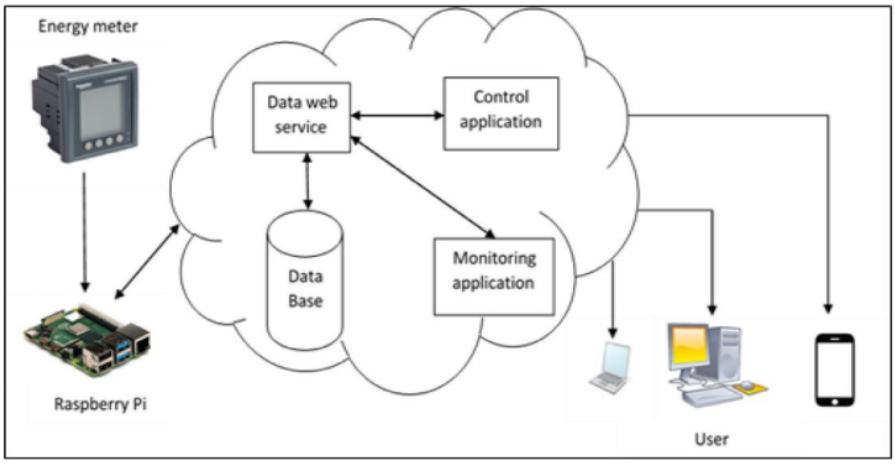

Fig 2.2 Proposed concept [36]

For a panel production firm, energy management system has been developed and introduced that is based on raspberry pi. The company creates panels for High Tension (HT) and Low Tension (LT). The company's average electrical capability is 22 kW. The business runs for eight (8) hours a day, with a 30-minute to one-hour lunch break. Various electrical and mechanical systems and the company's electricity utilization.

System design:

This mentioned IoT-operated energy management system consists of the industry's latest energy meters, Cloud (Data Base, Data Web Service, Control Program, Monitoring Application), raspberry pi and tablets, handheld computers, desktops, etc are used for display system.

CHAPTER 3

HARDWARE DESCRIPTION

3.1 Introduction

This chapter contains the all equipment details, equipment figure and equipment pin diagram of the project.

3.2 Arduino Nano:

Arduino nano is a tech, initiative and developer community open-source organization developing and manufacturer of single-board microcontrollers and digital interface construction kits. The GNU Lesser General Public License(LGPL) or GNU General Public License(GPL) of its products[1], permits all of them arduino boards and apps to be developed as well as commercialised. We can found the arduino boards are on the market in pre configured form or as DIY kits.

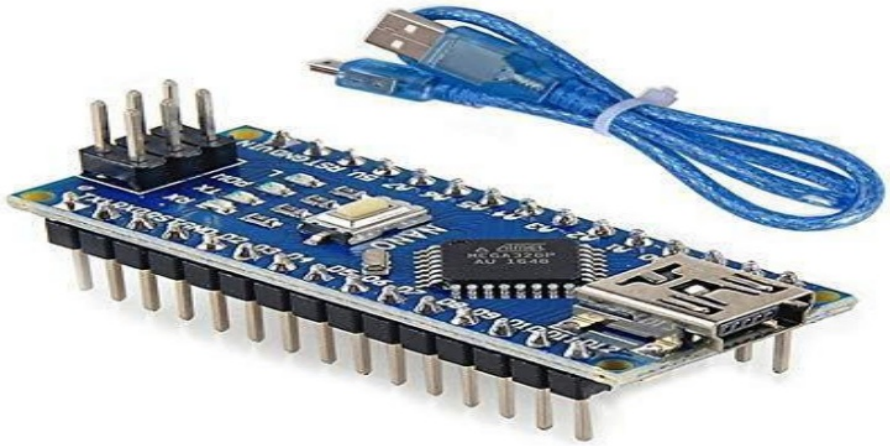

Figure 3.1 Arduino Nano [2]

Number of microprocessors and controllers used during the design of arduino board. Inbuilt input/output (I/O) optical and analog pin-sets that can be wired as various additional boards or breadboards and other circuits also available in arduino boards.

The board has serial communications interfaces , including Universal Serial Bus (USB), which is also used to load program is available in some versions . The C and C++ programming languages are used to program micro controllers. To utilize traditional compiler tool chains, the arduino provides an integrated development system (IDE) focused on the Computing language architecture. In 2005 arduino project started as a student program at the Ivrea Interaction Design Institute in Ivrea, Italy[2] for amateurs and professionals to use sensors and actuators to create devices and applications with their surroundings in a very low-cost and fast way. Easy robots, thermostats and motion detectors are typical types of such devices designed for amateur hobbies.

3.2.1 Input and Output:

Using pin Mode(), digital Write(), and digital Read() keys we can use14 digital pins on the Nano as an input or output. 5 volts is the operating voltage. Arduino pins can supply or receive a maximum of 40 mA current and 20-50 KOhms pull-up resistor that has in the Arduino. And also there is some pins that have specialist functions:

- Serial pin : Serial: 0 (RX) and 1 (TX). Used while receiving (RX) and transmitting (TX) serial TTL files. The corresponding pins of the FTDI USB-to-TTL Serial chip are wired to these pins.
- Outside Interrupts: 2 and 3. These pins may be programmed to cause a low value interrupt, an edge rising or dropping, or a value update. For info, see the Interrupt() connect function.
- PWM pin : 3,5,6,9,10,11 no. pin provide the analog Write() feature with an 8-bit PWM display. SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (MISO), 13 (MIS) (SCK).

- LED pin : Thirteen. A built-in LED connected to digital pin 13 is available. The Lead is on when the pin is HIGH, and when the pin is LOW, it is off.

8 analog inputs is available in the arduino nano, each one having a resolution of 10 bits (i.e. 1024 different values). They quantify ground to 5 volts by default, but it is possible to use the analog Reference feature to adjust the upper end of their range. It is not practical to use analog pins 6 and 7 as optical pins. Furthermore, some pins have specialized functions.

A couple of other pins are on the board:

- From AREF. Voltage of reference for the analog inputs. Used for analog guide Reference ().
- Reset. Set. To reset the microcontroller, drop this line to LOW. Usually, a reset button is applied to shields that obstruct the one on the monitor.

Communication:

Arduino Nano can communicate with a computer, another arduino or other microcontrollers via a number of facilities. ATmega328 provides serial UART TTL (5V), available on 0 (RX) and 1 (1) optical pins (TX). Into the FTDI FT232RL monitor a serial USB connectivity is channeled, and the FTDI drivers that provide a virtual com connection to the system on the device. In the arduino program, a serial display is included that enables the transfer of simple data to the board and from the board. Both LEDs on the board will flash as information is transmitted through the FTDI chip and the USB connection to the computer except for serial communication on pins 0 and 1. serial networking is provide by the SIL(Serial Interface Library)on all of the Nano's digital pins. The ATmega328 also enables I2C (TWI) and SPI communication. A Wire Library is provided by the arduino software to ease the use of the I2C bus.

Programming :

The Arduino software is usually use for the programming of arduino nano. From the Tools > Board menu, pick 'Arduino Duemilanove or Nano w/ ATmega328' (according to the microcontroller on your board). Pre-burned with a bootloader, by using the ATmega328 , we can upload a new firmware on the arduino nano without the need of an external hardware programmer. It communicates using the original protocol of the STK500. The bootloader can also be bypassed and the microcontroller programmed using Arduino ISP.

Automatic (Software) Reset :

The Arduino Nano can be reset before uploading by software running on a connected computer instead of requiring a manual press of the reset button because of its unique design. One of the hardware flow control lines (DTR) of the FT232RL is attached by a 100 nano farad capacitor to the ATmega328 reset string. The reset line drops long enough to reset the chip while this line is claimed (taken low). This feature is used by the arduino

program to allow you to upload code by simply pressing the upload button in the arduino setting. This suggests that there will be a shorter timeout for the boot loader, since the DTR reduction will be well synchronized with the start of the upload .There are other consequences of this setup. When the Nano is attached to either a Mac OS X or Linux device, it resets each time a program connection is made to it (via USB). The boot loader works on the Nano for the next half-second or so. Although it is designed to ignore abnormal data (i.e. something but downloading new code), after opening a link, the first few bytes of data sent to the board can be intercept by it. When a sketch active on the board take in one-time initialization or other data when it first begins, make sure that after opening the link and before transmitting this data, the program with which it interacts waits a second.

Table 3.1 Arduino Specification

Microcontroller	ATmega328
Architecture	AVR
Operating Voltage	5 V
Flash Memory	32 KB of which 2 KB used by boot loader
SRAM	2 KB
Clock Speed	16 MHz
Analog IN Pins	8
EEPROM	1 KB
DC Current per I/O Pins	40 mA (I/O Pins)
Input Voltage	7-12 V
Digital I/O Pins	22 (6 of which are PWM)

3.3 Current Sensor:

A sensor which senses a wire's electric current and produces a signal commensurate with that current is called current sensor .The produced signal may be the Analog voltage or current or even a digital output. The signal that is generated can be used to show the measured current in an ammeter or stored in the data acquisition system for some further study.

Fig 3.2 Current Sensor [4]

The measured current and the output signal can be as follows:

- AC (Alternating current) input,
  - Analog output, can copy the wave shape of the sensed current.
  - Bipolar output, can copy the wave shape of the sensed current.
  - Unipolar output, that is proportional to the average or RMS value of the sensed current.

- DC (Direct current) input,
  - Unipolar, with a unipolar output, that duplicates the wave shape of the sensed current
  - Digital output, that switches when the sensed current exceeds a certain threshold

3.3.1 Technologies:

- Hall effect sensor
- Transformer or clamp meter of the current (suitable for AC current only).
- The kind of Fluxgate Transformer (suitable for AC or DC current).
- Shunt Resistor, whose voltage across it is directly proportional to the current.
- Rogowski coil, an electronic instrument to calculate alternating current (AC) or pulses of high-speed current.
- Giant Magneto resistance(GMR): Magnetic filed sensor with higher precision than Hall Effect ideal for AC & DC Current. Put parallel to the filament of the magnet.

A type of current sensor based on the Hall Effect is known as Hall effect sensor the hall effect phenomena was found in 1879 by Edwin Hall. Both kinds of current signals (i.e. AC, DC, or pulsating current) can be detected by Hall Effect current sensors. These sensors are currently commonly used. Because of their large applications and the form of production they have in many industries.

Table 3.2 Current Sensor Specifications

VCC	Sensor Measured Watts / Amps	Output Voltage Range
3.3V	2 watts to 3000 watts	.05V to 2.8V
5V	2 watts to 3000 watts	.05V to 4.5V

3.4 KA3525A PWM IC:

The KA3525A is an integrated monolithic circuit that contains all of the control circuits needed for a regulator that modulates pulse duration. In the KA3525A a voltage reference, an error amplifier, a modulator for pulse duration, an oscillator, an under-voltage lockout, an oscillator, a soft start circuit, and the chip's output driver are available.

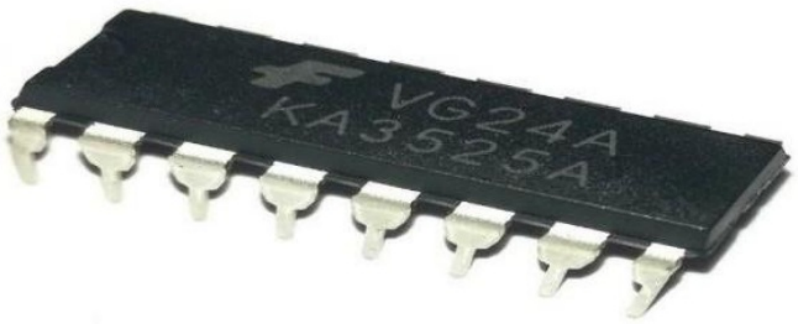

Fig 3.3 PWM IC [5]

Features

- Reference volt 5V ± 1%
- Oscillator Sync terminal
- Internal Soft Start.
- Dead time Control
- Under-Voltage Lockout

3.5 Piezoelectric Sensor :

An instrument that detects changes in friction, acceleration, temperature, strain, or force by translating them to an electrical charge using the piezoelectric effect is called piezoelectric sensor. The prefix piezoelectric is 'press' or 'squeeze' in Greek.

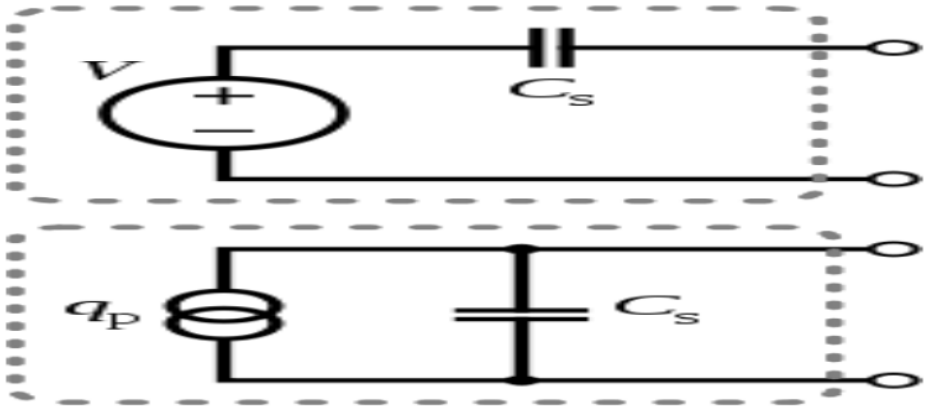

Fig 3.4 Internal diagram of piezoelectric sensor [5]

The DC output impedance of a piezoelectric sensor is very high and can be modelled as a proportional voltage source and filter network. The voltage V at the source is directly proportional to the stress, friction or tension applied.[7] This mechanical force is then correlated with the output signal as if it had gone through the analogous circuit.

The results of the sensor's mechanical structure and other non- idealities contains in a detailed model of piezoelectric sensor.[8] The inductance Lm is due to the seismic mass and inertia of the sensor itself. Ce is inversely proportional to a sensor's mechanical elasticity. transducers static capacitance is C0, arising from an inertial mass of infinite size.[8]

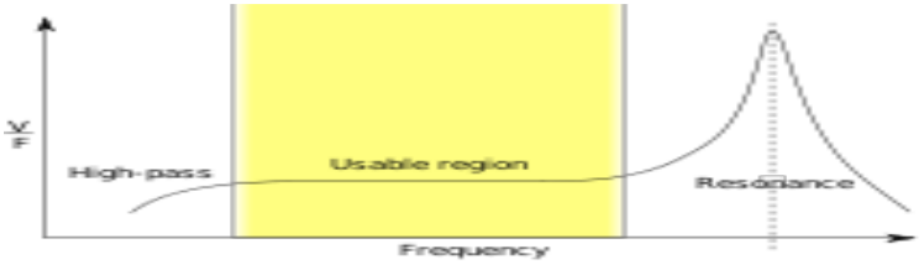

Fig 3.5 Frequency response of a piezoelectric sensor [5]

The results of the sensor's mechanical structure and other non- idealities contains in a detailed model of piezoelectric sensor.[8] The inductance Lm is due to the seismic mass and inertia of the sensor itself. Ce is inversely proportional to a sensor's mechanical elasticity. transducers static capacitance is C0, arising from an inertial mass of infinite size.[8]

Sensor element's insulation leakage resistance is shown by Ri . Ri also works in parallel with the insulation resistance if the sensor is attached to a load resistance, both raising the high-pass cut-off frequency.

The sensor can be modelled in the flat area as a voltage source in series with the load source capacitor in parallel with the capacitance. We need to make sure that the resistance to load and leakage must be high sufficient to ensure that little interest frequencies are not lost. In area which Cs reflects the capacitance of the sensor surface itself, calculated by the standard formula for capacitance of parallel plates, a simpler equivalent circuit model may be used.[8][9]

Piezoelectric sensor may also be modelled as a source of charge parallel to the capacitance of the source, with the charge directly proportional to the force applied, as described above .[7]

Different physical quantities can be determined depending on piezoelectric technology, with pressure and acceleration being the most important. A thin membrane and a large base are used for pressure sensors, meaning that the applied pressure precisely loads the elements in one direction. For accelerometers, the crystal components are bound to a

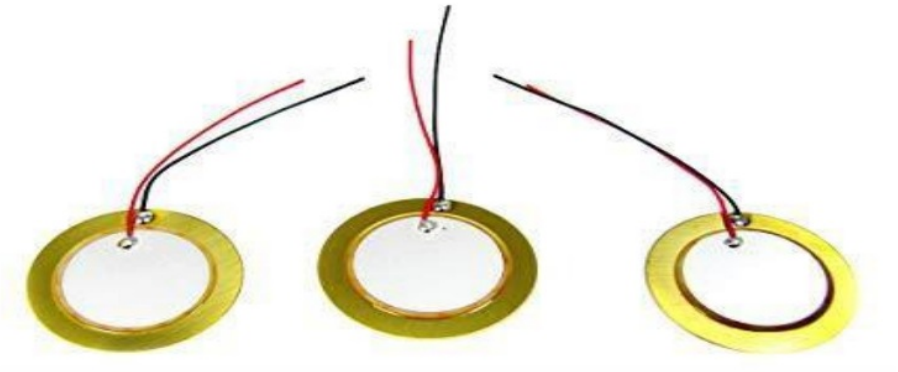

Fig 3.6 Piezoelectric Sensor [6]

seismic mass. When the accelerometer encounters a movement, according to Newton's second law of motion, the invariant seismic mass loads the elements. The key distinction between these two cases in the working theory is the way they apply forces to the sensing components. The force to the components in a pressure sensor passes by a thin membrane, as well as in accelerometers the forces are applied by an attached seismic mass. Sometimes, sensors are more than one physical quantity sensitive. When they are subjected to shocks, pressure sensors display inaccurate signals. In addition to the pressure sensing components, advanced pressure sensors therefore use acceleration correction elements.

By carefully matching those parts, the in order to extract the true pressure information, the acceleration signal (released from the compensation element) is subtracted from the combined pressure and acceleration signal. Mechanical movements may also extract otherwise unused energy from vibration sensors. This is done by transforming mechanical pressure into usable electrical energy using piezoelectric materials .[10]

3.5.1 Application:

For the calculation of different systems, piezoelectric sensors are flexible instruments. In many industries, piezoelectric sensors are used for quality assurance, process management, also it is used for experiment and improvement. Piezoelectric effect was discovered by Pierre Curie in 1880, but the piezoelectric effect begin to be used by manufacturers in industrial sensing applications in 1050s. Piezoelectric effect calculation theory has been gradually used since then, and has become an established technology with outstanding intrinsic reliability.

Range of applications successfully using it , such as medical, aerospace, nuclear instrumentation, and consumer electronics tilt sensors [1] or pressure sensors in cell phone touch pads. The automotive industry using the piezoelectric components to control combustion when designing internal combustion engines. The sensors are either mounted directly into the cylinder head in additional holes or the spark/glow plug is fitted with an integrated piezoelectric miniature sensor. [2]

A collection of inherent advantages are closely related to the rise of piezoelectric technology. In certain piezoelectric compounds, the strong modulus of elasticity is equal to that of many metals and goes up to 106 N/m2. While electromechanical systems that respond to compression are piezoelectric sensors, display shows zero deflection of the sensing element. That's how piezoelectric sensors become rugged, an incredibly high natural frequency and outstanding linearity over a large range of amplitudes.

Furthermore, piezoelectric components is also impervious to electromagnetic fields and radiation and allows calculations under intense conditions. Materials that are used (particularly gallium phosphate or tourmaline) are extremely stable at high temperatures, allowing a operating range of up to 1000 °C for sensors. In addition to the piezoelectric effect, Tourmaline displays pyro electricity; this is the ability to produce an electrical signal as the crystal temperature varies. Piezoelectric ceramic materials also have this influence. This comparison table of characteristics of piezoelectric sensor materials vs. other forms is given by Gautschi in Piezoelectric Sensorics (2002). [3]

3.6 Wi-Fi Module (ESP8266):

ESP8266A offer a full and self-contained Wi-Fi networking system , that allows it to either host the application or unload all Wi-Fi networking capabilities from another application processor. When the program is hosted by ESP8266 and when it is the only application processor on the computer, it can boot directly from an external flash. In order to boost device performance in such applications and to minimize the memory requirements, it has incorporated cache .[13]

Fig 3.7 Wi-fi Module (ESP 8266) [7]

The Wi-Fi Module is a self-contained SOC with an optimized stack of TCP/IP protocols which can provide Wi-Fi network connectivity to any microcontroller. The ESP8266 is capable of either hosting a device or discharging from another application processor all Wi-Fi networking functions. Every ESP8266 module comes with an AT command set firmware pre-programmed, ensuring we can simply attach this to our Arduino computer and get as much Wi-Fi capability as a Wi-Fi Shield provides.

This module is very cost-effective board.. This wifi module is very much capable of efficient on-board processing and storage capability . The high degree of integration of the on-chip that enables limited external circuitry, like the front-end module, a minimal region of the PCB will occupy.

3.6.1 Wi-Fi Module (ESP8266) Pin Configuration:

Table 3.3: Wi-Fi Module (ESP 8266) Pin Configuration

Pin No.	Pin Name	Pin Connection	Pin Features
1	Ground	Connected to the GND pin	
2	TX	Connected to the Rx pin	It is used as a purpose toInput/output pin when not used as TX.
3	GPIO-2	Input/output pin.	
4	CH_EN	Chip Enable – Active high	
5	GPIO-0	Input/output pin.	Direct the module to serial programming when held low during start up
6	Reset	Reset pin.	
7	RX	Input/output pin.	This can act as a general purpose Input/output pin when not used as RX [14]
8	VCC	+3.3V supply	

3.6.2 Wi-Fi Module (ESP8266) Features:

- Cost-effective and lightweight Wi-Fi module
- Supply of power: +3.3V
- Maximum Current : 100mA
- Present source input/output voltage: 3.6V (max) (max)
- Deep sleep support (<10uA) supports

3.7 Liquid-crystal display (LCD):

A display which is flat panel or other electronically modulated optical device that uses the light-modulating characteristics of liquid crystals in combination with polarizers is known as a liquid-crystal display (LCD. Light directly can not be emit by LCD.[1] For viewing random images or fixed images with low detail material that can be shown or obscured LCD's are capable, for example preset words, numbers, and 7 segment displays, as in a digital clock.

Except that arbitrary images are created from a matrix of tiny pixels, they use the same simple hardware, whereas other displays have bigger components. Depending on the polarizer configuration, LCDs will usually be either on (positive) or off (negative). For example, on a backdrop that is the color of the backlight, a character positive LCD with a backlight will have black lettering and a character negative LCD will have a black background with the letters having the same color as the backlight. Optical filters on blue LCDs are applied to white to give them their distinctive look .[12]

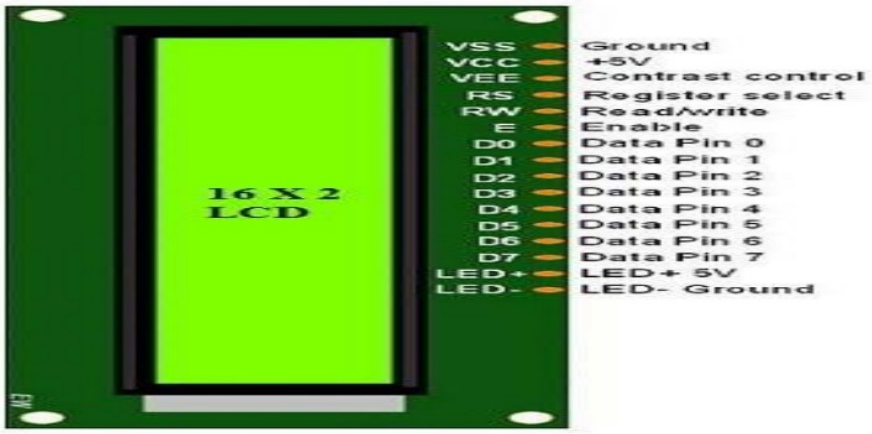

Fig 3.8 LCD Display [8]

LCDs are used for wide variety of applications, including LCD Tv , computer monitors, instrument screens and indoor and outdoor signage etc. LCD's are also used in digital cameras, clocks, calculators, and mobile telephones, including smartphones, small LCD

screens are popular. Sometimes also LCD's are used in DVD players, video game consoles and clocks. In almost all applications, heavy, bulky cathode ray tube (CRT) displays are replaced by LCD's .A larger variety of panel sizes than CRT and plasma monitors are available for LCD panels, LCD screens are available in various sizes ranging from small digital watches to very big TV receivers. OLEDs are replacing the LCD's, which is capable of quickly transformed into many shapes and have a response time that is very less, broader color gamut, very close to unlimited color contrast and viewing angles, lower weight and a slimmer profile for a given display size and the consumption of power is theoretically lower (as the display is only "on" where needed and there is no backlight). OLEDs however are more costly for a given display size because of the very costly electroluminescent materials or phosphors they use. OLEDs still suffer from screen burn-in due to the use of phosphors, and there is currently no way to recycle OLED screens, although We can also recycle LCD panels, even though there is still no widespread technology needed to recycle LCDs. Effort to extend the lifetime of LCDs are quantum dot displays that deliver comparable efficiency as an OLED display, but it is not yet practical to recycle the Quantum dot layer that provides these displays with their characteristics[12].

Specifications

- **Resolution** : The LCD's resolution is represented by means the number of pixel columns and rows (e.g., 1024 ⁇ 768). Three sub-pixels red, green, and blue are normally comprised of each pixel. This was one of the few LCD output characteristics that remained uniform across various designs. There are new designs, however, that share sub-pixels between pixels and add quattron to mixed effects, trying to improve a display's perceived resolution effectively without increasing the real resolution.
- **Spatial performance:** Pixels per inch is the term for resolution that is often used for a computer monitor or others display for very close distance, that is compatible with the printing related industry. Density of the monitor varies by use, with televisions which has a low long-distance viewing intensity and portable devices providing a high density for close-range information. Depending on the display and its use, the viewing angle of an LCD can be significant, whereas the drawbacks of some display systems mean that the display only shows correctly at certain angles.

- **Temporary performance:** how well a LCD can view shifting images is called its LCD's temporal resolution, or how precise the data is draws by display and how many times per second. It doesn't matter how low the refresh rate, LCD pixels won't blink on/off between frames, so LCD monitors display no refresh-induced flicker.[140] However a lower refresh rate can mean visual errors such as ghosting or smearing, particularly for fast moving images.
- **Color performance:** There are several words that describe various facets of a display's color performance. The spectrum of colors that can be shown is the color gamut, and the intensity of color, which is the fineness with which the color range is broken. The color spectrum is a reasonably clear feature, but even at the technical level, it is seldom addressed in marketing materials. There are no advantages of providing a color palette that reaches the content seen on the computer, but monitors are only made to function within or beyond the range of a certain standard .[141] In LCD color and color control, there are additional elements, such as white point and gamma correction, which explain what color white is and how the other colors are seen compared to white.
- **Brightness and contrast ratio:** The ratio of a full-on pixel's brightness to a full-off pixel is the contrast ratio. The light emerges from a backlight that is either fluorescent or a series of LEDs; the LCD itself is just a light valve and does not emit light. Brightness is commonly stated as the LCD's maximum light intensity, which can vary considerably depending on the LCD's clarity and the backlight brightness. Generally speaking, brighter is better, but there is still a trade-off between energy consumption and light.

3.8 4x4 KEYPAD Pin Configuration:

There are 4x4 KEYPAD Components available in various sizes and shapes. Yet they do have the same pin setup. By arranging 16 buttons in matrix shape, it is easy to render the 4X4 KEYPAD.

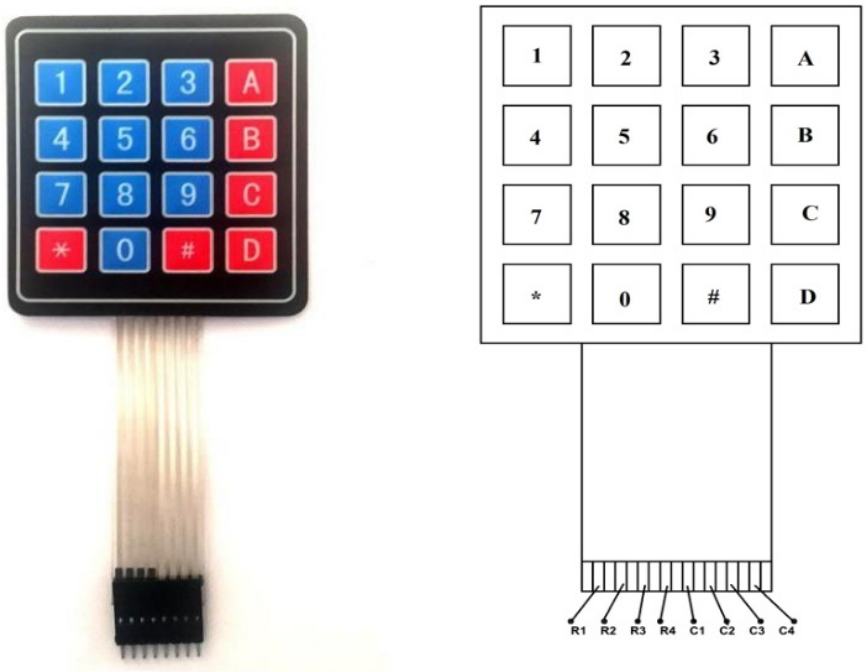

Fig 3.9 4*4 Keypad [9]

Table 3.4 Keypad Pin diagram

Pin Number	Description
1	Pin no. 1 is drawn out from 1st ROW
2	Pin no. 2 is drawn out from 2nd ROW
3	Pin no. 3 is drawn out from 3rd ROW
4	Pin no. 4 is drawn out from 4th ROW
5	Pin no. 5 is drawn out from 1st COLUMN
6	Pin no. 6 is drawn out from 2nd COLUMN
7	Pin no.7 is drawn out from 3rd COLUMN
8	Pin no. 8 is drawn out from 4th COLUMN

3.8.1 4X4 KEYPAD Module Features and Specifications

- Full Voltage in each section or BUTTON: 24V
- 30mA Overall Current through each Section or BUTTON:
- Maximum temperature of operation: 0°C to 50°C
- Ultra-thin interface
- Backing adhesive
- Simple design
- Broad lifetime.

3.9 Relay Switch Circuit:

An electro mechanical systems that control a pair of movable contacts from an open position to a closed position using an electromagnet is called Relay. The advantages of relays is that running the relay coil requires a comparatively limited amount of electricity, but the control generators, heaters, lamps or AC circuits that can consume far more electrical power on their own relay itself can be used. It is an output mechanism (actuator) that comes in a range of shapes, sizes and designs and has numerous electronic circuit applications and uses.

Electrical relays could be used to allow circuits of low power electronic or machine type to switch relatively high currents or both 'ON' or 'OFF' voltages, to regulate it, some kind of relay switch circuit is necessary. The architecture and the variants of relay switching circuits are massive, transistors and MOSFETs are use in many cheap electronic projects as their primary switching system. The relay coil with fast DC switching (ON-OFF) power from a number of input sources are provide by the transistor, so here is some of the most common ways to switch relays.

NPN Relay Switch Circuit:

Depending on the input voltage frequency, a relay switch circuit has the coil powered by an NPN transistor switch TR1 as shown. When the transistor's base voltage is zero (or negative) it acts like an open switch. No collector current flows from collector in this state and the relay coil is de-energized and if no current flows through the Center then no current will flow into the relay coil. The current is flowing from Base to Emitter (B to E) regulates the larger relay coil current flowing through the transistor from the Collector to Emitter if a sufficiently high positive current is now pushed into the Base to saturate the NPN transistor. Total amount of relay coil current that is flowing into the collector is approximately between 50 and 800 times that of the necessary base current to push the transistor into saturation for most bipolar switching transistors.

NPN Relay Switch Circuit:

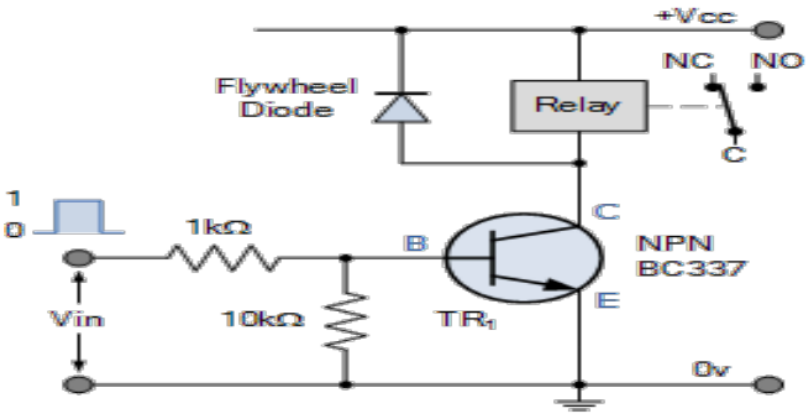

Fig 3.10 NPN relay Switching circuit [10]

We have to also remember that relay coil is an electromagnet but as well as it is also an inducer. As power is added to the coil due to the transistor's switching operation, as a consequence of the coil's DC resistance as described by Ohms Rule, (I = V/R), a maximum current will run. Any of this electrical energy is contained within the magnetic field of the relay coil. The current flowing through the relay coil reduces as the transistor turns "OFF", and the magnetic field collapses. However, when it attempts to sustain the current in the relay coil, the accumulated energy inside the magnetic field must go elsewhere and a reverse voltage is generated around the coil. This behavior creates a high voltage spike through the coil of relays that, if left to build up, will destroy the switching NPN transistor.

Thus, a "flywheel diode," also known as a freewheeling diode, is linked around the relay coil to avoid damage to the semiconductor transistor. The reverse voltage around the coil is clamped to around 0.7V by this flywheel diode, dissipating the stored energy and shielding the switching transistor. Only where the supply is a polarized DC voltage are Flywheel diodes applicable. A different safety system is needed for an AC coil, and an RC snubber circuit is used for this.

3.9.1 NPN Darlington Relay Switch Circuit:

NPN transistor relay transfer circuit is suitable for swapping small loads, such as LEDs and miniature relays. Switching larger relay coils or currents outside the general purpose transistor range of a BC109 is often more important and this can be done using Darlington Transistors.

Two independently linked Bipolar Transistors can be made of Darlington Transistor pairs as shown or available as a single standard device: Foundation, Emitter and Collector connecting leads. As seen, the two NPN transistors are joined such that the first transistor's collector current, TR1, becomes the second transistor's base current, TR2. The flipping transistor, TR2, immediately switches "ON" by applying a positive base current to TR1.

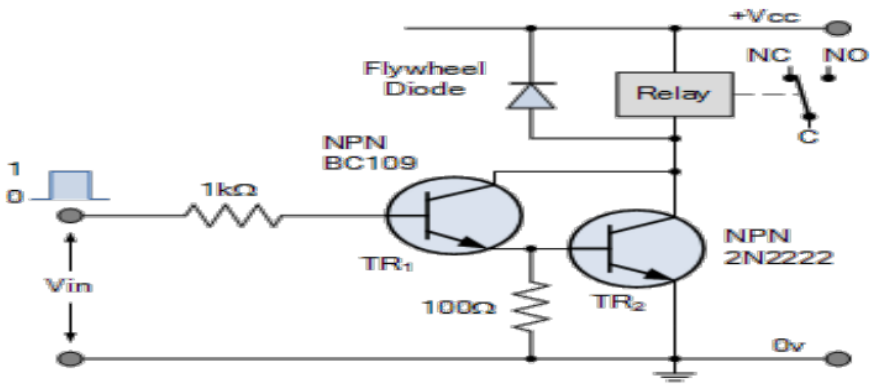

Fig : 3.11 Internal diagram of NPN relay [12]

If we place two independent transistors as a switching pair of Darlington, then a small value resistor (100 to 1000's) is normally mounted between the main switching transistor's base and emitter TR2, to ensure that it switches entirely OFF. To shield TR2 from the produced back emf when de-energized by the relay coil flywheel diode is used.

3.10 MOSFET:

The commonly used semiconductor technology to switch and amplify electrical signals on electronic devices is known as MOSFET. The transistor includes a broad variety of applications and utilizes the transistor. The MOSFET is an integral circuit core and due to these very small sizes, it can be built and manufactured in a single chip. The MOSFET consisted of four terminals with sources(S), gate(G), drain(D) and body(B) connections. MOSFET is a three-terminal field-effect transistor because it is often mounted on the source terminal. The MOSFET can be used in both digital and analog circuits, by far the most common transistor.

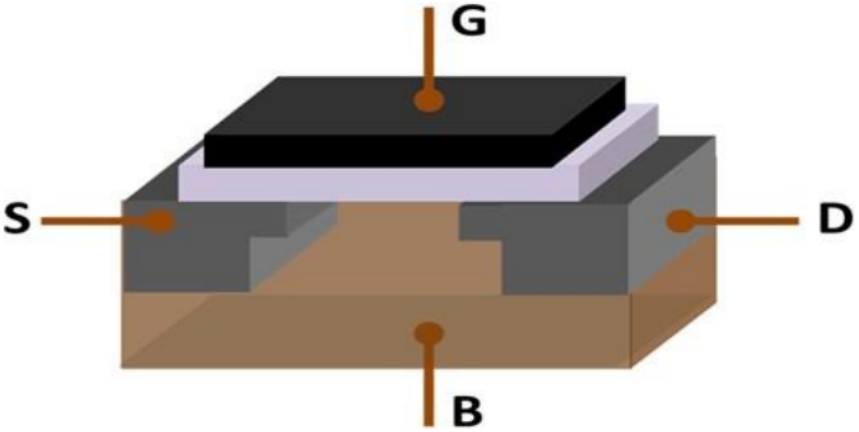

Fig 3.12 MOSFET [13]

The MOSFET acts by electronically adjusting the wideness of a channel from which charge carriers flow. The charging carriers enter the canal at the source and leave through the pipe. An electrode voltage that is known as the gate between the source and the drain handle the channel diameter. It is insulated near the channel by metal oxide layer which is unbelievably thin. The main part is the MOS power existing in the device .

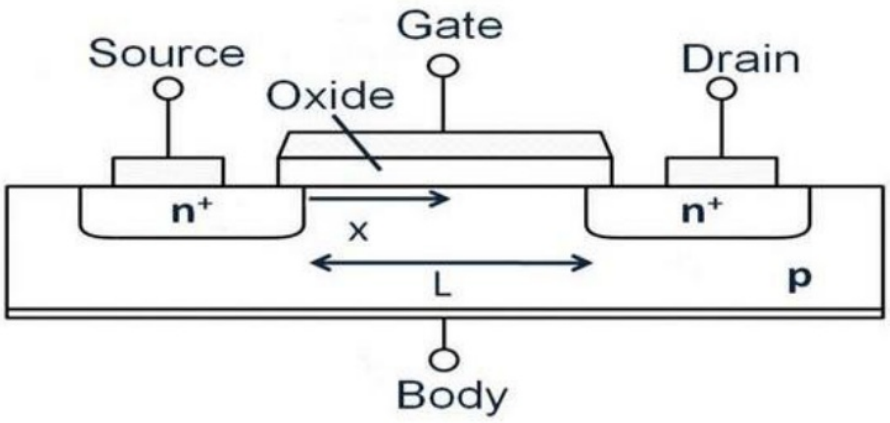

Fig 3.13 MOSFET Body [13]

The MOSFET is two type:

- Depletion Mode
- Enhancement Mode

Depletion Mode:

The full conductance is displayed by the channel whew there is no voltage in the gate.The channel conductivity decreases when the gate voltage is either positive or either negative. For example;

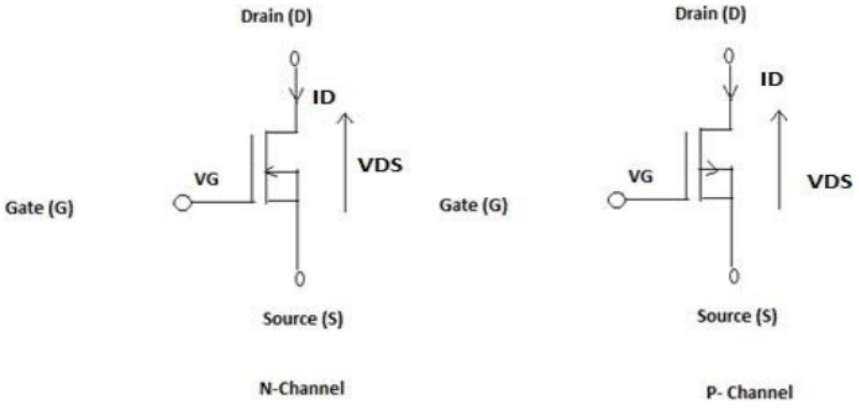

Fig 3.14 Depletion type MOSFET [13]

Enhancement mode:

The system does not work when there is no voltage at the gate. The higher the voltage on the lock, the faster the system will work.

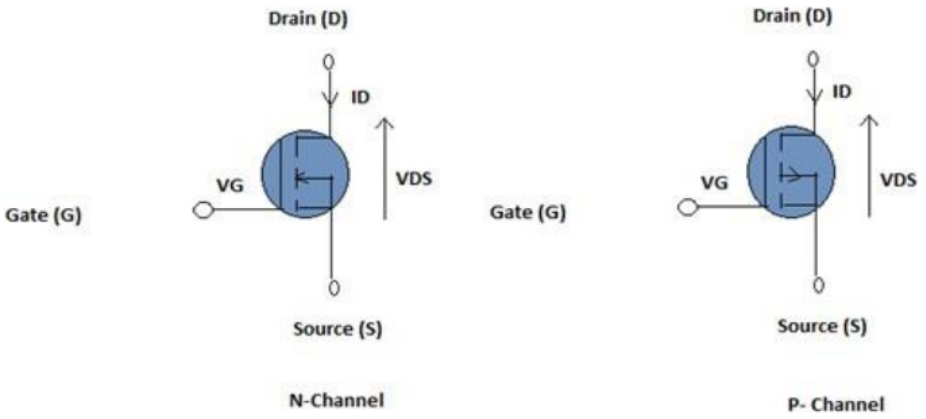

Fig. 3.15 Enhancement type MOSFET [13]

3.9.1 Working Principle of MOSFET:

The MOSFET's purpose is to be able to regulate the movement of voltage and current between the source and the drain. It's more like a switch running. The MOSFET operation relies on the MOS capacitor. The primary component of the MOSFET is the MOS capacitor At the lower oxide layer in between source and the drain terminal, the semiconductor barrier. It can be reversed by adding positive or negative gate voltages from p-type towards n-type. The holes that are already present under the oxide layer having a repulsive force when we apply the positive gate voltage and the holes with the substrate are forced downwards. The depletion area of the binding negative charges aligned with the acceptor atoms. The channel reaching the electrons is created. Electrons are also drawn by the positive voltage within the channel from the n + source and drain areas. Still, the current flows freely between the source and a voltage is placed between the drain and the source called drain voltage, and the gate voltage regulates the electrons in the channel. A hole channel under the oxide layer would be created if we add negative voltage instead of positive voltage.

P channel MOSFET:

Between source and drain, the P- Channel MOSFET has a P- Channel area. It is a system for four terminals, such as gate, drain, source, body. The drain and source are strongly doped p + area and n-type is the body or layer. Positively charged holes are the movement of current.

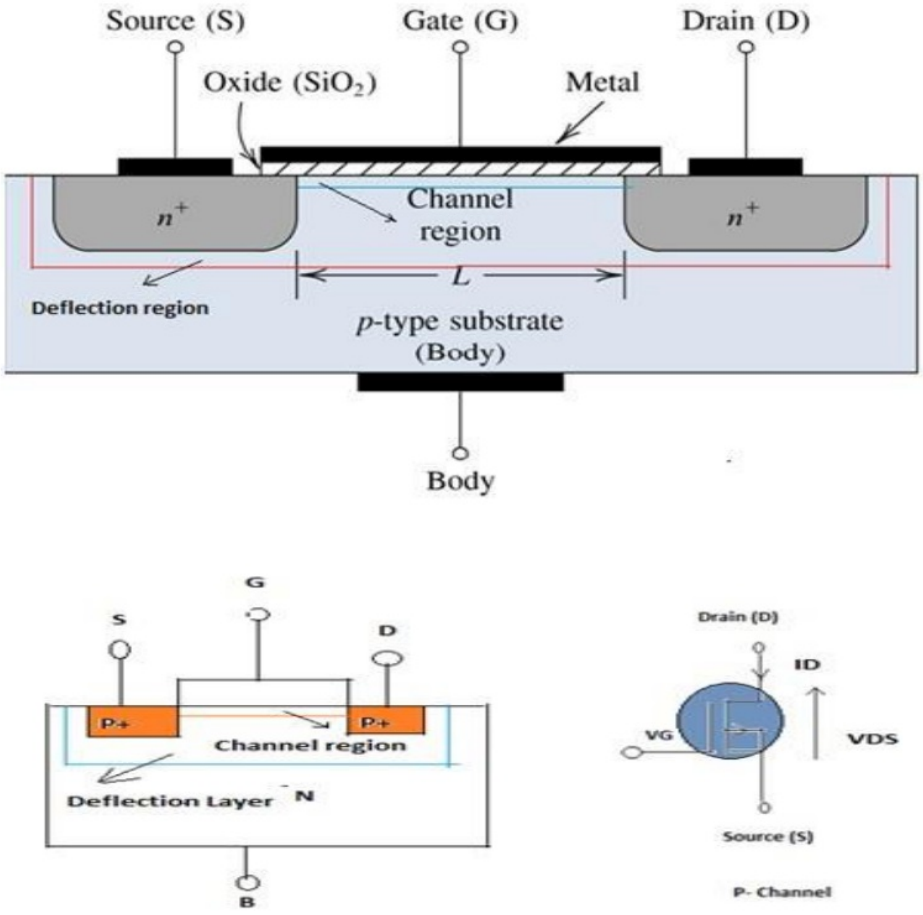

Fig 3.16 MOSFET Block Diagram [14]

3.9.2 N- Channel MOSFET:

The N-Channel MOSFET is a four terminal unit, such as gate, drain, source, body, and has an N-channel region between source and drain. The drain and source of this type of MOSFET is a highly doped n+ area and the substrate or body is P- type. As a product of the negatively charged ions, the current flows. The holes present under the oxide layer are forced downward into the substrate with a repulsive force as we apply the positive gate voltage. The area of depletion is populated with the attached negative charges associated with the acceptor atoms. The channel reaching the electrons is created. The positive voltage also draws electrons into the channel from the n + source and drain areas. The current freely flows between the source and the drain if a voltage is applied between the drain and source, electrons in the channel are regulated by the gate voltage., a hole channel would be formed under the oxide layer if we add negative voltage, instead of positive voltage.

3.10 Solar Panel:

The term called solar panel is used for a photo-voltaic (PV) cell. Photo-voltaic cells assembled in an installation system is a PV module. Photo-voltaic cells uses sunlight to produce direct current. A series of PV modules is known as a PV panel, and an array is a system of panels.

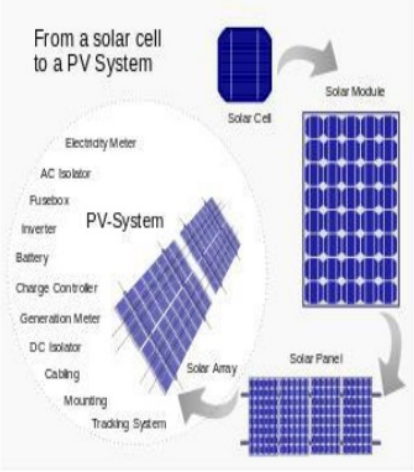

Fig 3.17 Solar cell to PV panel Process [14]

Arrays of a photovoltaic system provide electrical devices with solar energy. The most common application used for solar energy collection outside of agriculture is solar water heating systems. [1] Via the photovoltaic effect, photovoltaic modules use light energy (photons) from the Sun to produce electricity. Crystalline silicon cells based on wafers are used for some modules. To protect cells from mechanical damage and moisture is the most important task. Most PV modules are very rigid, but as well as thin-film cell based semi-flexible ones are available also. Connection of all the PV cell are in series electrically, one to the other to the desired voltage, and then to raise the amperage in parallel. The module wattage is the mathematical product of the module voltage and the amperage [2]. MC4 connectors allow easy, weatherproof connections to the rest of the device. MC4 can also be used as a USB power interface. For desired output voltage, to provide the desired current potential (ampere) of the solar panel or PV system module electrical contacts are made in series or in parallel. The conducting wires are sized according to capacity and can include silver, copper or other non-magnetic conductive transition metals that carry the current off the modules. In the event of partial module shading, bypass diodes can be integrated or used externally to optimize the performance of module parts that are already illuminated. Some special modules of solar PV contain concentrators in which light is concentrated on smaller cells through lenses or mirrors. This makes cost-effective use of cells with a high cost per unit area (such as gallium arsenide) possible. It is possible to recycle most parts of a solar cell, Including up to 95% of some semiconductor or glass components, as well as significant quantities of ferrous and non-ferrous metals.[33] Several private businesses and non-profit organizations are actively involved in end-of-life module take-back and recycling operations.[34] The scope for recycling depends on the form of technology that used in the modules making process.

- Silicon based modules: In the beginning process aluminum frames and junction boxes are dismantled manually. Then the module is then vanquished in the mill and the various fractions - glass, plastics and metals - are separated.[35] More than 80% of the incoming weight can be recovered.[36] This procedure can be carried out by flat glass recyclers as the morphology and structure of a PV module is identical to those flat glasses used in the construction and automobile industry. For eg, the recovered glass is readily embraced by the glass foam and insulating glass industry.

- Non-silicon-based modules: Complex recycling processes, for example use of chemical baths, are needed to isolate the various semiconductor materials.[37] The recycling process for cadmium telluride modules starts by crushing the module and then removing the various fractions. This method of recycling is intended to recycle up to 90% of the glass and 95% of the semiconductor materials found in it .[38] In recent years, private businesses have developed several commercial-scale recycling facilities.[39]

3.10.1 Pollution and energy in production:

A well-known way of producing renewable, emission-free energy is the solar panel. It generates, however, only direct current electricity (DC), which is not what is used by ordinary appliances. Solar PV systems are mostly made up of solar PV panels (modules) and inverters (changing DC to AC). Photovoltaic solar panels are primarily composed of solar photovoltaic cells, which do not differ fundamentally from the material used to produce computer chips. The method of manufacturing solar PV cells (computer chips) is energy consuming and includes chemicals that are extremely poisonous and harmful to the environment. Around the world, there are few solar PV manufacturing plants that manufacture PV modules with PV provided capacity. During the processing process, this step significantly decreases the carbon footprint. The handling of the chemicals used in the production process is subject to the local laws and regulations of the factories.

Impact on electricity :

With the rising levels of photovoltaic rooftop networks, the transfer of energy becomes two-way. Electricity is exported to the grid when there is more local output than demand. Traditionally, though, an electricity network is not built to cope with the 2-way transmission of energy. Any technological problems could, thus, occur. By the end of 2017, over 30 percent of households in Queensland Australia used rooftop PV. From 2015 onwards, the popular Californian 2020 duck curve also appeared for a lot of populations. When electricity flows from PV households back to the network, an over-voltage problem will result.[66] There are methods for handling the over-voltage problem, such as monitoring the PV inverter power factor, new electricity distributor-level voltage and energy control devices, re-producing the electricity wires, management of demand side etc. Disadvantages and costs that are related to these solutions are also present. While electric networks are down solar panels are also not capable to completely provide power to a house or other system, such as during the October 2019 California power shutdown, since they are intended to supply power to the grid, not directly to households.

CHAPTER 4

SYSTEM DESIGN

4.1 Introduction:

This chapter contains the project block diagram, block diagram description, flow chart, circuit diagram and circuit description.

4.2 Block Diagram:

The overall block diagram of this project has shown in **Fig 4.1**. In this project, we have used an Arduino Nano to connect all the components . Two current sensor has used to measure the load current and a potential transformer is used to measure the AC voltage. A 16x2 LCD display has used to visualize all the results on the display.

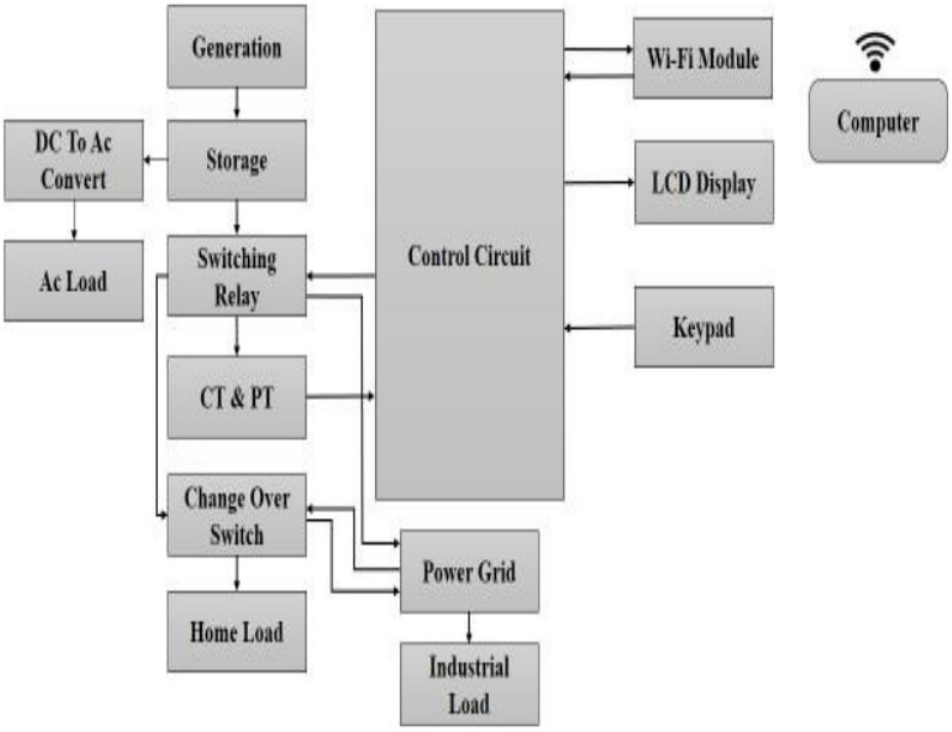

Fig 4.1 System Block Diagram

4.1 Working Procedure of Block Diagram:

Power unit:

A SMPS is a power supply that transfers power during a non-conducting switch-over system, which is turned on and off at higher frequency and induction or condensing storage elements.. A SMPS is an electrical circuit which transfers power .A variety of electronic equipment, which include computers and other essential devices requiring stable and efficient power supplies, typically use high-performance switching power

WIFI module:

All routers have a web page that can be connected for Wi-Fi security setup purposes. Then toggle on WEP (Privacy of Wire Equivalence) and enter a password. The radio signals are emitted by Wi-Fi receivers from antennas and routers that pick up signals, such as laptops and mobile phones that are ready for Wi-Fi cards. Whenever the machine receives the signals for the router within the 100-150 foot range, it automatically connects the system. The range of the Wi-Fi depends on the venue, indoor or outdoor areas. An internet link between the user and the provider is setup by Wifi cards that read the signals.

4.2 System Flow Chart:

The overall Flow Chart of this project has shown in **Fig 4.2.**

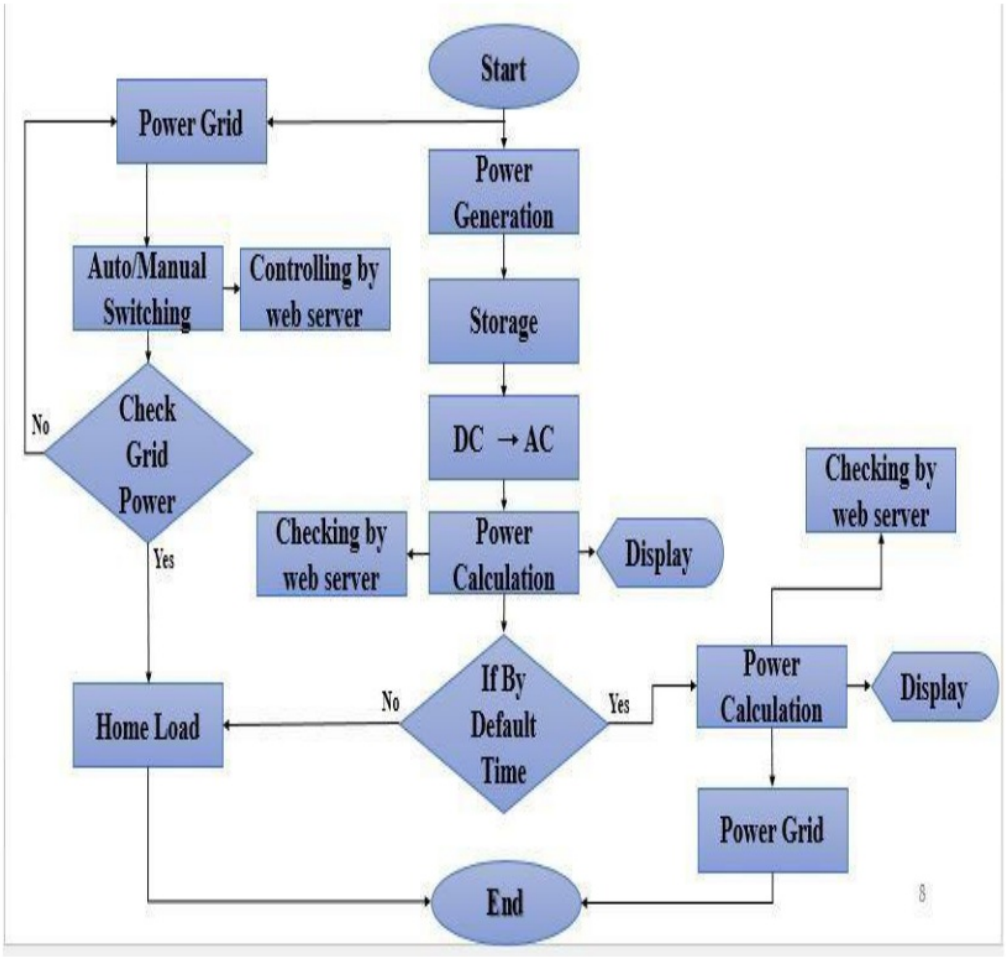

Fig 4.2 : System Flow Chart

4.3 Circuit Diagram:

The circuit diagram diagram of this project has shown in Fig 4.3. The circuit diagram is drawn using the Easy EDA Circuit simulation website.

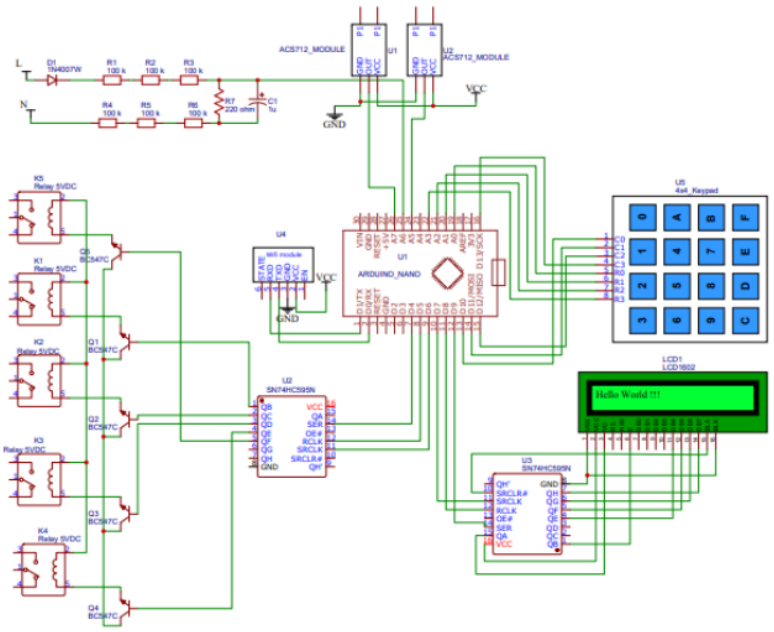

Fig 4.3 Circuit Diagram

4.4 Circuit Description:

In this system circuit diagram is shown. All the connection of the modules those have been used in this system with the arduino board is shown clearly in this diagram. All the VCC and GND connection of Current Sensor, Wi-Fi module, Key pad, microcontroller IC and LCD has been connected with the GND and VCC Connection of the arduino. The arduino nano is started and simultaneously the Wi-Fi module is powered and connection is established between Wi-Fi module and access point through which can upload and access the sensor value over internet. Wi-fi module sent to data at server for calibrate the program condition value and update the server display data. Similarly wifi module check to data for the sensor value check. The server link declaration the arduino nano program then total system configure by the wifi module. The control taken through the user are send by arduino nano and uploaded over the cloud server, then from the cloud server the controller retrieves the data through Wi-Fi module and performs the required action, depending on the control signal provided by the user. Total system power generate by the renewable energy source likes solar energy, Pizeo sensor and total energy storage the battery. The battery Dc voltage convert the ac voltage by the inverter circuit. The inverter circuit provide the all load power. . In this system load controlling by relay controlling circuit through the arduino nano output signal to shift resistor value signal. We calculate the load voltage by the potential transformer and measure the current by the current sensor.

CHAPTER 5
IMPLEMENTATION AND RESULT

5.1 Introduction

This chapter contains the total system result, hardware picture, controlling method of the project. Our project can operate by two way, one way is controlling by website (Automatically) and another way is controlling by manually.

Website is two part:

1. Controlling.
2. Monitoring the whole System.

5.2 Website Interface to control and Monitor the electrical loads

The figure 5.1 shows the website interface to log in the server user name and password, when we enter the correct username and password then we will log in the web page and we can see the result over the website.

Fig 5.1 User Log In Text

This figure shows how we can control all the electrical load by using a website. After log into the web page and connect the hotspot to wifi module then we can control and monitor the loads.

Fig 5.2 Different Load Control

5.3 Monitoring Section:

This figure shown the all electrical loads overview. After turning on all the loads we can see the real time energy usage and real time pricing of the consumed energy.

Fig 5.3 Web Site Monitoring Section

5.4 Controlling Section:

In this segment we set the time for load controlling. This system RTC Based Load controlling time set by 4*4 keypad

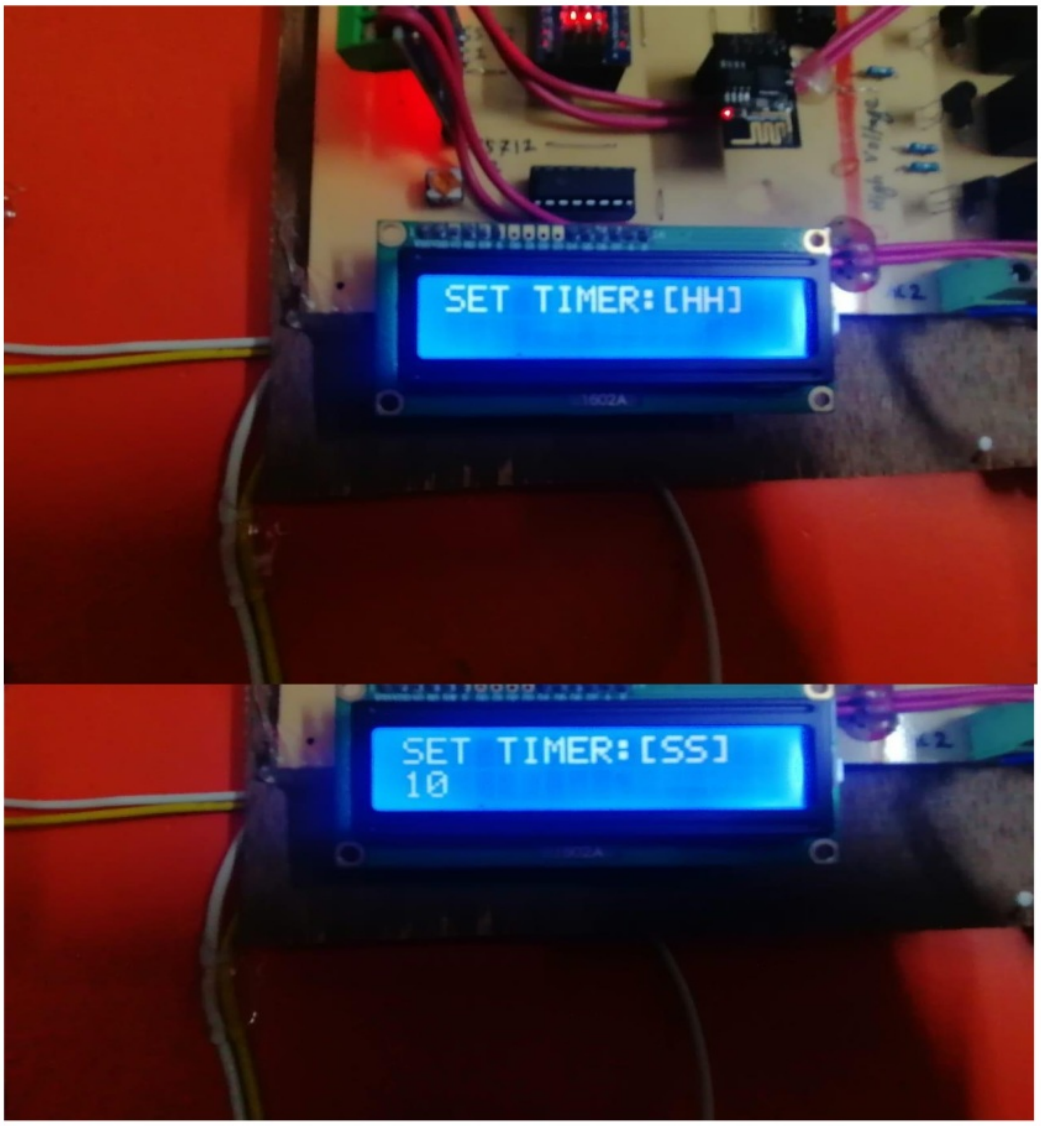

Fig 5.4 Timer Set

In the figure 5.5 we can see the energy consumed by the electrical loads and the real time pricing of the consumed energy.

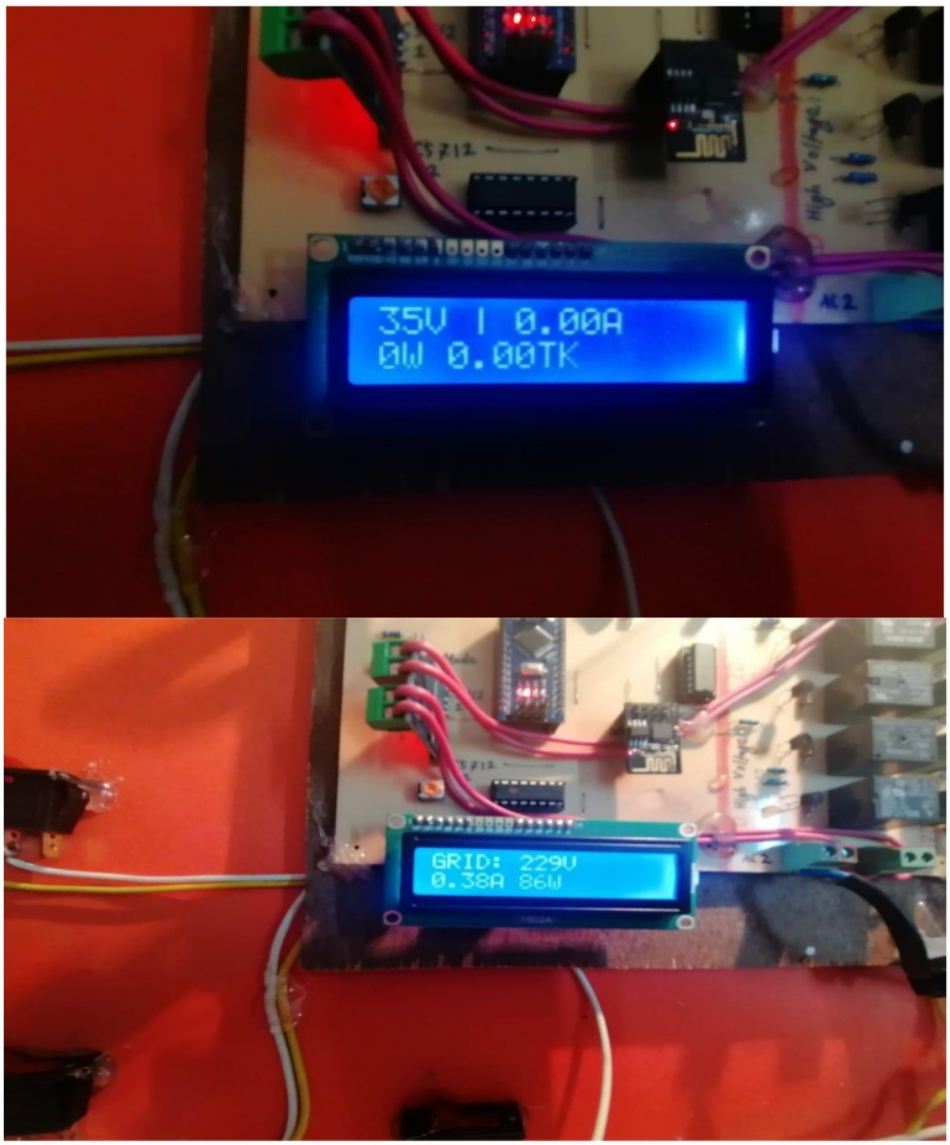

Fig 5.5 Load value Display

5.5 Hardware Set-Up:

Figure 5.6 and 5.7 shows the whole project in a hardware setup and also the project output.

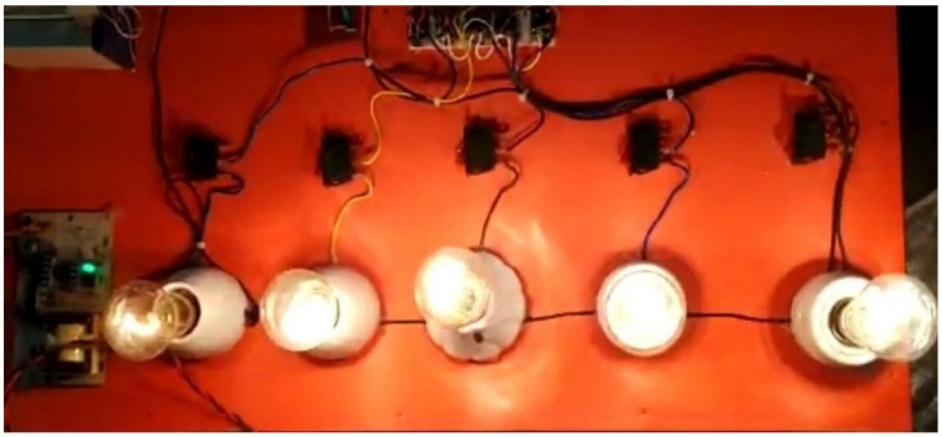

Fig 5.6 Output of the system

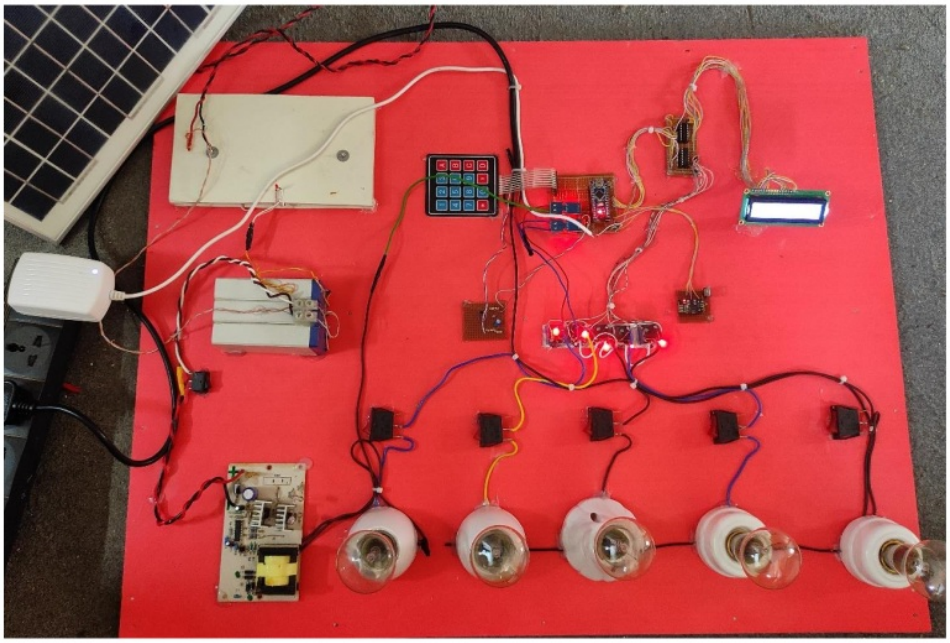

Fig 5.7 Total System.

5.6 Comparison of this project with some other related works

- We storage the power in the battery.
- We supply the power in suitable time.
- Total system monitoring by IoT.
- We can control all the electrical loads by IoT..

5.7 Cost Analysis

In this section we discussed about the cost analysis of this project. The total cost of this project is much cheaper than compared to other related works.

Table 4.1 Cost Analysis

Sl. No	Particulars	Total Price (In BDT)
01	ARDUINO NANO (ATmega328P)	300
02	LCD Display	280
03	Key Pad	320
04	Shift Resistor	140
05	Piezoelectric Sensor	200
06	Artificial Light	240
07	Batten Holder	300
08	Current Sensor	220
09	Relay	260
10	Wi-Fi Module	350
11	Transistor	180
12	Solar Cell	650
13	Miscellaneous	700
Total=		**4140/-**

CHAPTER 6

CONCLUSION

6.1 Introduction

This chapter contains Conclusion, Advantages, Limitations, Applications and Future work.

6.2 Conclusion

Without effective utilization of electricity, it is virtually difficult to eliminate power losses, ensure proper billing, and please consumers IoT based monitoring and controlling of loads could be the future because its reduce human effort and and energy. Also the renewable energy is the future for the power system .This is done with great care and much effort to design and assemble .The hardest work was to connect the mobile hotspot to the wired device wifi module, Arduino nano to the sensor value, show the sensor value on the server and LCD display, etc. Using sensor networks and communications, our technology has improved monitoring and controlling of electrical loads, better and quicker balance of supply and demand, improving power efficiency. If we build more in the framework, our cost of project creation can be minimized. Finally with tremendous inspiration and effort it has become possible to implement the whole project

6.3 Advantages of our project

- Better controlling and monitoring using sensor networks and communications.
- Real time power consumption and pricing.
- Reduced operations and management cost.
- Increase the efficiency by saving time and reducing power loss.
- Expanding deployment of renewable energy sources.

6.4 Limitations of our project

- The system is not packed in a single box closed system.
- All the components are not ascended in a single PCB layout.
- The system does not have the feature of self-healing.

6.5 Applications of our project

- Web based monitoring and controlling.
- Display of real time energy consumption and real time estimated pricing.
- Renewable energy generation and distribution purpose.
- Network Communications.

6.6 FUTURE WORK

Some future work that can be done later by further research is proposed as follows;

- Self - healing and self -detecting of error can be integrated in future.
- Enhancement of energy storage system of renewable energy could be developed in future.
- Some other types of renewable energy source could be integrated with the system.

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APPENDIX

```
#include <LiquidCrystalSerial.h>
#include <SoftwareSerial.h>
#include <Keypad.h>

#define WIFI_SSID "iotmonitoring"
#define WIFI_PASS "12345678"

char keys[4][4] = {
  {'1', '2', '3', 'A'},
  {'4', '5', '6', 'B'},
  {'7', '8', '9', 'C'},
  {'*', '0', '#', 'D'}
};

byte rowPins[4] = {A3, A2, A1, A0};
byte colPins[4] = {13, 12, 11, 10};

Keypad keypad = Keypad(makeKeymap(keys), rowPins, colPins, 4, 4);
LiquidCrystalSerial lcd(7, 9, 8);
#define butt A4
#define SH 6
#define DS 4
#define ST 5
#define rly1 1
#define rly2 2
#define rly3 3
#define rly4 4
#define rly5 5

bool r1 = 1, r2 = 1, r3 = 1, r4 = 1, r5 = 1;

void setup() {
  Serial.begin(115200);
  lcd.begin(16, 2, SERIAL);
  randomSeed(analogRead(A7));

  pinMode(SH, OUTPUT);
```

```
  pinMode(DS, OUTPUT);
  pinMode(ST, OUTPUT);

  output(rly1, r1);
  output(rly2, r2);
  output(rly3, r3);
  output(rly4, r4);
  output(rly5, r5);

  Serial.println((String)"CON=" + WIFI_SSID + "," + WIFI_PASS + ",");
}

int acVolt, wh1, wh2;
float amount, amp1, amp2;
byte ss, mm, hh;
byte setSS, setMM, setHH;
byte tSS, tMM, tHH;

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void loop() {
  char key = keypad.getKey();
  acVolt = getVoltage(A6);
  amp1 = getCurrent(A7) - 0.09;
  amp2 = getCurrent(A5) - 0.09;
  wh1 = acVolt * amp1;
  wh2 = acVolt * amp2;

  else {
66
   lcd.setCursor(0, 0);
   lcd.print((String)"GRID: " + acVolt + "V  ");
   lcd.setCursor(0, 1);
   lcd.print((String)amp2 + "A " + wh2 + "W   ");
  }

  if (gridFlag == 1) {
   if (tSS == setSS && tMM == setMM && tHH == setHH) {
    tSS = 0; tMM = 0; tHH = 0;
    r5 = !r5;
    output(rly5, r5);
   }
  }
```

```
 if (ss % 10 == 0) {
  checkServer();
  Stringlink= "WEB=0,http://kitsware.com/projects/energymeter/update_machine.php?";
  link += (String)"ac1=" + acVolt + "&";
  link += (String)"ac2=" + acVolt + "&";
  link += (String)"amp1=" + amp1 + "&";
  link += (String)"amp2=" + amp2 + "&";
  link += (String)"wh1=" + wh1 + "&";
  link += (String)"wh2=" + wh2 + "&";
  link += (String)"time=" + setHH + ":" + setMM + ":" + setSS;
  Serial.println(link);
  delay(1500);
 }

 checkSMS();
 if (key >= '1' && key < '6') OTPMode(key - 49);
 if (key >= 'A') setupTimer();
 runClock();
}

void checkServer() {
 Serial.println("WEB=1,http://kitsware.com/projects/energymeter/stat_machine.php");
 while (!Serial.available());
 if (Serial.available()) {
  String rx = Serial.readString();
  action(rx);
 }
}

void action(String &rx) {
 if (rx.indexOf("l1=1") != -1) r1 = 0;
 else if (rx.indexOf("l1=0") != -1) r1 = 1;
 if (rx.indexOf("l2=1") != -1) r2 = 0;
 else if (rx.indexOf("l2=0") != -1) r2 = 1;
 if (rx.indexOf("l3=1") != -1) r3 = 0;
 else if (rx.indexOf("l3=0") != -1) r3 = 1;
 if (rx.indexOf("l4=1") != -1) r4 = 0;
 else if (rx.indexOf("l4=0") != -1) r4 = 1;
 if (rx.indexOf("l5=1") != -1) r5 = 0;
 else if (rx.indexOf("l5=0") != -1) r5 = 1;
```

```
 output(rly1, r1);
 output(rly2, r2);
 output(rly3, r3);
 output(rly4, r4);
 output(rly5, r5);

 Stringlink= "WEB=0,http://kitsware.com/projects/energymeter/update_machine.php?";
 link += (String)"l1=" + !r1 + "&";
 link += (String)"l2=" + !r2 + "&";
 link += (String)"l3=" + !r3 + "&";
 link += (String)"l4=" + !r4 + "&";
 link += (String)"l5=" + !r5;
 Serial.println(link);
 delay(1500);
}


}

void setupTimer() {
 lcd.clear();
 lcd.setCursor(0, 0);
 lcd.print("SET TIMER:[HH]");
 delay(200);

 int x = 0;
 String val= "";
 while (1) {
  char key = keypad.waitForKey();
  if (key == 'B') break;
  lcd.setCursor(x, 1);
  lcd.print(key);
  delay(500);
  val += key;
  x++;
 }
 setHH = val.toInt();

 lcd.clear();
```

```
lcd.setCursor(0, 0);
lcd.print("SET TIMER:[MM]");
delay(200);

x = 0;
val = "";
while (1) {
  char key = keypad.waitForKey();
  if (key == 'B') break;
  lcd.setCursor(x, 1);
  lcd.print(key);
  delay(500);
  val += key;
  x++;
}
setMM = val.toInt();

lcd.clear();
lcd.setCursor(0, 0);
lcd.print("SET TIMER:[SS]");
delay(200);

x = 0;
val = "";
while (1) {
  char key = keypad.waitForKey();
  if (key == 'B') break;
  lcd.setCursor(x, 1);
  lcd.print(key);
  delay(500);
  val += key;
  x++;
}
setSS = val.toInt();
lcd.clear();
tSS = 0; tMM = 0; tHH = 0;
if (setSS || setMM || setHH) gridFlag = 1;
else gridFlag = 0;
}
```

```
void runClock() {
  static long ct = millis();
  if (millis() - ct > 1000) {
    ss++;
    cp = 0;
    if (ss == 60) {
      ss = 0;
      mm++;
      if (mm == 60) {
        hh++;
        mm = 0;
      }
    }
    tSS++;
    if (tSS == 60) {
      tSS = 0;
      tMM++;
      if (tMM == 60) {
        tHH++;
        tMM = 0;
      }
    }
    ct = millis();
  }
}



void sendSMS(String number, String msg) {
  lcd.clear();
  lcd.print("Sending SMS...");
  lcd.setCursor(0, 1);
  lcd.print("Please wait...");

  gsm.print("AT+CMGF=1\r\n");
  delay(200);
  gsm.print((String)"AT+CMGS=\"" + number + "\"\r\n");
  delay(200);
  gsm.print(msg);
  gsm.write(0x1A);
```

```
  gsm.print("\r\n");
  delay(3000);

  lcd.clear();
}

  }
}

int getVoltage(byte pin) {
  float result;
  int readValue;
  int maxValue = 0;
  int minValue = 1024;

  for (int i = 0; i < 500; i++) {
    readValue = analogRead(pin);
    if (readValue > maxValue) maxValue = readValue;
    if (readValue < minValue) minValue = readValue;
    checkSMS();
  }
  result = ((maxValue - minValue) * 6400.0) / 1024.0;
  return (result / 2.0) * 0.707;
}

double getCurrent(byte pin) {
  float result;
  int readValue;
  int maxValue = 0;
  int minValue = 1024;
  const int mVperAmp = 185;
  double VRMS = 0;
  double AmpsRMS = 0;

  for (int i = 0; i < 500; i++) {
    readValue = analogRead(pin);
    if (readValue > maxValue) maxValue = readValue;
    if (readValue < minValue) minValue = readValue;

void output(uint8_t pin, bool state) {
```

```
  static long val = 0;
  bitWrite(val, 7 - pin, state);
  for (int i = 0; i < 8; i++) {
    digitalWrite(DS, bitRead(val, i));
    digitalWrite(SH, 1);
    digitalWrite(SH, 0);
  }
  digitalWrite(ST, 1);
  digitalWrite(ST, 0);
}
```

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