SREERAMA GOVERNMENT POLYTECHNIC COLLEGE

THRIPRAYAR, THRISSUR 680567

DEPARTMENT OF ELECTRONICS ENGINEERING

PROJECT REPORT

SUN TRACKING SOLAR PANEL SYSTEM

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CERTIFICATE

*This is to certify that the project report entitled '**SUN TRACKING SOLAR PANEL SYSTEM** ' by the following students of sixth semester, in partial fulfilment of the requirements for the award of **ELECTRONICS ENGINEERING** under the DIRECTORATE OF TECHNICAL EDUCATION, Kerala state during the academic year 2019-2020 is a bonafide record of the work done under our supervision.*

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PROJECT GUIDE **PROJECT COORDINATOR**

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ABSTRACT

Solar panel has been used increasingly in recent years to convert solar energy to electrical energy. The solar panel can be used either as a stand-alone system or as a large solar system that is connected to the electricity grids. The earth receives 84 Terawatts of power and our world consumes about 12 Terawatts of power per day. We are trying to consume more energy from the sun using solar panel. In order to maximize the conversion from solar to electrical energy, the solar panels have to be positioned perpendicular to the sun. Thus the tracking of the sun's location and positioning of the solar panel are important. The goal of this project is to design an automatic tracking system, which can locate position of the sun. The tracking system will move the solar panel so that it is positioned perpendicular to the sun for maximum energy conversion at all time. Photoresistors will be used as sensors in this system. The system will consist of light sensing system, microcontroller, gear motor system, and a solar panel. Our system will output up to 40% more energy than solar panels without tracking systems.

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CHAPTER 1
INTRODUCTION

As the non renewable energy resources are decreasing, use of renewable resources for producing electricity is increasing. Solar panels are becoming more popular day by day. Solar panel absorbs the energy from the Sun, converts it into electrical energy and stores the energy in a battery.This energy can be utilized when required or can be used as a direct alternative to the grid supply. Utilization of the energy stored in batteries is mentioned in below given applications.The position of the Sun with respect to the solar panel is not fixed due to the rotation of the Earth. For an efficient usage of the solar energy, the Solar panels should absorb energy to a maximum extent.

This can be done only if the panels are continuously placed towards the direction of the Sun. So, solar panel should continuously rotate in the direction of Sun. This article describes about circuit that rotates solar panel.

Trackers direct solar panels or modules toward the sun. These devices change their orientation throughout the day to follow the sun’s path to maximize energy capture.In photovoltaic systems, trackers help minimize the angle of incidence (the angle that a ray of light makes with a line perpendicular to the surface) between the incoming light and the panel, which increases the amount of energy the installation produces. Concentrated solar photovoltaics and concentrated solar thermal have optics that directly accept sunlight, so trackers must be angled correctly to collect energy. All concentrated solar systems have trackers because the systems do not produce energy unless directed correctly toward the sun.

Single-axis trackers rotate on one axis moving back and forth in a single direction. Different types of single-axis trackers include horizontal, vertical, tilted, and polar aligned, which rotate as the names imply. Dual-axis trackers continually face the sun because they can move in two different directions. Types include tip-tilt and azimuth-altitude. Dual-axis tracking is typically used to orient a mirror and redirect sunlight along a fixed axis towards a stationary receiver. Because these trackers follow the sun vertically and horizontally they help obtain maximum solar energy generation.

There are also several methods of driving solar trackers. Passive trackers move from a compressed gas fluid driven to one side or the other. Motors and gear trains direct active trackers by means of a controller that responds to the sun’s direction. Finally, a chronological tracker counteracts the Earth's rotation by turning in the opposite direction.

Selecting a solar tracker depends on system size, electric rates, land constraints, government incentives, latitude and weather. Utility-scale and large projects usually use horizontal single-axis trackers, while dual-axis trackers are mostly used in smaller residential applications and locations with high government Feed-In-Tariffs. Vertical-axis trackers are suitable for high latitudes because of their fixed or adjustable angles.

1.1 OBJECTIVE OF THE PROJECT

- The objective of this project is to control the position of a solar panel in accordance with the motion of sun.
- The system will always keep the perpendicular alignment to the sun.
- Most of the energy from the sun can be utilized.
- Maximum sunlight can be converted to electrical energy.

CHAPTER 2

SYSTEM OVERVIEW

2.1 MOTIVATION

In day to day life the use of electrical energy is increasing.The power is required to work every equipment or devices. But we don't have enough power to meet our daily requirements. That is why the load shedding and power cuts are employed sometimes. To overcome thease problems we can use the renewable energy resources rather than the non renewable energy resources.

The sunlight is one of the major renewable energy resources. Our project is aimed to utilize the maximum sunlights to generate electrical power with the sun position tracking.

2.2 NEED ANALYSIS

1. What is expected budget of this project?

Ans: 10,000/-

2. Which Microcontrollers can be used in this project?

Ans: AT mega328

3. What is the required supply voltage for the microcontroller?

Ans: 5 V

4. What is the operating voltage of Arduino?

Ans: 5V to 12V

5. What are the main parts that can to be implemented in this project?

Ans: Microcontroller ATmega328, Ardiunouno board, Motor driver, Geared DC motors, LDR sensors, voltage regulators, solar panel, battery.

6. What type of sensor is used to detect the light?

Ans: LDR

7. What is the maximum ourput voltage of solar panel in the day light?

Ans: 20V

8. Is this system is single or dual axis tracker?

Ans: Dual axis.

9. How is the battery charging?

Ans: From the solar energy. Which is given to the battery though a voltage regulator.

10.What is the specification of battery used?

Ans: 12V, 1.3Ah

2.3 BLOCK DIAGRAM

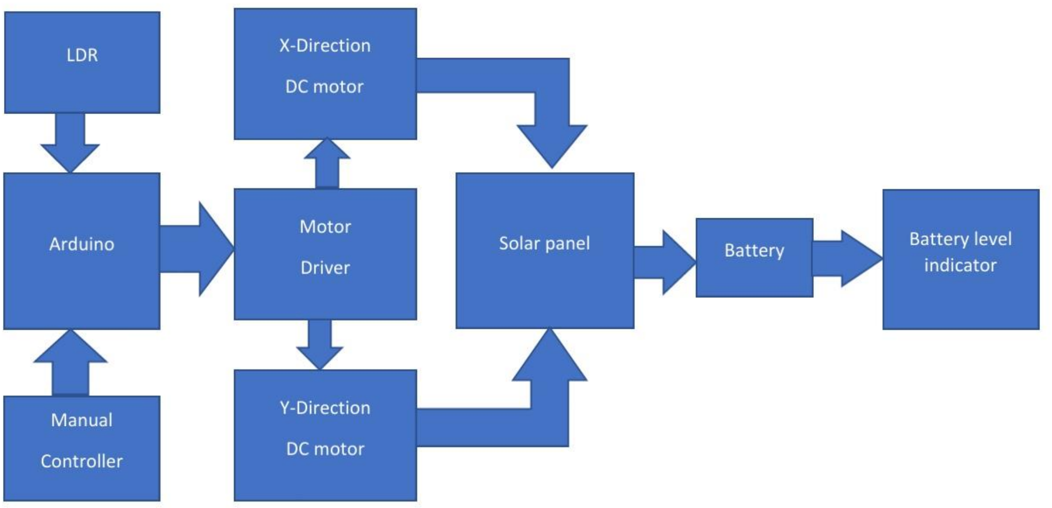


Fig 2.3.1

2.4 CIRCUIT DIAGRAM

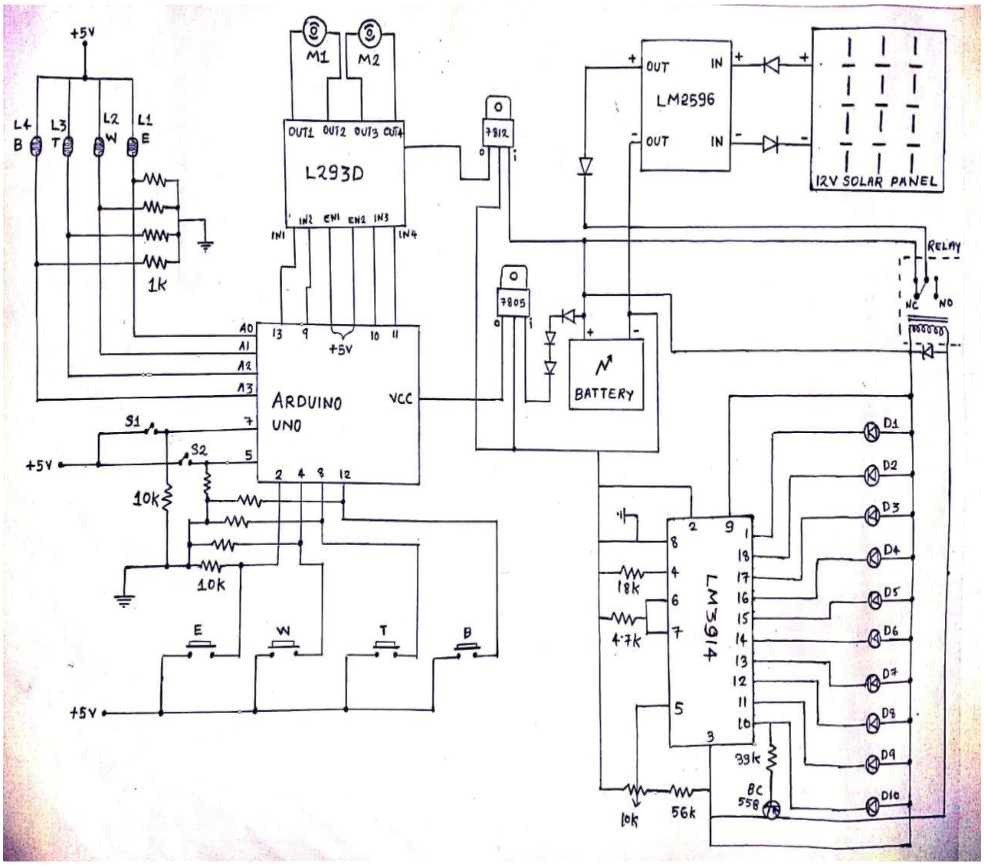


Fig.2.4.1 Circuit Diagram

2.5 COMPONENTS

- Arduino uno board
- L293D Motor Driver ic
- Geared DC Motors
- LDRs
- Switches
- Rechargable Battery
- LM2596 IC
- LM3914 IC
- Solar Panel
- Voltage Regulators - 7805, 7809, 7812

- LEDs, Resistors, Diodes
- PCB & Connecting wires

2.5.1 Arduino uno

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 worring 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.

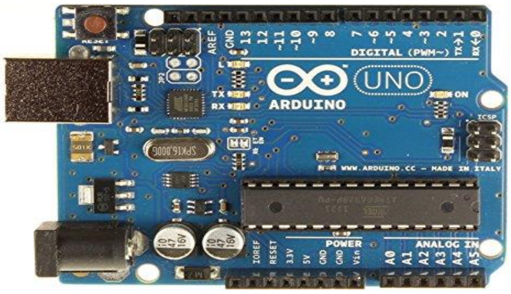


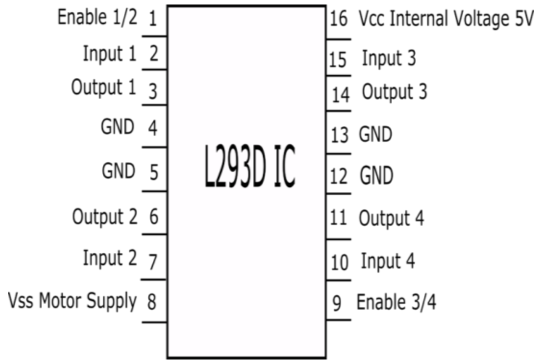
Fig.2.5.1.1 Arduino uno

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.

- **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.

2.5.2 L293D Motor Driver

The Motor Driver is a module for motors that allows you to control the working speed and direction of two motors simultaneously .This Motor Driver is designed and developed based on L293D IC.L293D is a 16 Pin Motor Driver IC. This is designed to provide bidirectional drive currents at voltages from 5 V to 36 V.



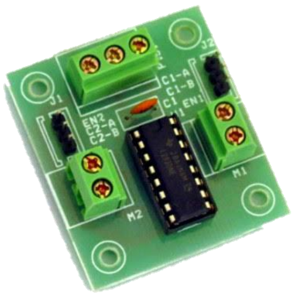


Fig2.5.2.1

Concept

It works on the concept of H-bridge. H-bridge is a circuit which allows the voltage to be flown in either direction. As you know voltage need to change its direction for being able to rotate the motor in clockwise or anticlockwise direction, Hence H-bridge IC are ideal for driving a DC motor.

In a single L293D chip there are two h-Bridge circuit inside the IC which can rotate two dc motor independently. Due its size it is very much used in robotic application for controlling DC motors. Given below is the pin diagram of a L293D motor controller.

There are two Enable pins on l293d. Pin 1 and pin 9, for being able to drive the motor, the pin 1 and 9 need to be high. For driving the motor with left H-bridge you need to enable pin 1 to high. And for right H-Bridge you need to make the pin 9 to high. If anyone of the either pin1 or pin9 goes low then the motor in the corresponding section will suspend working. It's like a switch.

Working of L293D

There are 4 input pins for l293d, pin 2,7 on the left and pin 15 ,10 on the right as shown on the pin diagram. Left input pins will regulate the rotation of motor connected across left side and right input for motor on the right hand side. The motors are rotated on the basis of the inputs provided across the input pins as LOGIC 0 or LOGIC 1.

In simple you need to provide Logic 0 or 1 across the input pins for rotating the motor.

2.5.3 Geared DC Motor

Geared DC motors can be defined as an extension of DC motor which already had its Insight details demystified here. A geared DC Motor has a gear assembly attached to the motor. The speed of motor is counted in terms of rotations of the shaft per minute and is termed as RPM .The gear assembly helps in increasing the torque and reducing the speed. Using the correct combination of gears in a gear motor, its speed can be reduced to any desirable figure. This concept where gears reduce the speed of the vehicle but increase its torque is known as gear reduction. This Insight will explore all the minor and major details that make the gear head and hence the working of geared DC motor.

Fig 2.5.3.1

Gear motors are used in applications that require lower shaft speed and higher torque output. This describes a wide range of applications and scenarios, including many of the machines and equipment we interact with on a daily basis. From ATV wipers to hospital beds, servo mechanisms to packaging equipment, paint mixers to juice dispensers, gear motors are used to power a significant number of machines and applications.

2.5.4 LDR (Light dependent resistor)

A Light Dependent Resistor (LDR) is also called a photoresistor or a cadmium sulfide (CdS) cell. It is also called a photoconductor. It is basically a photocell that works on the principle of photoconductivity. The passive component is basically a resistor whose resistance value decreases when the intensity of light decreases. This optoelectronic device is mostly used in light varying sensor circuit, and light and dark activated switching circuits. Some of its applications include camera light meters, street lights, clock radios, light beam alarms, reflective smoke alarms, and outdoor clocks.c

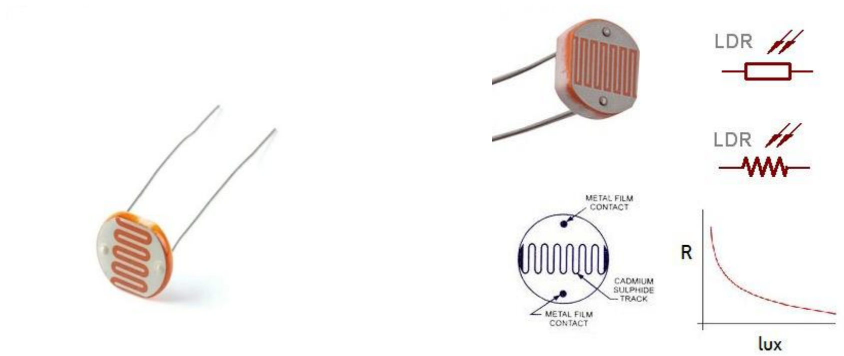


Fig 2.5.4.1

The snake like track shown above is the Cadmium Sulphide (CdS) film which also passes through the sides. On the top and bottom are metal films which are connected to the terminal leads. It is designed in such a way as to provide maximum possible contact area with the two metal films. The structure is housed in a clear plastic or resin case, to provide free access to external light. As explained above, the main component for the construction of LDR is cadmium sulphide (CdS), which is used as the photoconductor and contains no or very few electrons when not illuminated. In the absence of light it is designed to have a high resistance inthe range of megaohms. As soon as light falls on the sensor, the electrons are liberated and the conductivity of the material increases. When the light intensity exceeds a certain frequency, the photons absorbed by the semiconductor give band electrons the energy required to jump into the conduction band. This causes the free electrons or holes to conduct electricity and thus dropping the resistance dramatically (< 1 Kiloohm).

The equation to show the relation between resistance and illumination can be written as

$$R = A.E^a$$

where E – Illumination (lux)

R – Resistance (Ohms)

A,a – constants

The value of ‘a’ depends on the CdS used and on the manufacturing process. Values usually range betwee 0.7 and 0.9.

Advantages

LDR’s are cheap and are readily available in many sizes and shapes. Practical LDRs are available in a variety of sizes and package styles, the most popular size having a face diameter of roughly 10 mm. They need very small power and voltage for its operation.

Disadvantages

Highly inaccurate with a response time of about tens or hundreds of milliseconds.

2.5.5 Rechargable Battery

A rechargeable battery, storage battery, or secondary cell, (or archaically accumulator) is a type of electrical battery which can be charged, discharged into a load, and recharged many times, as opposed to a disposable or primary battery, which is supplied fully charged and discarded after use. It is composed of one or more electrochemical cells. The term "accumulator" is used as it accumulates and stores energy through a reversible electrochemical reaction. Rechargeable batteries are produced in many different shapes and sizes, ranging from button cells to megawatt systems connected to stabilize an electrical distribution network. Several different combinations of electrode materials and electrolytes are used, including lead–acid, nickel–cadmium (NiCd), nickel–metal hydride (NiMH), lithium-ion (Li-ion), and lithium-ion polymer (Li-ion polymer).

Fig 2.5.5.1

Rechargeable batteries typically initially cost more than disposable batteries, but have a much lower total cost of ownership and environmental impact, as they can be recharged inexpensively many times before they need replacing. Some rechargeable battery types are available in the same sizes and voltages as disposable types, and can be used interchangeably with them.

2.5.6 Voltage Regulators

A voltage regulator is a system designed to automatically maintain a constant voltage level. A voltage regulator may use a simple feed-forward design or may include negative feedback. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages.

Electronic voltage regulators are found in devices such as computer power supplies where they stabilize the DC voltages used by the processor and other elements. In automobile alternators and central power station generator plants, voltage regulators control the output of the plant. In an electric power distribution system, voltage regulators may be installed at a substation or along distribution lines so that all customers receive steady voltage independent of how much power is drawn from the line.

- **LM7805**

The voltage regulator IC 7805 is actually a member of the 78xx series of voltage regulator ICs. It is a fixed linear voltage regulator. The xx present in 78xx represents the value of the fixed output voltage that the particular IC provides. For 7805 IC, it is +5V DC regulated power supply. This regulator IC also adds a provision for a heat sink. The input voltage to this voltage regulator can be up to 35V, and this IC can give a constant 5V for any value of input less than or equal to 35V which is the threshold limit.

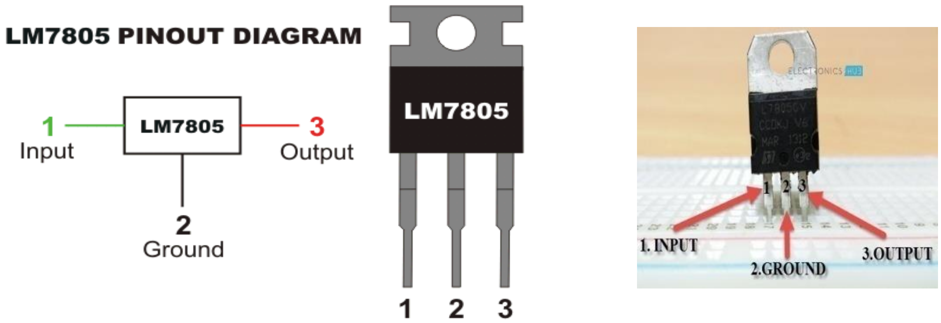


Fig 2.5.6.1

- **LM7809**

7809 IC is an iconic regulator IC that finds its application in most of the projects. The name 7809 signifies two meaning, “78” means that it is a positive voltage regulator and “09” means that it provides 9V as output. So our 7809 will provide a +9V output voltage.

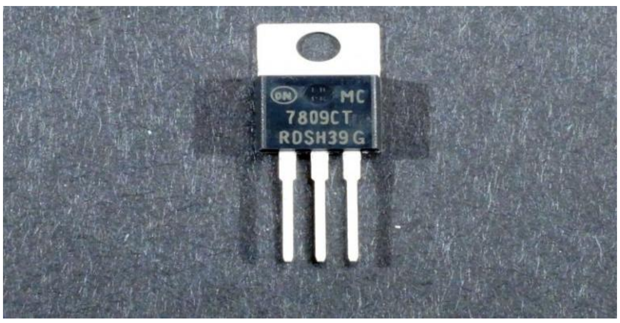


Fig 2.5.6.2

The output current of this IC can go up to 1.5A. But, the IC suffers from heavy heat loss hence a Heatsink is recommended for projects that consume more current. For example, if the input voltage is 15V and you are consuming 1A, then (15-9) * 1 = 6W. This 6 Watts will be dissipated as heat.

2.5.7 Buck Converter LM2595

DC-DC Buck Converter Step Down Module LM2596 Power Supply is a step-down(buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version. The LM2596 series operates at a switching frequency of 150kHz, thus allowing smaller sized filter components than what would be required with lower frequency switching regulators.

Fig 2.5.7.1

2.5.8 Battery Level Indicator LM3914

The LM3914 is a monolithic integrated circuit that senses analog voltage levels and drives 10 LEDs, providing a linear analog display. This ic is used for Dot and Bar Display. A single pin changes the display from a moving dot to a bar graph. The current drive to the LEDs is regulated and programmable, eliminating the need for resistors. This feature is one that allows operation of the whole system from less than 3V.

The linear scaling of the output thresholds makes the device usable, for example, as a voltmeter. In the basic configuration, it provides a ten-step scale that is expandable to over 100 segments with other LM3914 ICs in series.

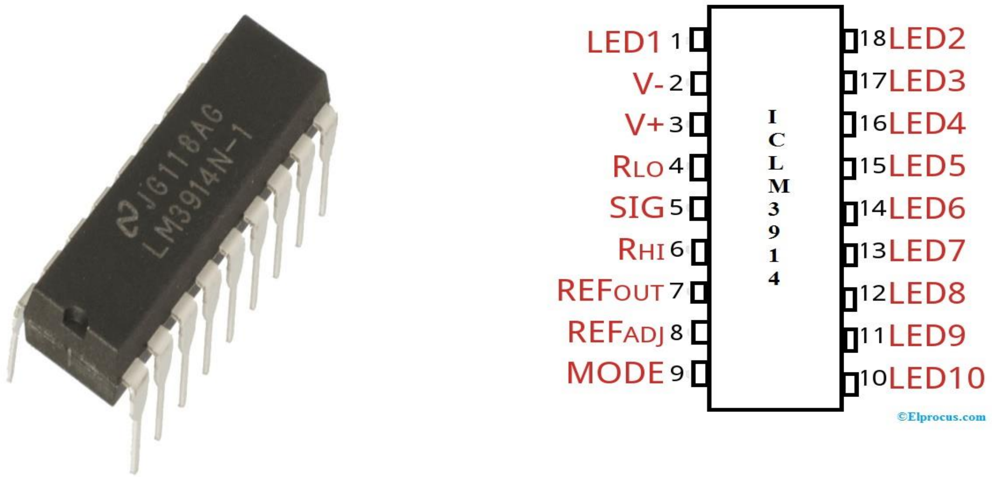


Fig 2.5.8.1

impedance buffer operates with signals from ground to 12V and is protected against reverse and overvoltage signals. The signal is then applied to a series of 10 comparators; each of which is biased to a different comparison level by the resistor string.

Working of lm3914

The LM3914 is relatively low-powered itself, and since any number of LEDs can be powered from about 3V, it is a very efficient display driver. The typical standby supply current (all LEDs OFF) is 1.6mA (2.5mA max). However, any reference loading adds 4 times that current drain to the V+ (pin 3) supply input. For example, an LM3914 with a 1mA reference pin load (1.3k), would supply almost 10mA to every LED while drawing the only 10mA from its V+ pin supply. At full-scale, the IC is typically drawing less than 10% of the current supplied to the display.

Circuit Diagram Of Battery Level Indicator

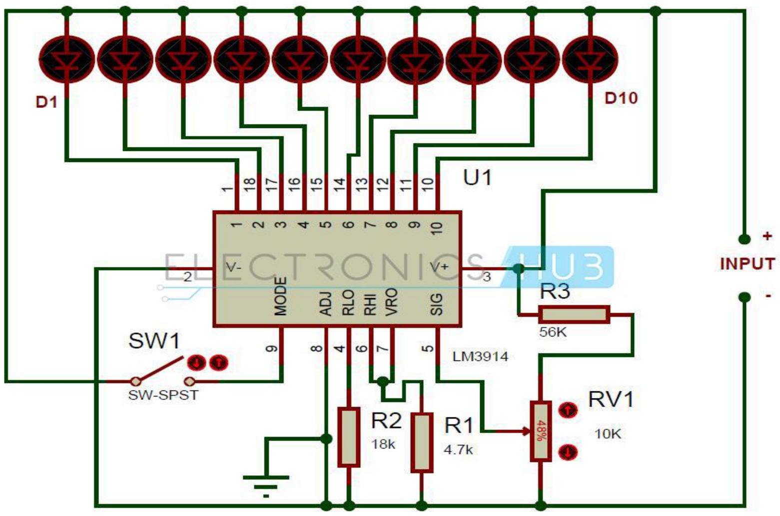


Fig 2.5.8.2

2.5.9 Solar Panel

Definition : Solar panels are those devices which are used to absorb the sun's rays and convert them into electricity or heat.

Description : A solar panel is actually a collection of solar (or photovoltaic) cells, which can be used to generate electricity through photovoltaic effect. These cells are arranged in a grid-like pattern on the surface of solar panels.Thus, it may also be described as a set of photovoltaic modules, mounted on a structure supporting it. A photovoltaic (PV) module is a packaged and connected assembly of 6×10 solar cells.

When it comes to wear-and-tear, these panels are very hardy. Solar panels wear out extremely slow. In a year, their effectiveness decreases only about one to two per cent (at times, even lesser).Most solar panels are made up using crystalline silicon solar cells.

Installation of solar panels in homes helps in combating the harmful emissions of greenhouse gases and thus helps reduce global warming. Solar panels do not lead to any form of pollution and are clean

. They also decrease our reliance on fossil fuels (which are limited) and traditional power sources.These days, solar panels are used in wide-ranging electronic equipments like calculators, which work as long as sunlight is available.

Fig 2.5.9.1

However, the only major drawback of solar panels is that they are quite costly. Also, solar panels are installed outdoors as they need sunlight to get charged.

CHAPTER 3

SYSTEM INTEGRATION

3.1 Working

The proposed tracking system does tracking of sunlight more effectively by providing PV panel rotation in two different axis. In dual-axis tracking system optimum power is achieved by tracking the sun in four directions. In this way we can capture more sun rays. The dual-axis solar tracker follows the angular height position of the sun in the sky in addition to following the sun's east-west movement. The dual-axis working is similar to single axis but it captures the solar energy more effectively by rotating in the horizontal as well as the vertical axis.. The tracker model is composed of four LDR sensors, two geare motors and arduinouno . One set of sensors and one motor is used to tilt the tracker in sun's east - west direction and the other set of sensors and the other motor which is fixed at the bottom of the tracker is used to tilt the tracker in the sun's north-south direction. The motors are basically performing function of sun tracking. Upper panel holder stepper motor tracks the sun linearly and base stepper motor tracks the parabolic displacement of sun. These stepper motors and sensors are interfaced with a microcontroller which is controlling stepper motors on the basis of sensor's input. LDR sensors sense the light and sends signal to microcontroller. Microcontroller is doing comparison of signal received from LDR sensors and on the basis of stronger signal it is deciding rotation direction of gearemotor.The LDR sensors after sensing the light forward the signal to Microcontroller. Microcontroller is intelligent device which is taking actions on the basis of sensor input and activating the motor driver's circuit accordingly. Now suppose if sun changes it location and moves from east to west, it will cause light intensity to be different on one sensor as compared to other one. On the basis of light intensity difference on sensors, controller activates driver circuits and moves motors to new positions where light falling on sensor pairs is same. The same process will keep on with change in sun's location in the sky. As a result this proposed model is able to capture more sun rays and system's solar energy conversion capability is greatly enhanced. Controller is performing signal comparison and is the main deciding element.

The voltage generated by solar panel is varying and needs to be regulated. A regulator can be used after the solar panel which may regulate the voltage coming from solar panel. Tracker circuitry requires power supply for its working and for this purpose supply is provided by generated solar energy. There is no need to provide external power supply which makes our system economical and cost effective too. The purposed model can also be used as a standalone system by introducing battery storage and proper control of storage system. Battery storage is controlled on the basis of generated voltage. Charging and discharging events for storage are decided on the basis of generated voltage.

3.2 APPLICATION SOFTWARE

3.2.1 Arduino Software

The Arduino IDE is a cross platform application written in java that utilizes the C programming language. This provides you access to a huge Arduino Library that's perpetually broadening because of open-source Company and in addition uploading programs to the board with one click can be done. First, we must always tack the board and port settings to allow us to transfer or upload code. Arduino boards are usually connected via the USB cable.

3.2.2 C &Embedded C

The software part programming through Arduino Uno software (IDE). It is easy to write code and upload it to the board. C and Embedded C language are used for programming.

C LANGUAGE

C is a high-level and general-purpose programming language that is ideal for developing firmware or portable applications. Originally intended for writing system software, C was developed at Bell Labs by Dennis Ritchie for the Unix Operating System in the early 1970s.

Ranked among the most widely used languages, C has a compiler for most computer systems and has influenced many popular languages – notably C++.

Some of C's most important features include:

- Fixed number of keywords, including a set of control primitives, such as if, for, while, switch and do while
- Multiple logical and mathematical operators, including bit manipulators
- Multiple assignments may be applied in a single statement.
- Function return values are not always required and may be ignored if unneeded.
- Typing is static. All data has type but may be implicitly converted.
- Basic form of modularity, as files may be separately compiled and linked
- Control of function and object visibility to other files via extern and static attributes.

HISTORY OF C

C is a general-purpose programming language which features economy of expression, modern control flow and data structures, and a rich set of operators. C is not a "very high level" language, nor a "big" one, and is not specialized to any particular area of application. But its absence of restrictions and its generality make it more convenient and effective for many tasks than supposedly more powerful languages.

The history of C programming language is quite interesting. C was originally designed for and implemented on the UNIX operating system on the DEC PDP-ll, by Dennis Ritchie. C is the result of a development process that started with an older language called BCPL. BCPL was developed by Martin Richards, and it influenced a language called B, which was invented by Ken Thompson. B led to the development of C in the 1970s.

For many years, the de facto standard for C was the version supplied with the UNIX operating system. In the summer of 1983 a committee was established to create an

ANSI (American National Standards Institute) standard that would define the C language. The standardization process took six years (much longer than anyone reasonably expected).

The ANSI C standard was finally adopted in December 1989, with the first copies becoming available in early 1990. The standard was also adopted by ISO (International Standards Organization), and the resulting standard was typically referred to as ANSI/ISO Standard C. In 1995, Amendment 1 to the C standard was adopted, which, among other things, added several new library functions. The 1989 standard for C, along with Amendment 1, became a base document for Standard C++, defining the C subset of C++. The version of C defined by the 1989 standard is commonly referred to as C89.

During the 1990s, a new standard for C was being developed. It was the 1999 standard for C, usually referred to as C99. In general, C99 retained nearly all of the features of C89. The C99 standardization committee focused on two main areas: the addition of several numeric libraries and the development of some special-use, but highly innovative, new features, such as variable-length arrays and the restrict pointer qualifier. These innovations have once again put C at the forefront of computer language development.

C89 is the version of C in widest use, it is currently accepted by all C compilers, and it forms the basis for C++.

Embedded C

Embedded C is a generic term given to a programming language written in C, which is associated with a particular hardware architecture. Embedded C is an extension to the C language with some additional header files. An embedded system is a computer system with a dedicated function within a larger mechanical or electrical system, often with real-time computing constraints. It is embedded as part of a complete device often including hardware and mechanical parts. Embedded systems control many devices in common use today.

3.4 Flow Chart

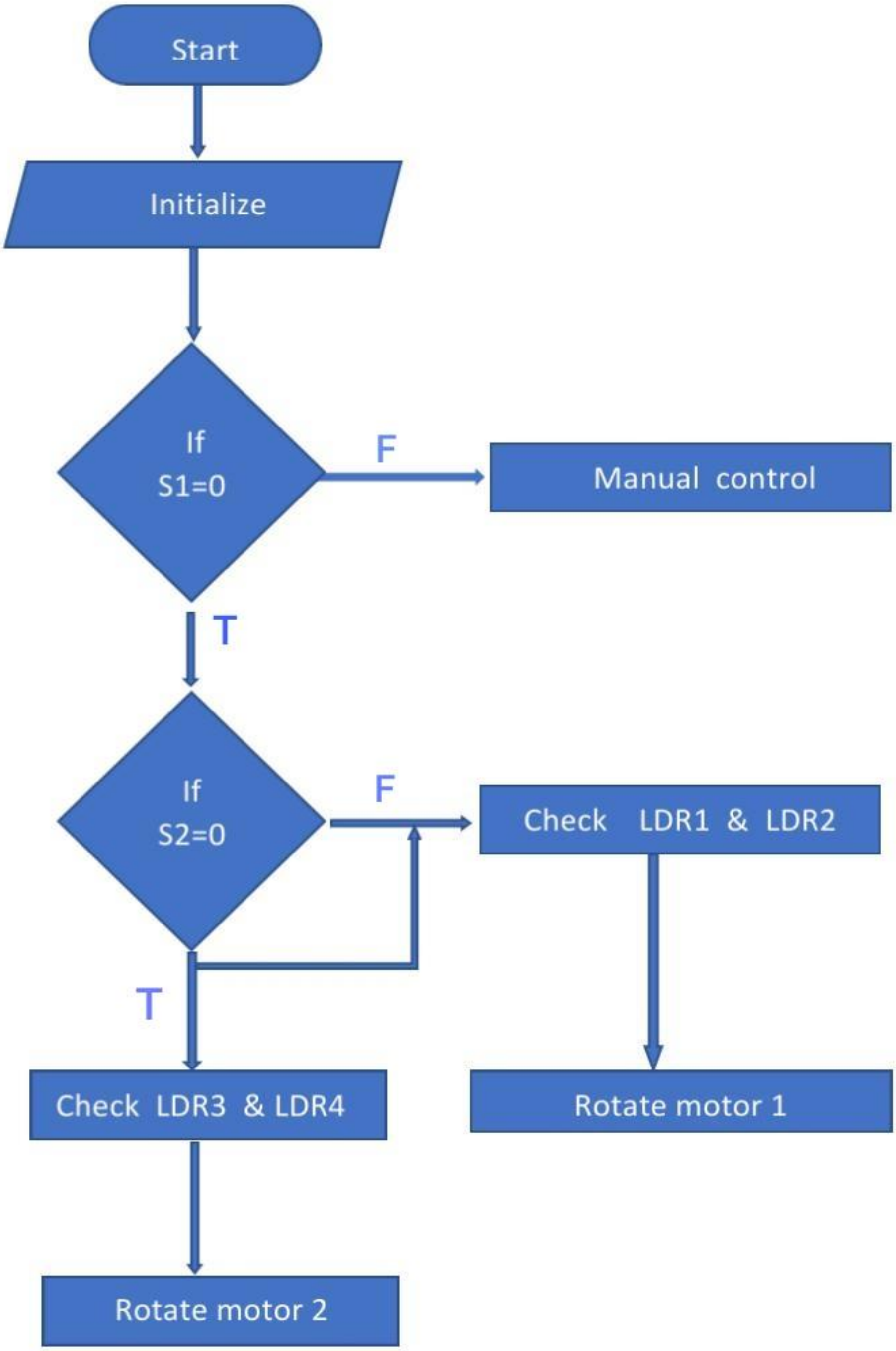


fig 3.4.1.1

3.5 Product Photos

Fig 3.5.1

CHAPTER 4

ADVANTAGES, DISADVANTAGES, APPLICATIONS & FUTURESCOPE

4.1 ADVANTAGES

- Dual-axis trackers follow the Sun continually and provide constant power output throughout the day.
- These solar trackers provide a reasonable solution in cases of the limited power capacity of the connection to the grid.
- These trackers generate 45-50% higher power output per year, as compared to a static station of the same installed.
- The payback period on investment is lower in the case of dual-axis trackers. Also, there will be a significant increase in profits during their lifespan.
- The solar energy can be reused as it is non-renewable resource.
- This also saves money as there is no need to pay for energy used (excluding the initial setup cost)

4.2 DISADVANTAGES

- Dual-axis trackers have higher technical complexity, which makes it potentially vulnerable to glitches.
- These trackers have a shorter lifespan and lesser reliability.
- Low performance in cloudy or overcast weather

4.3 APPLICATIONS

- These panels can be used to power the traffic lights and streetlights
- These can be used in home to power the appliances using solar power.
- These can be used in industries as more energy can be saved by rotating the panel.

4.4 FUTURE SCOPE OF THE PROJECT

Automatic solar tracking system offers a prototype for implementing a large array type solar tracker. This will be an expansion of mechanical as well as electronic system Following additions can be made to the prototype to maximize the power conversion:

• By connecting the solar panels in an array more energy can be extracted.

• Using aluminum type of material for the assembly set up the weight upon the motors can be reduced which will automatically reduce the power consumption of the system.

• With the monocrystalline PV panel in use the efficiency of the project can be increased. Monocrystalline PV panels have also more lifetime than polycrystalline panels.

CHAPTER 5

CONCLUSION

The innovative designs in sun tracking systems have enabled the development of many solar thermal and photovoltaic systems for a diverse variety of applications in recent years compared to the traditional fixed panels. Solar systems which track the changes in the sun's trajectory over the course of the day collect a far greater amount of solar energy, and therefore generate a significantly higher output power. This paper has presented a review of the major types of sun tracking systems developed over the past 20 years. It has been shown that these sun tracking systems can be broadly classified as single axis and dual axis, depending on their mode of rotation. Further it can be classified as active and passive tracker depending on the actuator. The sub division and their basic principles of each method have been reviewed. Overall, the results presented in this review confirm that the azimuth and altitude dual axis tracking system is more efficient compared to other tracking systems. However in cost and flexibility point of view single axis tracking system is more feasible than dual axis. In future the present paper details will be useful in selecting an accurate and particular tracker with respect to region, available space and estimated cost. The present work may be useful to improve the design characteristics of different types of solar tracking systems to improve performance.

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APPENDIX

Program Code

```
intebuttonPin = 4;
intwbuttonPin = 5;
inttbuttonPin = 2;
intbbuttonPin = 3;
int switch1Pin = 6;
int switch2Pin = 7;
inteldr = A2;
intwldr = A3;
inttldr = A4;
intbldr = A5;
int IN1 = 8;
int IN2 = 10;
int IN3 = 11;
int IN4 = 12;
inteastldr = 0;
intwestldr = 0;
inttopldr = 0;
intbotldr = 0;
int error = 0;
intposerror = 0;
inttberror = 0;
inttbposerror = 0;
inteastbutton = 0;
intwestbutton = 0;
inttopbutton = 0;
intbotbutton = 0;
intonoffswitch = 0;
intsingledualswitch = 0;
void setup()
```

```
{
pinMode (A2, INPUT);
pinMode (A3, INPUT);
pinMode (A4, INPUT);
pinMode (A5, INPUT);
pinMode (4, INPUT_PULLUP);
pinMode (5, INPUT_PULLUP);
pinMode (2, INPUT_PULLUP);
pinMode (3, INPUT_PULLUP);
pinMode (8, OUTPUT);
pinMode (10, OUTPUT);
pinMode (11, OUTPUT);
pinMode (12, OUTPUT);
pinMode (6, INPUT_PULLUP);
pinMode (7, INPUT_PULLUP);
Serial.begin(9600);
}
void loop()
{
digitalWrite(IN1, LOW);
digitalWrite(IN2, LOW);
digitalWrite(IN3, LOW);
digitalWrite(IN4, LOW);
onoffswitch = digitalRead(switch1Pin);
  while  (onoffswitch == LOW  )
 {
eastbutton = digitalRead(ebuttonPin);
                if (eastbutton == HIGH)
  {
digitalWrite(IN2, LOW);
digitalWrite(IN1, HIGH);
digitalWrite(IN3, LOW);
digitalWrite(IN4, LOW);
    }
```

```
    else
 {
digitalWrite(IN2, LOW);
digitalWrite(IN1, LOW);
digitalWrite(IN3, LOW);
digitalWrite(IN4, LOW);
    }
westbutton = digitalRead(wbuttonPin);
                 if (westbutton == HIGH)
  {
digitalWrite(IN1, LOW);
digitalWrite(IN2, HIGH);
digitalWrite(IN3, LOW);
digitalWrite(IN4, LOW);
    }
    else
 {
digitalWrite(IN2, LOW);
digitalWrite(IN1, LOW);
digitalWrite(IN3, LOW);
digitalWrite(IN4, LOW);
    }
topbutton = digitalRead(tbuttonPin);
                if (topbutton == HIGH)
  {
digitalWrite(IN4, LOW);
digitalWrite(IN3, HIGH);
digitalWrite(IN1, LOW);
digitalWrite(IN2, LOW);
    }
    else
{
digitalWrite(IN2, LOW);
digitalWrite(IN1, LOW);
```

```
digitalWrite(IN3, LOW);
digitalWrite(IN4, LOW);
    }
botbutton = digitalRead(bbuttonPin);
              if (botbutton == HIGH)
{
digitalWrite(IN3, LOW);
digitalWrite(IN4, HIGH);
digitalWrite(IN1, LOW);
digitalWrite(IN2, LOW);
  }
  else
{
digitalWrite(IN2, LOW);
digitalWrite(IN1, LOW);
digitalWrite(IN3, LOW);
digitalWrite(IN4, LOW);
  }
onoffswitch = digitalRead(switch1Pin);
singledualswitch = digitalRead(switch2Pin);
  }
onoffswitch = digitalRead(switch1Pin);
singledualswitch = digitalRead(switch2Pin);
while  (onoffswitch == HIGH &&singledualswitch == LOW )
{
eastldr = analogRead(A2);
westldr = analogRead(A3);
error = (eastldr - westldr);
poserror = abs(error);
 if (poserror> 50)
{
 if (error > 0)
{
digitalWrite(IN2, LOW);
```

```
digitalWrite(IN1, HIGH);
  }
  else if (error < 0)
{
digitalWrite(IN1, LOW);
digitalWrite(IN2, HIGH);
  }}
  else if (poserror<= 50 )
{
digitalWrite(IN1, LOW);
digitalWrite(IN2, LOW);
    }
onoffswitch = digitalRead(switch1Pin);
singledualswitch = digitalRead(switch2Pin);
}

onoffswitch = digitalRead(switch1Pin);
singledualswitch = digitalRead(switch2Pin);
while  (onoffswitch == HIGH &singledualswitch == HIGH )
{
eastldr = analogRead(A2);
westldr = analogRead(A3);
topldr = analogRead(A4);
botldr = analogRead(A5);

tberror = ( topldr - botldr);
tbposerror = abs(tberror);
      error = ( eastldr - westldr );
poserror = abs(error);
  if (poserror> 50 )
{
 if (error > 0)
{
digitalWrite(IN2, LOW);
```

```
digitalWrite(IN1, HIGH);
  }
  else if (error < 0)
{
digitalWrite(IN1, LOW);
digitalWrite(IN2, HIGH);
  }}
  else if (poserror<= 50 )
{
digitalWrite(IN1, LOW);
digitalWrite(IN2, LOW);
    }
   if (tbposerror> 50)
{
if (tberror> 0)
 {
digitalWrite(IN4, LOW);
digitalWrite(IN3, HIGH);
}
else if (tberror< 0)
{
digitalWrite(IN3, LOW);
digitalWrite(IN4, HIGH);
    }}
  else if (poserror<= 50 )
{
digitalWrite(IN4, LOW);
digitalWrite(IN3, LOW);
  }
onoffswitch = digitalRead(switch1Pin);
singledualswitch = digitalRead(switch2Pin);
}
digitalWrite(IN1, LOW);
digitalWrite(IN2, LOW);
```

```
digitalWrite(IN3, LOW);
digitalWrite(IN4, LOW);
}
```

DATA SHEET