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ARDUINO BASED SOLAR TRACKING SYSTEM

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Abstract: Solar tracking based on Arduino is a solar tracking project in which solar panels move with the sun in order to increase sunlight capture and consequently electricity generation. Most solar panels are fixed in one position; however, these devices work best when they are particularly directed towards sunlight. This are bright tracking systems that change the orientation of the panel to always face the sun so once the energy efficiency increases, its potential increases. It consists of Light Dependent Resistors (LDR) item sensors that measure the amount of sunlight that falls on them. They are placed on the solar panel to detect light from different directions. In such a way is that Arduino can read the data from the sensors and make a decision whether to move the panel or not. The servo motor controlled by Arduino is used to move the panel. If one side of the panel receives more sunlight, it sends a command to the motor to turn the panel toward the sun. Therefore, the panel is put in the best place for collecting energy. The sun can track the two axes or on one axis (that is, moving horizontally) for astute tracking. This low-priced, simple tracking system enhances the generation of solar power and contributes to sustainable power sources.

***Keywords*— Arduino UNO, Servo Motor, LDR, Resistor, Solar Panel.**

1.Introduction:

A solar tracking system harnesses solar energy at maximum efficiency, permitting dynamic orientation adjustment of solar panels that will capture the sun's rays for all hours of the day. Fixed solar panel installations tend to only reflect sunlight for part of the day; tracking systems therefore continuously align the panels since southward energy capture occurs, which results in an increased capture of energy and improved efficiency of the system as a whole. Solar tracking appears to be advantageous especially in sites where abundant direct sun exposure is present; it may increase energy output of photovoltaic (PV) systems. Majorly, solar trackers are classified into two types, single-axis and dual axis. The former has its panel adjusted along just one axis whether horizontal or vertical, while the latter has it aligned on two, azimuth (where east and west refer to) and elevation (up and down), to allow direct alignment with sun rays available. Thus, they give optimal efficiency improvement albeit considering more complex systems to design. In our project we are using single axis tracker for make is easy & more efficient for usage. An Arduino microcontroller incorporated with servo motors automates the tracking feature in this arrangement. Servo motors are more miniature, more precise motors generally suited for angular adjustments being done in angles to adjust panel angles they work with load. Light-dependent resistors (LDRs) function as sensors in this regard for detecting direction of sunlight and convey that information to the Arduino controller in the event that the light captured was high or low. The Arduino interface would then tell the servo motors commands to rotate or position the solar panel because such symptoms were present. This Arduino-servo set up can be seen as one of the easiest and cheapest possible ways of building a solar tracker, which optimally places the panel to receive more direct sunlight each day. Maximizes energy generated by always aligning solar panels with sun position. Maximize grape sunshine optimally during the whole day. Real-time sun tracing sensors incorporated into Arduino control each solar panel so that they are always optimally positioned during sunlight hours for an improved overall yield of electric energy and solar efficiency while at the same time reducing the number of panels needed, conserving resources, and fewer costs in bigger installations. Automatically responds to different conditions of sunlight, adjusting to be used at the highest exposure under cloudy or shaded-condition periods. Works alone without supervision and has minimal demands, making it appropriate for off-grid and remote locations; it saves effort and operational costs. Provides on-ground types of training with regard to programming, electronics, and using renewable energy: for students, hobbyists, and informal education institutes. Arduino enables performance data logging for efficiency assessments, improvements, or troubleshooting using real-time data, because it can expand the capacity of the system through additional sensors or characteristics wherein one can customize the solution to different power needs and locations.

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2. Literature Review:

Today's social conditions are tied to the prototype set in place by the early external elements creating conditions for change. He don't understand how anyone can live without being convinced that religions are absolutely man-made. From establishment, he believes, all religions are from man. He thinks that all religions evolve as men evolve. Man is one of the basic forces shaping a certain form of life in each society and so it is related to the basic unit of all life that is society, which is constantly changing and adapting through the years. Everything relies on change. After all, it was an early-materially of the process of dehistoricization - most of the other natural relations had become historically detached from practice as well. Introduced in the early 2000s, the Arduino microcontroller platform diversified solar tracking for DIY societies. The low-cost, user-friendly characteristics of the device made it possible for hobbyists and students to build automated devices like solar trackers. An enthusiast could now make his own tracker using the basic LDRs and a servo motor, making the use of such inaccurate but still precise controls as servo motors available to create small changes in the panel positions for grassroots comparisons against easily surpassed commercial devices. Nowadays, solar tracking is part and parcel of designing a solar installation at the utility scale, especially in bright sun regions. The most modern systems use GPS and advanced control algorithms to better align panels even under variable atmospheric operative conditions. AI and machine learning are already being integrated into the tracking systems, such that they can predict sunlight patterns and make pre-emptive adjustments to maximize energy capture. From early heliostats through sophisticated GPS-controlled actuated tracking systems, solar tracking has reflected the evolution of electronics and renewable energy technologies. Arduino-based trackers have thus made solar tracking accessible-even to small-scale experimentation and invention at home by inventions with solar tracking. Sharma A, Baredar P., & Kumar, R. (2015). A review on “Solar Tracking System” with PV panel. International Journal of Science and Research (IJSR), 4(2), 2095-2100. This paper reviews various solar tracking systems and discusses different types of tracking mechanisms, their benefits, and their application in photovoltaic

systems. [1] Elamari, M., & Abusara, M. (2014). An automatic solar tracking system for photovoltaic panels. Energy Procedia, 36, 541-545.This article discusses the design and implementation of an automatic solar tracking system, including considerations for using Arduino and other low-cost microcontrollers. [2] Kaur, R., & Sharma, S. (2014). Design and development of a sun tracking mechanism using Arduino Uno microcontroller. International Journal of Engineering Research & Technology (IJERT), 3(5), 1479-1482. This study focuses on an Arduino-based dual-axis solar tracker and evaluates its performance compared to fixed solar panel setups. [3] Prasanna, V., Raju, G. S., & Rao, P. N. (2016). Design and implementation of a dual-axis solar tracker using Arduino. International Journal of Engineering Development and Research (IJEDR), 4(2), 319-324.This paper covers the design process and testing of a dual-axis solar tracking system controlled by an Arduino, highlighting energy gains and mechanical design aspects. [4] Kishor, N., Singh, R., & Mukhopadhyay, S. (2014). Solar photovoltaic tracking system based on Arduino platform. Proceedings of the IEEE Students' Conference on Engineering and Systems (SCES), 1-4.This conference paper presents the implementation of a single-axis solar tracker using Arduino, LDR sensors, and DC motors, with insights into system efficiency. [5] Gupta, P., & Shrivastava, G. (2016). A low-cost Arduino-based dual-axis solar tracker using LDR and servo motors. International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering (IJIREEICE), 4(2), 39-42. This article provides a practical overview of a dual-axis solar tracker using Arduino, light-dependent resistors (LDRs), and servo motors to improve solar capture. [6] Al-Mohamad, A. (2004). Efficiency improvements of photovoltaic panels using a sun-tracking system. Applied Energy, 79(1), 345-354.While not Arduino-specific, this paper presents foundational research on the performance improvements of photovoltaic panels through sun tracking, serving as a theoretical basis for more recent Arduino-based systems. [7] Fathy, A., & Hassan, M. (2018). Development of an Arduino-based dual-axis solar tracking system. Renewable and Sustainable Energy Reviews, 89, 95-103.This study outlines the development of an Arduino-controlled dual-axis solar tracker, focusing on hardware implementation, software algorithms, and energy capture efficiency. [8] Siyambalapitiya, A., & Rajapakse, A. D. (2017). Low-cost

Arduino-based dual-axis solar tracker with improved solar energy collection. Energy Reports, 3, 243-250.The authors discuss the effectiveness of an Arduino-based system, assessing cost, ease of design, and overall performance relative to single-axis trackers. [9]

3. Design and Implementation:

The connection of LDR sensors to analog pins and a servo motor to the PWM pin on the Arduino kick-starts the design and simulation process of the solar tracking system at Arduino level. Write Arduino codes to read LDR values, compare them, and adjust the servo angle of the motor to align the solar panel with the strongest light sources. Create the circuit simulation in the proteus software, upload the code, and observe the servo's reaction during a change in light. Simulate the conditions that change light on the LDRs and observe the way they behave to test tracking. If all is well, the design can be applied in practical installations-real time tracking. The working mechanics of the Arduino-Based Solar Tracking System begin by having the two LDR sensors placed so that they can see the sun at different angles. Each of them will create signals that vary on the amounts of sunlight they receive from time to time and route them into input pins of Arduino. The next step is to read values from those sensors and compare to one another in Arduino, and if there are considerable differences, then one side will receive more sunlight than the other side. Based on this evaluation, the Arduino will conclude if there is a need to reposition the solar panel. Action through control signals to a servo motor circuit by a motor driver circuit will adjust the angle at which the solar panel will face, thus repositioning it according to the brighter light. This goes on and on because the system will keep doing the tracking during that time of day by checking and adjusting to always face the strongest sunlight. For example, it will be exposed to simulate the light in the LDRs and then vary it to test the response, which once certified, can then be real-time used to simulate sunlight tracking. This method maximizes energy collected from any condition toward which the solar panels turn as optimum orientation.

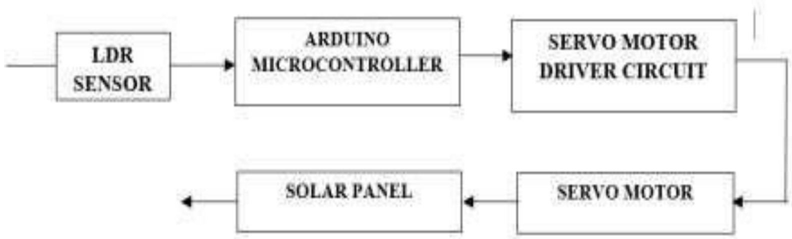

Figure 1: Block Diagram

4. Simulation Parameter:

To outline different facets which are indispensable to the simulation process. These parameters can be taken advantage of in the device based on the required outcome. Proper consideration of these parameters leads to the sought performance characteristics allowing the sensor to accurately read angles of the solar at the desired ranges and in different operating conditions.

Table 1: Parameter of different devices

Sl. No	Components	Specification
1	Arduino UNO	5V
2	LDR	3.3V - 5V
3	Resistor	10KΩ
4	Servo Motor	4.8V
5	Solar Panel	-

5. Result Analysis:

A more efficient way to provide energy benefits from solar panels would be to track the movement of the sun by means of an Arduino-based solar tracking system. Unlike static panels that are stationary, tracking systems arrange the panel in one angle to obtain maximum sunlight exposure which can, in turn, increase the overall energy output. Solar panels collect maximum energy when directly facing the sun, so tracking the sun from sunrise to sunset increases energy capture. This efficiency improvement is very important for renewable energy systems because, with the limited surface area of solar panels, higher output is absolutely needed. Generally, an Arduino-based solar panel tracking

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encompasses a dual-axis tracker in that the solar panel can be moved vertically and horizontally. This is a major advantage over single-axis trackers that follow only one direction usually east to west or even have panel systems that are just stationary. The point with respect to capturing sunlight is that, even when the sun is at lower angles, around early morning and in the late afternoon, the dual-axis tracker allows the solar panel to capture that sunlight. Otherwise, during those times of the day, a stationary panel would not be capturing as much energy. Under testing results, dual-axis tracking has been quantified as delivering clear advantages in terms of overall energy output, leading to a very stable generation of electricity as sunlight intensity changes during the day. The main aspect in functional part of this system contains Light Dependent Resistors (LDRs) which senses sunlight intensity and helps the system orient according to the path of the sun to calculate where the panel should be placed according to optimum exposure of light. If the sun moves from its position, it is detected from the change in LDRs, which gives input to the Arduino microcontroller from which the angle of the panel gets controlled accordingly. The Arduino is programmed to interpret the data read from the LDRs and provides commands to motors or servos that actuate the movement of the panel as per the detected sunlight intensity from its surrounding.

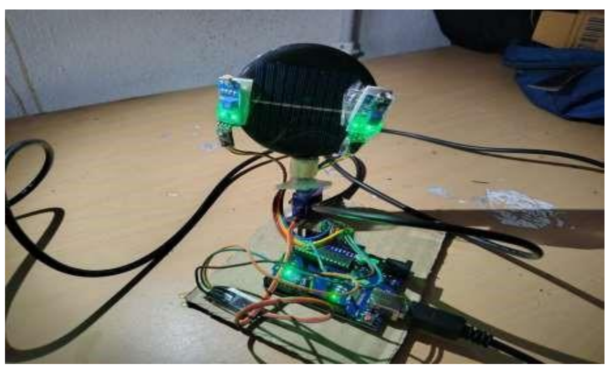

Figure 2: Working model after the connection

6. Conclusion:

Here we are demonstrate about the how we align the solar panel according to the sun direction then we can generate maximum power generation into sun. Our prototype is rotate in single axis, because our country is situated in the equator region so solar is comes towards directly so there are no need to make it dual axis. Using this technology we can generate electricity efficiency without losing it. For make the globe carbon free this type of small initiative are play a major role in upcoming time. Our technology is cheaper to apply in solar system so maximum people can set up the system in their old solar set up to make the solar panel hi-tech to track the solar and get maximize benefit to fulfill their daily electricity consumption. Our technology can provide the additional power booster to achieve India long term strategy net zero carbon emission by 2070 target at COP26 in 2021(ministry of External Affairs,2021).

7. Reference:

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