ARDUINO BASED DUAL AXIS SOLAR TRACKING SYSTEM

S Ponmani, Associate Professor
Department of CSE
Rajalakshmi Engineering College
Chennai, India
ponmani.s@rajalakshmi.edu.in

Vimal K B, UG Student
Department of CSE
Rajalakshmi Engineering College
Chennai, India
210701309@rajalakshmi.edu.in

Vishal D, UG Student
Department of CSE
Rajalakshmi Engineering College
Chennai, India
210701313@rajalakshmi.edu.in

Yashvanth NG, UG Student
Department of CSE
Rajalakshmi Engineering College
Chennai, India
210701319@rajalakshmi.edu.in

ABSTRACT:

A Proposed system of our project utilizing Arduino technology provides an efficient and cost-effective means of maximizing solar energy absorption for photovoltaic panels or solar thermal collectors. The system employs two motors, one for horizontal (azimuth) movement and the other for vertical (elevation) adjustment, allowing the solar panel to follow the sun's trajectory across the sky for optimal energy capture. It is a low-cost system that provides better efficiency. Here the analog signals are analyzed and controlled by Arduino Uno. This automatic system is completely programmed. The energy obtained from the sun is collected using a solar panel by arranging four LDRs. The amount of energy obtained and positions at two LDRs on the same axis are compared and analyzed to decide the movement of the servo motors which moves the panel to the direction where more energy is available. The Arduino microcontroller serves as the brain of the system, processing data from light sensors to adjust the panel's orientation throughout the day. By maintaining the panel perpendicular to the sun's rays, the system enhances energy output, improves efficiency, and can reduce overall energy costs. The implementation of such a system demonstrates the potential for smarter, more sustainable solar energy solutions.

Keywords: Solar Tracker, Azimuth movement, LDR sensor, Sunlight, Optimize energy efficiency

I.INTRODUCTION

Nowadays the depletion of conventional energy resources forced many researchers to search for various renewable energy sources. Among the non-conventional resources available, solar energy has the greatest potential to be converted into electrical energy. Converting solar energy into electrical energy signifies one of the favorable technologies, providing dirt-free, dependable with negligible environmental impact. Solar energy is well known as an unrestricted, endless source, and involves no pollution filtrates or greenhouse gas emissions.

The solar photovoltaic industry has been improving very well recently. Most of the currently installed PV systems are of the fixed-tilt mounting design, of which the PV 2 modules are tilted at an optimal angle. For this type, these PV modules are reduced to severe cosine losses during harnessing of solar energy, especially early in the morning, and in the late evening. This project employs a sun-tracking solar panel to track the maximum rays using LDRs. This is more acceptable when compared to the light-sensing method which may not be accurate. The main aim of this work is to design a system that could track the sun with solar panels in a more efficient way compared to the existing system. This is obtained by coupling the LDR sensors with a servo sg motor to the solar panel such that the panel maintains its face always perpendicular to the sun to generate maximum energy. This is achieved by employing a programmed ARDUINO IC.

1.1 Motivation

The proposed system allows solar panels to follow the sun's path more precisely throughout the day, leading to increased energy production compared to a fixed or single-axis system. By keeping solar panels oriented toward the sun at all times, the system can produce more power and maximize the return on investment for solar energy installations. Arduino is an affordable and accessible platform for building the control system, making it feasible for hobbyists and professionals alike. ncreased solar energy production contributes to a reduction in reliance on fossil fuels, promoting a cleaner and more sustainable energy source.

1.2 Objectives

The main goal of the system is to increase the solar panel's exposure to sunlight, thereby maximizing the energy output from the solar panels.

The system should accurately track the sun's movement across the sky, adjusting the solar panel's position in both the horizontal (azimuth) and vertical (elevation) axes.Utilize Arduino to automatically control the system's movement based on sensors that detect the sun's position or pre-programmed algorithms. Design the system for easy access and maintenance, with components that can be easily replaced or serviced.

II. LITERATURE REVIEW

The US Patent no. 0215199 A1 [2007] by Robert H. Dold describes a two axis solar tracker capable of withstanding extreme weather conditions. The solar tracker includes a solar array, a frame, a base, a pivot frame, and a first and second actuator. The solar array is mounted to the frame and captures sunlight. The US patent No. 0308091 [2008] by Ronald P Corioclaimsas an object of the his invention to mechanically link multiple solar trackers in a large array configuration so that they may operate in unison, driven by a single motor and tracker controller, whereby the mechanical linkage system is designed such that it must only be capable of withstanding the relatively low forces. Qiang Xiei's US Patent No.0051017 A1 [2010] refers to a solar collector which may receive and direct solar radiation onto a photovoltaic (or, solar) cell. A concentrating solar collector may also convert the received solar radiation into a concentrated radiation beam prior to directing the radiation onto the solar cell. A US patent No. 0293861 by William F Taylor [2009] describes a conventional solar tracker employing controllable moveable solar panels to expose them continuously to the path of the sun both throughout the day and throughout the year.

III EXISTING SYSTEM

In the numerous studies Solar Tracker is used to track the sunlight for producing energy in the form of sunlight. In the paper [1] by A Kulkarni(2021) which is the base paper for our project. In the existing system it consists of a microcontroller, sensors, voltage regulator, driver circuit, dc geared motor, and solar panel frame axis. Here the sensors are arranged in such a way that the solar panel rotates in only one degree of freedom. When the sun travels from east to west, the sun's highest position also changes. Hence this system is only helpful in tracking either of the axes. Therefore, the output energy is also not ideal.

IV. PROPOSED SYSTEM:

The Dual-axis solar tracking system that tracks the maximum sun rays using LDR sensors. This block diagram is designed according to track solar rays in both axes all day. The system includes a power supply, Arduino, two servo motors, four LDR sensors, battery, charge controller, and solar panel. This total system is designed in a form so that it tracks the sun efficiently and obtains maximum solar energy from the sun and increases the output efficiency and provides better performance even in cloudy conditions. The power supply is given to Arduino. The LCD is also powered by the Arduino. The analog information is transferred from LDRs to Arduino. According to the Arduino program, instructions are given to the servo motors and these motors eventually provide movement to the solar panel.

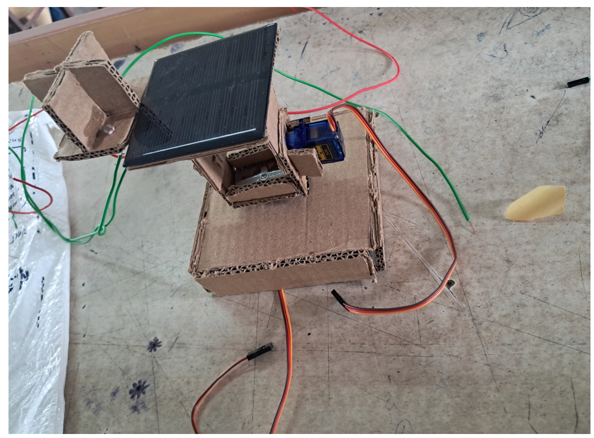

Fig. 4.1 Model of our proposed system.

V.WORKING :

The proposed system optimizes solar panel orientation by continuously adjusting its position along two axes—horizontal and vertical This system uses sensors to detect the sun's position and motors to tilt and rotate the panels, ensuring they are always perpendicular to the sun's rays. By doing so, the system maximizes solar energy absorption throughout the day and across seasons, significantly increasing the efficiency and energy yield compared to fixed panels. The real-time adjustments help to counteract the sun's apparent motion, allowing for optimal solar exposure and improved overall performance of solar installations.

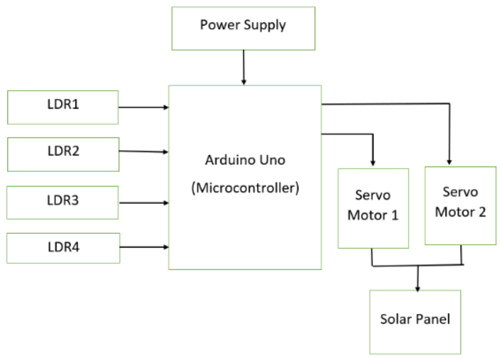

Fig. 5.1 Model Architecture

The major components which are used in dual axis solar tracking systems are:

1. Arduino UNO board x 1
2. Solar panel x 1
3. SG90 servo motor x 1 -
4. LDR sensor x 2
5. 10k resistor x 2
6. Jumper wires
7. Rigifoam / Foam board / Cardboard

5.1 Arduino UNO board x 1:

The Arduino UNO is a microcontroller board based on the ATmega328P, featuring 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header, and a reset button, making it ideal for beginners and advanced users to create interactive projects.

Fig 5.1.1 Arduino

5.2 Solar panel x 1:

A solar panel is a device that converts sunlight into electrical energy, typically composed of numerous photovoltaic cells.

Fig. 5.2.1 Solar panel

5.3 SG90 servo motor x 1:

The SG90 servo motor is a compact, lightweight actuator commonly used in hobbyist robotics and control systems, capable of precise angular movement typically up to 180 degrees.

5.4 LDR sensor x 2:

LDR sensors, or Light Dependent Resistors, are components that change their resistance based on light intensity, typically used in light sensing and detection applications.

5.5 10k resistor x 2:

Two 10k resistors are passive electrical components, each with a resistance of 10,000 ohms, used to limit current and divide voltages in electronic circuits.

5.6 Jumper wires:

Jumper wires are electrical wires with connector pins at each end, used to connect components on a breadboard or other prototyping setup without soldering.

5.7 Rigifoam / Foam board / Cardboard:

Rigifoam, foam board, or cardboard are versatile, lightweight materials often used for crafting, model-making, and creating structural prototypes in various projects.

VI METHODOLOGY:

· The methodology for the proposed system involves using sensors and a microcontroller to continuously adjust the orientation of solar panels to face the sun directly throughout the day. Light-dependent resistors (LDRs) or other sensors are strategically positioned around the solar panel to measure sunlight intensity from different directions. The sensor data is sent to the microcontroller, which processes the readings and calculates the optimal position for the solar panels based on where the sunlight is strongest. The microcontroller then sends control signals to servo motors or other actuators, which adjust the azimuth and elevation of the solar panels accordingly. This real-time adjustment maximizes energy production by keeping the panels aligned with the sun, regardless of the time of day or season. This process is repeated continuously, ensuring efficient and optimal solar energy harvesting throughout the day.

VII RESULTS AND DISCUSSION

In the proposed system, the primary result is a significant increase in solar energy production compared to fixed solar panel systems. By dynamically adjusting the orientation of the solar panels to follow the sun's path across the sky throughout the day, the system ensures that the panels are always optimally positioned for maximum sunlight exposure. This leads to improved efficiency and higher energy output, potentially increasing overall solar panel performance. The tracking system's real-time adjustments allow for continuous optimization, even in changing weather conditions. Future improvements might focus on integrating advanced sensors or machine learning algorithms to further refine the tracking system's accuracy and efficiency.

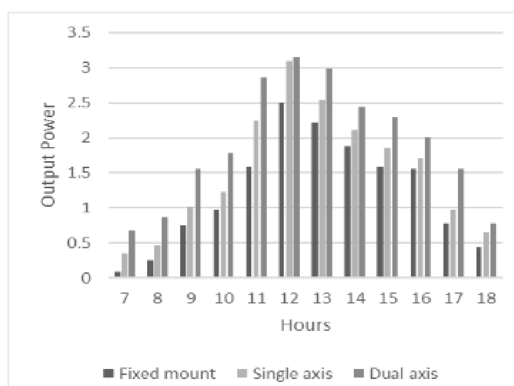

Fig. 7.1.1 Bar chart for different tracking system

VIII CONCLUSION

The proposed system is a highly effective solution for maximizing solar energy harvesting by continuously adjusting the orientation of solar panels to follow the sun's path across the sky. This system offers increased energy production and efficiency by maintaining optimal angles for solar exposure throughout the day and across seasons. By using sensors like LDRs and components such as SG90 servo motors, dual-axis tracking systems enable precise, automated panel positioning, thereby enhancing the overall performance and return on investment of solar installations. This technology plays a crucial role in advancing sustainable energy solutions and can be applied to a range of solar projects, from residential rooftops to large-scale solar farms.

IX.REFERENCES:

[1] M. R. Patel, Wind and Solar Power Systems Design, Analysis and Operations, 2nd Edition, CRC Press Taylor & Francis Group Producing a PCB.n.d., BocaRaton,2020.

[2] Kais I. Abdul-lateef, A Low cost single-axis sun tracking system using PIC microcontroller, Diyala Journal of Engineering Sciences, Vol. 05, No. 01, pp.65-78, June 2019.

[3] Design and Implementation of a Sun Tracker with a Dual-Axis Single Motor “Jing-Min Wang and Chia-Liang Lu’’,2014.

[4] Khan, Rafid Adnan, Rezwanul Mahmood. M, and Anisul Haque. "Enhanced energy extraction in an open loop single-axis solar tracking PV system with optimized tracker rotation about tilted axis." Journal of Renewable and Sustainable Energy 10, no. 4 (2018).

[5] Fernández-Ahumada, L. M, Ramírez-Faz. J, López-Luque. R, M. VaroMartínez, Moreno-García. I. M., and Casares de la Torre. F. "A novel backtracking approach for two-axis solar PV tracking plants." Renewable Energy 145 (2020).

[6] Sidek, M.H.M., Azis, N., Hasan, W.Z.W., Ab kadir, M.Z.A., Shafie, S. and Radzi, M.A.M., 2017. Automated positioning dual-axis solar tracking system with precision elevation and azimuth angle control. Energy, 124, pp.160-170.

[7] Vieira, R.G., Guerra, F.K.O.M.V., Vale, M.R.B.G. and Araujo, M.M., 2016. Comparative performance analysis between static solar panels and single-axis tracking system on a hot climate region near to the equator. Renewable and Sustainable Energy Reviews, 64, pp.672-681.

[8] Reddy, J.S., Chakraborti, A. and Das, B., 2016. November. Implementation and practical evaluation of an automatic solar tracking system for different weather conditions. In 2016 IEEE 7th Power India International Conference (PIICON) (pp. 1-6). IEEE.

[9] Hoffmann, F.M., Molz, R.F., Kothe, J.V., Nara, E.O.B. and Tedesco, L.P.C., 2018. Monthly profile analysis based on a two-axis solar tracker proposal for photovoltaic panels. Renewable energy, 115, pp.750-759.

[10] Singh, P., Pahuja, R., Karwasra, M., Beniwal, S., Bansal, M. and Dadhich, A., 2016. Dual Axis Solar Tracking System for Solar panel. Bulletin of Electrical Engineering and Informatics, 5(4), pp.403-411.

[11] Das, A. and Swthika, O.V., 2016. Arduino Based Dual Axis Sun Tracking System. Advanced Science Letters, 22 (10), pp.2837-2840.

[12] Fuentes, M., Vivar, M., Burgos, J.M., Aguilera, J. and Vacas, J.A., 2014. Design of an accurate, low-cost autonomous data logger for PV system monitoring using Arduino that complies with IEC standards. Solar Energy Materials and Solar Cells, 130. Pp.529-543.

[13] Rosenblatt, A. and Aaron, N., 2014. Solar Tracking System (2014).

[14] Barsoum, N., Nizam, R. and Gerard, E., 2016. New approach on development a dual axis solar tracking prototype. Wireless Engineering and Technology, 7(1), pp. 1-11.

[15] Vit, J. and Krejcar, O., 2016. Smart solution of alternative energy source for smart houses. In International conference on Industrial, Engineering and Other Applications of Applied Intelligent Systems (pp. 830- 840). Springer, Cham.s.