PROJECT REPORT

on

Remotely Monitoring the Condition Of Solar Power System Using Arduino

Submitted by

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Certified that this project report titled **“Remotely Monitoring the Condition Of Solar Power System Using Arduino”** is the Bonafide work of **“Mohammed Samraan Ghouse [Reg No: RA1711004010033], Mohammed Furquan Hussain [Reg No: RA1711004010205], Aftab Nadaf [Reg No: RA1711004010580]”** who carried out the project work under my supervision.Certified further, that to the best of my knowledge the work reported herein does not form any other project report or dissertation on the basis of which adegree or award was conferred on an earlier occasion on this or any other candidate.

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ABSTRACT

Using Internet of Things (IOT) Technology for Observing solar power generation can eventually upsurge the efficiency and maintenance of the solar panel. Our Project is based on implications of newer cost actual methodology based on IOT to anonymously monitor a solar plant for performance evaluation & Scrutiny. This will smoothen the way of preventive and successive maintenance, problem detection of the solar panel in response to real time monitoring. This new technology has many applications like solar cities, Smart villages, Micro grids and Solar Street lights etc. As Renewable sources of energy increased at a rate faster than any other time in history during this period. The planned & analyzed system recommends to the online display of the power usage of solar energy as a renewable & sustainable energy. This monitoring & Surveillance is done through Arduino using Web IOT server using smart monitoring displays. This helps the peer to study of energy analytics. Analysis impacts on the renewable energy usage and responds accordingly.

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my guide, Mrs. S T Aarthy her valuable guidance, consistent encouragement, personal caring, timely help and providing me with an excellent atmosphere for doing research. All through the work, in spite of her busy schedule, she has extended cheerful and cordial support to me for completing this research work.

Author

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CHAPTER 1

INTRODUCTION

1.1 Overview:

- By Using the Internet of Things (IOT) Technology mainly for analyzing & monitoring the solar power generation can dramatically increase the performance and service of the solar panel.
- Our idea is based on employing of new cost methodology which based on IoT to anonymously & remotely monitor a solar plant for performance evaluation. This will loosen the way of preventive and active maintenance, problem detection of the solar panel w.r.t to real time monitoring.
- Also wireless monitoring energy efficiency of solar power system using new generation instrumentation through IOT and Arduino Uno module will help the peers in applying different preventive steps by which consistency on increased energy production & efficiency can be maintained.
- The monitoring is done with Arduino using Web server based software. The new Smart Monitoring display systems shows daily usage of this renewable energy.
- This helps the peer to study and engage energy resources. Analysis can directly impact on the renewable energy usage.
- Direct influence of contact thermal resistances is calculated & Evaluated by the Open-Circuit Voltage (OCV) method used for the Maximum Power Point Tracking (MPPT).

MPPT or Maximum Power Point Tracking is algorithm that mainly included in charge controllers used for extracting (or) collecting maximum available power from PV module under various conditions and circumstances. The voltage (V) at which Photo Voltaic (PV) module can produce maximum amount of power is called maximum power point (or peak power voltage)
And open-circuit voltage is mainly the difference of electrical potential between two terminals (or) ports of a device when it is disconnected from any circuit.

1.2 Existing system vs. Proposed system

EXISTING SYSTEM	PROPOSED SYSTEM
➢ Monitoring system is not implemented. ➢ Manually checking the output values of the solar panel through older techniques like multimeter (digital meter). ➢ No real time comparison ➢ No control for the user wirelessly Drawbacks ➢ Maintenance is difficult. ➢ Life of the solar panel is decreases eventually.	➢ Monitoring system is implemented using MPPT (Maximum Power Point Tracking) Algorithm and OCV (Open Circuit Voltage) ➢ Sensors are used to check the output values of the solar panel to know the life. ➢ Real time comparison along with and low efficiency indication is given. ➢ Provides wireless control Advantages ➢ Maintenance is easy. ➢ Increases the life of the solar panel.

1.3 Working Principal

The micro-controller which act as the brain of the entire system. This is used to control all the operations of the hardware are interfaced with the controller. The voltage and current sensor is used to measure the output values from the solar panel. Battery is connected to relay for the power production during night time. we are interfacing dc motor to show the power we are getting from panel and RTC is for automatic switching of relay according to time. all the operations are displayed on the LCD and monitored in the IOT . Initial value fetch from the voltage and current sensor of the solar panel get to reduced day by day so that reduction of life of the solar panel can be monitored and displayed by IOT.

1.4 Problem Statement

Main objectives of this proposed health monitoring system for solar power system is to:-

1. Eliminate the need for physical (or) in-person maintenance for solar panels.
2. Automatic measurement of current, voltage and efficiency and send it through network carrier wirelessly through GSM module.
3. Auto on / off w.r.t time of the day.
4. To detect unusual readings for the solar panels.
5. To transmit & analyze the data through IoT module on network Carrier (GSM).
6. To process and detect faulty readings automatically through Arduino IDE.

CHAPTER 2

LITERATURE SURVEY

2.1 REVIEW ON SOLAR POWER REMOTE MONITORING AND CONTROLLING USING IoT

The Internet of Things (IoT) has a vision in which the internet extends into the real world, which incorporates eve-ryday objects. Solar power remote monitoring and controlling using IoT is to monitor and control the power in the solar panels from anywhere in the world.

Using the Internet of Things Technology for supervising solar photovoltaic power generation can greatly enhance the performance, monitoring and maintenance of the plant. With advancement of technologies the cost of renew-able energy equipments is going down globally encouraging large scale solar or photovoltaic installations. The solar tracking is used to increase the power consumption according to sun direction. The influence of contact thermal resistances is evaluated by the Open-Circuit Voltage (OCV) method used for the Maximum Power Point Tracking(MPPT).

2.2 Photovoltaic Remote Monitoring System Based on GSM

In remote area, the need for monitoring PV system is crucial to ensure stable PV power delivery. This paper describes the hardware and software design for PV monitoring system in remote area. The monitoring system is equipped with voltage sensor, current sensor, temperature sensor and irradiation sensor and GSM modem for data transmission.

2.3 Implementation of IoT based PV Monitoring System with Message Queuing Telemetry Transfer protocol and Smart Utility Network

For the IoT based PV monitoring
system, we developed IoT gateway based on inexpensive Raspberry pi hardware and adopted the Message Queuing Telemetry Transfer (MQTT) protocol at IoT gateway and Smart Phone. And also we can down the cost by using the Smart Utility Network(SUN) communication of the license-exempt band which is sub-1Ghz ba

CHAPTER 3

HARDWARE & SOFTWARE REQUIREMENTS with Specifications & Description

3.1 HARDWARE REQUIREMENTS:

> ARDUINO UNO.
> SOLAR PANEL.
> VOLTAGE SENSOR.
> CURRENT SENSOR.
> RELAY.
> BATTERY.
> GSM MODULE.
> RTC.
> DC MOTOR.
> LCD DISPLAY.
> IOT MODULE.
> POWER SUPPLY.

3.2 SOFTWARE REQUIREMENTS:

> ARDUINO IDE.
> EMBEDDED C.

3.3 Arduino UNO

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board.

Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs. The software, too, is open-source, and it is growing through the contributions of users worldwide.

WHY ARDUINO?

Thanks to its simple and accessible user experience, Arduino has been used in thousands of different projects and applications. The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users. It runs on Mac, Windows, and Linux. Teachers and students use it to build low cost scientific instruments, to prove chemistry and physics principles, or to get started with programming and robotics. Designers and architects build interactive prototypes, musicians and artists use it for installations and to experiment with new musical instruments. Makers, of course, use it to build many of the projects exhibited at the Maker Faire, for example. Arduino is a key tool to learn new things. Anyone -children, hobbyists, artists, programmers -can start tinkering just following the step by step instructions of a kit, or sharing ideas online with other members of the Arduino community.

There are many other microcontrollers and microcontroller platforms available for physical computing. Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's Handyboard, and many others offer similar functionality. All of these tools take the messy details of microcontroller programming and wrap it up in an easy-to-use package. Arduino also simplifies the process of working with microcontrollers, but it offers some advantage for teachers, students, and interested amateurs over other systems:

> **Inexpensive** - Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the

Arduino module can be assembled by hand, and even the pre-assembled Arduino modules cost less than $50.

> **Cross-platform** - The Arduino Software (IDE) runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows.

> **Simple, clear programming environment** - The Arduino Software (IDE) is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well. For teachers, it's conveniently based on the Processing programming environment, so students learning to program in that environment will be familiar with how the Arduino IDE works.

> **Open source and extensible software** - The Arduino software is published as open source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C programming language on which it's based. Similarly, you can add AVR-C code directly into your Arduino programs if you want to.

> **Open source and extensible hardware** - The plans of the Arduino boards are published under a Creative Commons license, so experienced circuit designers can make their own version of the module, extending it and improving it. Even relatively inexperienced users can build the breadboard version of the module in order to understand how it works and save money.

ARDUINO UNO:

The UNO is the best board to get started with electronics and coding. If this is your first experience tinkering with the platform, the UNO is the most robust board you can start playing with. The UNO is the most used and documented board of the whole Arduino family.

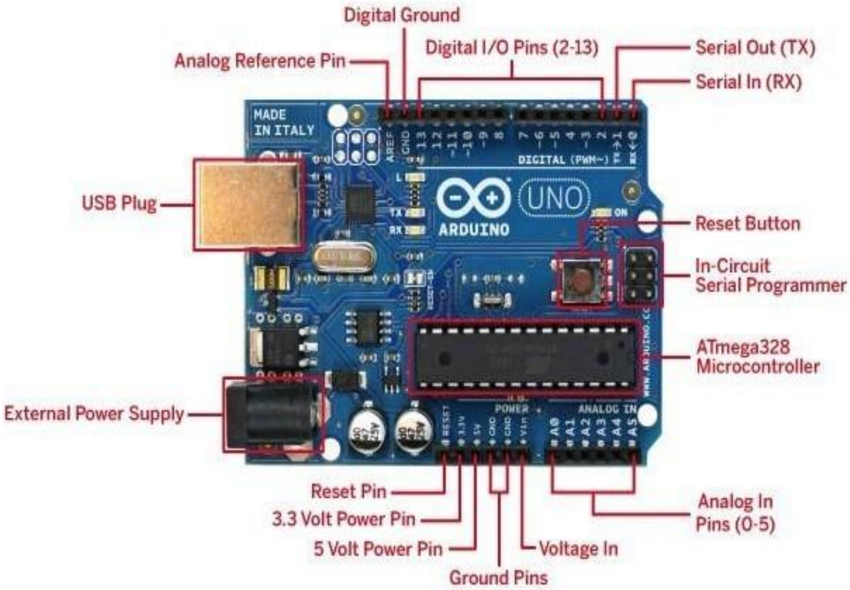


Figure:- 3.1

Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

Microcontroller	[ATmega328P]
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by boot loader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
LED_BUILTIN	13
Length	68.6 mm
Width	53.4 mm
Weight	25 g

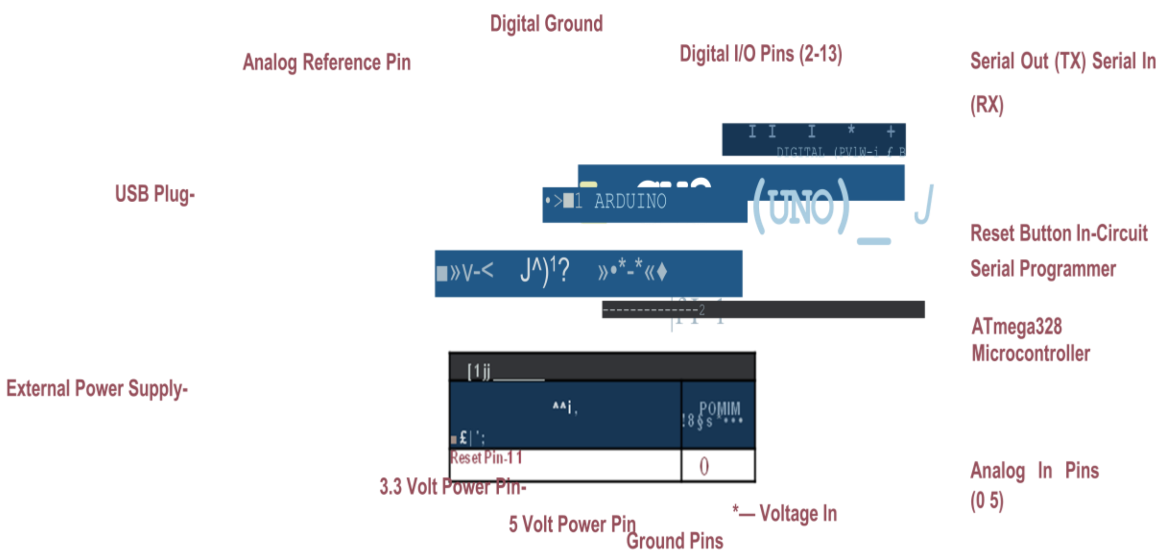


Figure :- 3.2

HARDWARE:

Arduino is open-source hardware. The hardware reference designs are distributed under a Creative Commons Attribution Share-Alike 2.5 license and are available on the Arduino website. Layout and production files for some versions of the hardware are also available.

Although the hardware and software designs are freely available under copyleft licenses, the developers have requested the name Arduinoto be exclusive to the official product and not be used for derived works without permission. The official policy document on use of the Arduino name emphasizes that the project is open to incorporating work by others into the official product. Several Arduino-compatible products commercially released have avoided the project name by using various names ending in -duino. An early Arduino board with an RS-232 serial interface (upper left) and an Atmel ATmega8 microcontroller chip (black, lower right); the 14 digital I/O pins are at the top, the 6 analog input pins at the lower right, and the power connector at the lower left.

Most Arduino boards consist of an Atmel 8-bit AVR microcontroller (ATmega8, ATmega168, ATmega328, ATmega1280, ATmega2560) with varying amounts of flash memory, pins, and features. The 32-bit Arduino Due, based on the Atmel SAM3X8E was introduced in 2012. The boards use single or double-row pins or female headers that facilitate connections for programming and incorporation into other circuits. These may connect with add-on modules termed shields. Multiple and possibly stacked shields may be individually addressable via an PC serial bus. Most boards include a 5 V linear regulator and a 16 MHz crystal oscillator or ceramic resonator. Some designs, such as the LilyPad, run at 8 MHz and dispense with the onboard voltage regulator due to specific form-factor restrictions.

Arduino microcontrollers are pre-programmed with a boot loader that simplifies uploading of programs to the on-chip flash memory. The default bootloader of the Arduino UNO is the optiboot bootloader. Boards are loaded with program code via a serial connection to another computer. Some serial Arduino boards contain a level shifter circuit to convert between RS-232 logic levels and transistor-transistor logic (TTL) level signals. Current Arduino boards are programmed via Universal Serial Bus (USB), implemented using USB-to-serial adapter chips such as the FTDI FT232. Some boards, such as later-model Uno boards, substitute the FTDI chip with a separate AVR chip containing USB-to-serial firmware, which is reprogrammable via its own ICSP header. Other variants, such as the Arduino Mini and the unofficial Boarduino, use a detachable USB-to-serial adapter board or cable, Bluetooth or other methods. When used with traditional microcontroller tools, instead of the Arduino IDE, standard AVR in¬system programming (ISP) programming is used.An official Arduino Uno R2 with descriptions of the I/O locations

The Arduino board exposes most of the microcontroller's I/O pins for use by other circuits. The Diecimila,^ Duemilanove,^ and current Uno^ provide 14 digital I/O pins, six of which can produce pulse-width modulated signals, and six analog inputs, which can also be used as six digital I/O pins. These pins are on the top of the board, via female 0.1-inch (2.54 mm) headers. Several plug-in application shields are also commercially available. The Arduino Nano, and Arduino-compatible Bare Bones Board and Boarduino boards may provide male header pins on the underside of the board that can plug into solderless breadboards.

Many Arduino-compatible and Arduino-derived boards exist. Some are functionally equivalent to an Arduino and can be used interchangeably. Many enhance the basic Arduino by adding output drivers, often for use in school-level education, to simplify making buggies and small robots. Others are electrically equivalent but change the form factor, sometimes retaining compatibility with shields, sometimes not. Some variants use different processors, of varying compatibility.

The Arduino Uno can be programmed with the (Arduino Software (IDE)). Select "Arduino/Genuino Uno from the Tools > Board menu (according to the microcontroller on your board). For details, see the reference and tutorials.

3.4 LIQUID CRYSTAL DISPLAY:

LCD screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

A **16x2 LCD** means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix.

This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed

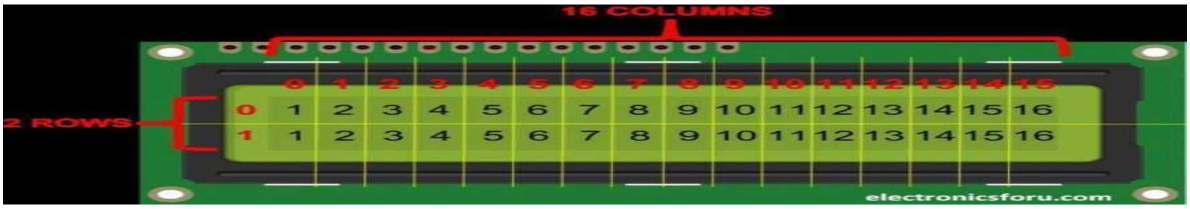
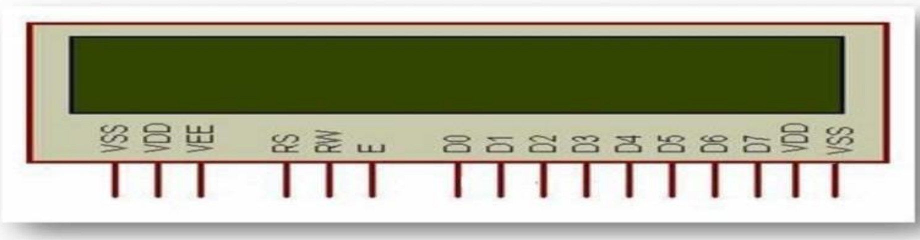


Figure :- 3.3

on the LCD. The data is the ASCII value of the character to be displayed on the LCD. Click to learn more about internal structure of a LCD.



16X2 LCD PINOUT DIAGRAM Figure :- 3.4

PIN NO.	FUNCTION	NAME
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	VCC
3	Contrast adjustment; the best way is to use a variable resistor such as a potentiometer. The output of the potentiometer is connected to this pin. Rotate the potentiometer knob forward and backwards to adjust the LCD contrast.	Vo / VEE
4	Selects command register when low, and data register when high	RS (Register Select)
5	Low to write to the register; High to read from the register	Read/write
6	Sends data to data pins when a high to low pulse is given; Extra voltage push is required to execute the instruction and EN(enable) signal is used for this purpose. Usually, we make it en=0 and when we want to execute the instruction we make it high en=1 for some milliseconds. After this we again make it ground that is, en=0.	Enable
7	8-bit data pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Backlight VCC (5V)	Led+
16	Backlight Ground (0V)	Led-

Figure :- 3.5

3.5 Voltage Sensor

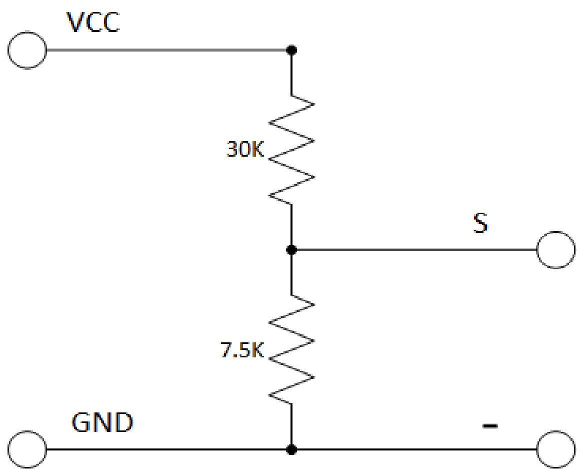
SPECIFICATIONS:
Divider ratio: 5:1
Resistor Tolerance: 1%
Max input voltage: 25V
Resistor Value: 30K/7.5K Ohm

Pin out:

INPUT
1... GND
2....0-25V

OUTPUT
1Sense
2N/C
3GND

Figure :- 3.6



3.6 RELAY

Relays are the primary protection as well as switching devices in most of the control processes or equipment. All the relays respond to one or more electrical quantities like voltage or current such that they open or close the contacts or circuits. A relay is a switching device as it works to isolate or change the state of an electric circuit from one state to another.

Classification or the types of relays depend on the function for which they are used. Some of the categories include protective, reclosing, regulating, auxiliary and monitoring relays.

Protective relays continuously monitor these parameters: voltage, current, and power; and if these parameters violate from set limits they generate alarm or isolate that particular circuit. These types of relays are used to protect equipment like motors, generators, and transformers, and so on.

Figure :- 3.7

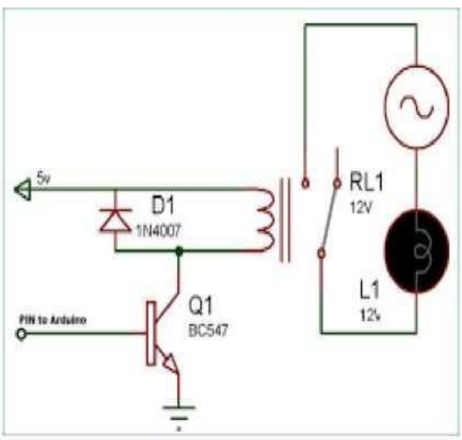


Figure :- 3.8

3.7 ACS712 & Bi-CMOS Hall IC

Figure :- 3.9

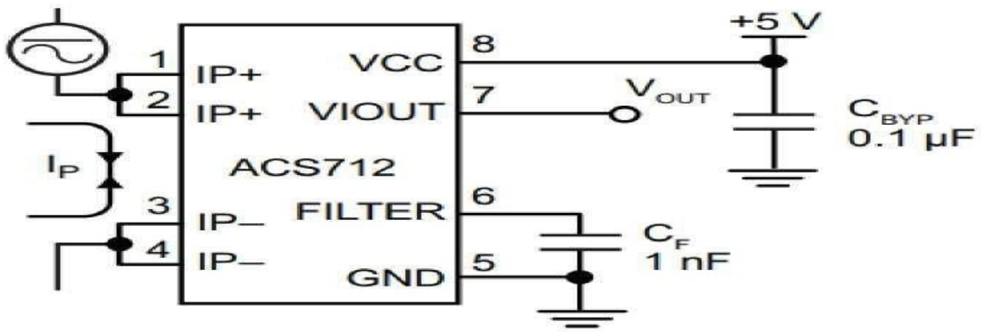


Figure :- 3.10

- The device consists of a precise, low-offset, linear Hall 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 the Hall IC converts into a proportional voltage.

- Device accuracy is optimized through the close proximity of the magnetic signal to the Hall transducer.
- A precise, proportional voltage is provided by the low-offset, chopper-stabilized BiCMOS Hall IC, which is programmed for accuracy after packaging.
- The thickness of the copper conductor allows survival of the device at up to 5× overcurrent conditions.
- This allows the ACS712 to be used in applications requiring electrical isolation without the use of opto-isolators or other costly isolation techniques.

3.8 INTERNET OF THINGS (GSM MODULE)

The internet of things (IoT) is the network of physical devices, vehicles, buildings and other items embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data. In 2013 the Global Standards Initiative on Internet of Things (IoT-GSI) defined the IoT as "the infrastructure of the information society. The IoT allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, smart homes, intelligent transportation and smart cities. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure. Experts estimate that the IoT will consist of almost 50 billion objects by 2020.

INFRASTRUCTURE:

The Internet of Things will become part of the fabric of everyday life. It will become part of our overall infrastructure just like water, electricity, telephone, TV and most recently the Internet. Whereas the current Internet typically connects full-scale computers, the Internet of Things (as part of the Future Internet) will connect everyday objects with a strong integration into the physical world.

1. Plug and Play Integration

If we look at IoT-related technology available today, there is a huge heterogeneity. It is typically deployed for very specific purposes and the configuration requires significant technical knowledge and may be cumbersome. To achieve a true Internet of Things we need to move away from such small-scale, vertical application silos, towards a horizontal infrastructure on which a variety of applications can run simultaneously.

2. Infrastructure Functionality

The infrastructure needs to support applications in finding the things required. An application may run anywhere, including on the things themselves. Finding things is not limited to the start-up time of an application. Automatic adaptation is needed whenever relevant new things become available, things become unavailable or the status of things changes. The infrastructure has to support the monitoring of such changes and the adaptation that is required as a result of the changes.

3. Physical Location and Position

As the Internet of Things is strongly rooted in the physical world, the notion of physical location and position are very important, especially for finding things, but also for deriving knowledge. Therefore, the infrastructure has to support finding things according to location (e.g. geo-location based discovery). Taking mobility into account, localization technologies will play an important role for the Internet of Things and may become embedded into the infrastructure of the Internet of Things.

4. Security and Privacy

In addition, an infrastructure needs to provide support for security and privacy functions including identification, confidentiality, integrity, non-repudiation authentication and authorization. Here the heterogeneity and the need for interoperability among different ICT systems deployed in the infrastructure and the resource limitations of IoT devices (e.g., Nano sensors) have to be taken into account.

Data Management

Data management is a crucial aspect in the Internet of Things. When considering a world of objects interconnected and constantly exchanging all types of information, the volume of the generated data and the processes involved in the handling of those data become critical. A long-term opportunity for wireless communications chip makers is the rise of Machine-to-Machine (M2M) computing, which one of the enabling technologies for Internet of Things. This technology spans abroad range of applications. While there is consensus that M2M is a promising pocket of growth, analyst estimates on the size of the opportunity diverge by a factor of four [16]. Conservative estimates assume roughly 80 million to 90 million M2M units will be sold in 2014, whereas more optimistic projections forecast sales of 300 million units. Based on historical analyses of adoption curves.

for similar disruptive technologies, such as portable MP3 players and antilock braking systems for cars, it is believed that unit sales in M2M could rise by as much as a factor of ten over the next five years, see Figure 2.29 [16]. There are many technologies and factors involved in the “data management” within the IoT context. Some of the most relevant concepts which enable us to understand the challenges and opportunities of data management are:

- Data Collection and Analysis
- Big Data
- Semantic Sensor Networking
- Virtual Sensors
- Complex Event Processing.

ESP8266EX also integrates an enhanced version of Tensilica’s L106 Diamond series 32-bit processor, with on-chip SRAM, besides the Wi-Fi functionalities.

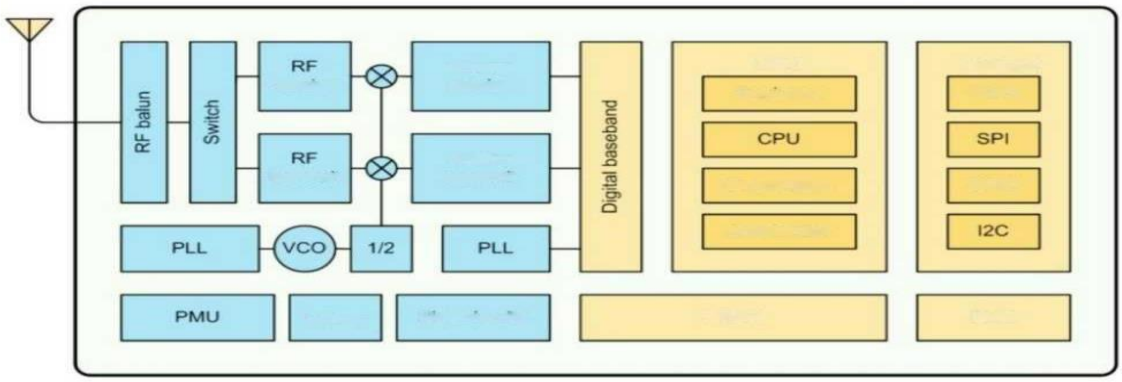


Figure :- 3.11

ESP8266EX is often integrated with external sensors and other application specific devices through its GPIOs; codes for such applications are provided in examples in the SDK. Espressif Systems’ Smart Connectivity Platform (ESCP) demonstrates sophisticated system-level features include fast sleep/wake context switching for energy-efficient VoIP, adaptive radio biasing. For low-power operation, advance signal processing, and spur cancellation and radio co-existence features for common cellular, Bluetooth, DDR, LVDS, LCD interference mitigation.

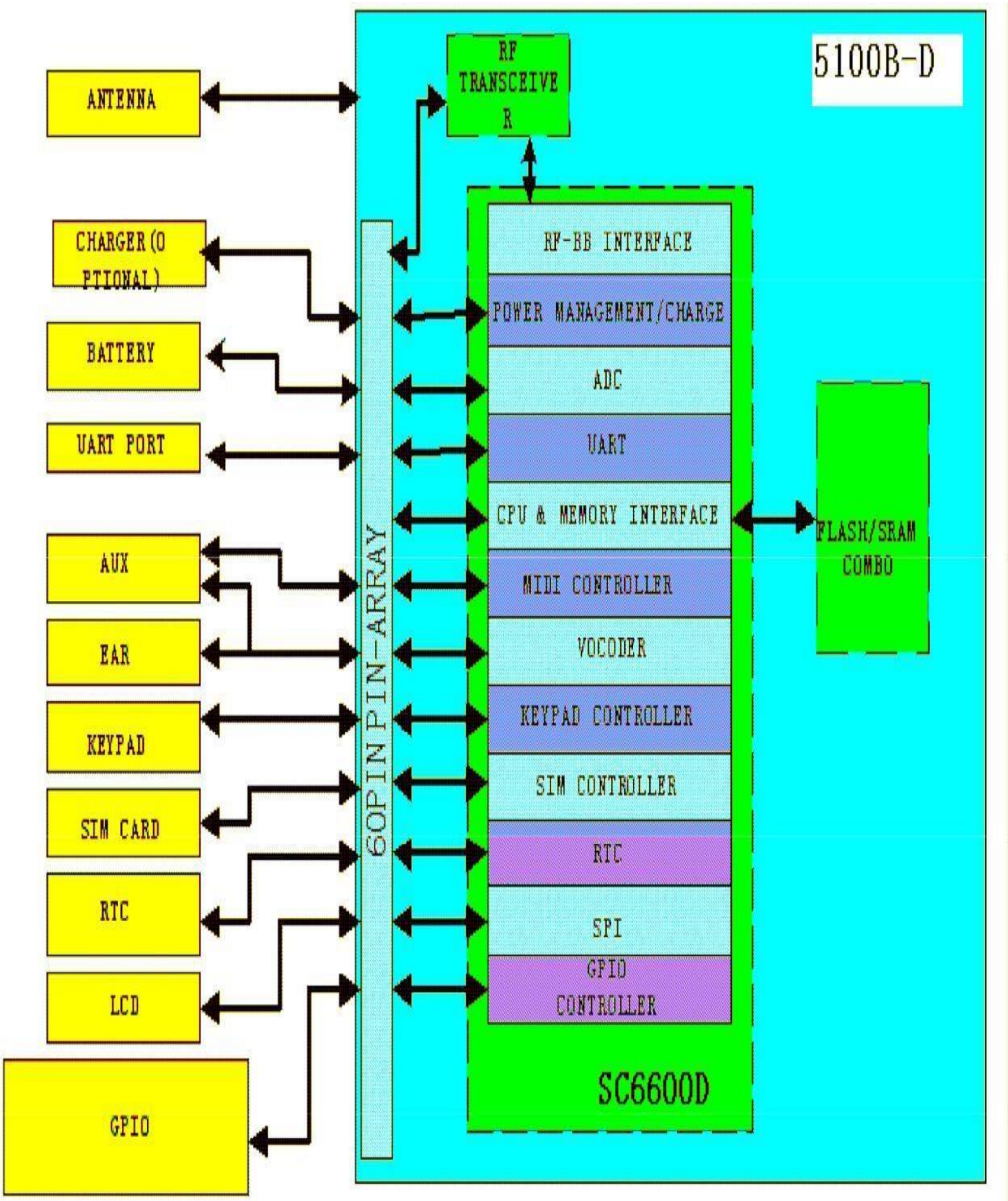
Features

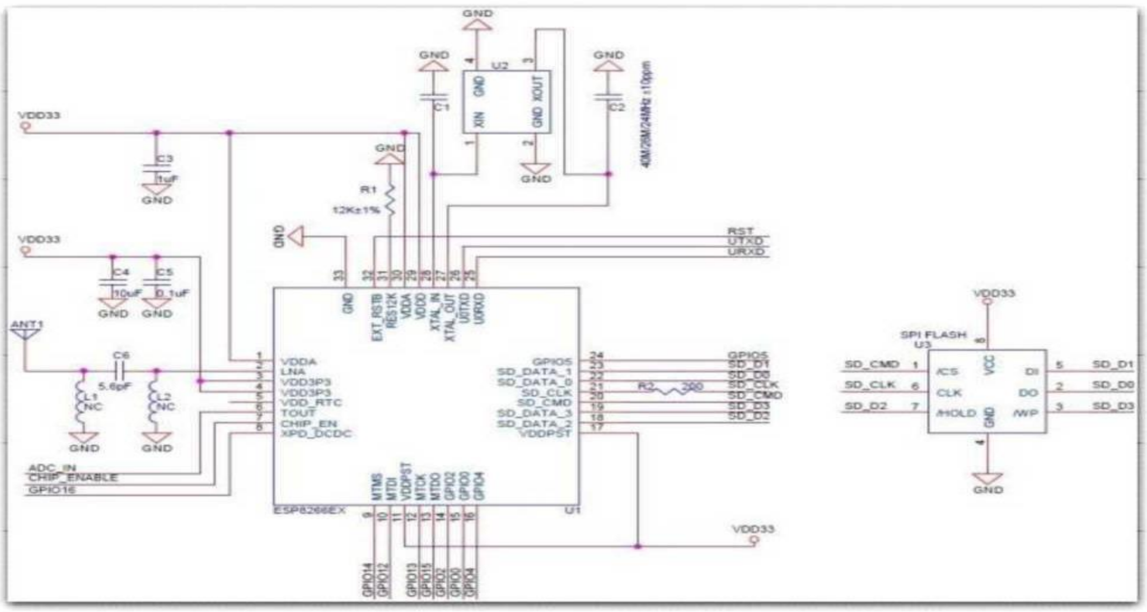
- 802.11 b/g/n
- Integrated low power 32-bit MCU
- Integrated 10-bit ADC
- Integrated TCP/IP protocol stack
- Integrated TR switch, balun, LNA, power amplifier and matching network
- Integrated PLL, regulators, and power management units
- Supports antenna diversity
- Wi-Fi 2.4 GHz, support WPA/WPA2
- Support STA/AP/STA+AP operation modes
- Support Smart Link Function for both Android and iOS devices
- Support Smart Link Function for both Android and iOS devices
- SDIO 2.0, (H) SPI, UART, I2C, I2S, IRDA, PWM, GPIO
- STBC, 1x1 MIMO, 2x1 MIMO
- A-MPDU & A-MSDU aggregation and 0.4s guard interval
- Deep sleep power < 5uA

ESP-12E PIN CONFIGURATION

Figure :- 3.12

Figure :- 3.13



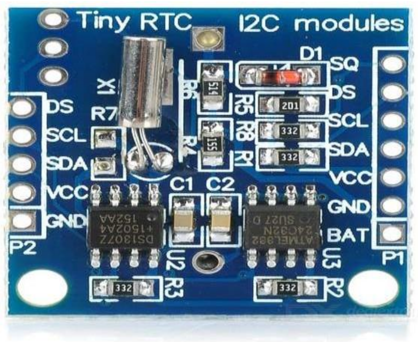


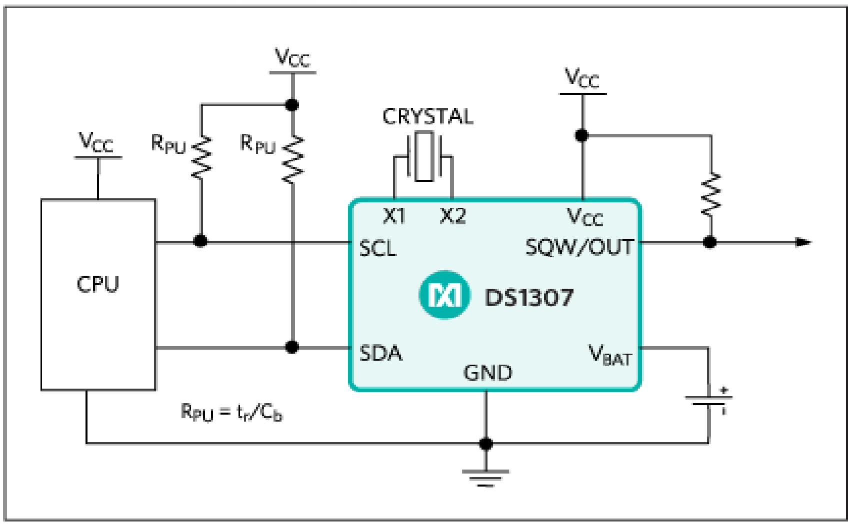
Schematics of Esp-12E Wi-Fi Module

Figure :- 3.14 Schematic representation of gsm module

Figure :- 3.15

3.9 DS1307 serial real-time clock (RTC)





DS1307: Typical Operating Circuit

Figure :- 3.16 & 3.17

Key Features

- Completely Manages All Timekeeping Functions
    - Real-Time Clock Counts Seconds, Minutes, Hours, Date of the Month, Month, Day of the Week, and Year with Leap-Year Compensation Valid Up to 2100
    - 56-Byte, Battery-Backed, General-Purpose RAM with Unlimited Writes
    - Programmable Square-Wave Output Signal
- Simple Serial Port Interfaces to Most Microcontrollers
    - I^{2}C Serial Interface
- Low Power Operation Extends Battery Backup Run Time
    - Consumes Less than 500nA in Battery-Backup Mode with Oscillator Running
    - Automatic Power-Fail Detect and Switch Circuitry
- 8-Pin DIP and 8-Pin SO Minimizes Required Space

- Optional Industrial Temperature Range: -40°C to +85°C Supports Operation in a Wide Range of Applications

Underwriters Laboratories (UL) Recognized.

CHAPTER 4

PROJECT METHODOLOGY, UNDERSTANDING & SYSTEM DESIGN

4.1 System Architecture & Design

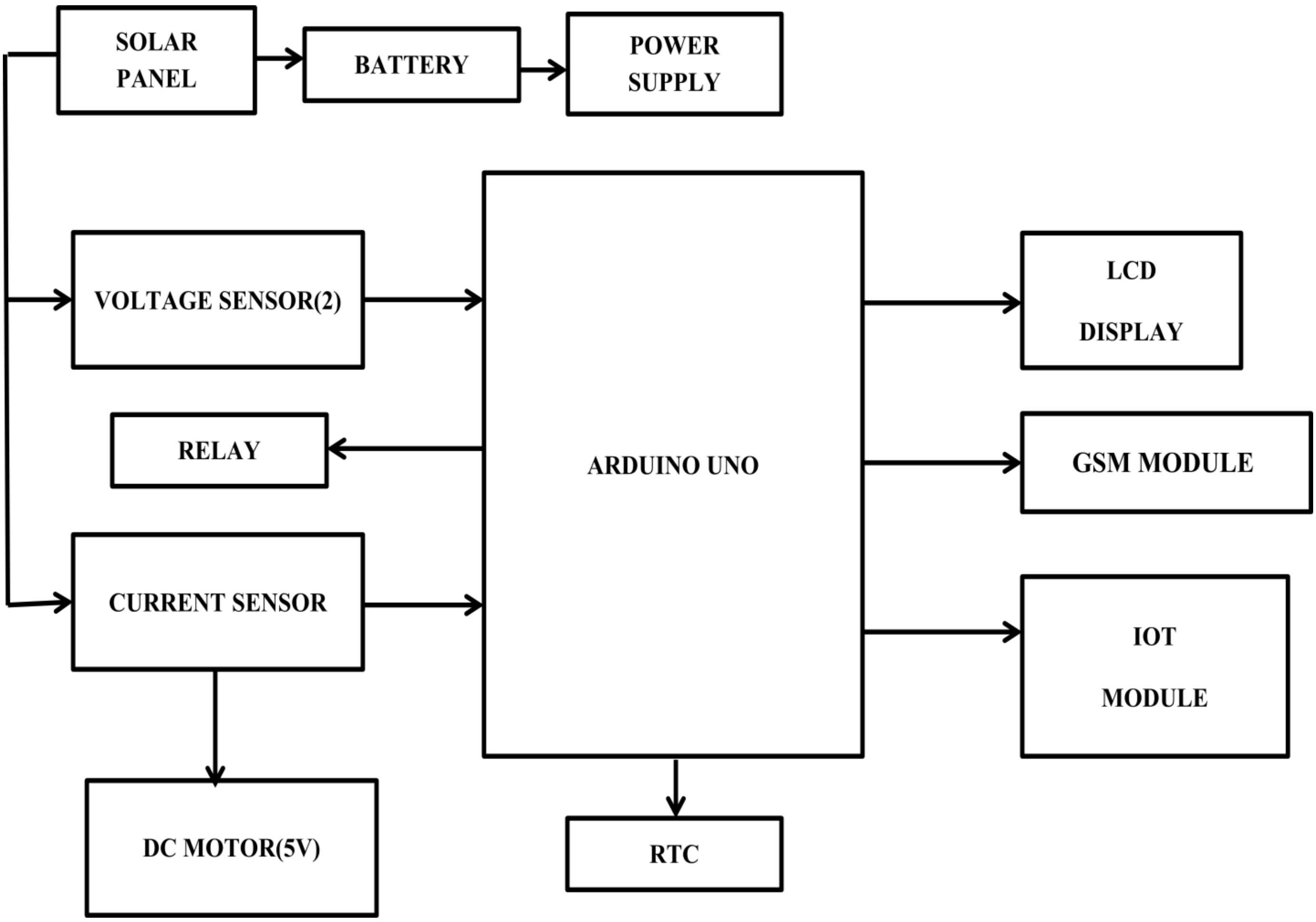


Figure :- 3.18

4.2 METHODOLOGY

FLOW CHART FOR PROPOSED MODEL

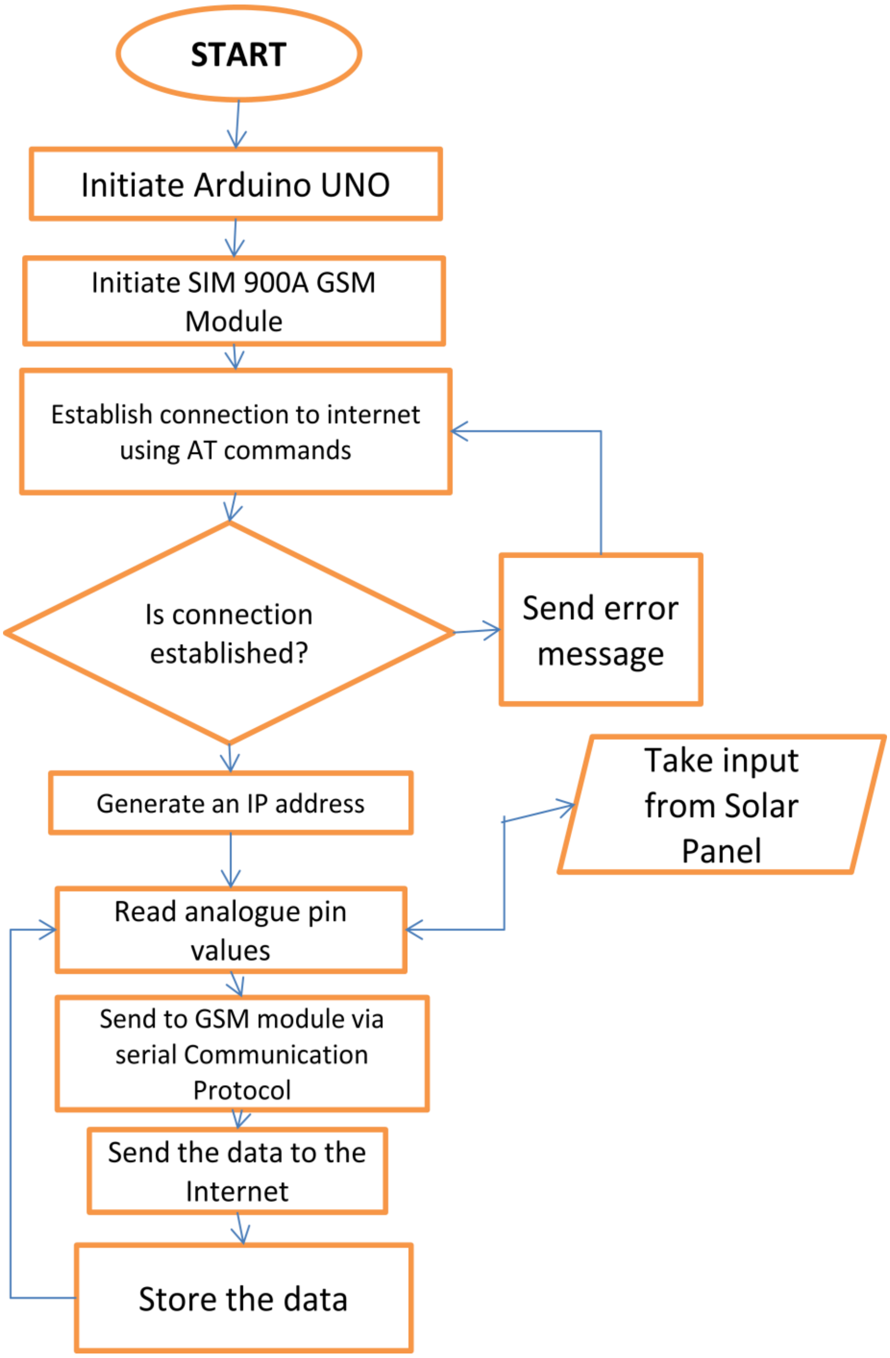


Figure :- 3.19

4.3 WORKING PRINCIPLE:

The micro-controller is a component which presents as the brain of the entire system. This is used to monitor and recuperate all the operations of the hardware and then it is interfaced with the controller. The voltage (v) and current (i) sensor is used to measure the output values from the solar panel. The battery is connected to a relay for the power generation during night time and the interfacing dc motor to show the power that we are getting from panel and RTC is used for automatic switching of relay according to time. All the operations are displayed on the LCD and monitored in the IOT module. Initial value fetch from the voltage and current sensor of the solar panel is reduced day by day so that reduction of life of the solar panel can be monitored and presented by IOT.

4.4 Step by Step work done to insure working of model

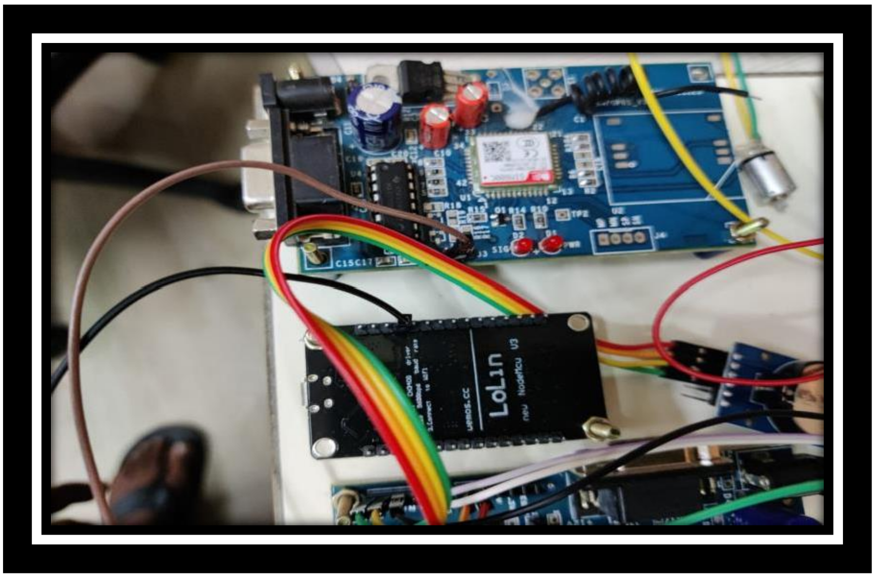
- Identification & differentiation between different gates and ports of Arduino.
- Preparing an Embedded C program to make the project functional.
- Working out different codes to improve voltage, Current & temperature parameters.
- Implementation of MPPT (MAXIMUM POWER POINT TRACKING) Algorithm in Photovoltaic cell.
- Setting up Wireless link between IOT module and display
- Setup and configuration of Solar panel and determination of its output.
- Continuation on working on the Embedded C code to program the Arduino.

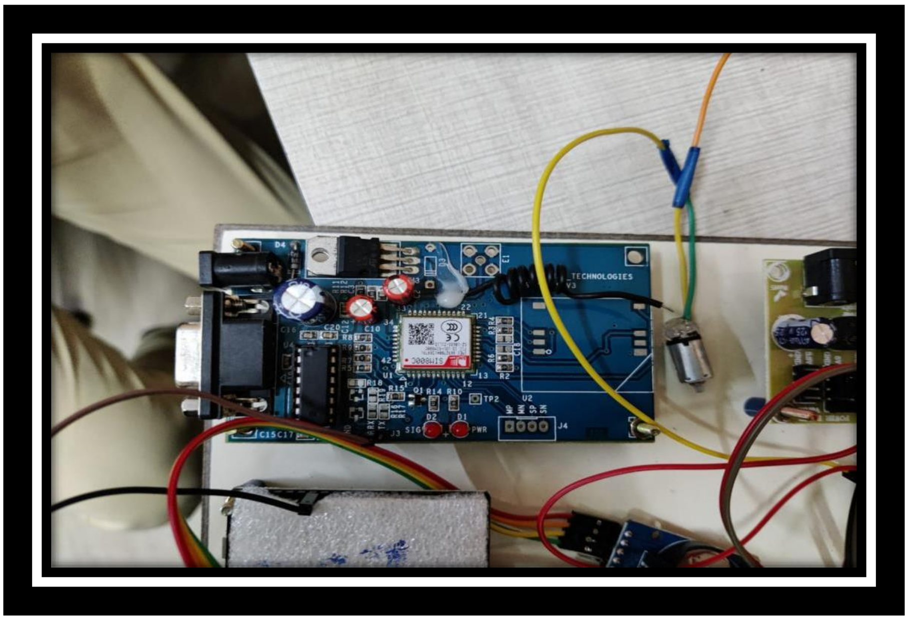
- Setting up a link for communication between solar panel, Arduino, IOT & message receiver.
- Assembly and testing of the sensors present in the model.
- Configuring the sensors and determination of their maximum value.

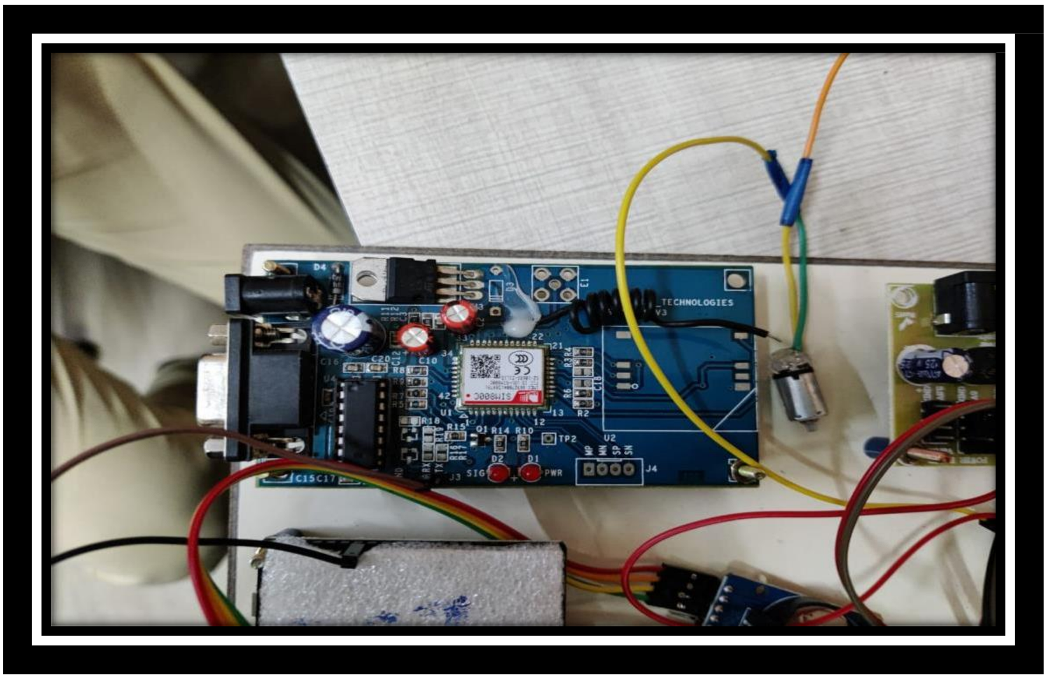
CHAPTER 5

MODEL PROJECT WORKING/ DEMONSTRATION

5.1 Working Model with Pictorial Representations



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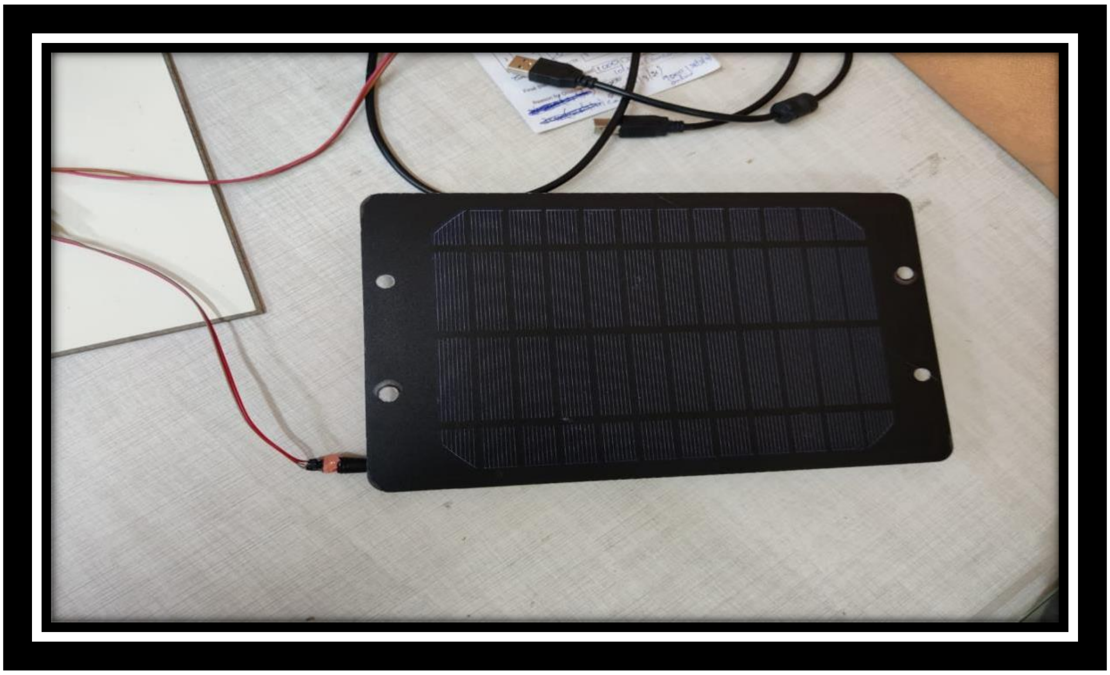
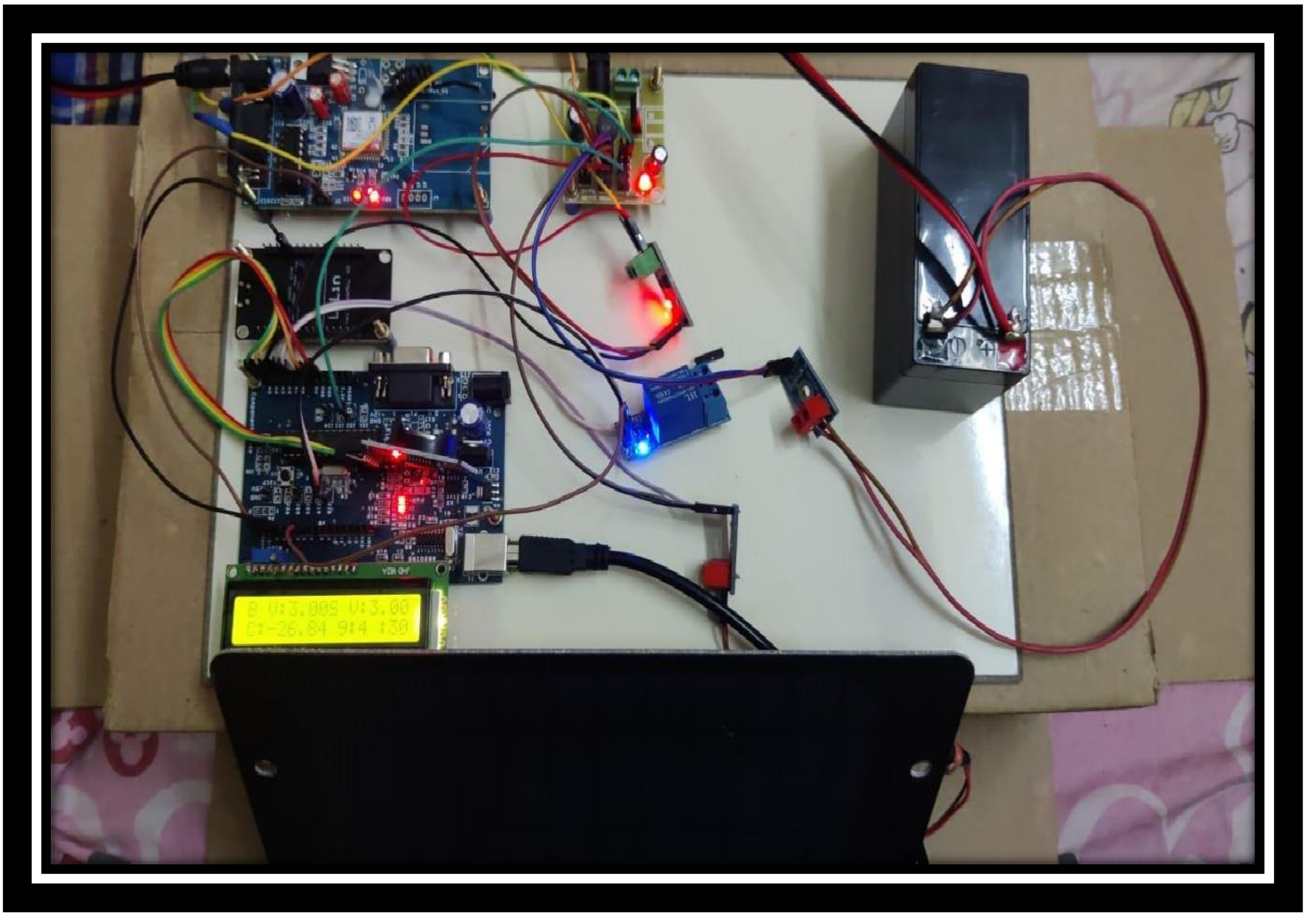
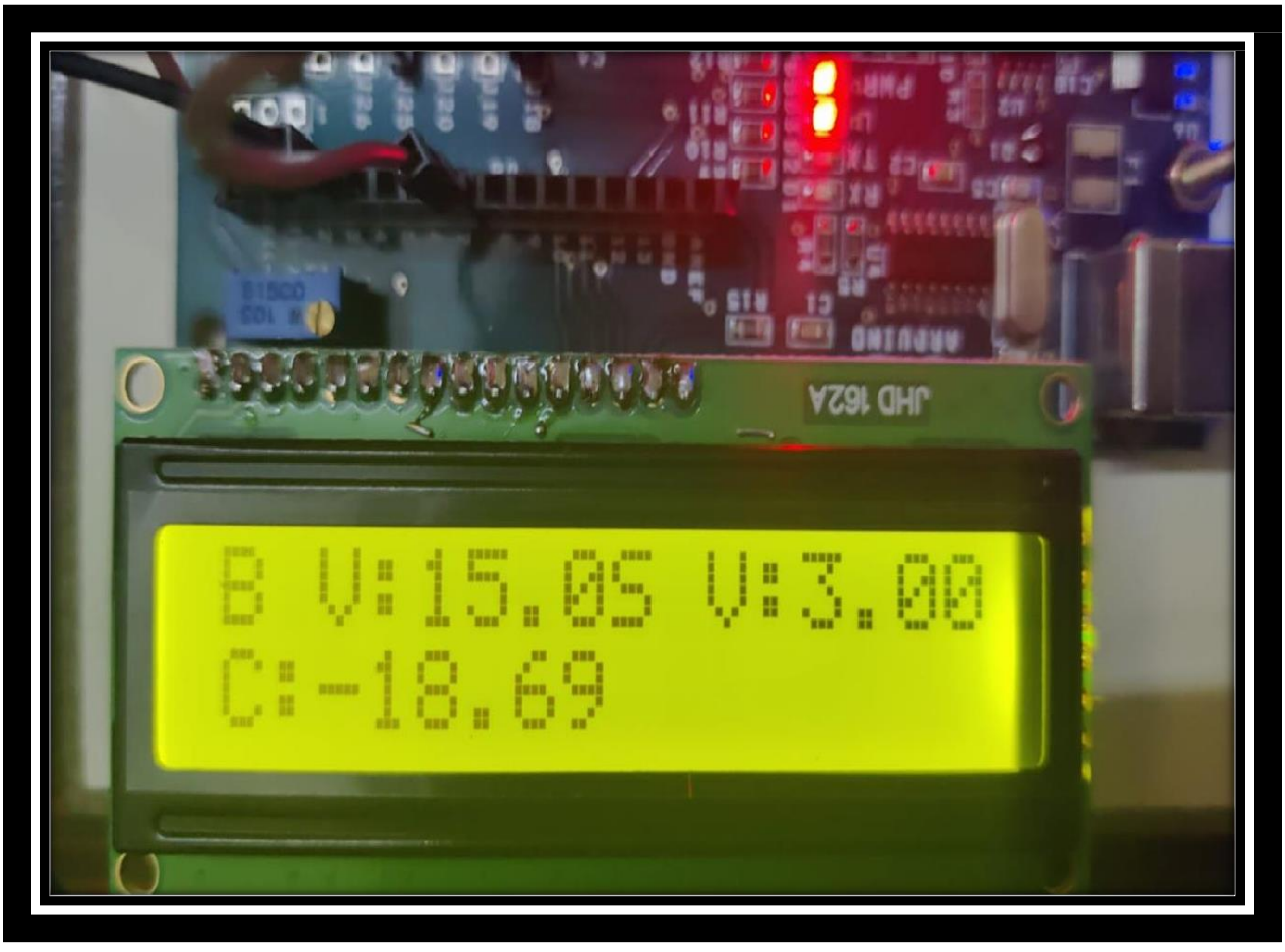



B V:3.005 V:3.00
C:-26.84 9:4 :30


JHD 162A
ARDUINO
B V:15.05 V:3.00
C:-18.69

5.2 Coding (Embedded C)

File Edit Sketch Tools Help

ITWI05

```
#include"lcd.h"
#include"rtc.h"
#include"gsm.h"
#include"iot.h"

#define battery_volt A1
#define solar_volt A2
#define current A3

#define relay 7

float batt_volt = 0;
float sol_volt = 0;

void setup()
{
  Serial.begin(9600);
  iot.begin(9600);
  lcd.begin(16, 2);
  rtc_begin();
  pinMode(battery_volt, INPUT);
  pinMode(solar_volt, INPUT);
  pinMode(current, INPUT);
  pinMode(relay, OUTPUT);
  digitalWrite(relay, LOW);
  lcd.clear();
  lcd.setCursor(0, 0);
```

File Edit Sketch Tools Help

Upload

ITWI05

```
  lcd.print("smart energy");
  lcd.setCursor(0, 1);
  lcd.print("monitoring");
  delay(2000);
}

void loop()
{
  ////////////////////////VOLTAGE SENSOR////////////////////////////

  batt_volt = (analogRead(battery_volt) * 25) / 1023;
  sol_volt = (analogRead(solar_volt) * 25) / 1023;

  ////////////////////////CURRENT SENSOR////////////////////////////

  unsigned int x = 0;
  float AcsValue = 0.0, Samples = 0.0, AvgAcs = 0.0, AcsValueF = 0.0;

  for (int x = 0; x < 150; x++)
  { //Get 150 samples
    AcsValue = analogRead(A0);      //Read current sensor values
    Samples = Samples + AcsValue;  //Add samples together
    delay (3);                     // let ADC settle before next sample 3ms
  }
  AvgAcs = Samples / 150.0;        //Taking Average of Samples

  //((AvgAcs * (5.0 / 1024.0)) is converitng the read voltage in 0-5 volts
```

File Edit Sketch Tools Help

ITWI05

```
AvgAcs = Samples / 150.0;        //Taking Average of Samples

//((AvgAcs * (5.0 / 1024.0)) is converitng the read voltage in 0-5 volts
//2.5 is offset(I assumed that arduino is working on 5v so the viout at no current comes
//out to be 2.5 which is out offset. If your arduino is working on different voltage than
//you must change the offset according to the input voltage)
//0.185v(185mV) is rise in output voltage when 1A current flows at input
AcsValueF = -(6.0 - (AvgAcs * (12.0 / 1024.0)) ) / 0.185;

//////////LCD DISPLAY/////////////
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("B V:");
lcd.setCursor(4, 0);
lcd.print(batt_volt);
lcd.setCursor(8, 0);
lcd.print("S V:");
lcd.setCursor(12, 0);
lcd.print(sol_volt);
lcd.setCursor(0, 1);
lcd.print("C:");
lcd.print(AcsValueF);
delay(1000);

rtc_check();
iot_send("*Battery Voltage:" + String(batt_volt) + ",Solar Voltage:" + String(sol_volt) + "#");
```

File Edit Sketch Tools Help

ITWI05

```
    send_sms("8897668373", "DAY TIME, SOLAR SUPPLY");
  }
  if ((Min == 4) && (Sec < 10))
  {
    digitalWrite(7, LOW);
    lcd.clear();
    lcd.setCursor(2, 0);
    lcd.print("NIGHT TIME");
    lcd.setCursor(0, 1);
    lcd.print("BATTERY SUPPLY");
    iot_send("*NIGHT TIME, BATTERY SUPPLY#");
    send_sms("8897668373", "NIGHT TIME, BATTERY SUPPLY");
  }

  if (sol_volt < 3)
  {
    lcd.clear();
    lcd.setCursor(1, 0);
    lcd.print("    VOLTAGE  ");
    lcd.setCursor(3, 1);
    lcd.print("  VALUE DROP ");
    delay(2000);
    send_sms("8897668373", "SOLARPANEL VOLTAGE VALUE DROPPED");
  }

  delay(1000);
}
```

CHAPTER 6

Results/ Model Graph/ Readings

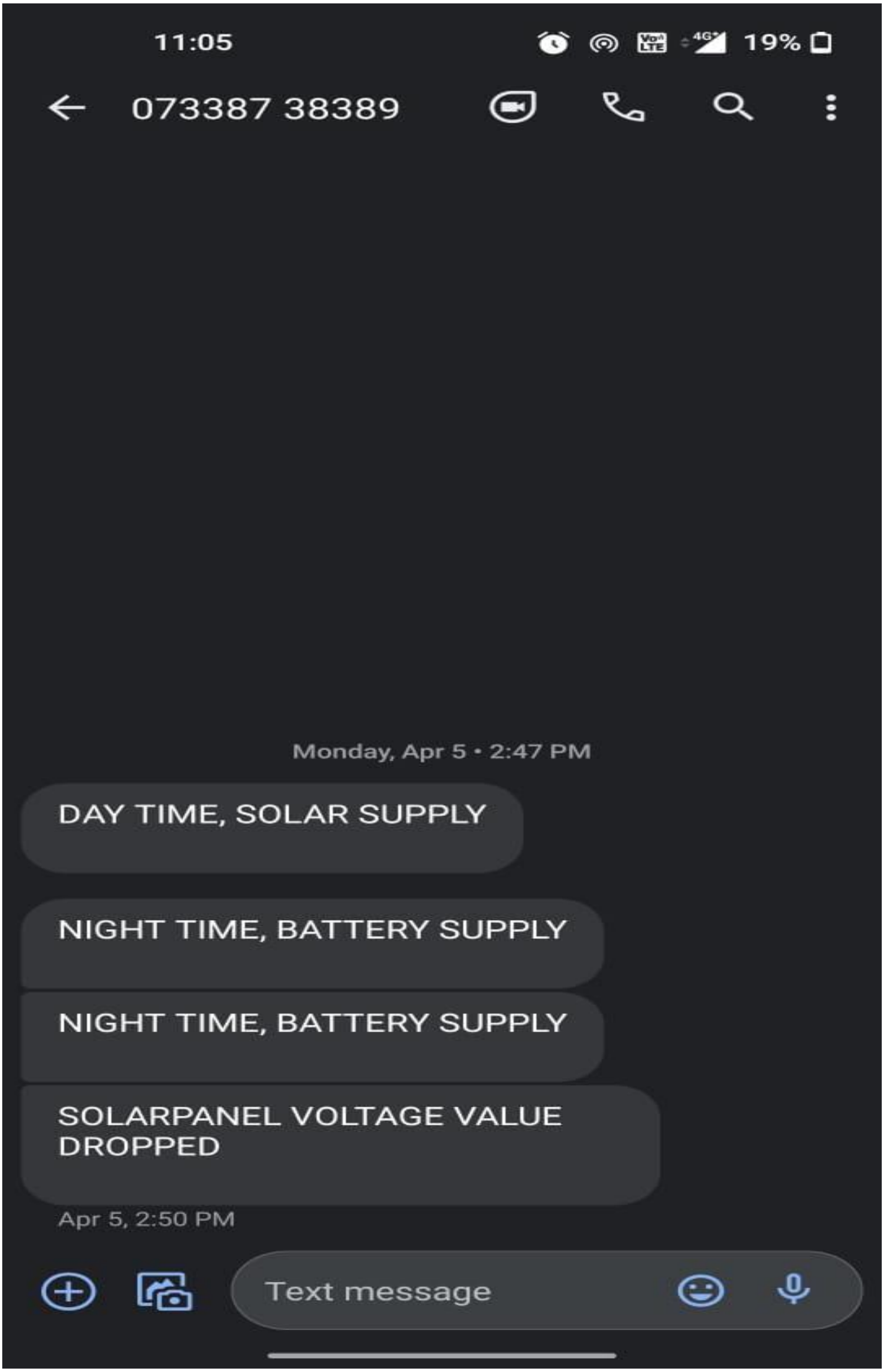
6.1 Real time Voltage and Current READINGS

Clearlog

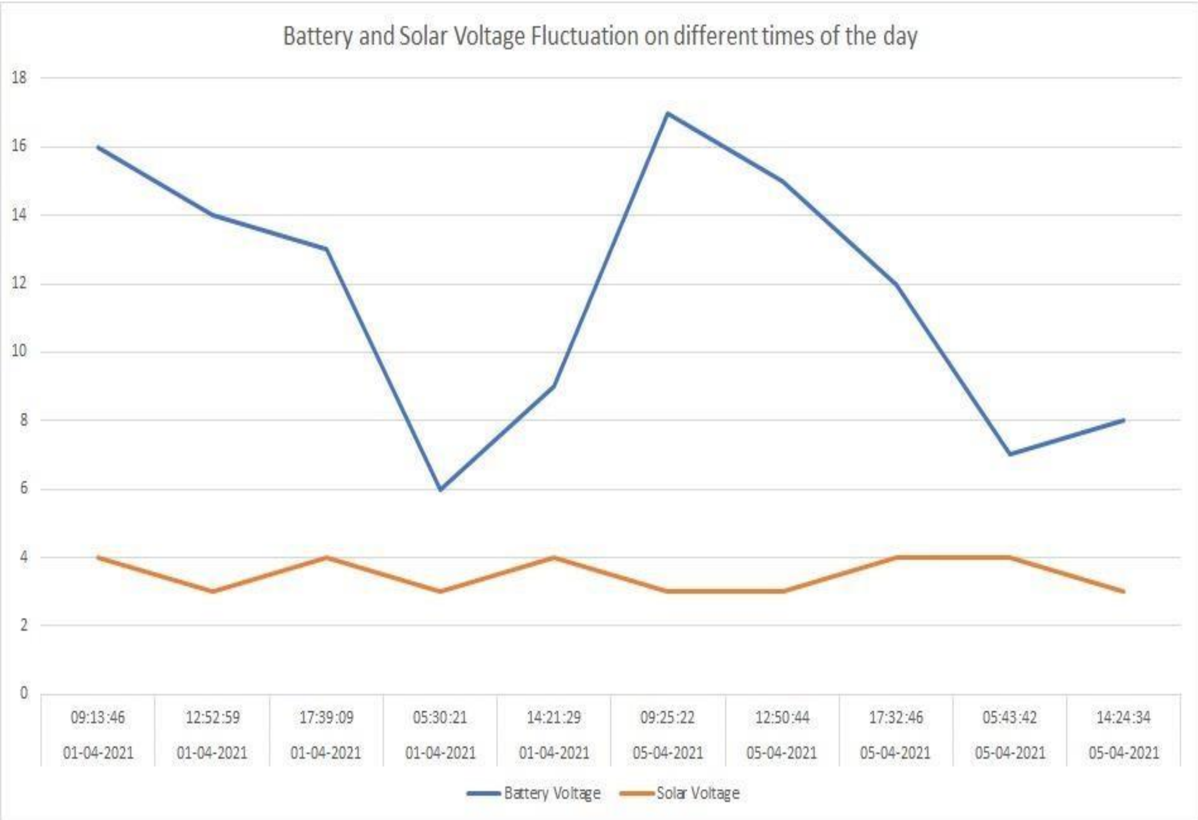
LogID	DATA	DATE TIME
1	Battery_Voltage:15.00,Solare:3.00	13/5/2021 10:50:29
2	Battery_Voltage:15.00,Solar_Voltage:3.00	13/5/2021 10:50:31
3	Battery_Voltage:15.00,Solar_Voltage:3.00	13/5/2021 10:50:38
4	Battery_Voltage:15.00,Solar_Voltage:3.00	13/5/2021 10:50:40
5	Battery_Voltage:15.00,Solar_Voltage:3.00	13/5/2021 10:50:42
6	Battery_Voltage:15.00,Solar_Voltage:3.00	13/5/2021 10:50:44
7	Battery_Voltage:15.00,Solar_Voltage:3.00	13/5/2021 10:50:46
8	Battery_Voltage:15.00,Solar_Voltage:2.00	13/5/2021 10:50:48
9	Battery_Voltage:15.00,Solar_Voltage:3.00	13/5/2021 10:50:50
10	Battery_Voltage:15.00,Solar_Voltage:3.00	13/5/2021 10:50:52
11	Battery_Voltage:15.00,Solar_Voltage:2.00	13/5/2021 10:50:54
12	Battery_Voltage:15.00,Solar_Voltage:3.00	13/5/2021 10:50:58
13	Battery_Voltage:15.00,Solar_Voltage:3.00	13/5/2021 10:51:1
14	Battery_Voltage:15.00,Solar_Voltage:2.00	13/5/2021 10:51:5
15	Battery_Voltage:15.00,Solar_Voltage:3.00	13/5/2021 10:51:13
16	Battery_Voltage:15.00,Solar_Voltage:2.00	13/5/2021 10:51:17
17	Battery_Voltage:15.00,Solar_Voltage:3.00	13/5/2021 10:51:26
18	Battery_Voltage:15.00,Solar_Voltage:3.00	13/5/2021 10:51:29
19	Battery_Voltage:15.00,Solar_Voltage:3.00	13/5/2021 10:51:33
20	Battery_Voltage:15.00,Solar_Voltage:3.00	13/5/2021 10:51:36
21	Battery_Voltage:15.00,Solar_Voltage:3.00	13/5/2021 10:51:44
22	Battery_Voltage:15.00,Solar_Voltage:3.00	13/5/2021 10:51:46
23	Battery_Voltage:15.00,Solar_Voltage:3.00	13/5/2021 10:51:48

22	Battery_Voltage:15.00,Solar_Voltage:3.00	13/5/2021 10:51:46
23	Battery_Voltage:15.00,Solar_Voltage:3.00	13/5/2021 10:51:48
24	Battery_Voltage:15.00,Solar_Voltage:2.00	13/5/2021 10:51:50
25	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:51:59
26	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:52:3
27	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:52:6
28	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:52:10
29	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:52:13
30	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:52:17
31	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:52:20
32	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:52:24
33	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:52:27
34	DAY_TIME, SOLAR_SUPPLY	13/5/2021 10:52:29
35	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:52:34
36	DAY_TIME, SOLAR_SUPPLY	13/5/2021 10:52:36
37	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:52:41
38	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:52:44
39	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:52:48
40	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:52:52
41	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:52:55
42	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:52:59
43	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:53:2
44	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:53:6
45	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:53:9
46	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:53:13
47	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:53:20
48	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:53:22
49	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:53:24
50	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:53:27
51	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:53:30
52	Battery_Voltage:16.00,Solar_Voltage:3.00	13/5/2021 10:53:34

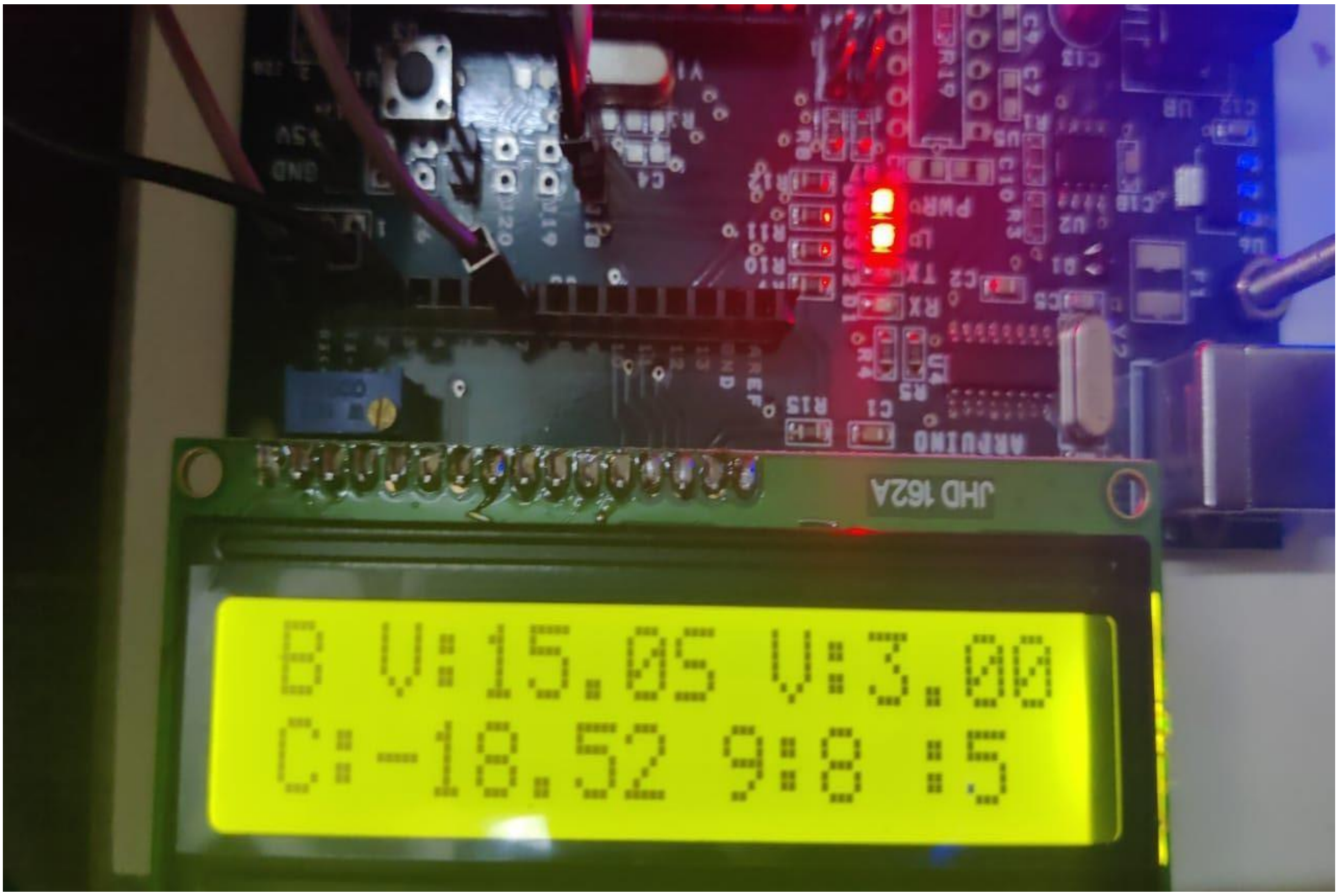
6.2 Real time Messages on mobile



6.3 Real time Graph comparison w.r.t day and Night



6.4 Real time voltage and current on LCD display



CHAPTER 7

CONCLUSION

7.1 Applications

- Monitoring heat and efficiency on busy streets during the day while charging and maintaining steady output of current and voltage during night.
- Used in Solar heaters and can detect over heating.
- Used in new generation solar Electric Vehicles to maintain steady flow of power.
- Used in mass production of electricity at solar power generating farms.

7.2 Future Scopes

- In the coming years, technology improvements will ensure that solar becomes even cheaper.
- It could well be that by 2030, solar will have become the most important source of energy for electricity production in a large part of the world. This will also have a positive impact on the environment and climate change.
- Going forward the solar industry has very clear cost-reduction roadmaps, which should see solar costs halving by 2030.
- There is already a move in place towards higher-efficiency modules, which can generate 1.5 times more power than existing, similarly sized modules today using a technology called tandem silicon cells. These are going to have a large impact going forward.
- In addition, there are production innovations coming down the pipeline that will reduce the amounts of costly materials such as silver and silicon used in the manufacture of solar cells, as well as innovations such as bifacial modules which allow panels to

capture solar energy from both sides. The other important innovation is around how best to integrate solar into our homes, businesses and power systems. This means better power electronics and a greater use of low-cost digital technologies.

7.3 Demo Link

Drive Link for the Project Demo

https://drive.google.com/file/d/1PfDmRNowaX_hx6JLiAe_cepfWRQUKPEb/view

7.4 Conclusion

- Utilization of IoT for monitoring of a solar power plant is a vital step as day by day renewable energy sources are getting incorporated into utility grid. Thus automation and intellectualization of solar power plant monitoring will intensify future decision making process for large scale solar power plant and grid integration of such plants.

- We suggested an IoT based remote monitoring system for solar power plant, the approach is studied, implemented and successfully attained.

- The remote transmission of data to a server for management. IoT based remote monitoring will upgrade energy effectiveness of the system by making use of low power consuming advanced wireless modules thereby decreasing the carbon foot print.
- Web Console based interface will reduce time of manual monitoring and aid in the process of scheming task of plant management.
- A provision of advance remotely manage the Solar PV plants of various operations like remote shutdown, remote management is to be integrated with this system later.

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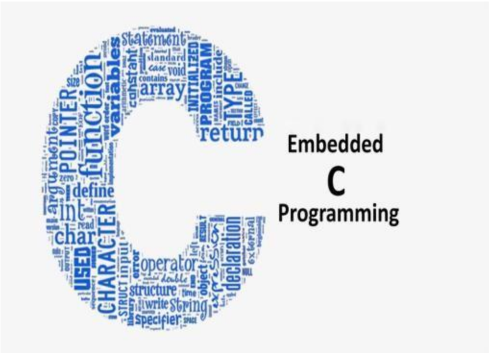
- [3] Byeongkwan Kang, Sunghoi Park,Tacklim Lee, and Sehyun Park,(2015)” IoT-Based Monitoring System using Tri-Level Context Making Model for Smart Home Services”, IEEE International Conference onConsumer Electronics (ICCE).
- [4] Marijana Vidas-Bubanja (2014) “Implementation of Green ICT for Sustainable Economic Development”, International Conference on Control, Instrumentation, Energy & Communication (CIEC)



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