Dual Axis Solar Tracking System

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Abstract- ***Solar panels are devices that convert light into electricity. Solar panels use sunlight to generate power. Solar panels work best when the sun is shining. As the angle of the sun varies throughout the day and seasons, this affects the amount of electricity a solar power system will generate. To make solar power systems work more efficiently, this project will include the design and construction of a microcontroller-based solar panel tracking system. Solar tracking allows more energy to be produced because the solar array can remain aligned to the sun. In this project, we will design a dual-axis solar tracker that allows solar panels to move on two axes, aligned both north-south and an east-west. This type of system is designed to maximize solar energy collection throughout the year. This project will make use of the Light Depending Resistor (LDR) which is important to detect the sunlight by following the source of the sunlight location. Arduino Uno microcontroller is used to control the motors based on LDR. The drastic improvement in power output from the solar panel can be seen on a LCD Display attached to the system. This project discusses the development of a prototype for a dual-axis solar tracking system.***

Indexed Terms- **Solar Panel, Arduino Uno, LDR, LCD**

I. INTRODUCTION

This project will utilize the maximum solar energy through solar panels. To do so, a digital automatic sun tracking system is proposed. The project will help solar panels to get the maximum sunlight automatically thereby increasing the efficiency of the system. In this project, a working dual-axis solar tracker is built by using a balanced concept which is four signals from the different sensors are compared. Light Dependent Resistor (LDR) as a light sensor has been used. The four light-sensors are separated by a divider which will create a shadow on one side of the light sensor if the solar panel is not perpendicular to the sun. This will create a variation in light intensities sensed by the light sensors. The difference in these values will the Arduino know that solar panel isn't perpendicular to the sun, Arduino, as a microcontroller, will control the movement of the motors via motor driver IC (L298n). Data will be received from the sensors and then processed by the Arduino. The Arduino will send the processed data to the Bi-directional DC-geared motor via motor driver IC (L298n) to ensure the solar panel is perpendicular towards the Sun. Motor driver IC (L298n) controls the rotation of the motor either to rotate clockwise or anticlockwise. The solar panel that attached to the motors will be reacted according to the direction of the motors. To get maximum intensity of light and zero voltage difference (error degree) the position of the panel must always perpendicular to the light source. Uses of Single Axis throughout the year do not maintain the output power. The position of the sun will change from the position of installed solar tracker and make the panel no more perpendicular to the sun which affects the output power. Therefore, dual-axis solar tracking moves the solar panel to be always perpendicular to the sun. The tracker will track the sun throughout the years and maintaining the output power generated by the solar panel. An LDR is a component that has a (variable) resistance that changes with the light intensity that falls upon it. They are also called as photoconductors, photoconductive cells or simply photocells. Here we have used four LDRs to sense the light falling on the solar panel is perpendicular to all four directions. So, the values of all four LDR should be the same to achieve the correct direction for the solar panel.

II. LITERATURE SURVEY

Guihua Li, Runsheng Tang, Hao Zhong, "Optical Performance of Horizontal Single-Axis Tracked Solar Panels" Solar Energy Research Institute Yunnan Normal University Kunming 650092, PR China, published in International Conference on Future Energy, Environment, and Materials. In this paper they

investigated horizontal single-axis tracked solar panels. They obtained result as east west axis tracking was poor to improve the energy while tracking the sun about south-north was best. The efficiency increased for east-west axis was less than 8% whereas for south-north axis increased by 10-24%.

Ashwin R, Varun A.K, "Design and fabrication of single axis solar tracking system" Department Of Mechanical Engineering, Jeppiaar Engineering College, Chennai, published in 2014 International Journal of Mechanical And Production Engineering. In this paper they presented a sensor based single axis solar tracker to achieve highest degree of energy through solar panel. It keeps tracking continuously for the maximum strength of light.

This system spontaneously changes its direction when the sun moves from its position to get maximum light energy. Therefore, the experimental result shows the robustness and productiveness of the proposed method. Jaya Prakash S, Manjunatha R, Punith Gowda T H, John Abhishek M, Sangeetha V, "Survey on automatic solar tracking system" Dept. Of CSE, K.S Institute of Technology, Bengaluru, India published in International Journal of Innovations in Engineering and Science, Vol. 3, No.5, 2018.

This paper explains about the effects of global warming and how can we take advantage from this effect like how the Solar energy is used for electrical energy generation. Solar tracking System is based on AVR microcontroller, which is a brain of a complete system. This controller will monitor and control the intensity and rotation respectively. This system is more cost effective and efficient. System installation is easy. But the trackers are complex than the fixed solar systems.

Dhanalakshmi.V, Lakshmi Prasanna H.N, "Dual axis solar tracker using arduino uno" Dept. of EEE, Dr.T.T.I.T, KGF, published in International Journal on Recent and Innovation Trends in Computing and Communication Volume: 4 Issue: 6 In this paper they presented a smart dual axis solar tracker. They used arduino uno for the development of their proposed model. After the experiment, they observed that maximum voltage was tracked about 25% to 30% and the generating power increased by 30% compared to a static system.

III. METHODOLOGY

The project is built using a balanced concept which is four signals from the different sensors are compared. Light Dependent Resistor (LDR) as a light sensor has been used. The four light sensors are separated by divider which will create shadow on one side of the light sensor if the solar panel is not perpendicular to the sun. The Arduino microcontroller will take continuous readings of LDR and control the motors accordingly by sending signals to motor driver. Motor driver IC(L298n) controls the rotation of the motor either to rotate clockwise or anticlockwise depending on the signal from Arduino microcontroller. The solar panel that attached to the motors will be reacted according to the direction of the motors.

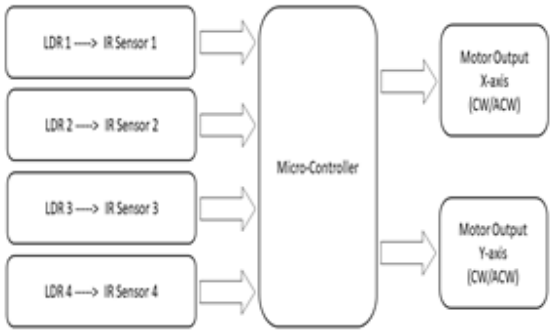


Fig 1: Block Diagram

IV. HARDWARE DECRIPTION

1. ARDUINO UNO

The Arduino Uno is a microcontroller board based on the ATmega328.It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards or breadboards (shields) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some

models, which are also used for the microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler toolchains the Arduino project provides an integrated development environment (IDE) based on the Processing language project loading programs from personal computers.

2. 7805 VOLTAGE REGULATOR

A voltage regulator IC maintains the output voltage at a constant value. 7805 IC, a member of 78xx series of fixed linear voltage regulators used to maintain such fluctuations, is a popular voltage regulator integrated circuit (IC). The xx in 78xx indicates the output voltage it provides. 7805 IC provides +5 volts regulated power supply with provisions to add a heat sink. A 7805 IC's input voltage range can vary from 7 Volts to 35 Volts. As you may have noticed, there is a significant difference between the input voltage & the output voltage of the voltage regulator. This difference between the input and output voltage is released as heat. The greater the difference between the input and output voltage, the more the heat generated. If the regulator does not have a heat sink to dissipate this heat, it can get destroyed and malfunction. Hence, it is advisable to limit the voltage to a maximum of 2-3 volts above the output voltage. So, we now have 2 options. Either design your circuit so that the input voltage going into the regulator is limited to 2-3 volts above the output regulated voltage or place an appropriate heatsink, that can efficiently dissipate heat.

3. SOLAR PANEL

Solar panels are devices that convert light into electricity. A solar panel is a collection of solar cells. Lots of small solar cells spread over a large area can work together to provide enough power to be useful. The more light that hits a cell, the more electricity it Solar Photovoltaic (PV) is a technology that converts sunlight (solar radiation) into direct current electricity by using semiconductors. When the sun hits the semiconductor within the PV cell, electrons are freed and form an electric current. Solar PV technology is generally employed on a panel (hence solar panels). PV cells are typically found connected and mounted on a frame called a module. Multiple modules can be wired together to form an array, which can be scaled up or down to produce the amount of power needed. PV cells can be made from various semiconductor materials. The most commonly used material today is silicon.

4. LIGHT DEPENDENT RESISTORS (LDR)

A Light Dependent Resistor (LDR) is also called a photo resistor or a cadmium sulphide (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. 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.

5. IR-SENSOR

An infrared sensor is an electronic device, that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measure only infrared radiation, rather than emitting it that is called a passive IR sensor. Usually, in the infrared spectrum, all the objects radiate some form of thermal radiation. These types of radiations are invisible to our eyes, which can be detected by an infrared sensor. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode that is sensitive to IR light of the same wavelength as that emitted by the IR LED. When IR light falls on the photodiode, the resistances and the output voltages will change in proportion to the magnitude of the IR light received.

6. IR Transmitter

Infrared Transmitter is a light emitting diode (LED) which emits infrared radiations. Hence, they are called IR LED's. Even though an IR LED looks like a normal LED, the radiation emitted by it is invisible to the human eye. There are different types of infrared

transmitters depending on their wavelengths, output power and response time. A simple infrared transmitter can be constructed using an infrared LED, a current limiting resistor and a power supply. When operated at a supply of 5V, the IR transmitter consumes about 3 to 5 mA of current. Infrared transmitters can be modulated to produce a particular frequency of infrared light. The most commonly used modulation is OOK (ON – OFF – KEYING) modulation. IR transmitters can be found in several applications. Some applications require infrared heat and the best infrared source is infrared transmitter. When infrared emitters are used with Quartz, solar cells can be made.

7. IR Receiver

Infrared receivers are also called as infrared sensors as they detect the radiation from an IR transmitter. IR receivers come in the form of photodiodes and phototransistors. Infrared Photodiodes are different from normal photo diodes as they detect only infrared radiation. Different types of IR receivers exist based on the wavelength, voltage, package, etc. When used in an infrared transmitter – receiver combination, the wavelength of the receiver should match with that of the transmitter. It consists of an IR phototransistor, a diode, a MOSFET, a potentiometer and an LED. When the phototransistor receives any infrared radiation, current flows through it and MOSFET turns on. This in turn lights up the LED which acts as a load. The potentiometer is used to control the sensitivity of the phototransistor. The one we use in our project does not contain its transmitter and receiver because we do not need to sense infrared light, here we need to sense sunlight so we connect LDR in place of photodiode at the receiver's place.

8. MOTOR DRIVER (L298N)

The L298N is a dual-channel H-Bridge motor driver capable of driving a pair of DC motors. That means it can individually drive up to two motors making it The L298N is an integrated monolithic circuit in a 15- lead Multi watt and PowerSO20 packages. It is a high voltage, high current dual full-bridge driver designed to accept standard TTL logic level sand drive inductive loads such as relays, solenoids, DC and stepping motors. Two enable inputs are provided to enable or disable the device independently of the input signals. The emitters of the lower transistors of each bridge are connected and the corresponding external terminal can be used for the connection of an external sensing resistor. An additional supply input is provided so that the logic works at a lower voltage ideal for building two-wheel robot platforms.

9. POWER PINS

The L298N motor driver module is powered through 3-pin 3.5mm-pitch screw terminals. It consists of pins for motor power supply (Vs), ground and 5V logic power supply (Vss). From Vs pin the H-Bridge gets its power for driving the motors which can be 5 to 35V. Vss is used for driving the logic circuitry which can be 5 to 7V. And they both sink to a common ground named 'GND'. The module has an on-board 78M05 5V regulator from STMicroelectronics. It can be enabled or disabled through a jumper. When this jumper is in place, the 5V regulator is enabled, supplying logic power supply (Vss) from the motor power supply (Vs). In this case, 5V input terminal acts as an output pin and delivers 5V 0.5A. You can use it to power up the Arduino or other circuitry that requires 5V power supply. When the jumper is removed, the 5V regulator gets disabled and we have to supply 5 Volts separately through 5 Volt input terminal.

10. GEAR MOTOR

A gear motor is a specific type of electrical motor that is designed to produce high torque while maintaining a low horsepower, or low speed, motor output. Gear motors can be found in many different applications, and are probably used in many devices in your home. Gear motors are commonly used in devices such as can openers, garage door openers, washing machine time control knobs, and even electric alarm clocks. Common commercial applications of a gear motor include hospital beds, commercial jacks, and cranes. Regardless of what type of gear motor you're dealing with, they all work in the same manner. Gear motors are commonly used in commercial applications where a piece of equipment needs to be able to exert a high amount of force in order to move a very heavy object. A gear motor is an all-in-one combination of a motor and gearbox. The addition of a gear head to a motor reduces the speed while increasing the torque output. The most important parameters in regards to gear motors are speed (rpm), torque (lb-in) and efficiency (%). A gear motor or stepping motor is a dc brushless electric motor that divides a full rotation into a display

device is an output device for presentation of information in visual or tactile form. When the input information is supplied as an electrical signal, the display is called an electronic display number of equal steps. The motor's position can then be commanded to move and hold at one of these steps without any position sensor for feedback as long as the motor is carefully sized to the application with respect to torque and speed.

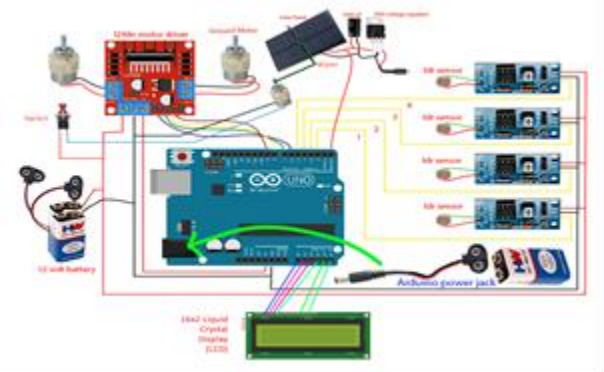
11. 16x2 Liquid Crystal Display (LCD)

LCD modules are very commonly used in most embedded projects, the reason being its cheap price, availability and programmer friendly. An LCD (Liquid Crystal Display) screen is an electronic display module and has a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. 16×2 LCD is named so because; it has 16 Columns and 2 Rows.

12. 9 V BATTERY

The nine-volt battery, or 9-volt battery, is a common size of battery that was introduced for the early transistor radios. It has a rectangular prism shape with rounded edges and a polarized snap connector at the top. This type is commonly used in walkie-talkies, clocks and smoke detectors.

V. CIRCUIT DIAGRAM



Circuit Diagram for Dual-Axis Solar Tracker

1. Connect all four LDR to the IR-sensors by replacing its photodiode.
2. Connect Vcc of motor driver (L298N) to the +5V of Arduino.
3. Connect Vcc of all four IR-sensors to the +5V of motor driver (L298N).
4. Common the GND of all IR-sensors, Arduino, and motor driver.
5. Connect the OUT of all IR-sensors to the Digital Pin 2, 3, 4, and 5 of the Arduino respectively.
6. Connect IN1, IN2, IN3, and IN4 of the motor driver to the Arduino Digital Pin 6, 7, 8, and 9 respectively.
7. Connect OUT1 and OUT2 of the motor driver to one Gear motor. And OUT3 and OUT4 to another Gear motor.
8. Connect a 9V Battery to the Arduino and a 12V Battery to the motor driver(L298N).

CONCLUSION AND FUTURE SCOPE

The aim of this project was to design a dual axis tracking system which can sense the incident solar light on the panel and move it in the direction of maximum solar light incident. The tracking controller is implemented by means of ATmega328p microcontroller. The necessary software is developed via Arduino Uno IDE. In building the solar tracking system, LDRs (Light Dependent Resistors) are used to determine solar light intensity and an LCD to display the power output from the solar panel. The proposed solar tracking system can track sun light automatically. The purpose of renewable energy from this paper offered new and advanced idea to help the people. It has been proved through previous research that solar tracking system with single-axis freedom can increase energy output by approximately 20%, whereas the tracking system with double axis freedom can increase the output by more than 40%. Therefore, this work in this paper is to develop and implement a dual-axis solar tracking system with both degree of freedom and the detection of the sunlight using sensors. The proposed system is eco-friendly. Solar radiation tracker has played a vital role in increasing the efficiency of solar panels in recent years, thus proving a better technological achievement. The key importance of a dual axis solar tracker lies in its ability to provide better efficiency and sustainability compared to a static solar panel and single axis solar tracker. The tracking system is designed such that it can trap the energy of all possible directions. It can be used for small and medium scale power generations.

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