Smart Control System
For
Solar Home Automation Using Mobile Phone

The degree of Bachelor of Science
In
Electronics and Telecommunication Engineering

Department of ECE
East West University, Dhaka Bangladesh

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DECLARATION

We hereby declare that we carried out the work reported in this project in the Department of Electronics and Communications Engineering, East West University, under the supervision of **Dr. Md. Habibur Rahman**. We solemnly declare that to the best of our knowledge, no part of this report has been submitted elsewhere for award of a degree. All sources of knowledge used have been duly acknowledged.

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CERTIFICATE

This is to certify that the project entitled **"Smart Control System For Solar Home Automation Using Mobile Phone"** is being submitted by **Md. Shamim Ahmed**, **Imam Hossain Jowel and Kazi Asfiqur Rahman Asik** of Electronics and Communications Engineering Department, East West University, Dhaka in partial fulfillment for the award of the degree of Bachelor of Science in Electronics and Telecommunication Engineering, is a record of project carried out by them. They have worked under my supervision and guidance and have fulfilled the requirements which to my knowledge have reached the requisite standard for submission of this dissertation.

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ABSTRACT

As the sources of conventional energy are consuming day by day, resorting to alternative sources of energy like solar and wind energy has become our main concern. Now a days using solar panel to preserve the solar power as electricity is one of the most popular way. Solar-powered home appliance systems are already available in rural as well as urban areas. Solar charge controller and the load of the battery is the core of the main solar system. Charge controller plays an important role as the battery's overall life depends mainly on it. In this point of view, this project presents designing a Solar Charge Controller for the Solar Battery and combines it with an Android device by which one can easily control the function of connecting and disconnecting the battery and load during battery over charging or discharging as well as the capacity to control intensity of the home appliances according to the load of the battery. Mosfets are used as switch to ON & OFF the battery and load. To control the intensity an optocoupler and a mosfet are used. Here Optocoupler is used for better isolation. Instead of using readily available microcontroller board, here Arduino microcontroller (2560) has been used to make the system cost-effective. The source code for the Arduino microcontroller is written in Arduino software. Furthermore, a blutooth device (HC-05) is used to connect with the android device. The system has been simulated and practically implemented. Performance study of the system shows that it works properly within the range 10 meter distance for a 12 V battery providing 2A electricity.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Solar power is arguably the cleanest, most reliable form of renewable energy available, and it can be used in several forms to help power our home or business. Solar-powered photovoltaic (PV) panels convert the sun's rays into electricity. This electricity can then be used to supply as renewable energy to our home or business.

In solar power system, charge controller is the heart of the system which is designed to protect the rechargeable battery. Solar power have the advantage of being less maintenance and pollution free but their main drawbacks is high fabrication cost, low energy conversion efficiency. Since solar panels still have relatively low conversion efficiency, the overall system cost can be reduced using a efficient solar charge controller which can extract the maximum possible power from the panel .

In our country most of the people are living in rural areas where national grid transmission line is not reached till now. The existing electric grids are not capable of fulfilling the requirement of electricity. So renewable energy sources like Photo Voltaic panels and wind-generators are the best options. Besides in urban areas practicing of using solar power system is increasing day by day. But the procedure of using solar power charge controller remains conventional. Still it is being operated manually. We can easily create an automation with charge controlling system through our mobile handset and get a simple way to operate this.

1.2 LITERATURE SURVEY

With the development of the electronics technology in the last two decades, a new concept called Smart Home has become prevalent. In line with this concept of smart home, people have been trying to control their home appliances automatically. With the recent rapidly advancing mobile communication technology and the decrease in costs has also made it possible to remotely control our home appliances. On the other hand, to meet the requirement of increasing amount of electricity people are in search of most possible ways. They are inventing new technologies that can create power supply. Solar power energy is the most efficient way among them. So advancing this system and finding more efficient way to use this is still going on.

Though the concept of combining the home appliance system with the solar charge controller is almost new there are several works previously done in both of these fields. Deba [1] created a solar power that was designed to protect the rechargeable battery. He also created another[2] charge controller system that was designed to increase the efficiency level and having a display that describes the present condition of the charge controller. Marufa [3] proposed a design of smart Charge controller for the solar battery charging station to prevent the battery for destruction and to enhance the efficiency and to used in it home system. Sriskanthan [4] introduced a home automation system that

can control home appliances from a PC using Bluetooth. However, the system cannot be controlled by the cell phone. Abhishek [5] proposed the System of Home Appliance where intensity of light and fan can be controlled through a smart phone using Bluetooth device.

1.3 MOTIVATION

Solar power generating systems absorb sunlight and convert it into electricity that we can use. Every second, the sun sends about 42 trillion kilocalories of energy to the Earth. If we could convert 100% of this solar energy into electricity, we could create one year's worth of power for the entire planet in a single hour. For this we need a source where we can accumulate this energy. We use battery, but batteries are only the most vulnerable part of the system. No battery can overcome the faults of a bad charging system. Best battery performance is achieved when the characteristics of the battery are matched to the charging source. This is the job of the charge control system. Besides the using of smart phone is increasing in a large numbers. If we can create a combination between this solar charge controller and the smart phone it will be lot easier to the users to operate the system. Considering all these we are motivated to do this project as it will help our people in several ways.

1.4 OBJECTIVES

Now a day's mobile phone is a part and parcel of our daily life. We can control every electronic device of our home like increasing the intensity of Light, Fan, AC, etc within shortage range by using mobile phone through apps(ardudroid). In this project, we describe how to control and designing a smart home appliance control system which is based on microcontroller. We design a system which can turn on and off   without any switch. We can apply this system in any big office, industry, shop or university classroom etc. It also used for secured our home or workplace.
The followings are the objectives of this project to ensure it meets the aim.

- To design a control system for solar home application using bluetooth device.
- To design a circuit that can efficiently control different appliances connected to the
- Smart control system.
- To design a circuit that can automatically switch ON and OFF the solar home
- appliance using mobile phone through apps
- To test our designed system with a wide range of electrical and electronic
- Equipment and troubleshoot any errors.

CHAPTER 2

THEORETICAL BACKGROUND

2.1 PV PANEL

Solar cells, also called photovoltaic (PV) cells by scientists, convert sunlight directly into electricity. PV gets its name from the process of converting light (photons) to electricity (voltage), which is called the PV effect. In a photovoltaic cell, light excites electrons to move from one layer to another through semi-conductive silicon materials. This produces an electric current.

Solar cells called photovoltaic made from thin slices of crystalline silicon, gallium arsenide, or other semiconductor materials convert solar radiation directly into electricity. Cells with conversion efficiencies greater than 30 percent are now available. By connecting large numbers of these cells into modules, the cost of photovoltaic electricity has been reduced to 20 to 30 cents per kilowatt-hour. Americans currently pay 6 to 7 cents per kilowatt-hour for conventionally generated electricity.

The simplest solar cells provide small amounts of power for watches and calculators. More complex systems can provide electricity to houses and electric grids. Usually though, solar cells provide low power to remote, unattended devices such as buoys, weather and communication satellites, and equipment aboard spacecraft.

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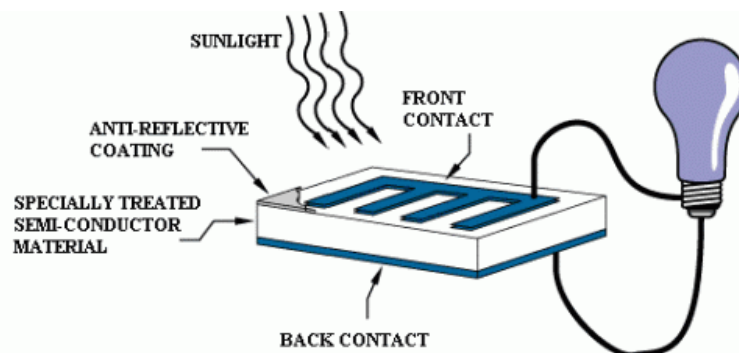
The diagram above illustrates the operation of a basic photovoltaic cell, also called a solar cell. Solar cells are made of the same kinds of semiconductor materials, such as silicon, used in the microelectronics industry. For solar cells, a thin semiconductor wafer is specially treated to form an electric field, positive on one side and negative on the other. When light energy strikes the solar cell, electrons are knocked loose from the atoms in the semiconductor material. If electrical conductors are attached to the positive and negative sides, forming an electrical circuit, the electrons can be captured in the form of an electric current -- that is, electricity. This electricity can then be used to power a load, such as a light or a tool.

A number of solar cells electrically connected to each other and mounted in a support structure or frame is called a photovoltaic module. Modules are designed to supply electricity at a certain voltage, such as a common 12 volts system. The current produced is directly dependent on how much light strikes the module.
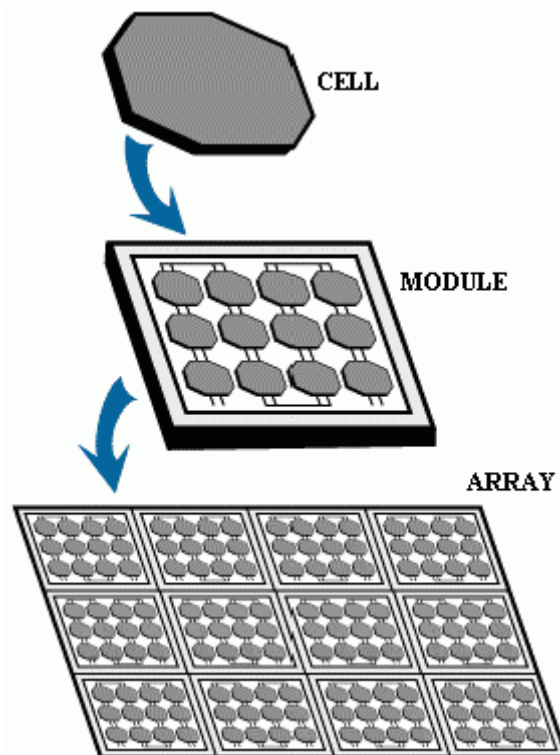
Figure 2.1 PV Panel

Multiple modules can be wired together to form an array. In general, the larger the area of a module or array, the more electricity that will be produced. Photovoltaic modules and arrays produce direct-current (dc) electricity. They can be connected in both series and parallel electrical arrangements to produce any required voltage and current combination.

Today's most common PV devices use a single junction, or interface, to create an electric field within a semiconductor such as a PV cell. In a single-junction PV cell, only photons whose energy is equal to or greater than the band gap of the cell material can free an electron for an electric circuit. In other words, the photovoltaic response of single-junction cells is limited to the portion of the sun's spectrum whose energy is above the band gap of the absorbing material, and lower-energy photons are not used. One way to get around this limitation is to use two (or more) different cells, with more than one band gap and more than one junction, to generate a voltage. These are referred to as "multi junction" cells (also called "cascade" or "tandem" cells). Multi junction devices can achieve a higher total conversion efficiency because they can convert more of the energy spectrum of light to electricity. A multi junction device is a stack of individual single-junction cells in descending order of band gap (Eg). The top cell captures the high-energy photons and passes the rest of the photons on to be absorbed by lower-band-gap cells. Much of today's research in multi junction cells focuses on gallium arsenide as one (or all) of the component cells. Such cells have reached efficiencies of around 35% under concentrated sunlight. Other materials studied for multi junction

devices have been amorphous silicon and copper indium diselenide. As an example, the multi junction device below uses a top cell of gallium indium phosphide, "a tunnel junction," to aid the flow of electrons between the cells, and a bottom cell of gallium arsenide.

2.2 CHARGE CONTROLLER

A charge controller, charge regulator or battery regulator limits the rate at which electric current is added to or drawn from electric batteries. It prevents overcharging and may prevent against overvoltage, which can reduce battery performance or lifespan, and may pose a safety risk. It may also prevent completely draining ("deep discharging") a battery, or perform controlled discharges, depending on the battery technology, to protect battery life. The terms "charge controller" or "charge regulator" may refer to either a stand-alone device, or to control circuitry integrated within a battery pack, battery-powered device, or battery recharger.

Charge controllers are sold to consumers as separate devices, often in conjunction with solar or wind power generators, for uses such as RV, boat, and off-the-grid home battery storage systems. In solar applications, charge controllers may also be called solar regulators.

Simple charge controllers stop charging a battery when they exceed a set high voltage level, and re-enable charging when battery voltage drops back below that level. Pulse width modulation (PWM) and maximum power point tracker (MPPT) technologies are more electronically sophisticated, adjusting charging rates depending on the battery's level, to allow charging closer to its maximum capacity. Charge controllers may also monitor battery temperature to prevent overheating. Some charge controller systems also display data, transmit data to remote displays, and data logging to track electric flow over time.
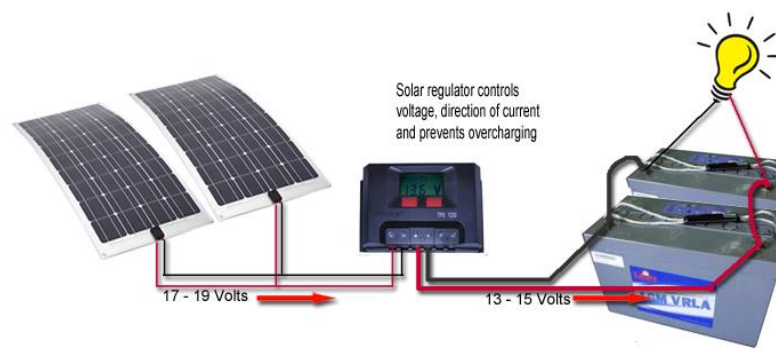

Figure-2.2 Solar Charge Controller

2.2.1 TYPES OF CHARGE CONTROLLER

1.ON/OFF

2. MPPT

3. PWM

The most basic charge controller (ON/OFF type) simply monitors the battery voltage and opens the circuit, stopping the charging, when the battery voltage rises to a certain level. Among the 3 charge controllers MPPT have highest efficiency but it is costly and need complex circuits and algorithm. But compared among them PWM charge controller is best for us which is treated as the first significant advance in solar battery charging.

2.2.2 TWO STAGE CHARGE CONTROLLER (ON/OFF)

One of the most popular types of charge controllers uses a simple ON/OFF series switch. Show in the Figure 2.1. The state of the switch is determined by two voltage thresholds. When the battery is bulk charging, the load switch is open and the full solar panel output is applied to the battery shown in Figure 2.3. When the upper threshold is reached, the load switch closes and the battery discharges through the load until the lower threshold is reached and the switch opens allowing the battery to charge once again.

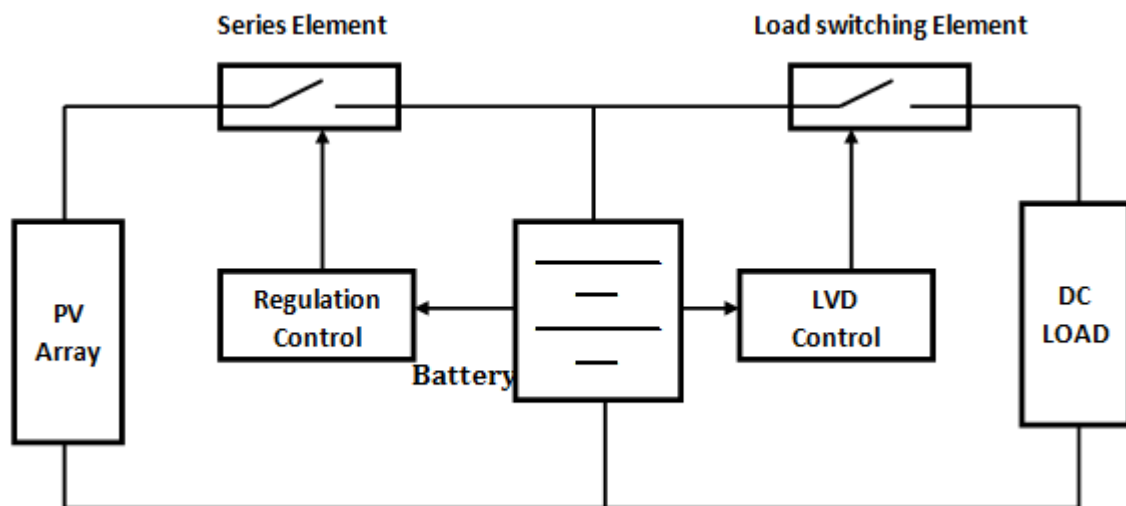**Figure 2.3 Two stage series charge controller**

In a series controller design, a relay or solid-state switch either opens the circuit between the array and the battery to discontinuing charging, or limits the current in a series-linear manner to hold the battery voltage at a high value. As these on-off charge cycles continue, the 'on' time becoming shorter and shorter as the battery becomes fully

charged. Because the series controller open-circuits rather than short-circuits the array as in shunt-controllers, no blocking diode is needed to prevent the battery from short-circuiting when the controller regulates.

While the specific control method and algorithm vary among charge controllers, all have basic parameters and characteristics. Manufacturers' data generally provide the limits of controller application such as PV and load currents, operating temperatures, losses, set points, and set point hysteresis values. In some cases, the set points may be dependent upon the temperature of the battery and/or controller, and the magnitude of the battery current. A discussion of the basic charge controller set points follows:

The battery voltage levels at which a charge controller performs control or switching functions are called the controller set points. Four basic control set points are defined for most charge controllers that have battery overcharge and over discharge protection features. The voltage regulation (VR) and the array reconnect voltage (ARV) refer to the voltage set points at which the array is connected and disconnected from the battery. The low voltage load disconnect (LVD) and load reconnect voltage (LRV) refer to the voltage set points at which the load is disconnected from the battery to prevent over discharge. Figure 2.2 shows the basic controller set points on a simplified diagram plotting battery voltage versus time for a charge and discharge cycle. A detailed discussion of each charge controller set point follows.

2.2.3 VOLTAGE REGULATION (VR) SET POINT

The voltage regulation (VR) set point is one of the key specifications for charge controllers. The voltage regulation set point is defined as the maximum voltage that the charge controller allows the battery to reach, limiting the overcharge of the battery. Once the controller senses that the battery reaches the voltage regulation set point, the controller will either discontinue battery charging or begin to regulate (limit) the amount of current delivered to the battery.
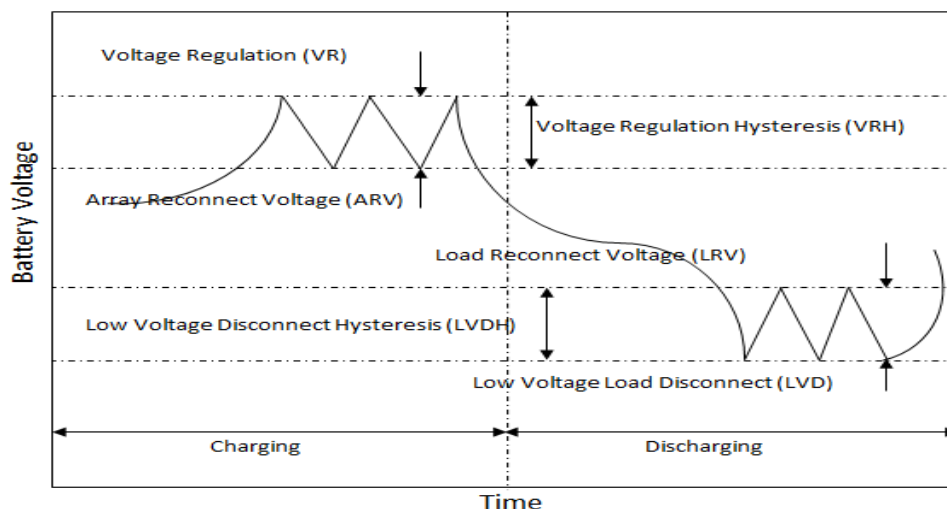

Figure 2.2 Controller set points

2.2.4 MAXIMUM POWER POINT TRACKING (MPPT)

A MPPT, or maximum power point tracker is an electronic DC to DC converter that optimizes the match between the solar array (PV panels), and the battery bank or utility grid. To put it simply, they convert a higher voltage DC output from solar panels (and a few wind generators) down to the lower voltage needed to charge batteries.

The Power point tracker is a high frequency DC to DC converter. They take the DC input from the solar panels, change it to high frequency AC, and convert it back down to a different DC voltage and current to exactly match the panels to the batteries. MPPT's operate at very high audio frequencies, usually in the 20-80 kHz range. The advantage of high frequency circuits is that they can be designed with very high efficiency transformers and small components.

The power point tracker (and all DC to DC converters) operates by taking the DC input current, changing it to AC, running through a transformer and then rectifying it back to DC, followed by the output regulator. In most DC to DC converters, this is strictly an electronic process, no real smarts are involved except for some regulation of the output voltage. Charge controllers for solar panels need a lot more smarts as light and temperature conditions vary continuously all day long, and battery voltage changes.

In the figure given below got from the Maui Solar Software "PV-Design Pro" computer program. we will see that it has a sharp peak at the upper right - that represents the maximum power point. What an MPPT controller does is "look" for that exact point, then does the voltage/current conversion to change it to exactly what the battery needs. In real life, that peak moves around continuously with changes in light conditions and weather.
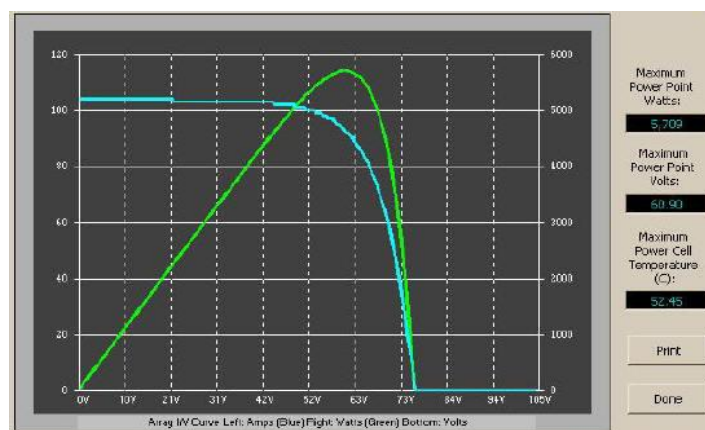

Figure 2.4 Controller set points

A MPPT tracks the maximum power point, which is going to be different from the STC (Standard Test Conditions) rating under almost all situations. Under very cold conditions a 120 watt panel is actually capable of putting over 130+ watts because the power output goes up as panel temperature goes down. But it will be lost if there is no

way of tracking that power point . On the other hand under very hot conditions, as the temperature goes up the power drops. That is why it gives less gain in summer.

2.2.5 PULSE WIDTH MODULATION(PWM)

Pulse Width Modulation (PWM) is the most effective means to achieve constant voltage battery charging by adjusting the duty ratio of the switches (MOSFET). In PWM charge controller, the current from the solar panel tapers according to the battery's condition and recharging needs. When a battery voltage reaches the regulation set point, the PWM algorithm slowly reduces the charging current to avoid heating and gassing of the battery, yet the charging continues to return the maximum amount of energy to the battery in the shortest time.

2.2.6 How does a PWM charge controller work

The purpose of Charge Controller is to ensure efficient charging and discharging of system battery or a bank of batteries . PWMs help to regulate the often inconsistent voltage put out by power sources (for example, solar panels) in order to protect the system batteries from overcharging. When a solar array has the PWM mode activated, the charge controller uniquely handles the job of battery charging by constantly checking the current battery state and self-adjusting accordingly to send only the right amount of charge to the battery.

In essence, this type of charge controller works by reducing the current from the power source according to the battery's condition and recharging requirements, which is in contrast to on/off charge controllers which suddenly cut off power transfer to minimize battery overcharging. The PWM charge controller does this by checking the state of the battery to determine both how long (wide) the pulses should be as well as how fast they should come.

With that information, the PWM charge controller then self-adjusts and sends the appropriate pulse to charge the battery, it varies the length and speed of the pulses sent to the battery as needed (see Figure). This is essentially a rapid on and off switch. When the battery is nearly discharged, the pulses may be long and continuous, and as it becomes charged, the pulses become shorter or trickled off. This trickle or finish type charging mode is important for systems that can go days or weeks with excess energy during periods when very little of the solar energy is consumed.
This type of charge controller is idea for solar arrays where excess energy is a regular occurrence, and provide several key benefits: higher charging efficiency, rapid recharging, and healthier batteries that operate at full capacity.

2.2.7 Benefits of Using a PWM Charge Controller

Traditional systems for charging solar system batteries relied on on-off regulators to limit battery outgassing during periods of excess energy production, but this often resulted in early battery failures and increased load disconnects. With a PWM algorithm, the charge controller can slowly reduce the charging current to prevent problems like gassing and overheating of the battery.
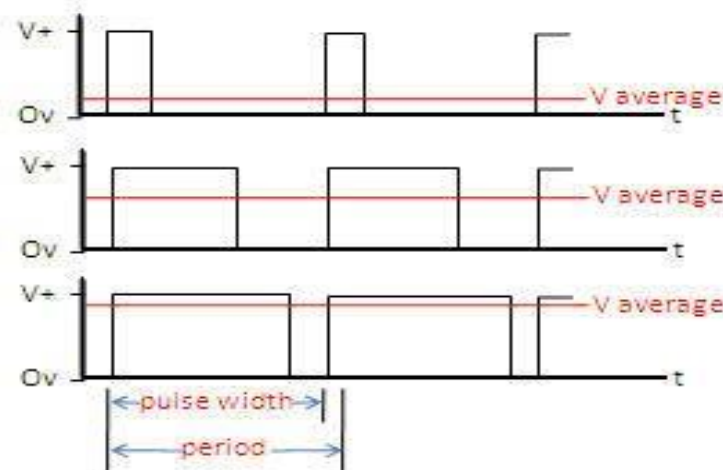
The benefits of this type of system are significant – a PWM charge controller will increase charging efficiency, allow for rapid recharging, and maintain healthy battery life. In all, a PWM charge controller comes with the following advantages:

• **Battery Aging Adjustments**: By automatically adjusting to the battery's needs, a PWM charge controller will overcome traditional problems with charge acceptance seen in older batteries.

• **Battery Gassing and Heating Reductions**: By recharging more quickly than other charge controllers, a PWM avoids problems with gassing and heating which damage the battery.

• **Charge Acceptance Increase:** Charge acceptance is a necessity with solar system batteries, though this has typically been a problem in solar arrays. A PWM algorithm, however, increases the charge acceptance of the battery so that more of the energy generated by the array gets captured.

• **Drifting Battery Cell Equalization**: Many PWM charge controllers hold battery cells in better balance through equalization, which evens out the acceptance of charge to avoid capacity deterioration.

• **High Battery Capacity Maintenance**: The state-of-charge should remain high in order to maintain a healthy system and preserve the life of the battery. PWM algorithms provide better battery capacity maintenance due to the increased number of charge/discharge cycles.

• **Lost Battery Recovery:** Sulfation of lead-acid batteries in solar systems is a significant problem due to extended undercharging, which results in grid corrosion and sulfate crystal formation on the battery's positive plates. PWM charge controllers have been shown to recover lost capacity over time by deterring sulfate deposit formation, and pushing through corrosion at the interface.

• **Self-Regulation with Drops in Voltage or Temperature**: Older charge controllers can be negatively impacted by temperature effects or voltage drops, creating problems with the final charge of the battery. But a PWM charge controller will taper the charge to minimize these impacts.

Taken together, these PWM advantages can be very attractive to PV owners looking for a simpler way to manage their solar charge. One downside of PWM charge controllers should be noted, however. The sharp pulses created by the controller can create interference for the owner operating radios and TVs. Another disadvantage in pulse width modulation charge controllers is the limitations they create for system growth.

(A) The Electronic Resistance: The Electronic Resistance encompasses the resistivity of the actual materials such as the metal cover and internal components; as well as how well this materials make contact with each other. The effect of this portion of the total effective resistance occurs very quickly and can be within first few milliseconds after a battery placed under load.

(B) Ionic resistance: Ionic resistance the resistance to the current follows within battery due to various electrochemical factors such as electrolyte conductivity, ion mobility, and electrode surface area. These polarization effect occur more slow then electronic resistance with the contribution to total effective resistance typically starting a few milliseconds or more after a battery is placed under load.

2.3 BATTERY

Small PV power systems require some means of storing the electrical energy collected by solar panels. The usual choice for this job is the lead-acid battery. While far from perfect, lead-acid batteries offer good performance over a wide temperature range when compared to other battery types. They are also relatively inexpensive and widely available. Again, no one type of battery is ideal for PV system applications. The designer must consider the advantages and disadvantages of different batteries with respect to the requirements of a particular application. Some of the considerations include lifetime, deep cycle performance, tolerance to high temperatures and overcharge, maintenance and many others.

2.4 MICROCONTROLLER

Micro suggests that the device is small, and controller means the device might be used to control object processes or events. A microcontroller sometimes abbreviated μC, uC or MCU Is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Program memory in the form of NOR flash or OTP ROM is also often included on chip, as well as a typically small amount of RAM.
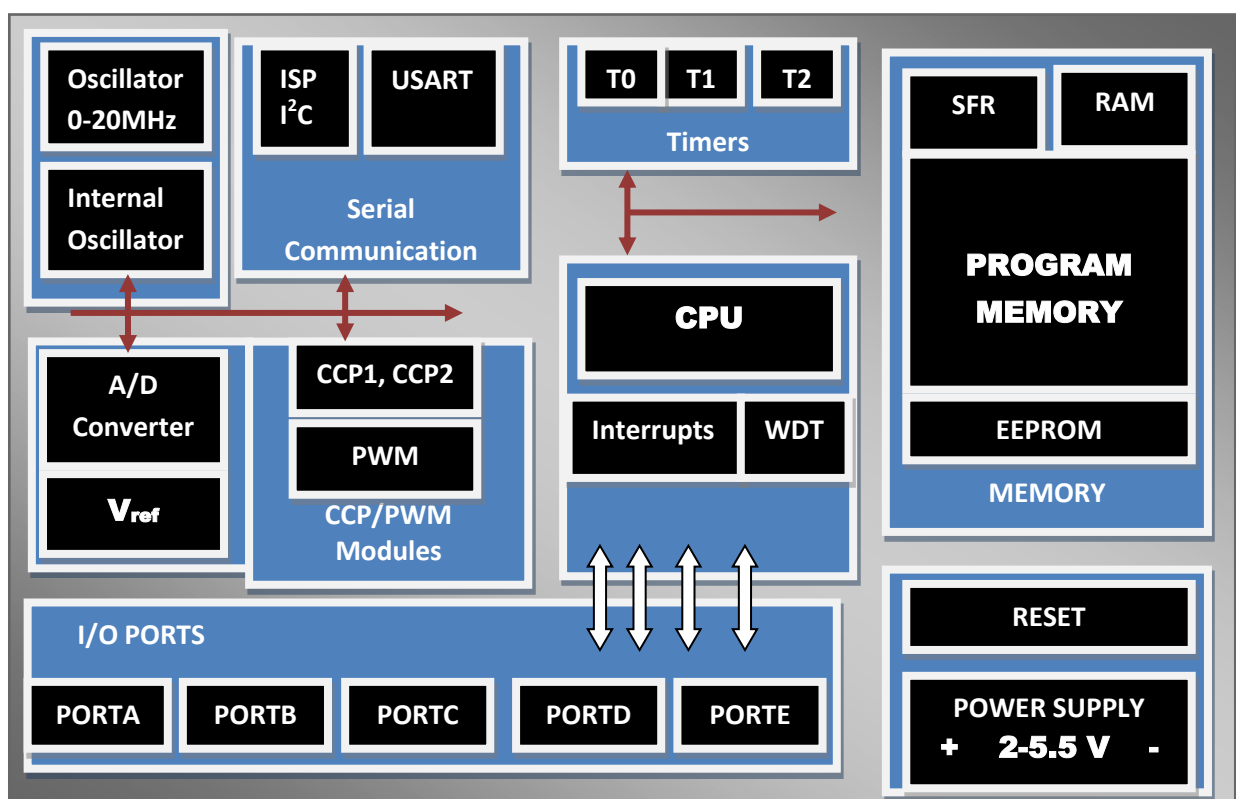

Figure 2.5 Microcontroller's fundamental components
(All components are on a single chip)

Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal or other general-purpose applications. That is, a MCU combines onto a same microchip:

1. The CPU core
2. Memory (both RAM and ROM)
3. Some parallel digital I/O and others

Other components of a microcontroller are given bellow:
- A timer module to allow the microcontroller to perform tasks for certain time period.
- A serial I/O port to allow the data to flow between microcontroller and other devices that support serial interfaces such as PC or others microcontroller.
- An ADC to allow the microcontroller to accept analogue input data for processing.

2.4.1 TYPES OF MICROCONTROLLERS

Microcontrollers can be classified on the basis of internal bus width, architecture, memory and instruction set as 4-bit, 8-bit, 16-bit and 32-bitmicrocontrollers.

4-bit Microcontrollers:
These 4-bit microcontrollers are small in size, minimum pin count and low cost controllers which are widely used for low end applications like LED & LCD display drivers, portable battery chargers etc. Their power consumption is also low. The popular 4-bitcontrollers are Renasa-M34501 which is a 20 pin DIP chip with 4kB of ROM, 256Bytes of RAM, 2-Counters and 14 I/O Pins. Similarly ATAM 862 series from ATMEL.

8-bit Microcontrollers:
These are the most popular and widely used microcontrollers. About 55% of all CPU sold in the world are 8-bitmicrocontrollers only. The 8-bit microcontroller has 8-bitinternal bus and the ALU performs all the arithmetic and logical operations on a byte instruction. The well-known 8-bit microcontroller is 8051 which was designed by Intel in the year 1980 for the use in embedded systems. Other 8-bit microcontrollers are Intel 8031/8052 and Motorola MC68HC11 and AVR Microcontrollers, Microchip's PIC Microcontrollers 12C5XX ,16C5X and 16C505 etc.

16-bit Microcontrollers:

When the microcontroller performs 16-bit arithmetic and logical operations at an instruction, the microcontroller is said to be a 16-bit microcontroller. The internal bus width of 16-bitmicrocontroller is of 16-bit. These microcontrollers are having increased memory size and speed of operation when compared to 8-bitmicrocontrollers. These are most suitable for programming in high level languages like C or C++.Examples of 16-bit microcontrollers are Intel 8096 family and Motorola MC68HC12 and MC68332 families. The performance and computing capability of 16 bit microcontrollers are enhanced with greater precision as compared to the 8-bitmicrocontrollers.

32-Bit Microcontrollers:

These microcontrollers used in high end applications like communication networks, robotics, cell phones, GPRS & PDAs etc. For example: PIC32, ARM 7, ARM9, SHARPLH79520, ATMEL 32(AVR) etc. are some of the popular 32-bit microcontrollers.

2.4.2 IMPORTANCE OF MICROCONTROLLER

- Low cost, small packaging
- Low power consumption
- Programmable, re-programmable
- Lots of I/O capabilities
- Easy integration with circuits
- For applications in which cost, power and space are critical
- Single-purpose

2.4.3 MICROCONTROLLER VERSUS MICROPROCESSOR

Microcontroller is an embedded controller for the purpose of dealing with specific tasks, whereas microprocessor is not an embedded deal with various tasks controller and it can Comparison of Microcontroller and Microprocessor are given bellow:

Microcontroller

1. Microcontroller having inbuilt RAM or ROM and inbuilt timer.
2. Input and output ports are available.
3. Inbuilt serial port.
4. Separate memory to store program and data.
5. Does a specific task.

6. Boolean operation directly possible.
7. It takes few instructions to read and write data from external memory.
8. Generally lower core clock frequency.
9. Microcontroller are less costly then microprocessor.
10. Microcontroller uses less power, generally built using a technology known as Complementary Metal Oxide Semiconductor (CMOS). This technology is a competent fabrication system that uses less power and is more immune to power spikes than other techniques.

Microprocessor

1. Do not have inbuilt RAM or ROM and timer.
2. Input and output ports are not available, requires extra device like 8155.
3. Do not have inbuilt serial port, requires 8250 device.
4. Program and data are stored in same memory.
5. Does multiple tasks.
6. Boolean operation is not possible directly.
7. It takes many instructions to read and write data from external memory.
8. Generally higher core clock frequency.
9. Microprocessor is more costly then microcontroller.
10. Microprocessor uses more power than microcontroller.

2.5 What is Arduino

An Arduino is an open-source microcontroller development board. Arduino consists of both a physical programmable circuit board and a piece of software or IDE (Integrated Development Environment) that runs on the computer, used to write and upload computer code to the physical board. Arduino can be used to read sensors and control things like motors and lights. This allows us to upload programs to this board which can then interact with things in the real world. With this, we can make devices can be made which respond and react to the world at large. For instance, we can read a humidity sensor connected to a potted plant and turn on an automatic watering system if it gets too dry. Or, we can make a stand-alone chat server which is plugged into our internet router. Or, we can have it tweet every time our cat passes through a pet door. Or, we can have it start a pot of coffee when the alarm goes off in the morning. Basically, if there is something that is in any way controlled by electricity, the Arduino can interface with it in some manner. And even if it is not controlled by electricity, we can probably still use things which are (like motors and electromagnets) to interface with it. The possibilities of the Arduino are almost limitless.

2.5.1 Why Arduino

There are many other microcontrollers and microcontroller platforms available for physical computing. Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's Handy board 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 BDT 800.

- **Cross-platform:** The Arduino software runs on Windows, Macintosh OSX,
- and Linux operating systems. Most microcontroller systems are limited to Windows.

- **Simple, clear programming environment:** The Arduino programming environment 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 the look and feel of Arduino.

- **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, AVR-C code can be added directly into the Arduino programs if one wants to.

- **Open source and extensible hardware:** The Arduino is based on Atmel's ATMEGA8 and ATMEGA 168 microcontrollers. The plans for the modules 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.

2.5.2 DIFFERENT TYPES OF ARDUINO BOARDS

There are a number of different types of Arduino boards to choose from. This is a brief overview of some of the more common types of Arduino boards one may encounter. The name and description of some common Arduino boards are given below.
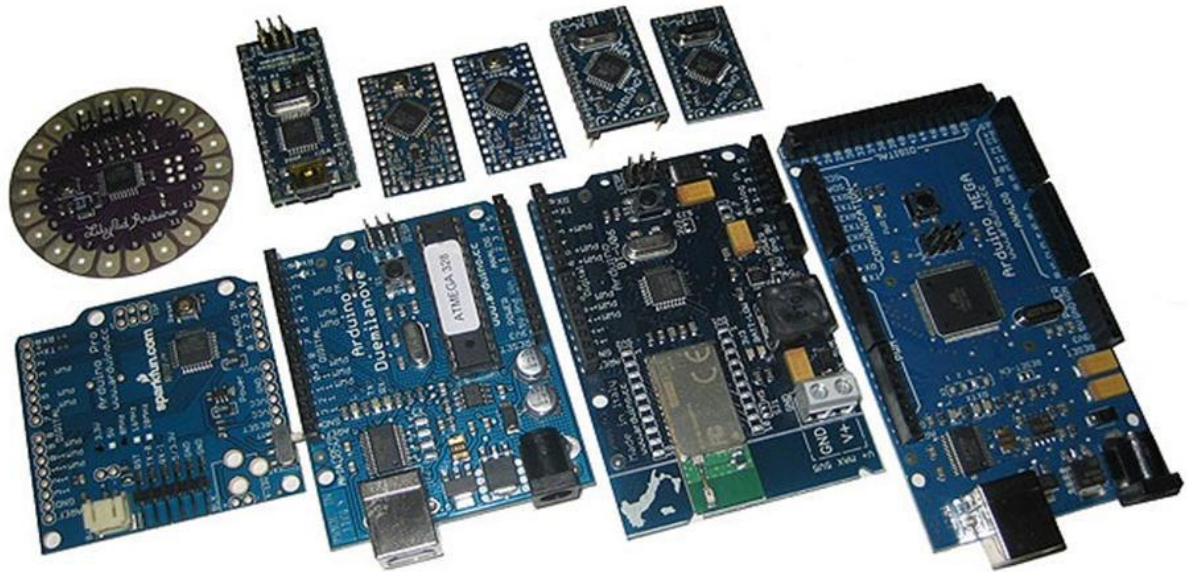

Figure 2.6 Different Types of Arduino Boards.

Arduino Uno: The most common version of Arduino is the Arduino Uno.This board is what most people are talking about when they refer to an Arduino. In the next step, there is a more complete rundown of its features.

Arduino NG, Decimila, and the Duemilanove (Legacy Versions): Legacy versions of the Arduino Uno product line consist of the NG, Diecimila and the Duemilanove. The important thing to note about legacy boards is that they lack particular feature of the Arduino Uno. Some key differences: The Diecimila and NG use an ATMEGA168 chips (as opposed to the more
powerful ATMEGA328),Both the Diecimila and NG have a jumper next to the USB port and require manual selection of either USB or battery power. The Arduino NG requires that we hold the rest button on the board for a few seconds prior to uploading a program.

Arduino Mega 2560: The Mega is the second most commonly encountered version of the Arduino family. It boasts 256 KB of memory (8 times more than the Uno). It also had 54 input and output pins, 16 of which are Analog pins, and 14 of which can do PWM. However, all of the added functionality comes at the cost of a slightly larger circuit board. It may make the project more powerful, but it will also make the project larger.

Arduino Mega ADK: This specialized version of the Arduino is basically an Arduino Mega that has been specifically designed for interfacing with Android smartphones.

Arduino LilyPad: The LilyPad was designed for wearable and e-textile applications. It is intended to be sewn to fabric and connected to other sewable components using conductive thread. This board requires the use of a special FTDI-USB TTL serial programming cable.

2.5.3 DIFFERENT PARTS OF ARDUINO UNO BOARD

Power (USB Interface/ External Power Supply): Every Arduino board needs a way to be connected to a power source. The Arduino Uno can be powered from a USB cable coming from a computer or a wall power supply that is terminated in a barrel jack. The USB connection is also how the code is loaded onto the Arduino board. There commended voltage for most Arduino
models is between 6 and12.

Pins (5V, 3.3V, GND, Analog, Digital, PWM, AREF): The pins on the Arduino are the places where wires are connected to construct a circuit. They usually have black plastic 'headers' that allow users to just plug a wire right into the board. The Arduino has several different kinds of pins, each of which is labeled on the board and used for different functions.
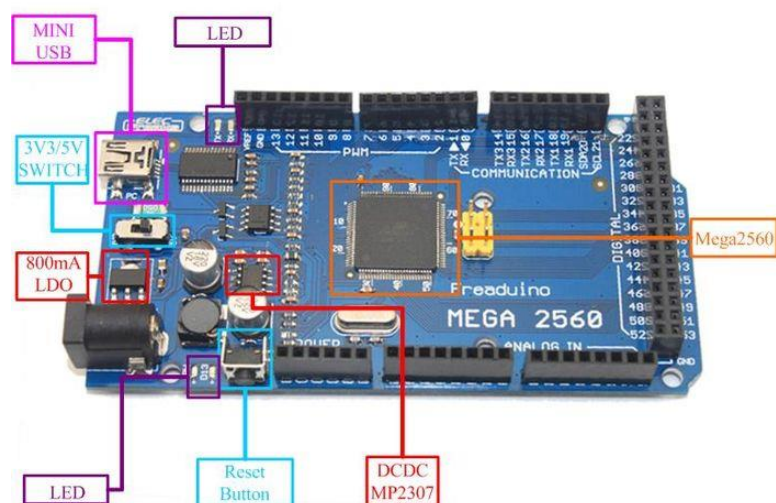

Figure 2.7 Different parts of Arduino Mega Board.

GND: Short for 'Ground'. There are several GND pins on the Arduino, any of which can be used to ground the circuit.

5V & 3.3V: The 5V pin supplies 5 volts of power, and the 3.3V pin supplies 3.3 volts of power. Most of the simple components used with the Arduino run happily off of 5 or 3.3 volts.

Analog Pins: The pins under the 'Analog In' label (A0 through A15 on the Mega) are Analog Input pins. These pins can read the signal from an analog sensor (like a temperature sensor) and convert it into a digital value that we can read by the Arduino.

Digital Pins: Across from the analog pins are the digital pins (0through 52 on the Mega). These pins can be used for both digital input and digital output.

PWM: Among the digital pins 15 pins provide PWM output which have tildes (~) next to them. These pins act as normal digital pins, but can also be used for Pulse-Width Modulation (PWM). These pins are able to simulate analog output.

AREF: Stands for Analog Reference. Most of the time, this pin is left alone. It is sometimes used to set an external reference voltage (between 0 and 5 Volts) as the upper limit for the analog input pins.

Reset Button: Arduino has a reset button. Pushing it will temporarily connect the reset pin to ground and restart any code that is loaded on the Arduino. This can be very useful if the code doesn't repeat, but we want to test it multiple times.

Test LED 13: There's a tiny LED next to the word AREF. This LED should light up whenever Arduino is plugged into a power source. If this light doesn't turn on, something is wrong.

TX / RX LEDs: TX is short for transmit, RX is short for receive. These markings appear quite a bit in electronics to indicate the pins responsible for serial communication. In this case, there are two places on the Arduino Mega where TX and RX appear – once by digital pins 0 and 1, and a second time next to the TX and RX indicator LEDs. These LEDs will give us visual indications whenever the Arduino is receiving or transmitting data.

Main IC: The black thing with all the metal legs is an IC, or Integrated Circuit. It is the brains of the Arduino. The main IC on the Arduino is slightly different from board type to board type, but is usually from the ATmega lineof IC's from the ATMEL Company. This can be important to know the IC type (along with the board type) before loading up a new program from the Arduino software. This information can usually be found in writing on the topside of the IC.

2.6 Arduino IDE

Before we can start doing anything with the Arduino, we have to download and install the Arduino IDE (integrated development environment). Arduino IDE is referred as the Arduino Programmer. The Arduino Programmer is based on the Processing IDE and uses a variation of the C and C++ programming languages. An Arduino program is called a sketch. All code in an Arduino sketch is processed from top to bottom. Arduino sketches are typically broken into five parts. The sketch usually starts with a header that explains what the sketch is doing, and who wrote it. Next, it usually defines global variables. Often, this is where constant names are given to the different Arduino pins. After the initial variables are set, the Arduino begins the setup routine. In the setup function, we set initial conditions of variables when necessary and run any preliminary code that we want to run once. This is where serial communication is initiated, which is required for running the serial monitor. From the setup function, we go to the loop routine. This is the main routine of the sketch. This is not only where the main code goes, but it will be executed over and over, so long as the sketch continues to run. Below the loop routine, there is often other functions listed. These functions are user-defined and only activated when called in the setup and loop routine. When these functions are called, the Arduino processes all of the code in the function from top to bottom and then goes back to the next line in the sketch where it left off when the function was called. Functions are good because they allow us to run standard routines - over and over - without having to write the same lines of code over and over. We can simply call upon a function multiple times, and this will free up memory on the chip because the function routine is only written once. It also makes code easier to read.
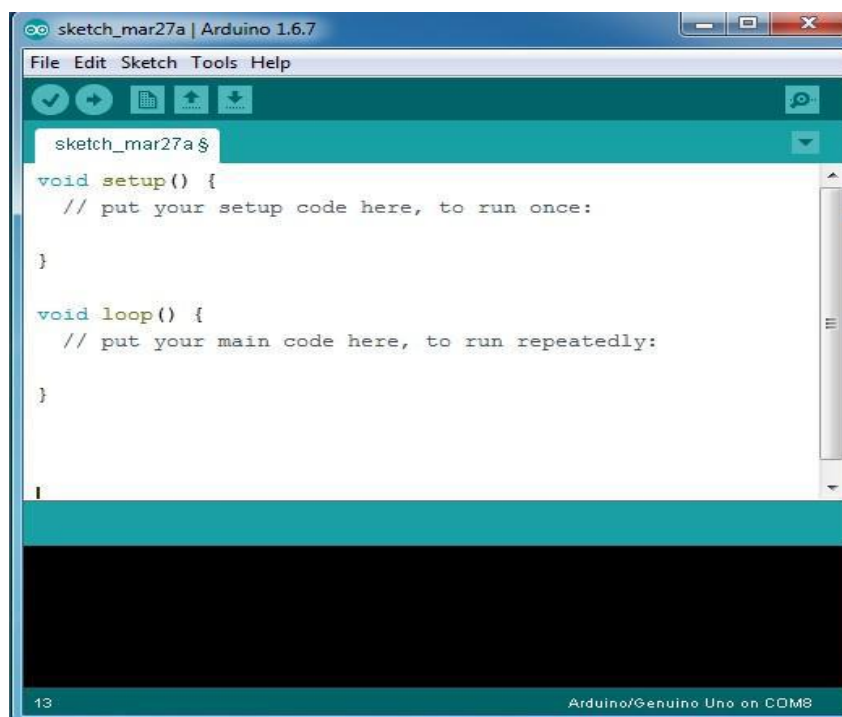
Figure 2.8 Arduino IDE

All of that said, the only two parts of the sketch which are mandatory are the Setup and Loop routines. Code must be written in the Arduino Language, which is roughly based on C. Almost all statements written in the Arduino language must end with a semicolon (;). Conditionals (such as if statements and for loops) do not need a semicolon (;). Conditionals have their own rules and can be found under "Control Structures" on the Arduino Language page. Variables are storage compartments for numbers. We can pass values in andout of variables. Variables must be defined before they can be used and need to have a data type associated with it.

2.7 Plugging the Arduino into the computer

Although the Arduino is plugged into the computer, it is not a true USB device. The board has a special chip that allows it to show up on the computer as a virtual serial port when it is plugged into a USB port. This is why it is important to plug the board in. When the board is not plugged in, the virtual serial port that the Arduino operates upon will not be present (since all of the information about it lives on the Arduino board).
Every single Arduino has a unique virtual serial port address. This means that every time we plug in a different Arduino board into the computer, we will need to reconfigure the serial port that is in use.

Settings: Before we can start doing anything in the Arduino programmer, we must set board type and serial port. To set the board, go to the following: Tools --> Boards Select the version of board that you are using. Since I have an Arduino Mega plugged in,

2.8 HC-05 BLUETOOTH MODULE

HC-05 Bluetooth Module is one of the most popular Bluetooth module used in embedded projects. It can be easily interfaced with Arduino Board, Raspberry Pi, and Microcontrollers through serial UART interface.
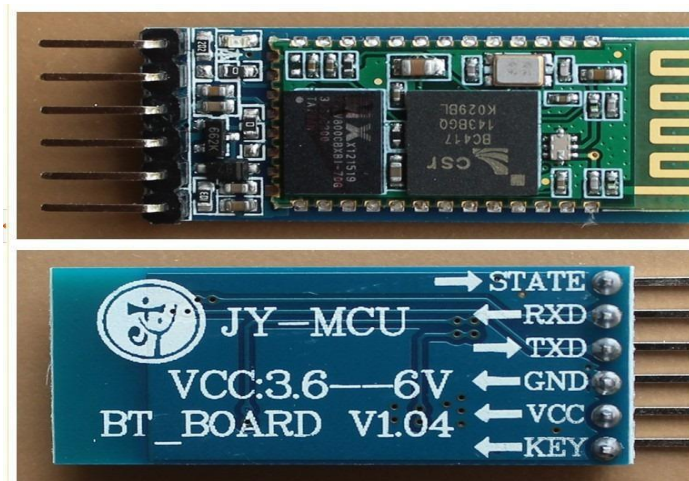

Figure 2.9 HC-05 Bluetooth Module

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR

(Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Blue core 04-External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature). It has the footprint as small as 12.7mmx27mm.

2.8.1 Specifications

- **Frequency:** 2.4GHz ISM Band
- **Bluetooth Protocol:** Bluetooth Specification V2.0 + EDR
- **Emission Power:** ≤4dBm, Class 2
- **Modulation:** GFSK (Gaussian Frequency Shift Keying)
- **Operating Voltage:** 3.3V
- **Input Power Supply:** 3.6V ~ 6V
- **Security:** Authentication & Encryption
- **Working Temperature:** -20°C ~ +75°C
- **Dimensions:** 35.7mm x 15.2mm x 5.6mm
- **PINS**: The pins found on the breakout board are,
- **KEY:** This pin has to be pulled high to enter AT mode.
- **VCC:** Indicated range is 3.6 to 6 volt. To be on safer side, we should connect it to 3.3 Volt.
- **GND:** Ground.
- **RXD:** Serial input pin, to be connected to the TX of the microcontroller.
- **TXD**: Serial output pin, to be connected to RX of the microcontroller.
- **STATE:** May or may not be connected to any pin. Supposedly outputs the Bluetooth connection status. This pin will not be needed.

2.8.2 Hardware features

- Typical -80dBm sensitivity
- Up to +4dBm RF transmit power
- Low Power 1.8V Operation ,1.8 to 3.6V I/O
- PIO control
- UART interface with programmable baud rate
- With integrated antenna
- With edge connector

2.8.3 Software features

- **Default Baud rate:** 38400, Data bits: 8, Stop bit: 1, Parity: No parity, Data control: has.
- **Supported baud rate:** 9600,19200,38400,57600,115200,230400,460800. Given a rising pulse in PIO0, device will be disconnected.
- **Status instruction port PIO1**: low-disconnected, high-connected;
- PIO10 and PIO11 can be connected to red and blue led separately. When master and slave are paired, red and blue led blinks 1time/2s in interval, while disconnected only blue led blinks 2times/s.
- Auto-connect to the last device on power as default.
- Permit pairing device to connect as default.
- **Auto-pairing PINCODE:"**0000" as default
- Auto-reconnect in 30 min when disconnected as a result of beyond the range of connection.

2.8.4 HOW DOES BLUETOOTH WORK

Bluetooth sends and receives radio waves in a band of 79 different frequencies
(channels) centred on 2.45 GHz, set apart from radio, television, and cell phones, and reserved for use by industrial, scientific, and medical gadgets. Bluetooth's short-range transmitters are one of its biggest plus points. They use virtually no power and, because they don't travel far, are theoretically more secure than wireless networks that operate over longer ranges, such as Wi-Fi. Bluetooth devices automatically detect and connect to one another and up to eight of them can communicate at any one time. They don't interfere with one another because each pair of devices uses a different one of the 79 available channels. If two devices want to talk, they pick a channel randomly and, if
that's already taken, randomly switch to one of the others (a technique known as spread-spectrum frequency hopping). To minimize the risks of interference from other electrical appliances (and also to improve security), pairs of devices constantly shift the frequency they're using—thousands of times a second. When a group of two or more Bluetooth devices are sharing information together, they form a kind of ad-hoc, mini computer network called a piconet. Other devices can join or leave an existing piconet at any time. One device(known as the master) acts as the overall controller of the network, while the others (known as slaves) obey its instructions. Two or more separate piconets can also join up and share information forming what's called a scatter net.

2.9 MOSFET

MOSFET stands for metal-oxide semiconductor field-effect transistor. It is a special type of field-effect transistor (FET). Although the MOSFET is a four terminal device with source (S), gate (G), drain (D), and body (B) terminals, the body (or substrate) of the MOSFET is often connected to the source
terminal, making it a three-terminal device like other field-effect transistors. Because these two terminals are normally connected to each other (short circuited) internally, only three terminals appear in electrical diagrams. It is widely used for switching and amplifying electronic signals in the electronic devices. Two basic types of MOSFET are n channel and p channel MOSFETs. In n channel MOSFET current is due to the flow of electrons in inversion layer and in p channel MOSFET current is due to the flow of holes.
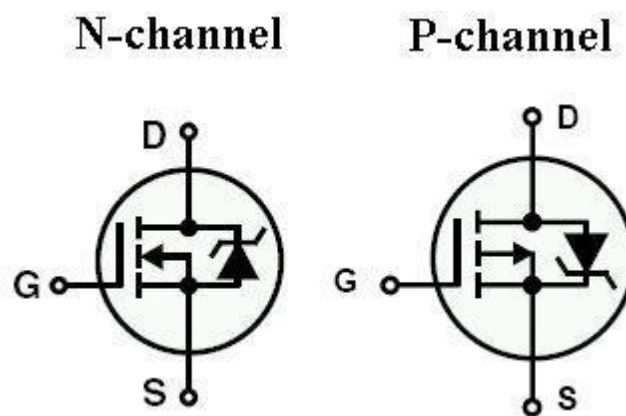

Figure 2.10 MOSFET symbols

2.9.1 MOSFET as a Switch

For a better understanding consider the below figure where N-channel enhancement type MOSFET is switched for different voltages at the gate terminal. MOSFET gate terminal is connected to VDD, so that the voltage applied at gate terminal is maximum. This makes the channel resistance becomes so small and allows maximum drain current to flow. This is called as saturation mode and in this mode the MOSFET is completely turned ON as a closed switch For P-channel enhancement MOSFET, for turning ON, gate potential must be more negative with respect to source. In cut off region, VGS applied is less than the threshold voltage level so the drain current is zero.

2.10 RECTIFIER DIODE

A rectifier diode lets electrical current flow in only one direction and is mainly used for power supply operation. Rectifier diodes can handle higher current flow than regular diodes and are generally used in order to change alternating current into direct current. They are designed as discrete components or as integrated circuits and are usually fabricated from silicon and characterized by a fairly large P-N-junction surface. This results in high capacitance under reverse-bias conditions. In high-voltage supplies, two rectifier diodes or more may be connected in series in order to increase the peak-inverse-voltage (PIV) rating of the combination.
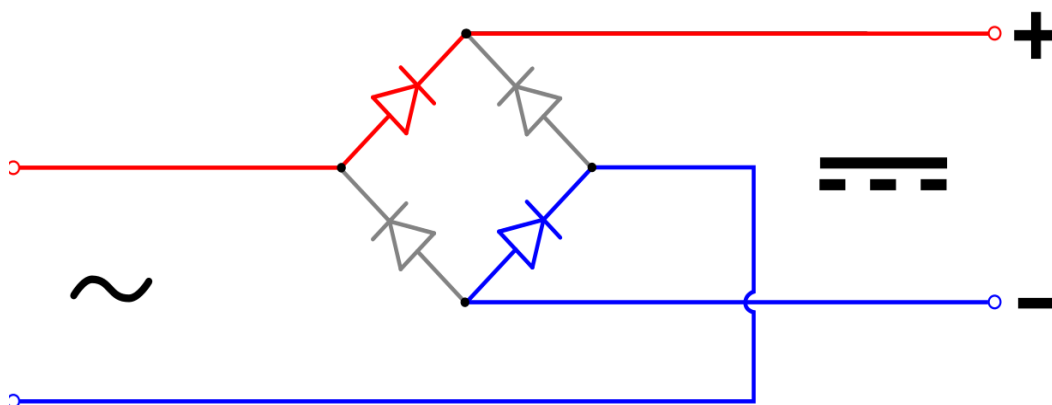

Figure 2.11 Rectifier Diode Bridge

2.10.2 Applications for Standard Rectifiers

Standard rectifiers can be found regulating the power in computers and the electrical power in motor vehicles. They can also be used in battery chargers for rechargeable batteries, computer power supplies and vehicle batteries. Also, while rectifier diodes are often used for AC to DC conversion, diodes with rectifying characteristics are found in other uses than in electronics. For example, a diode is used in the detector of radios in order to perform radio demodulation.

2.11 OPTOCOUPLER

An opto isolator (also known as optical coupler, optocoupler and opto-isolator) is a semiconductor device that uses a short optical transmission path to transfer an electrical signal between circuits or elements of a circuit, while keeping them electrically isolated from each other.

A common type of opto-isolator consists of an LED and a phototransistor in the same opaque package. Other types of source-sensor combinations include LED-photodiode, LED-LASCR, and lamp-photo resistor pairs. Usually opto-isolators transfer digital (on-off) signals, but some techniques allow them to be used with analog signals.
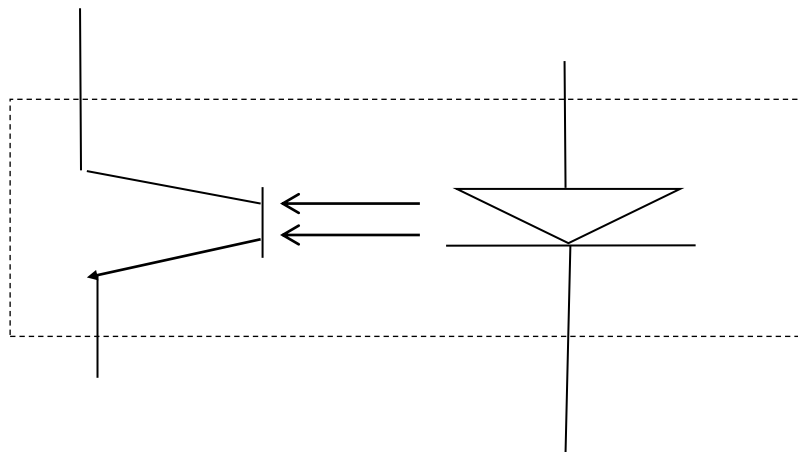
Figure 2.12 Opto-coupler internal circuits

An opto-isolator contains a source (emitter) of light, almost always a near infrared light-emitting diode (LED), that converts electrical input signal into light, a closed optical channel (also called dialectical channel), and a photo sensor, which detects incoming light and either generates electric energy directly, or modulates electric current flowing from an external power supply. The sensor can be a photo resistor, a photodiode, a phototransistor, a silicon-controlled rectifier (SCR) or a triac. Because LEDs can sense light in addition to emitting it, construction of symmetrical, bidirectional opto-isolators is possible. An opto-coupled solid state relay contains a photodiode opto-isolator which drives a power switch, usually a complementary pair of MOSFETs. A slotted optical switch contains a source of light and a sensor, but its optical channel is open, allowing modulation of light by external objects obstructing the path of light or reflecting light into the sensor.

2.12 ARDUDROID

ArduDroid is an Android App that can help us control the Arduino from the Android device. ArduDroid has a simple Android user interface to

1. Control Arduino's digital and PWM pins
2. Send text commands to Arduino
3. Receive data from Arduino over Bluetooth serial using HC-05Bluetooth module.

ArduDroid is used to send commands to Arduino to control a relay to turn electric gadgets on/off, control a robot servo, increase/decrease speed of a motor and reverse direction, dim a light, speed up a fan and so on.
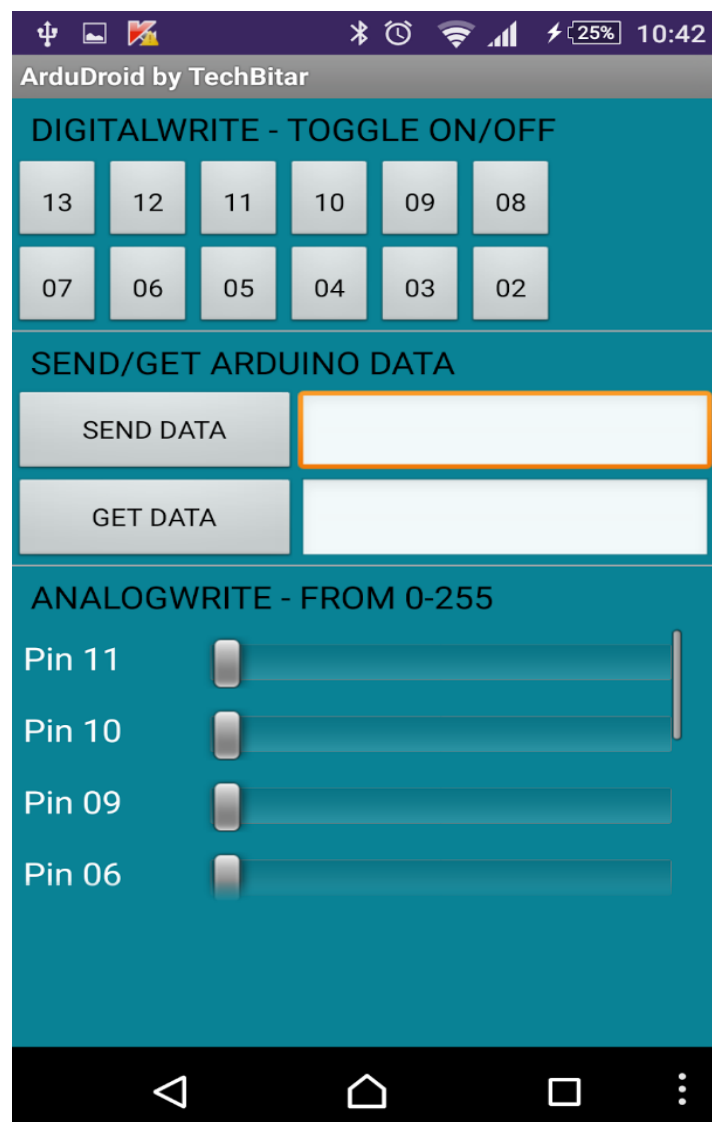

Figure 2.13: Ardudroid Application

CHAPTER 3

DESIGNS AND DEVELOPMENT
OF
THE SYSTEM

3.1 Block diagram of the system

The block diagram of the system is shown in Figure 3.1. It consists of Android device, HC-05 Bluetooth module, Arduino Uno, Charge controller, PWM signal and Home appliances. Android device uses Ardudroid (an Android application) to provide a user friendly graphical user interface for the remote control of the home appliances. When the toggle buttons on the App are pressed, corresponding Bluetooth signals are sent from the Android device to the Bluetooth module which is connected to the Arduino. An Analog output (A0) from Arduino is used as charge controller button and a digital output (11) from Arduino considered as PWM signal. The PWM signal is used as a mode of communication between the home appliances and the output of the Arduino. Arduino finds out which signal has been sent and compares it to the predefined signals assigned for each appliance.
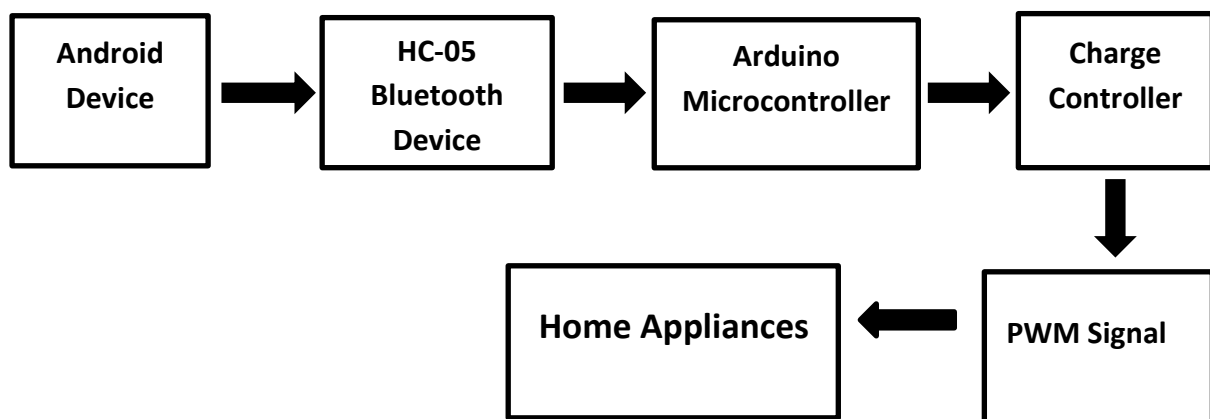
Figure 3.1: Block diagram of the system

3.2 Connecting HC-05 Bluetooth Module to Arduino

HC-05 module is an easy device to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. HC-05 is 6-pinModule. The module has 6 pins labelled on the back. KEY & STATE seem to be not required, as KEY is used for flashing the device and STATE simply indicates if the device is awake or not. So that leaves only GND, VCC, TXD, RXD. Some modules have VCC labelled for working voltages up to ~6 volts. These modules do not like anything except 3.3 volts on the VCC

line. A level converter is used to provide 3.3V on the RXD line. Two resistors, as a simple voltage divider are used to make the TTL level conversion. One 2.2k Ω resistor to ground, connected to a 1kΩ resistor, to the TXD line on the MCU. RXD pin is connected in between the two resistors for an output of

(Digital Pin 1), through the voltage divider configuration shown below. Now TXD of module is connected to RXD of Arduino (Digital Pin 0).
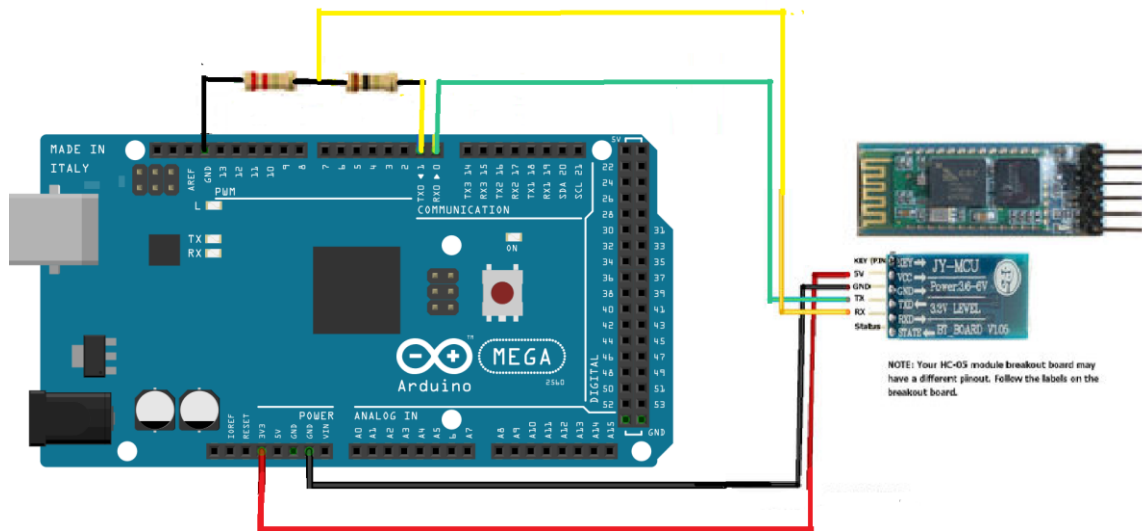

Figure 3.2: Concept diagram of HC-05 Bluetooth Module-Arduino connection

3.3 DESIGNING CHARGE CONTROLLER USING ARDUINO

A charge controller is an electronic circuit. It regulates the voltage and current coming from solar panels which is placed between a solar panel and a battery. It is used to maintain the proper charging voltage on the batteries. As the input voltage from the solar panel rises, the charge controller regulates the charge to the batteries preventing any overcharging. The whole system can be divided into the following subsections.

- Voltage sensing circuit

- Current sensing circuit

- Voltage regulator section

- Control section

- Switching section

The complete working circuit diagram is given bellow and described in the following subsections.:
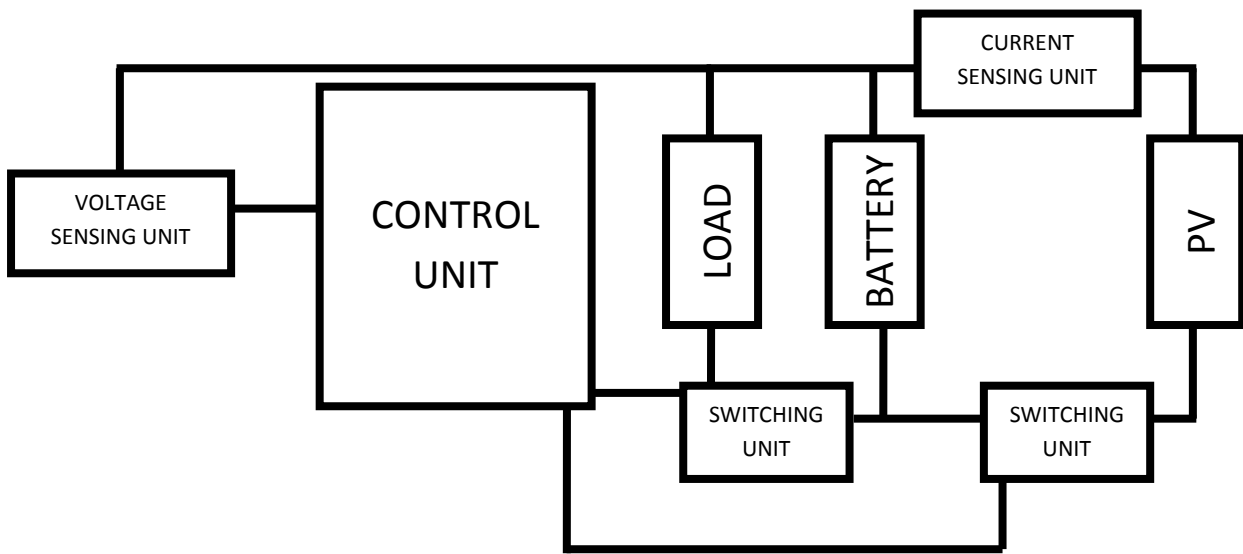
Figure 3.3 Block diagram of working circuit

3.3.1 Voltage sensing circuit

A voltage divider circuit is used to sense the battery voltage. This circuit is designed to sense the maximum battery voltage 16 Volts. The microcontroller pin A0 refers to the output voltage V1 (range 0-5 V) of this circuit is fed to. This input voltage is sense by microcontroller and sense the Set-points. The voltage divider circuit is shown below:

Figure 3.4 Voltage sensing circuit

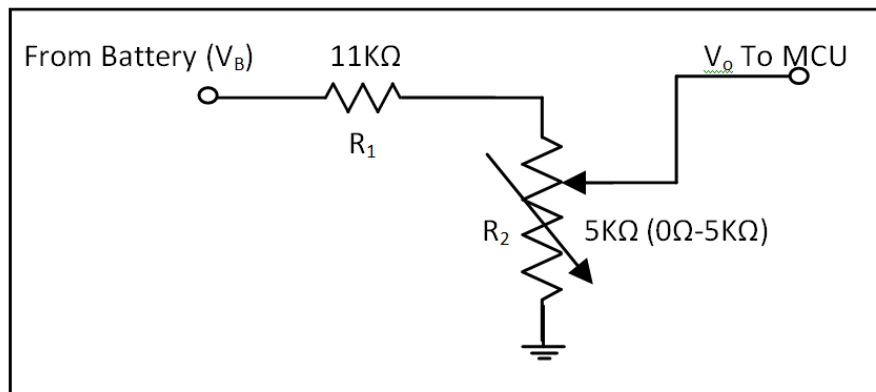According to the voltage divider rule the output voltage (V_o) is:

$$V_o = \frac{R2}{R1} \times V_B$$

Where, V_B= Battery voltage

3.3.2 Current sensing section

We already know that the Set-points are change with charging or discharging current. Therefore, for an intelligent charge controller we need to sense the current and input the result to the control unit. The control unit takes an input data and makes decision to change the Set-points. The current sensing section is shown in fig 3.3.
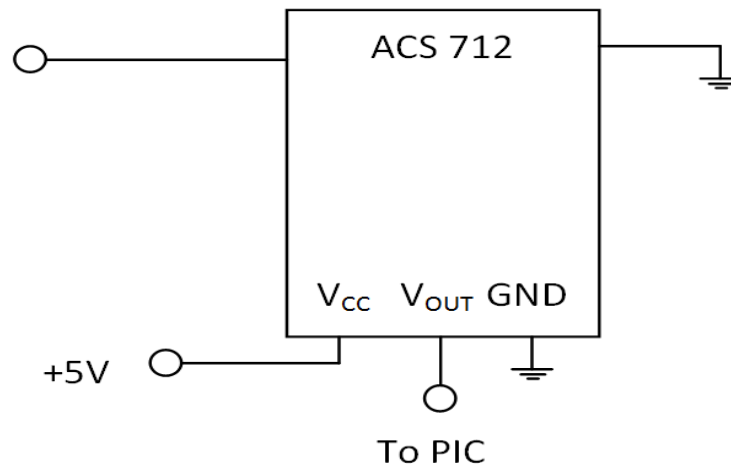

Figure 3.5 Hall current Sensor

3.3.3 Voltage regulator section

In this part of charge controller, we have used voltage regulator & for voltage regulation, we have used LM7805 to convert 12V to 5V. LM7805 is a linear voltage regulator. The microcontroller & the drive (mega 2560) is operated by this 5V.

3.3.4 Switching Section

Two power transistor (IRF540N) are used to create the switching function the charge controller. The switching sections block is shown in Fig 3.3. Transistors work as a switch and this switching is control by the control unit. When the gate of the transistor (IRF540N) is high (5V) then they work like a short circuited switch. When gate voltage is low the work like an open circuit switch.

Switching unit between PV and Battery

MOSFET IRF540N is used for switching function between battery and PV system. For switching we also used opto-coupler and transistor. When the output of control unit become zero then the transistor will not conduct and also the opto-coupler and the MOSFET gate voltage will be high and it will be switched on, so battery can start charging. On the other hand, when the output of control unit will be nonzero (high) then the transistor will conduct and also the opto-coupler and the MOSFET gate voltage will be low and it will be switched off so battery will stop charging.

Switching unit between Load and Battery

MOSFET IRF540N is also used for switching function between battery and Load. For switching we also used opto-coupler and transistor. When the output of control unit will be zero then the transistor will not conduct and also the opto-coupler and the MOSFET gate voltage will be high and it switched on so battery will start discharging. On the other hand, when the output of control unit will be nonzero (high) then the transistor will conduct and also the opto-coupler and the MOSFET gate voltage will be low and it will be switched off so that load can disconnect.

3.3.5 Control Section

The purpose of this section is to control the whole hardware. So a microcontroller (Mega 2560) is used to control the system. 5V is fed to port (A0) of the microcontroller. Output of the voltage sensing circuit is fed to the microcontroller .Thus port A0 is configured as input port. Two pins Pin6(Green LED) and Pin7(Red LED) are configured as output. Pin6 and Pin7 are used to control current flow between PV to battery and Battery to load of charge controller respectively. When load is too much high and low then Pin7 will be high. That means red LED will be ON. On the other hand when pin 6 will be ON it means battery is charging and Load is too low then green LED will be OFF. Another pin 11 is used as an analog output. We will use this pin to proceed the system for further advancement. This pin will be used as a PWM signal by which we can control the intensity of load. When battery is in full charge state or high pin 11 will send PWM signal and that will be used to control intensity. But when the load is Low that means red LED is high then it will not sen any signal. For performing the functions described above necessary program is written in the arduino microcontroller.

3.3.6 Schematic diagram of the charge controller

The complete schematic diagram for charge controller that is decribed on upper sections are given below-

Figure 3.6 Working circuit for charge controller

3.4 PWM SIGNAL GENERATION :

When we change the signal in arduino device, PWM signal at analog output pin no.11 change according to the signal. Signals are changed as an analog output signal. The average value is dependent on the duty cycle of the PWM signal. When the duty cycle is high the average value is high and when the duty cycle is low average value is also

become smaller. For high average value LED and Transistor inside the optocoupler become ON and vice versa. For the same reason transistor controls the Mosfet (IRF 540) by making it ON/OFF. Mosfet will control the power of load. It increase and decrease the intensity of load like light, fan etc.
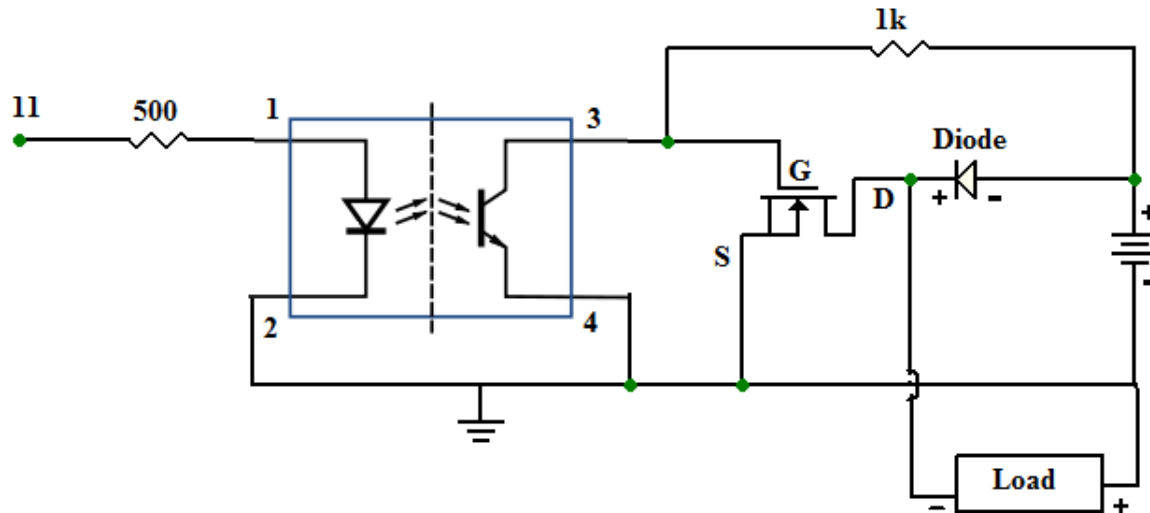

Figure 3.6 PWM signal generation.

3.5 Development of the entire system

Ardudroid android application is connected via HC-05 Bluetooth module which is already connected to an Arduino Mega as discussed above. An analog signal coming from arduino will be act as a charge controller. Another analog PWM signal controlled by a optocoupler and a Mosfet will be used to control the intensity of home appliances. Whole system will be controlled via a Bluetooth module as well as an Android App for a simple interface to control. Two wires and a power plug should be used. Wires should be connected to a power plug on one end to an appliances such as light, fan etc and other end to connection come from the Optocoupler and Mosfet and Diode.They will help to control the intensity. In this system, a 12V bulb, and a 12V fan are controlled using mosfet and optocoupler . The programming code is uploaded to the Arduino board. When uploading the code to Arduino, the RX and TX pins of the Bluetooth module are removed to disable the Bluetooth. Since USB and Bluetooth uses same TX/RX, it will throw an error when loading code if the Bluetooth is on. ArduDroid is an Android App which is used to send commands to Arduino to control the intensity of appliances (on/off & increase decrease). After making all the connections, LED on the module keeps blinking. This just ensures the device is powered properly. ArduDroid App is installed on an Android tablet from Google play. After installation, Bluetooth devices the menu tablet is opened, HC-05 Bluetooth module is found and the required numberspass-code is inserted and then the tablet with the Bluetooth module is paired. The Ardudroid App is opened and "connect me to a Bluetooth device" is clicked. If properly paired, the LED blinking on Bluetooth module will stop. Now, the pin number

on the App is clicked to control signal that connected to that pin which in turn control the corresponding appliance. When the buttons on the App are increased and decreased, corresponding Bluetooth signals are sent from the android tablet to the Bluetooth module which is connected to the Arduino. The Arduino finds out which signal has been sent and compares it to the predefined signals assigned for each appliance. When it identifies that signal, then the Arduino digital pin by passing 5V through it. Then a PWM signal from the the ardunio go through optocoupler,mosfet and diode and gives the the corresponding power to the appliance and make their intensity increased and decreased.
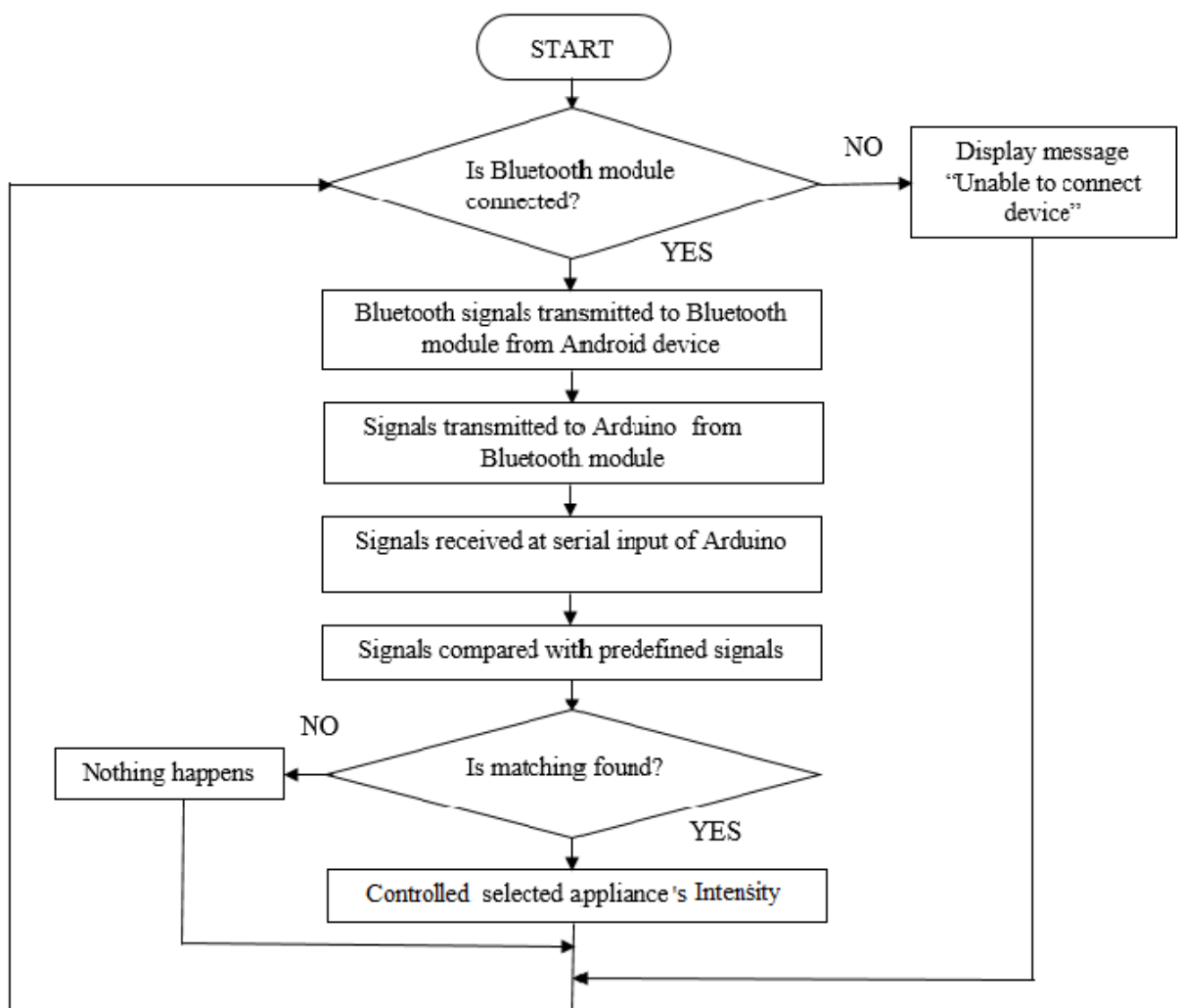
3.6 Flow chart of the developed system

Figure 3.7 Flowchart of Program
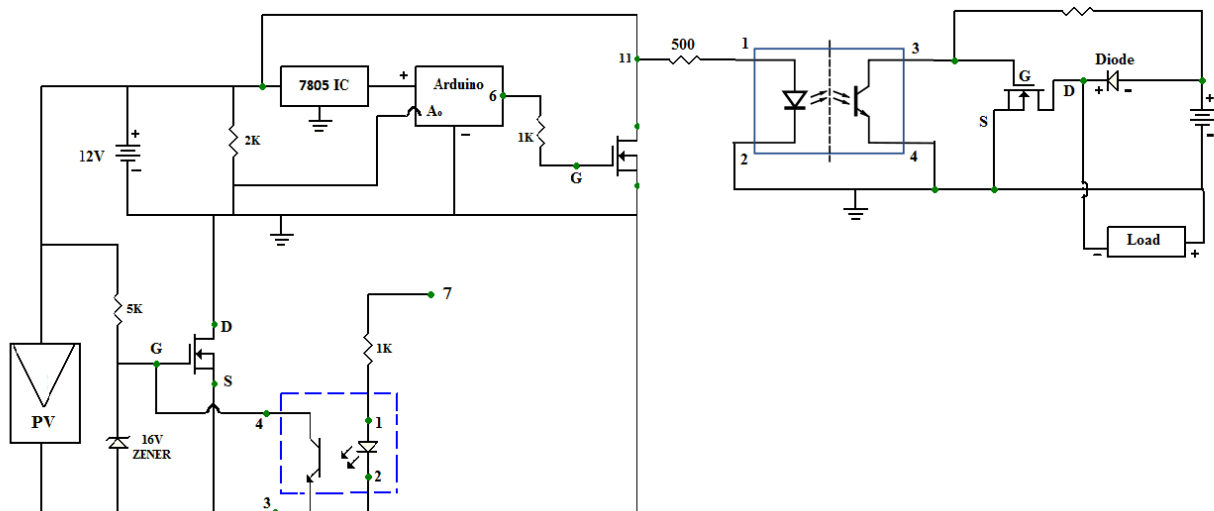
3.7 SCHEMATIC DIAGRAM OF THE SYSTEM

Figure 3.8 Complete Working Circuit

3.8 SOFTWARE DESIGN

A microcontroller is a small computer on a small integrated circuit, which consist of a CPU (Central Processing Unit), RAM (Random Access Memory), EPROM/PROM/ROM (Erasable Programmable Read Only Memory) Parallel and Serial I/O (Input /Output). All of its components are placed on a single board. Microcontrollers are designed for embedded applications. A microcontroller internally consists of all features required for computing system and functions as a computer without adding any external digital parts in it. Most of the pins in the microcontroller chip can be made programmable by the user. It is capable of handling Boolean functions and it has many bit handling instructions that can be easily understood by programmer. It is easy to design, small in size and low cost. Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, toys and other embedded systems.

We write the required program to funtion the the system properly. We embedded the program in arduino with the help of in Arduino Ide interface. The entire coding program is given with the file attached on the last pages of the book.

CHAPTER 4

SIMULATION AND PRACTICAL RESULT

4.1 INTRODUCTION

Earlier we have discussed about the simulation and practical system design and data collection. The whole systems are mainly divided into two operational modes. One is charge controlling mode another one is Controlling the intensity using android application. Every mode has been already described in brief in the previous chapters. In this chapter we have shown the simulation circuit diagram and the prototype of the system. In addition to that, we have also shown practically implemented circuit diagram of each unit. Finally, we have shown the performance analysis of the entire system and discussed results.

4.2 PROTOTYPE TESTING

After designing the software and the hardware architecture part, we implemented the working circuit diagram on the breadboard/project board for testing purpose. Here input voltage generated by power supply. We can see the microcontroller output state changes for load and battery for charge controller. Battery voltage levels and load indicating by LEDs are also operating properly. In addition, here we easily operated the android application from our mobile phone and controlled the intensity of power of load.

Battery is charging & Load is On

Load on means battery is low ,so it is charging.
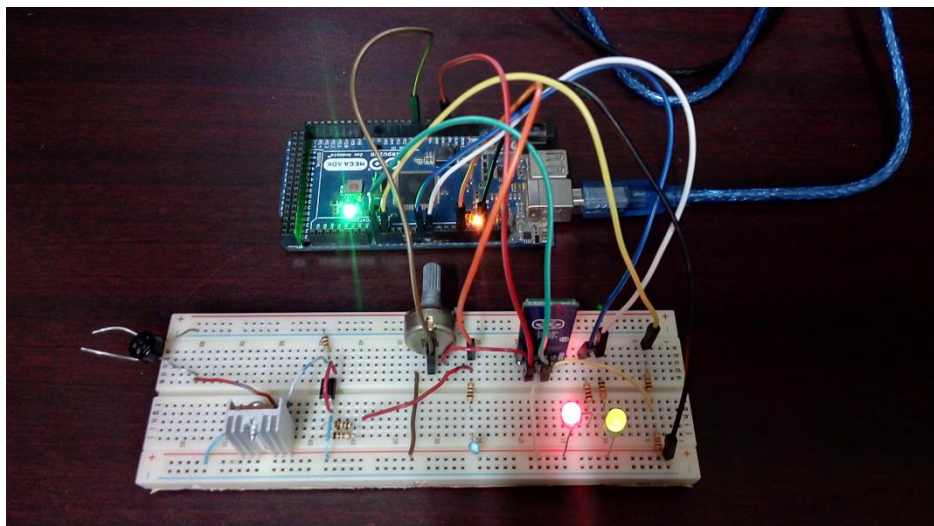
Battery is charging & Intensity High

Here battery charging state is On. Now we can control the intensity of blue LED indicating power of the load.
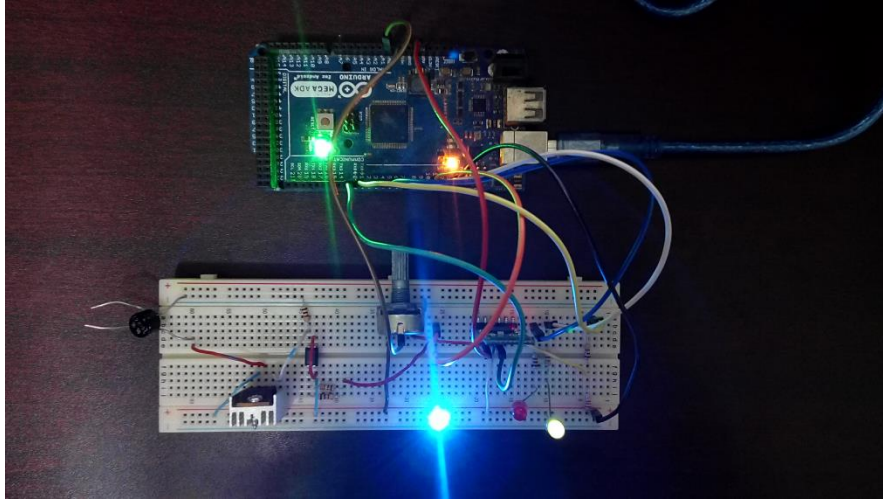

Figure: Prototype testing

Load On (Low)& Charge Off

Here battery charge is too much low. So red LED indicating. And in this situation we can control the intensity.
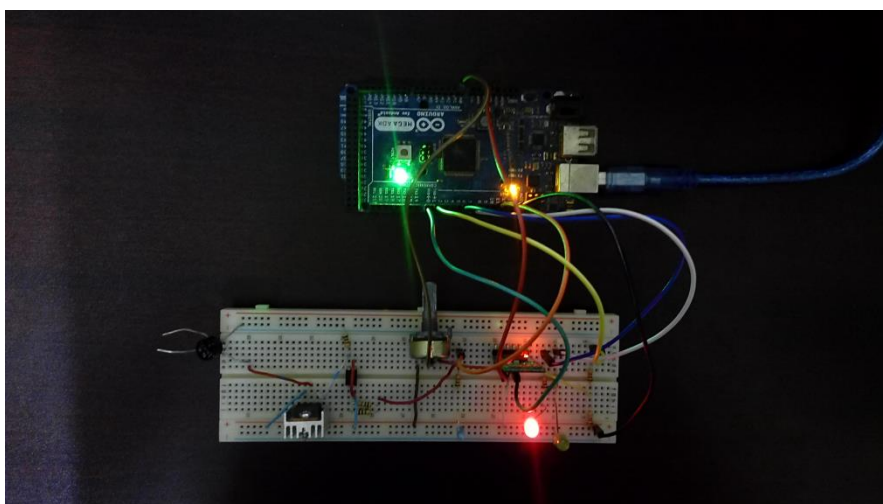

Figure: Prototype testing

Intensity Controll by using electric Fan

Here we used fan as a load and tested successfully the performance of controlling intensity by using ardudroid application.
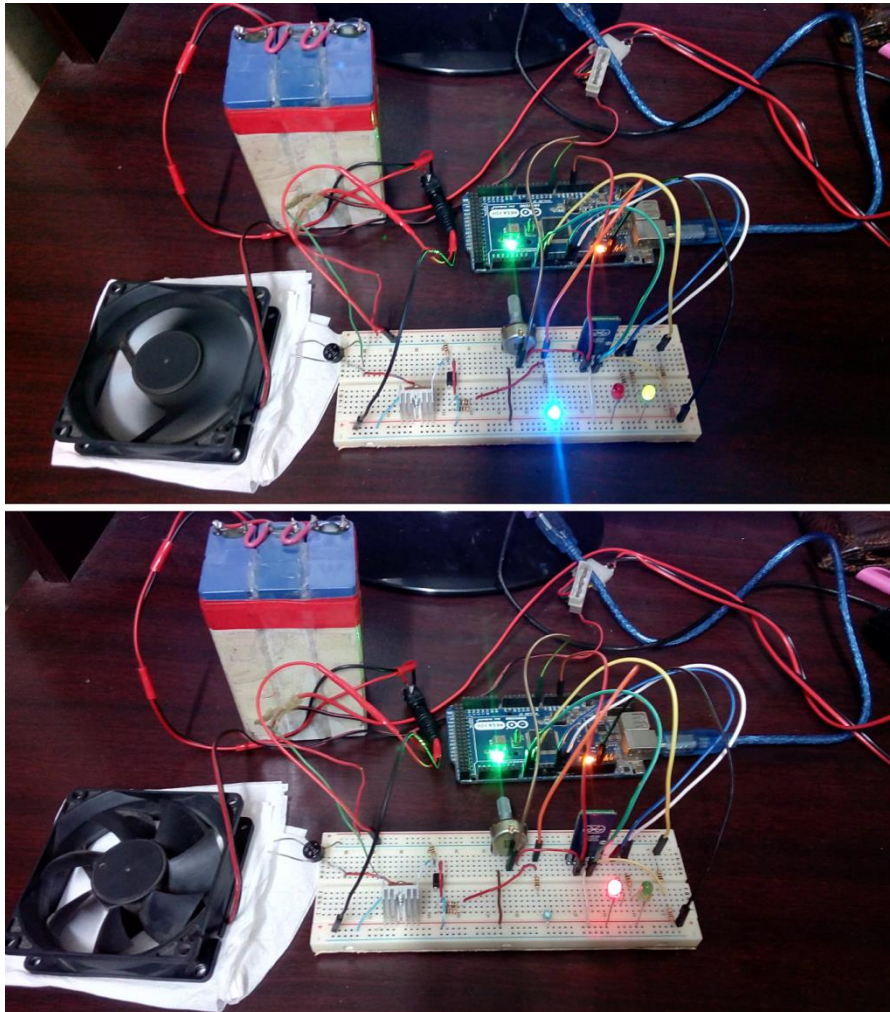

Figure: Prototype testing

CHAPTER 5

CONCLUSION AND FUTURE WORK

4.1 CONCLUTION

In future, the world will have to depend on renewable energy. The only source available around us is sunlight, and we can easily convert sunlight energy into electrical energy by using solar system. To implement the solar system in general purpose we need an efficient and smart solar charge controller as the life of the battery mainly depends on charge controller.So in this project we designed and implemented a Bluetooth-based home automation system that control the charge coming from solar panel as well intensity of the home appliances like light or fan. This project is based on Android platform which is Free Open Source Software. The total implementation cost of the project is very cheap and it is affordable by a common person. The users interact with the application interface of the android device and send control signal to the Arduino which in turn controls home appliances. The use of a Bluetooth module assists the use of this system from various locations in the house. The system is secured for access from any intruder. The users are expected to acquire pairing password for the Arduino BT and the Android device to access the home appliances. This adds a protection from unauthorized users. Another advantage of the system is the fact that application software is based on Android, which today has the largest smartphone base. With improvements in technology and the fact that Android is free and open source, cheap smart devices can be used as the controller in the project, making the overall system cost affordable for mass adoption. This system, though primarily aimed to reduce human effort, but it has a great market value if we can introduce it properly.

4.2 Merits

- The system can control home appliances remotely.
- It provides help and assistance especially to disabled and elderly.
- The system is secured for access from any unauthorized user.
- The system is very flexible and scalable. Any number of appliances can be added if required.
- The total implementation cost of the system is very cheap and it is affordable by a common person
- Internet connection is not required.

4.3 Limitations

- In our prototype design we could not use PV panel and its battery, instead we used a 12V battery as solar rechargeable battery.

- We assumed a fixed set of voltage for the charge controlling function, further work is needed to get exact functioning.

- Most commonly used Bluetooth in smart devices has an effective range of 10 meters (33 feet). Beyond this range, it can't control the home appliances.

- The application used in this system is developed only for Android.

- The system should be flexible to support various wireless technologies like Zigbee, WiFi and World Wide Web.

- We could not test the prototype for higher current as we haven't high current source, but tested it in simulation and it works correctly.

4.4 SCOPE OF IMPROVEMENT IN FUTURE

In our project, we constructed a prototype of an intelligent charge controller along with the function of controlling the intensity of home appliances through an android device. In future we can design and improve this system for a complete package for commercial production. The prototype is made with 12V and 2A. We can make it for high voltage and current to implement this on industrial purpose. We used Blutooth connection to control it from mobile phone. For high range of connection in future we can use GPS system. If we can overcome all the limitations we mentioned earlier then it has a great future in industrial and commercial implementation.

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Program Code

```
#define START_CMD_CHAR '*'

#define END_CMD_CHAR '#'

#define DIV_CMD_CHAR '|'

#define CMD_DIGITALWRITE 10

#define CMD_ANALOGWRITE 11

#define CMD_TEXT 12

#define CMD_READ_ARDUDROID 13

#define MAX_COMMAND 20

#define MIN_COMMAND 10

#define IN_STRING_LENGHT 40

#define MAX_ANALOGWRITE 255

#define PIN_HIGH 3

#define PIN_LOW 2

int sensorValue=0;
int LEDG=6;
int LEDR=7;

String inText;
void setup() {

  pinMode(LEDG,OUTPUT);
 pinMode(LEDR,OUTPUT) ;
 pinMode(11,OUTPUT) ;
 Serial.begin(9600);
  Serial.println("ArduDroid 0.12 Alpha by TechBitar (2013)");
  Serial.flush();

}

void loop()

{

//Charge controller
```

```
sensorValue=analogRead(0);
 if(sensorValue>800)
 digitalWrite(LEDG,LOW);
  if(sensorValue<600)
 digitalWrite(LEDG,HIGH);
 delay(15);
 sensorValue=analogRead(0);
  if(sensorValue>300)
 digitalWrite(LEDR,HIGH);
  if(sensorValue<100){
 digitalWrite(LEDR,LOW);
 digitalWrite(11,LOW);
 }

 delay(15);
//end of charge controller

 Serial.flush();
 int ard_command = 0;
 int pin_num = 0;
 int pin_value = 0;

 char get_char = ' ';
 if (Serial.available() < 1) return;
 get_char = Serial.read();
 if (get_char != START_CMD_CHAR) return;

 ard_command = Serial.parseInt();
 pin_num = Serial.parseInt();
 pin_value = Serial.parseInt();


 if (ard_command == CMD_TEXT){
  inText ="";
  while (Serial.available())  {
   char c = Serial.read();
   delay(5);
   if (c == END_CMD_CHAR) {
   break;

   }

   else {

    if (c !=  DIV_CMD_CHAR) {
     inText += c;
     delay(5);

    }

   }
```

```
      }

    }

  }


  if (ard_command == CMD_DIGITALWRITE){

   if (pin_value == PIN_LOW) pin_value = LOW;
   else if (pin_value == PIN_HIGH) pin_value = HIGH;
   else return;
   set_digitalwrite( pin_num,  pin_value);
   return;

  }


  if (ard_command == CMD_ANALOGWRITE) {
   analogWrite(11, pin_value );
   return;

  }

  if (ard_command == CMD_READ_ARDUDROID) {
   Serial.print(" Analog 0 = ");
   Serial.println(analogRead(A0));
   return;

  }

}
void set_digitalwrite(int pin_num, int pin_value)

{
 switch (pin_num) {
 case 11:
   pinMode(11, OUTPUT);
   digitalWrite(11, pin_value);
   break;


 }

}
```

THE END