



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 13, Issue 5, May 2024

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

 9940 572 462

 6381 907 438

 ijirset@gmail.com

 www.ijirset.com

Automatic Solar Tracking System to Enhance Efficiency of Solar Light Assemblage

**Prof. Nilesh C. Gaikwad, Prof. Swapnil H. Patil, Prof. Jayant J. Pharne, Sairaj S. Patil,
Dhanraj C Patil**

Workshop Superintendent, Department of Mechanical Engineering, Rajarambapu Institute of Technology,
Rajaramnagar, India

Lecturer, Department of Mechanical Engineering, Rajarambapu Institute of Technology, Rajaramnagar, India

Lecturer, Department of Mechanical Engineering, Rajarambapu Institute of Technology, Rajaramnagar, India

Student, Department of Mechanical Engineering, Rajarambapu Institute of Technology, Rajaramnagar, India

Student, Department of Mechanical Engineering, Rajarambapu Institute of Technology, Rajaramnagar, India

ABSTRACT: Bustling civilization is the vein through which modern civilization is operated. Energy day by day is put to use at its best to fulfil the desires and ambition of the peoples at large. Each and every corner of our life is caged with various layers of impediment and in this response, energy is becoming an indispensable factor. Therefore, the source of energy needs to be endless/ perpetual in order to carry this colossal population ahead. Human beings being evolutionary in nature are perhaps the best ever creation of nature is always in the race of envisaging the probable and available comforts and benefits in every possible angle in this perilous world. The evidential matrix manifests that in a dichotomy of various opinions what options best expedite the scarcity of energy in an immensely heterogeneous society like ours. Our motto is to endeavor in forwarding such noble goal of energy conservation. Taking a look at the present scenario it is evident that conventional sources of energy such as coal, natural gas, oil, etc. are at the edge of extinction. Being in mortal combat with time itself to fulfil every demand for energy the demand for these resources for energy has escalated to its zenith. The conventional use of energies due to the burning of fossil fuels like coal, oil and natural gas, the whole environment is getting polluted. The present project, therefore, is orchestrated with components like LDR module, DC Motor, Photovoltaic array etc. to enhance assemblage of solar energy to maximum level.

Image inpainting is the process of restoring the lost or damaged regions or modifying the image contents imperceptibly. It refers to the process of filling-in missing data in a designated region of the visual input. In this paper, the technique presented is for detection and removal of text from images. The system detects text using morphological operations, connected component labelling and a set of selection criteria which helps to filter out non text regions. So, the resultant image is the image with only texts. Text Inpainting is done in two steps. The first step detects the text region automatically, without user interaction and in the second step; the text is removed from the image using exemplar based Inpainting algorithm.

KEYWORDS: Text detection, Inpainting, Morphological operations, Connected component labelling.

I. INTRODUCTION

Introducing a revolutionary innovation in sustainable energy management: the Solar Light Tracking System. Harnessing the boundless power of the sun, this cutting-edge technology dynamically adjusts solar panels to optimize energy absorption throughout the day. By intelligently tracking the sun's movement across the sky, it ensures maximum efficiency, significantly enhancing the output of solar energy systems. Designed to revolutionize renewable energy utilization, the Solar Light Tracking System represents a pivotal advancement towards a greener, more sustainable future. In the pursuit of sustainable energy solutions, the utilization of solar power stands out as a beacon of hope for a greener future. However, the efficiency of solar energy systems has long been constrained by static panel positioning, limiting their ability to fully harness the sun's energy potential. Enter the Solar Light Tracking System: a groundbreaking technology that revolutionizes solar energy harvesting by dynamically aligning solar panels with the sun's trajectory throughout the day.

At its core, the Solar Light Tracking System operates on a simple yet ingenious principle: follow the sun. By employing sensors and motors, this system continuously adjusts the orientation of solar panels to maintain an optimal angle relative to the sun's position in the sky. This dynamic tracking capability allows solar panels to capture sunlight more effectively, significantly boosting energy production compared to fixed installations. The benefits of solar light tracking are manifold. Firstly, it maximizes energy generation by ensuring that solar panels receive direct sunlight for the longest possible duration each day. As the sun moves across the sky, the tracking system adapts accordingly, mitigating losses caused by shadows and obstructions. This efficiency improvement translates into higher energy yields, making solar power a more viable and cost-effective alternative to conventional energy sources.

Moreover, the Solar Light Tracking System enhances the reliability and stability of solar energy production. By optimizing panel orientation, it minimizes variations in output caused by changes in sunlight angle throughout the day and across seasons. This consistency is crucial for applications ranging from residential solar installations to large-scale solar farms, where predictable energy generation is essential for grid integration and economic viability. In addition to its technical advantages, solar light tracking embodies a commitment to sustainability and environmental stewardship. By maximizing the utilization of solar energy, it reduces reliance on fossil fuels, mitigating greenhouse gas emissions and combating climate change. Furthermore, the scalability and adaptability of this technology make it suitable for deployment in diverse settings, from urban rooftops to remote off-grid locations, empowering communities to transition towards cleaner energy sources. While the Solar Light Tracking System represents a significant advancement in solar energy technology, its implementation is not without challenges. The complexity of tracking algorithms, mechanical components, and control systems requires careful engineering and robust design to ensure reliability and longevity. Additionally, cost considerations remain a factor, although ongoing advancements in materials and manufacturing processes are driving down the price of solar tracking systems, making them increasingly accessible to a wider range of users.

II. SOLAR TRACKING SYSTEM MODULE

Basically, there are three modules in solar tracking system.

- a. The mechanism
- b. Driving motors
- c. The tracking controller

2.1 The mechanism

It is accountable to furnish with accurate movements, in the sake of following the footsteps of the sun throughout the day. The prototype of the device is made durable enough to withstand unfavorable weather condition. This mechanism of the solar tracking systems classifies themselves into two segments single axis tracker, dual axis tracker. Single axis tracking can be considered as one of the handy systems or prime solution in terms of small-scale photovoltaic power plants. Single axis tracking can be done using three different arrangements, which are based on the different axes of tracking-

- Inclined shaft installation
- South-North axis horizontal installation
- East-West axis horizontal installation.

Single axis tracker tracks in a single cardinal direction. The tracker has a single row tracking configuration. The above maintained methods are the different arrangements in which single axis tracker can be implemented. The working mechanism of all the maintained methods is at par with each other. The angle of the sun with the surface of the collector is computed and examined, the collectors are thus charged to track down the movement of the sun to meet the expectations of captivating a greater percentage of solar radiance. There are numerous other imposition of single axis tracking tracker, including-

- Horizontal Single Axis Tracker (HSAT)
- Horizontal Single Axis Tracker with Tilted Module (HTSAT)
- Vertical Single Axis Tracker (VSAT)
- Tilted Single Axis Tracker (TSAT)
- Polar Aligned Single Axis Tracker (PSAT)

The rotational axis in the dual axis tracker are orthogonal to each other. One of the axes is fixed in accordance with the ground level. This axis is known as the primary axis and the other axis is hence called the secondary axis. Dual axis trackers moved along two cardinal directions, horizontal and vertical. There are many applications of the dual axis tracker, the two most common being-

- Tip-Tilt Dual Axis Tracker
- Azimuthal Altitude Dual Axis Tracker.

The efficiency of these tracker is much more than any single axis tracker. It conventionally follows the movement of the sun and hence captures maximum solar energy.

2.2 Driving motors

The type of motor can be chosen according to precise movement required. In this case here motor used here is geared motor to achieve very precise movement according to sun movement.

2.3 Controllers

Solar tracking controllers can also categorize solar trackers into two different modules-

a. Open loop control- The approach followed requires microprocessor. This method has an inbuilt prototype which is based upon the records of the movement of sun throughout the day. Hence, the microcontroller computes the time and determines the position of the sun at that particular hour. The control system is not affected by any geographical conditions.

b. Closed loop control/Feedback controllers- This control system utilizes photosensor to compare the light intensity. These sensors are fixtures at the side of panel and help in detection of the position of the sun.

The prototype used in this research, is that of a horizontal single axis tracker. The tracking system utilizes photosensitive sensors to track down the movement or the path of the sun. This type of tracking technique is classified as active solar tracking. It is based on feedback control system or closed loop controlling. The intensities of light in our system are compared and the solar panel is charged to move in the direction of maximum available intensity. Thus, the system works on the feedback of the weather condition.

Also Effect of light intensity Variation in the intensities of light plays a significant role in depicting the amount of power output. This change in intensities monitors all the technical criteria such as voltage, circuit current, efficiency, shunt resistance etc. As a result, higher the intensities of light, greater is the power output.

III. CIRCUIT AND BLOCK DIAGRAMS IN PROJECT

3.1 Circuit and block diagram

The circuit diagram for the Arduino Based Solar Tracker Using LDR & Gear Motor is given below. Assemble the circuit as shown below.

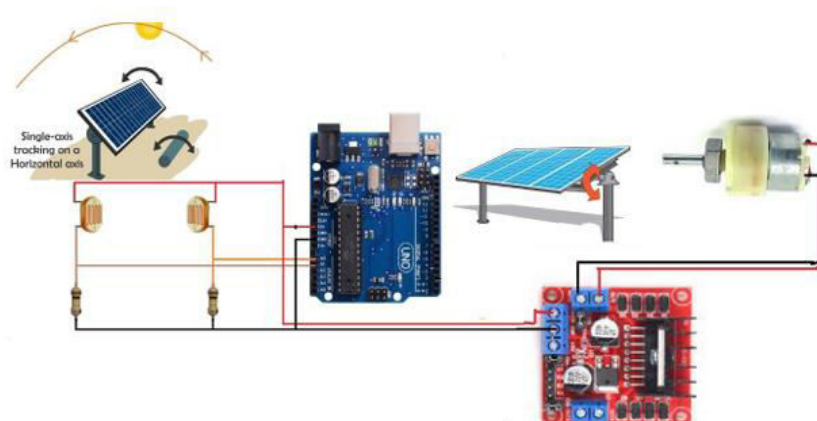


Fig.1 circuit diagram of working project.

The Solar Panel Tracker is designed to follow the sun movement so that maximum light intensity hits on the solar panel, thus increasing the power efficiency. We have designed a single-axis solar tracking system. In this system, the whole solar panel moves from east to west in a day to point in the direction of the sun. The use of a solar tracker circuit in the

field of energy production will increase its efficiency. This system can also be successfully implemented in other solar energy-based projects like water heaters and steam turbines.

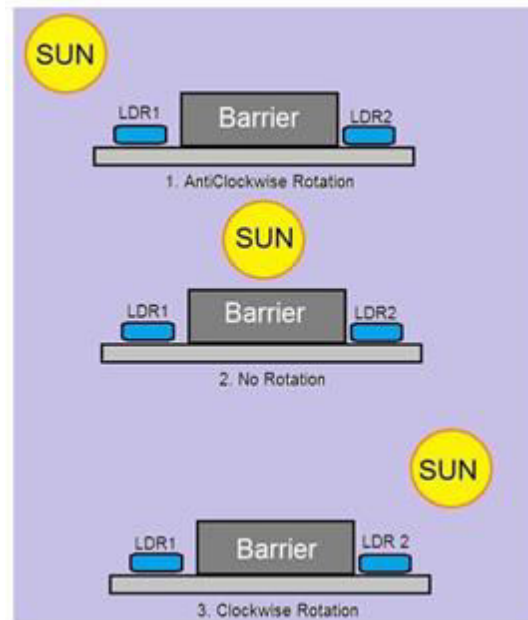


Fig.2 block diagram representing flow of project.

3.2 Working of the Project

Two LDR's (Light Dependent Resistor) LDR1 & LDR2 are connected to Analog pins of the Arduino. A solar plate is attached in parallel to the axis of the servo motor and both the sensors are kept on the solar plate as shown in the figure above. The design & the arrangement is done in such a manner that the movement of the sun is from LDR1 to LDR2, as shown in the image below.

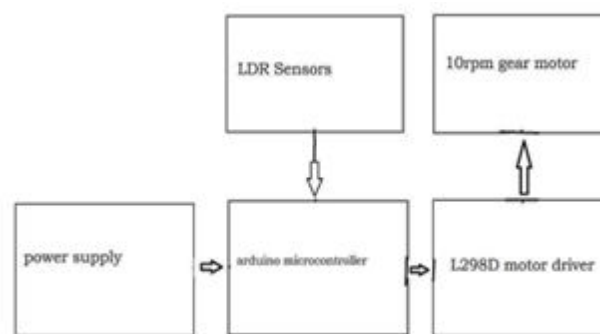


Fig.3 working based on positioning of sun.

There are three cases that are to be followed: -

Case 1: Sun is in the left side Light on LDR1 is high because the shadow of barrier falls on LDR2 so solar plate moves clockwise.

Case 2: Sun is in right Side Light on LDR2 is high because the shadow of barrier falls on LDR1 so solar plate movie anticlockwise.

Case 3: Sun is in the Center Light on both LDR's is equal so, plate will not rotate in any direction.



The principle of the solar tracking system is done by Light Dependent Resistor (LDR). Four LDR's are connected to Arduino analog pin AO to A4 that acts as the input for the system. The built-in Analog-to-Digital Converter will convert the analog value of LDR and convert it into digital. The inputs are from analog value of LDR, Arduino as the controller and the DC motor will be the output. LDR1 and LDR2, LDR3 and LDR4 are taken as pair. If one of the LDR in a pair gets more light intensity than the other, a difference will occur on node voltages sent to the respective Arduino channel to take necessary action. The DC motor will move the solar panel to the position of the high intensity LDR that was in the programming.

Following are the components used to track sun light with maximum precision.

- Arduino UNO
- 10 KΩ Resistor X 4
- Ldr x 2
- Connecting wires.
- Power supply
- Gear motor
- Motor Driver
- Solar panel

One of the important element of this project is Arduino UNO. Variety of Arduino are available in the market but for this project work Arduino used is as follows:

Table 1. Specifications of Arduino

| Feature | Specification |
|------------------------|---|
| Microcontroller | ATmega328 |
| Operating Voltage | 5V |
| Input Voltage | 7-12V |
| Input voltage limit | 6-20V |
| Digital I/O pins | 14 (of which 6 provide PWM output) |
| Analog Input Pins | 6 |
| DC Current per I/O Pin | 40 mA |
| Flash Memory | 50mA |
| SRAM | 32 KB (ATmega328) at which 0.5 KB used by boot loader |
| EEPROM | 1KB |
| Clock Speed | 16 MHz |

IV. SOFTWARE AND CODING

4.1 Software Installation Procedure

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software. This software can be used with any Arduino board. For latest software refer to link. <https://www.arduino.cc/en/Main/Software>

} Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students with or without a background in electronics and programming.

} Arduino is an open-source prototyping platform based on easy-to-use hardware and software.

} Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a message - and turn it into an output - activating a motor, turning on an LED, publishing something online and many more.

} You can tell your board what to do by sending a set of instructions to the microcontroller on the board.

} To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

Following steps needs to be followed before inserting program in board.

Step 1 : Download the Arduino environment: (<https://www.arduino.cc/en/Main/Software>) Get the latest version from the download page. When the download finishes, unzip the downloaded file. Make sure to preserve the folder structure. Double-click the folder to open it. There should be a few files and sub-folders inside.

Step 2 : Connect the board: The Arduino Uno, Mega, Duemilanove and Arduino Nano automatically draw power from either the USB connection to the computer or an external power supply. If you're using an Arduino Diecimila, you'll need to make sure that the board is configured to draw power from the USB connection. The power source is selected with a jumper, a small piece of plastic that fits onto two of the three pins between the USB and power jacks. Check that it's on the two pins closest to the USB port. Connect the Arduino board to your computer using the USB cable. The green power LED (labelled PWR) should go on.

Step 3 : Install the drivers: Installing drivers for the Arduino Uno or Arduino Mega 2560 with Windows7, Vista, or XP

Step 4: Launch the Arduino application: Double-click the Arduino application. (Note: if the Arduino software loads in the wrong language, you can change it in the preferences dialog. See the environment page for details.

Step 5: Open the blink example Open the LED blink example sketch: File > Open > Temp_and_humid.ino

Step 6: Select your board: You'll need to select the entry in the Tools > Board menu that corresponds to your Arduino.

Step 7: Select your serial port : Select the serial device of the Arduino board from the Tools | Serial Port menu. This is likely to be COM3 or higher (COM1 and COM2 are usually reserved for hardware serial ports). To find out, you can disconnect your Arduino board and re- open the menu; the entry that disappears should be the Arduino board. Reconnect the board and select that serial port.

Step 8 : Upload the program: Now, simply click the "Upload" button in the environment. Wait a few seconds - you should see the RX and TX leds on the board flashing. If the upload is successful, the message "Done uploading." will appear in the status bar.

4.2 Coding

Following sample coding is done to track exact location of sun to capture maximum energy.

```

/* Solar Tracker Code with 4 buttons for manual orientation and 4 ldr sensors to automatically tracking the sun.
*/
//set constant pin numbers int wbuttonPin = 4;
int ebuttonPin = 2; int tbuttonPin = 8; int bbuttonPin = 12; int switch1Pin = 7; int switch2Pin = 5; int eldr = A0;
int wldr = A1; int tldr = A2; int bldr = A3; int IN1 = 13; int IN2 = 9; int IN3 = 10; int IN4 = 11;
int eastldr = 0; int westldr = 0; int topldr = 0; int botldr = 0; int error = 0; int poserror = 0; int tborder = 0;
int tborder = 0; int westbutton = 0; int eastbutton = 0; int topbutton = 0; int botbutton = 0; int onoffswitch = 0;
int singledualswitch = 0; void setup() {
pinMode (A0, INPUT); pinMode (A1, INPUT);
pinMode (A3, INPUT); pinMode (A4, INPUT);
pinMode (8, INPUT_PULLUP);
pinMode (12, INPUT_PULLUP);
pinMode (13, OUTPUT);
pinMode (9, OUTPUT);
pinMode (10, OUTPUT);
pinMode (11, OUTPUT);
pinMode (4, INPUT_PULLUP);
pinMode (2, INPUT_PULLUP);
pinMode (5, INPUT_PULLUP);
pinMode (7, INPUT_PULLUP);
Serial.begin(9600);
}
void loop() {Serial.print("start programm"); digitalWrite(IN1, LOW);
digitalWrite(IN2, LOW); digitalWrite(IN3, LOW); digitalWrite(IN4, LOW);
onoffswitch = digitalRead(switch1Pin); singledualswitch = digitalRead(switch2Pin); while (onoffswitch == LOW) {
//manual rotating of the panel
eastldr = analogRead(A0); westldr = analogRead(A1); topldr = analogRead(A2); botldr = analogRead(A3);

```

```

eastbutton = digitalRead(ebuttonPin); if (eastbutton == HIGH)
{ digitalWrite(IN1, HIGH); digitalWrite(IN2, LOW);
} // rotate to east side when you push the right button else {
digitalWrite(IN1, LOW);
}
westbutton = digitalRead(wbuttonPin); if (westbutton == HIGH)
}
else if (error < 0) { digitalWrite(IN1, HIGH);
//Serial.print("IN1 HIGH");
}}
else if (poserror <= 10 ) { digitalWrite(IN1, LOW); digitalWrite(IN2, LOW);
}
Serial.println(eastldr); Serial.println(westldr); if (tbposerror > 10)
{ if (tberror > 0) { digitalWrite(IN4, HIGH);
} else if (tberror < 0) { digitalWrite(IN3, HIGH);
}
}
else if (poserror <= 10 ) { digitalWrite(IN4, LOW); digitalWrite(IN3, LOW);
}
onoffswitch = digitalRead(switch1Pin); singledualswitch = digitalRead(switch2Pin);} onoffswitch =
digitalRead(switch1Pin); singledualswitch = digitalRead(switch2Pin); delay(200);

```

V. RESULTS AND DISCUSSION

In conclusion, the Solar Light Tracking System stands as a testament to human ingenuity and innovation in the quest for a sustainable energy future. By harnessing the power of the sun more efficiently, this technology holds the promise of transforming the way we generate and utilize energy, paving the way towards a cleaner, greener, and more resilient world for generations to come. In this project Solar tracking systems using Arduino technology represent a fusion of renewable energy and modern automation. By integrating sensors, motors, and control algorithms, these systems dynamically adjust the position of solar panels to optimize their alignment with the sun's path throughout the day. At the heart of this innovation lies Arduino, an open-source microcontroller platform renowned for its versatility and ease of use. Arduino-based solar trackers leverage precise sensor data to calculate the sun's position, allowing them to adjust panel orientation accordingly. This real-time tracking not only maximizes solar energy harvesting but also demonstrates the power of accessible, DIY electronics in advancing sustainable energy solutions. With Arduino, solar tracking becomes not just a technological feat, but a tangible example of how grassroots innovation can drive positive change towards a more sustainable future.

REFERENCES

- [1] Ying-Tung Hsiao, China-Hong Chen, "Maximum Power Tracking for Photovoltaic Power System," Conference Record of the 2002 IEEE Industry Applications Conference. 37th IAS Annual Meeting, ISBN-0-7803-7420-7, 13-18 Oct, 2002, pp 1035-1039.
- [2] Mayank Kumar Lokhande, "Automatic Solar Tracking System," International Journal of Core Engineering & Management, October, 2014.
- [3] Scott J Hamilton, "Sun-Tracking Solar Cell Array System," University of Queensland, Department of Electrical Engineering, 1999
- [4] Furkan Dincer, Mehmet Emin Meral, "Critical Factors that Affecting Efficiency of Solar Cell," University of Yuzuncu Yil, Department of Electrical and Electronics Engineering, Van, Turkey, 2010.
- [5] R.Z. Wang, T.S. Ge, "Advances in Solar Heating and Cooling," Woodhead Publishing, 2016, Pages 81-93, ISBN 9780081003015,
- [6] M. A. Panait, T. Tudorache, "A Simple Neural Network Solar Tracker for Optimizing Conversion Efficiency in Off-Grid Solar Generators", International Conference on Renewable energies and Power quality (ICREPQ), march 12-14, Santander, 2008.
- [7] Juan Reca-Cardena, Rafael López-Luque, Chapter 9- Design Principles of Photovoltaic Irrigation Systems, "Advances in Renewable Energies and Power Technologies", Elsevier Science, 2018
- [8]. Juan Reca-Cardena, Rafael López-Luque, Chapter 9- Design Principles of Photovoltaic Irrigation Systems, "Advances in Renewable Energies and Power Technologies", Elsevier Science, 2018



- [9] C. Chang, Chapter 5 Tracking solar collection technologies for solar heating and cooling systems, “Advances in Solar Heating and Cooling”, Woodhead Publishing, 2016
- [10] Furkan Dincer, Mehmet Emin Meral, “Critical Factors that Affecting Efficiency of Solar Cell,” University of Yuzuncu Yil, Department of Electrical and Electronics Engineering, Van, Turkey, 2010.



INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details