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ARDUINO BASED DUAL AXIS SMART SOLAR TRACKER

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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. This project discusses the development of a prototype for a dual-axis solar tracking system.

KEYWORDS: Arduino Uno, Voltage regulator (7805),Solar Panel.

I. INTRODUCTION

Sun is an abundant source of energy and this solar energy can be harnesses successfully using solar photovoltaic cells and photovoltaic effect to convert energy into electrical energy. But the conversion efficiency of a normal PV cell is low. One of the main reason for this is that the output of PV cell is dependent directly on the light intensity and with the position of sun in the sky changing continuously from time to time, the absorption efficiency of an immobile solar panel would be significantly less at certain time day and year, for the solar photovoltaic cells are maximum productive when they are perpendicular to the sun and less productive otherwise. So to maximize the energy generation and improve the efficiency solar trackers are required. The solar tracker also provided lucrative solution for third world countries to integrate it into their solar system with a comparatively low cost through software based solution. 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.

The Arduino microcontroller controls all the motors of the tracker. The solar panel is aligned according to the intensity of sunlight under the control of the microcontroller. Since Arduino uses much less voltage than DC motor, so, we need to Interface a DC motor with the microcontroller, usually H-bridge is preferred way of interfacing a DC motor. These days many IC manufacturers have H-bridge motor drivers available in the market like L298n.

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.

A DC geared motor is a device that uses DC electricity to produce mechanical energy. The energy in electric current causes the DC geared motor to spin. Any devices attached to the motor can then take advantage of this spinning motion to create another type of motion. In a gear motor, the magnetic current turns gears that are either in a gear reduction unit or an integrated gearbox. A second shaft is connected to these gears. Gear head or gear motor was used in solar trackers which has the advantage of producing high torque.

A well-designed solar tracking system is necessary to improve the efficiency of the panel in a most economical way. The amount of power available to a solar panel is proportional to the amount of light that reaches it. The more light it gets, the more power it produces. By using a single-axis solar tracker can only capture the minimum power tracking sunlight in one direction which is the elevation movements from east to west by rotating the structure along the vertical axis. The use of single-axis tracking can increase the electricity yield by as much as 27% to 32%, but by using a dual-axis solar tracker, it can capture the maximum sunlight in two movements at the same time, so, dual-axis tracking increases the electricity output as much as 35% to 40%. Dual-axis solar trackers allow for two degrees of flexibility, offering a much wider range of motion. The primary and secondary axes work together to allow these trackers to point the solar panels at specific points in the sky.

II. BLOCK DIAGRAM DESCRIPTION

The main aim of the proposed system is to develop a cost effective instrument using an Arduino Microcontroller based solar tracking system. Block diagram of complete system is shown in Fig. 1 below which consists of power supply, Arduino Uno, LDR sensor, gear motor, and solar panel.

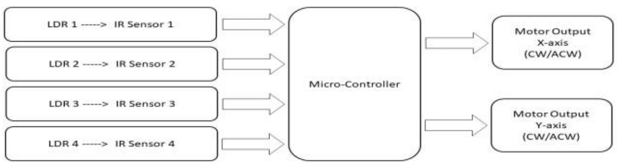
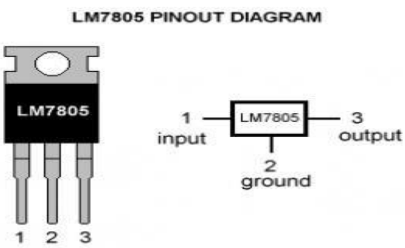


Fig. 1: Block diagram of System

A. 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.



B. OVERVIEW OF ARDUINO

Arduino is an open-source electronics prototyping platform, mostly based on small, easy-to-use hardware and software. It can affect devices, like lights, motors and other actuators by receiving input from sensor. All the action performed by Arduino is programmed to the microcontroller on the board via Arduino programming language and the Arduino development environment. Arduino projects can be standalone or communicate with other software applications running on a computer and other types of hardware.

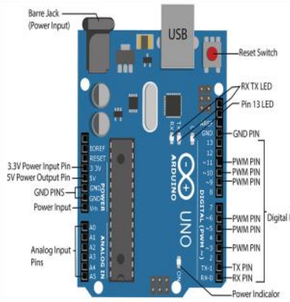


Fig. 2: Arduino Uno Microcontroller Development Board

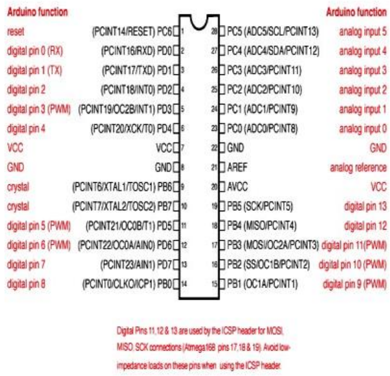


Fig.3: PIN Layout of Arduino Uno

C.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 produces.

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.

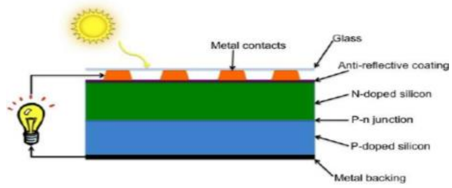


Fig. 4: Solar Panel Working

III. CONSTRUCTION PROCESS

STEP 1: First we have to construct a structure frame for solar panel which is capable to rotate along both axes.
STEP 2: Now mount the solar panel on the frame and then place the four LDR setup on it.

CIRCUIT DIAGRAM STEPS:

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 the batteries to both the ends.

After these steps, the project will look like the fig given below:

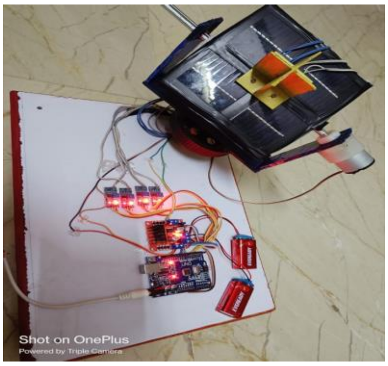


Fig. 5: Complete system

IV. IMPLEMENTATION

A. HARDWARE IMPLEMENTATION:
Complete system assembly of Solar is shown in Fig. 5,6 and 7. The system consists of Power supply unit for whole system, Arduino UNO board, , two gear motors, solar panel, four LDR sensors fixed on on solar panel and voltage divider circuitry.

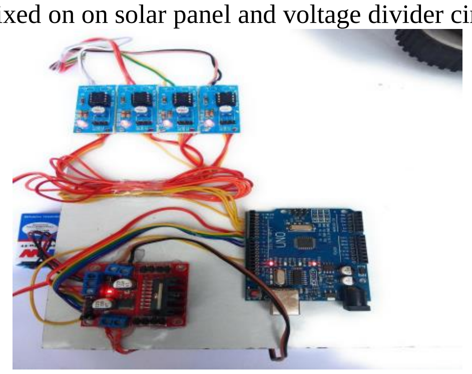


Fig. 6: Hardware assembly

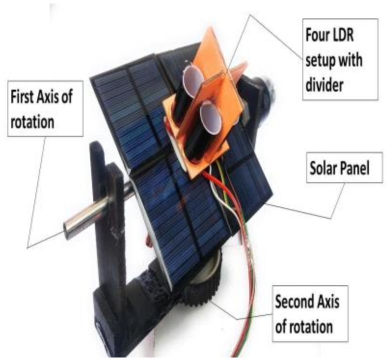


Fig. 7: Hardware Assembly of Solar Panel

B. SOFTWARE IMPLEMENTATION
Arduino program to make the above system working as required:
If all four LDRs are HIGH:

Do not send any signal to motors, system is receiving maximum sunlight.

If both LDRs of RIGHT are HIGH
Rotate the system to the right to receive maximum sunlight.

If both LDRs of LEFT are HIGH
Rotate the system to the left to receive maximum sunlight.

If both LDRs of TOP are HIGH
Rotate the system so that the solar panel rotates upwards to receive maximum sunlight.

If both LDRs of BOTTOM are HIGH
Rotate the system so that the solar panel rotates downwards to receive maximum sunlight.

If TOP-LEFT LDR is HIGH
Rotate the system to the left and upwards using both motors simultaneously to receive maximum sunlight.

If BOTTOM-LEFT LDR is HIGH
Rotate the system to the left and downwards using both motors simultaneously to receive maximum sunlight.

If TOP-RIGHT LDR is HIGH
Rotate the system to the right and upwards using both motors simultaneously to receive maximum sunlight.

If BOTTOM-RIGHT LDR is HIGH
Rotate the system to the right and downwards using both motors simultaneously to receive maximum sunlight.

Else do not send any signal to the motor driver.

The system will receive maximum sunlight based on the above conditions. This will make solar power generation most efficient throughout the year.

V. CONCLUSION

The aim of this project was to design a dual axis tracking systems which can sense the incident solar light on the panel and move it in the direction of maximum solar light incident. Further the advantages and disadvantages were also studied. The disadvantages were the challenges that had to be overcome. From this study the main conclusions are:

1. Proposed system is low cost and compact as compared to the other tracking systems in use for same application.
2. It is very easy to program and modify because it is Arduino based and no external programmer is required.
3. The designed system is automatic and provides better efficiency of the panel.
4. Reflection on the Solar panel has been decreased and, the efficiency of solar energy generation is increased.

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