Arduino-based Dual Axis Sun Tracking System

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The Arduino-based dual axis sun tracking system developed before doesn't work accurately when the sky is covered in clouds or smog. Also, since this solar tracking system has movable parts, its lifespan was reported to be lesser than that of traditional solar panels. This system even requires large area for its installation and regular maintenance for proper functioning. The main barrier to the widespread use of solar trackers has likewise been their expensive price. Our current project aims to overcome these drawbacks.

Abstract — **Solar energy has generated interest as one of the main sources of sustainable and renewable forms of energy due to its limitless existence and environmentally friendly nature. In this context, Solar panels can be used to convert solar energy to electricity. Solar panels or modules are directed towards the sun by trackers. To maximize energy capture, these devices adjust their orientation during the day to follow the sun's path. Solar trackers can increase the amount of electricity produced. As the sun moves across the sky, the modules may be continuously adjusted to the optimal angle, increasing the conversion efficiency of any solar application. Also, making the conversion process more efficient will be the key to lowering the cost of producing electricity from sunlight. The development of a sun tracking system using Arduino is demonstrated in this work, allowing solar panels to be moved in the direction of the greatest incident sunlight. As a result, we'll get a system that is more efficient, compact, reasonably priced, and easy to operate.**

Keywords — Arduino Uno, Dual Axis Tracker, Servo Motor, Solar Panels, LDR sensors

I. INTRODUCTION

Due to the rising need for green and sustainable energy, solar energy harvesting research has become one of the most popular engineering study areas, particularly in the field of renewable energy. Designing and creating dependable and efficient solar power systems is the subject of numerous research studies. To enhance and maximize the efficiency of solar energy absorption, One of the most important parts of a solar power system is solar tracking and control. Additionally, the solar tracker offered lucrative ways for developing nations to include it into their solar systems at a relatively low cost through software-based solutions. According to research, combining under diverse operational conditions, a tracking system with a solar panel can deliver precise results and be used to meet power needs.

Several researchers have developed various designs to boost the effectiveness of solar panels. V Sundara Siva Kumar and S Suryanarayana [2014], developed a straightforward and effective control strategy utilizing just one tracking motor resulting in accurate tracking of the sun and improved power gain [1]. Dhanalakshmi V & Lakshmi Prasanna H.N [2016], developed a smart two-axes solar tracker utilizing the Arduino Uno and noticed a comparable boost in generating electricity when compared to a static device [2]. Chaitali Medhane & Tejas Gaidhani [2017], developed a two-axis model using a MC and discovered that positioning the solar panel to match the sun's brightness was effective. Additionally, it increased productivity and offered the required safeguards against wind and rain [3]. Midriem Mirdanies and Roni Permana Saputra [2016], devised a two axes system utilizing a planetary algorithm along with webcam-based feedback analyzing to improve the effectiveness of obtaining power [4]. S.B. Elagib & N.H. Osman [2013], created a microcontroller-based sunlight tracking device utilizing solar mapping to increase the effectiveness of energy level while requiring the least amount of operator engagement which would be beneficial in remote locations having spotty network connectivity [5]. Jing-Min Wang and Chia-Liang Lu [2012], demonstrated a straightforward Implementation of a solar tracker that used just a single two-axes AC motor to determine where the sun was and a separate PV inverter to power the entire system. [6]. Song et al. offered a hybrid-based two-axes monitoring method which utilized an optical sensor & a rough accustoming with coordinate computation technique [7]. According to Hossein Mousazadeh [2009], Polar-axis and azimuth types have been proven to be among the most efficient sun-tracking devices [8].

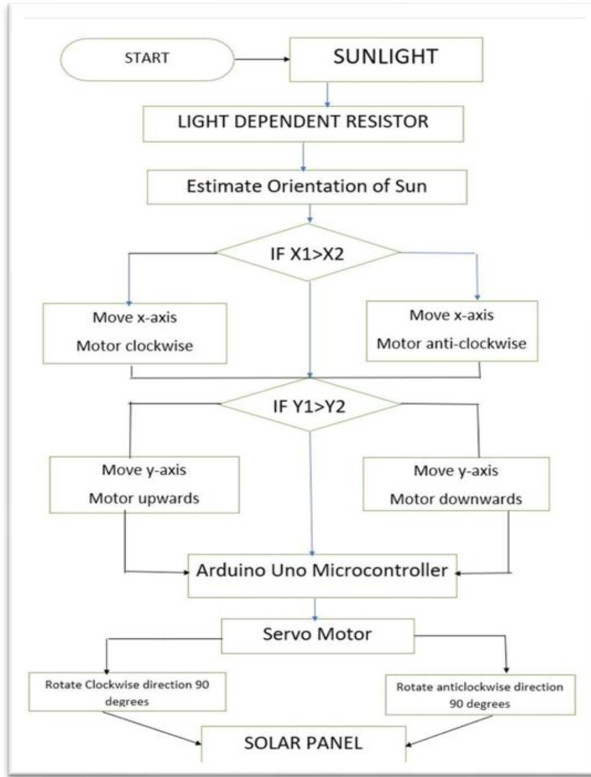
A dual axis tracking system with two degrees of freedom monitors the daily and seasonal motion of the sun. Simply by turning the solar panel to face the direction of the sun, an even better method of maximising the power produced by solar panels has been provided. Comparing the findings, it was discovered that a stationary solar panel does not produce as much energy as the direct beam of the sun. The results of the study indicate that solar panels' efficiency can be substantially increased if they rotate continuously in the direction of the sun. To track the sun, a microcontroller and a combination of LDR sensors can be used. The goal of this study was to create a dual axis sensor-less electromechanical sun tracking system which utilizes the concept of the solar sun chart algorithm that would be less expensive, have a simpler mechanism, and use less energy. Following the validation of all theoretical calculations, our attention turned to creating a hardware model composed of a mechanical framework, two sparsely powered DC servo motors to rotate the solar module in both axes, and an Arduino board to control the motors in accordance with the developed algorithm. Arduino received time and date information from a real-time clock (RTC). An analysis of the theoretical and empirical data was done after the tracking system was developed to support its accuracy.

II. METHODOLOGY/EXPERIMENTAL

A. Materials/Components/Flowchart/Block Diagram/ Theory

The following are the major components utilized in making of two-axes sun tracking system:

1. Solar panel
2. Arduino board
3. LDRs
4. Servo motor

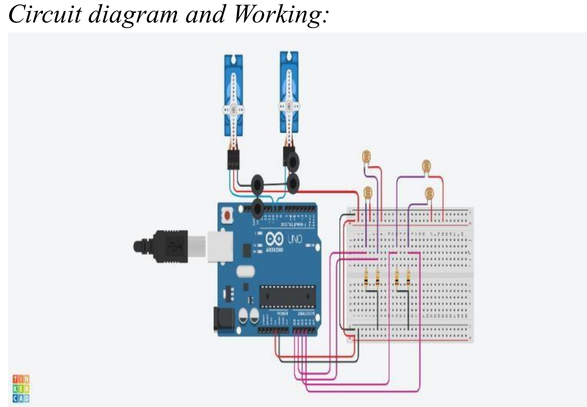


The *Flowchart* of process attached below demonstrates the progression of procedures taken during the design and operation of our project.

From the flowchart, it can be seen that the proposed project consists of three main buildings: the inputs, the controller and the outputs. The input comes from the LDRs, the Arduino acts as the controller, and the servo motor produces the output. The Arduino, the project's primary controller, has

LDRs providing analogue signal input. With the aid of an AD converter, these signals are transformed into digital signals. Once the solar panel location has been established, the MC triggers the servo motor.

Circuit diagram and Working:



LDRs serve as the main and principal light detectors. With the assistance of a pair of servo motors, the framework that holds the photovoltaic panel is fastened. A copy of the Arduino software is preloaded on the MC. LDR's detect the amount of sunlight striking on them. The four LDRs are separated into the top, bottom, left, and right. For east-west tracking, analogue readings from each of the top LDRs are compared to see if the upper row of LDRs receives more light, that direction will be followed by the vertical servo. The servo moves if the bottom row of the LDR receives more light. With regard to the solar panel's angular deflection, comparisons are made between the analogue values from two left LDRs and two right LDRs. In the event that the left set of LDRs receives more light than the right set, that direction will be followed by the servo. If the right side of the set of LDRs receives more light, the servo will move in that direction. By contrasting the voltages of the x and y axis sensors, the panel moves in one of several directions: clockwise, anticlockwise, upward, or below. Whenever a panel moves, it does so in the direction where sunlight is shining the brightest, thus offering more efficiency.

III. RESULTS AND DISCUSSIONS

Following the creation, development, and implementation of the intelligent sun tracking system that allows voltage measurement, It has been a success to increase the effectiveness of solar panels and create small, low-power systems. The system is tested throughout the day under various sun orientations to see how well it can recognize incident light under various circumstances. With the aid of panel movement, the output is obtained in accordance with maximum efficiency. The proposed dual axis tracker's existence is amply demonstrated as it has a significant performance boost, perfectly aligns with the direction of the sun, tracks the sun's movement, and does so in a more effective manner. The experimental findings unequivocally demonstrate the superiority of dual axis trackers over single axis trackers and fixed systems.

IV. FUTURE SCOPE

The different algorithms can be followed for more efficient tracking. The current work can be given more intelligence, such as after tracking once, it can predict the line of movement of sun across the sun. The system can also be installed with a floating system.

V. CONCLUSION

In this study, an Arduino-based microcontroller is employed to build a double-axis sun monitoring prototype and has been successfully put to use to boost solar panel efficiency. The prototype's main component is a solar panel, with other components including an Arduino board for control, a light sensor for light detection, and a servo motor for rotation. The proposed two axis solar tracker is far more efficient than the current permanently mounted and one-axis sun tracker. In comparison to other tracking systems used for the same application, it is also affordable and small. As it is Arduino based and doesn't require an external programmer, it is incredibly simple to program and modify.

VI. ACKNOWLEDGMENT

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