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Development of Automatic Solar Tracking System

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Abstract: *The development of a solar tracking system aims to enhance the efficiency and effectiveness of solar energy utilization. By continuously tracking the movement of the sun, the system can ensure that solar panels are always positioned at an optimal angle to receive maximum sunlight. This not only increases the overall energy production but also reduces the reliance on fossil fuels and mitigates the impact of climate change. The design of the solar tracking system involves the use of sensors and motors to orient the solar panels towards the sun throughout the day. The system comprises a control unit that processes data from the sensors and activates the motors to adjust the position of the solar panels. The sensors are responsible for detecting the position of the sun and providing real-time data to the control unit. These sensors are typically light sensors or GPS modules that accurately determine the sun's position in the sky.*

Keywords: Solar Tracking System, GPS modules, Solar Energy, Fossil Fuels

I. INTRODUCTION

Efficient and reliable solar tracking systems are pivotal in maximizing the potential of solar energy. As the demand for renewable energy sources continues to rise, the development of advanced tracking systems becomes increasingly important. In this context, the introduction provides an overview of the significance of solar tracking systems in the context of sustainable energy solutions. It aims to explore the key components and functionalities of such systems, along with their potential impact on renewable energy utilization. Additionally, the introduction delves into the technological advancements in solar tracking, highlighting the continuous improvements in efficiency and accuracy.[1]
Solar energy has become a vital component of the global push towards sustainable and renewable energy sources. As the world seeks to reduce its reliance on non-renewable resources and combat climate change, the development of solar tracking systems takes on greater significance. These systems play a crucial role in maximizing the efficiency of solar energy capture, ultimately contributing to a more sustainable energy landscape.[2]
The demand for advanced solar tracking systems has led to significant technological advancements in this field. Innovations in sensor technology, control algorithms, and motor components have resulted in increased accuracy and reliability of solar tracking systems. These developments have not only improved the overall energy output of solar installations but have also made them more cost-effective and accessible.[3]
In this paper, we will delve into the key components and functionalities of solar tracking systems, highlighting their potential impact on renewable energy utilization. Additionally, we will explore the latest technological advancements in solar tracking, showcasing the continuous improvements in efficiency and accuracy that are driving the evolution of these systems. Through this exploration, we aim to provide valuable insights into the role of solar tracking systems in the sustainable energy landscape and their potential to shape the future of renewable energy utilization.

II. LITERATURE REVIW

The paucity of available resources has forced contemporary society to look for measures to consummate the demands of the latter. With the nurturing civilization, the depletion of conventional fuels, due to human practices has been an alarm to sustainable development issues. The scarcity of energy and its source guided us towards the optimistic approach of using the alternative resources bestowed to humankind–Solar, tidal etc.
The Sun has been looked upon as an imperative source of energy. Solar energy is an eco-friendly resource as compared to its counterparts. The advancement of technology has out-turn foster techniques to utilize this energy into its own good use. Be it as thermal energy, electricity, fuel production and many more. Photovoltaic or concentrated solar power

(CSP) systems are operated to transfigure the solar power expropriated by the earth into electricity. Solar tracking device utilizes this expropriated solar power through the channel of photovoltaic arrays, an oriented scaffolding of photovoltaic/solar cells.[5]

Solar cells, also known as photovoltaic cells are used to convert light energy into electricity. Photovoltaic cells work on the principle of the photovoltaic effect, which is similar to the photoelectric effect. Differences being that the electrons in photovoltaic are not emitted instead contained in the material around the surface, creating a voltage difference. Solar cells are forged with crystalline silicon. It is the most commonly used material in a solar cell. The use of silicon in the solar cell has been very efficient and low cost. Two forms of crystalline silicon can be used to make solar cells. Other than silicon, solar cells can be fabricated with cadmium telluride (CdTe), Copper indium gallium (di)selenide (CIGS) etc. the fabrication of solar cells with materials other silicon is slightly expensive, thus making silicon the best material to be used in solar tracking systems.[6]

One of the finest and extensively used material, monocrystalline silicon has an efficiency of about 15- 20%. While under high temperature the performance of the cell material drops by 10-15% of the initial.Polycrystalline silicon is another form, cheaper than the latter but has the same band gap as that of monocrystalline silicon. Though it has the same band gap energy, it lags in efficiency, hence this material is used in low-cost products.Amorphous silicon cells can work under extremely high temperatures, but the efficiency of these cells is comparatively lower than the other silicon forms. [7]

The technologies which use CdTe, CIGS, Amorphous Thin-Film Silicon (a-Si, TF-Si) in the fabrication of solar cells are known as thin film photovoltaic modules. These thin-film solar cells are relatively cost- effective than the solar cells of crystalline silicon. [8]

There are several other factors on which the efficiency of a solar cell depends.

• Cell temperature
• Energy Conversion Efficiency
• Maximum power point tracking [9]

Solar panels are a cumulative orientation of photovoltaic cells. The PV cells are arranged in a solar panel or a PV array such that is serves the purpose of exciting the electron of the material consisting inside the solar cells using photons. The average amount of sunlight received by solar panels particular depends on the position of the sun. [10]

Being a repository of energies, Sun witnessed to be the eminent and ever continuing source of emitting radiation from it. A part of this source of natural energy is received by the solar panel. Certain ways have been developed to utilize this energy source as an alternative to other non- renewable sources. Considering its multitudinous flourishing ways in which it can be applied to bring about the change in conserving other resources, the manipulation of the energy source is encouraged. [11]

Solar panels are hence used to utilize solar power in electrical means. They are aligned different arenas to collect maximum solar power. Though, solar panels can be used to absorb or collect solar power, there work is bounded to certain hours of the day and the sunlight pouring directly on them, i.e. the angle between the sunrays and the panel is orthogonal. While at other hours of the day, the angle of the sunrays is different, hence the amount of the solar power captured is very less.

To overcome such pitfalls, and encapsulate the maximum available of solar energy the solar tracking systems were introduced. A solar tracking system is designed with the intention of keeping the angle between the sunrays and the solar array 90°.

The solar tracking system have three different modules-

- The mechanism
- Driving motors
- The tracking controller.

The mechanism 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.[8]

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. [9]

III. METHODOLOGY

The development of a solar tracking system involves a multi-faceted approach that encompasses various stages, from conceptualization to implementation. The methodology section aims to detail the specific steps and processes involved in the design and development of a solar tracking system.

Step1: Conceptual Design: The first stage of the methodology involves the conceptual design of the solar tracking system. This encompasses the identification of key components, such as sensors, motors, and control units, and their integration into a cohesive system. The conceptual design phase also involves evaluating different design options and determining the most suitable configuration for the intended application.

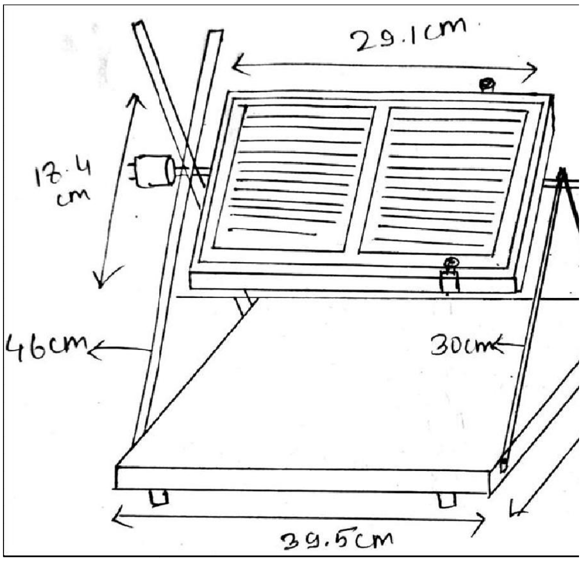

Figure 1: Conceptual Design Automatic Solar Tracking System.

Step 2: Component Selection: Once the conceptual design is established, the next step involves the selection of specific components for the solar tracking system. This includes sourcing high-quality sensors capable of accurately detecting the position of the sun, as well as motors with the appropriate torque and precision for adjusting the position of the solar panels. The selection of components is crucial in ensuring the overall reliability and performance of the solar tracking system.

Step 3: System Integration: After the components are selected, the system integration phase commences. This involves the physical assembly of the solar tracking system, including the mounting of sensors, motors, and solar panels. Additionally, it encompasses the wiring and connection of the different components, as well as the integration of the control unit for processing sensor data and activating the motors.

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Step 4: Calibration and Testing: Once the system is integrated, the calibration and testing phase begins. This involves fine-tuning the sensor readings and motor control mechanisms to ensure accurate and precise solar tracking. It also includes testing the system under various environmental conditions to validate its performance and reliability.

Step 5: Performance Evaluation: The final stage of the methodology involves evaluating the performance of the solar tracking system. This includes assessing its ability to consistently track the sun, its energy output compared to fixed solar panels, and its overall reliability in varying weather conditions.

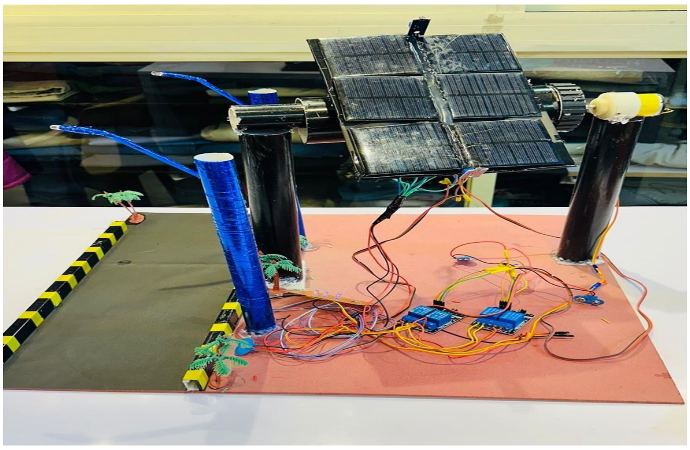

Figure 2: Integration of Components

Through a detailed exploration of each stage, the methodology aims to provide a comprehensive understanding of the design and development process of a solar tracking system, highlighting the intricacies and challenges involved in creating an efficient and reliable solution for maximizing solar energy utilization**.**

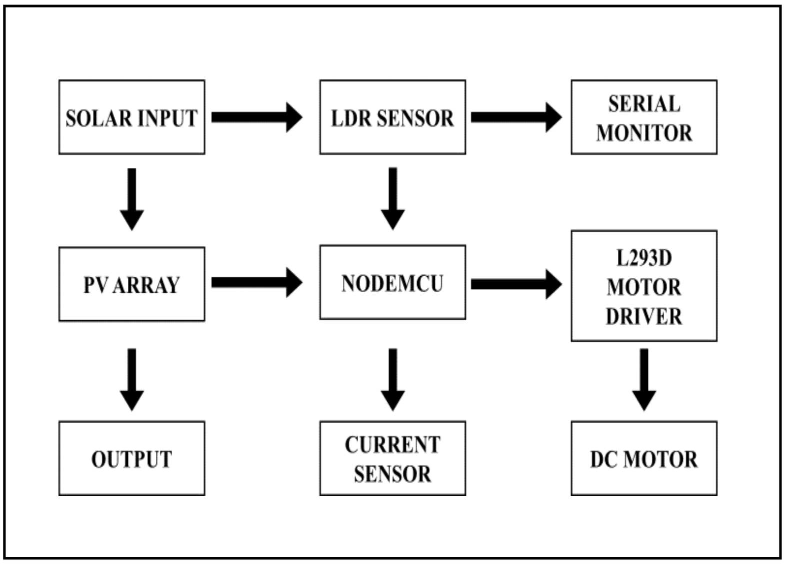

Figure 3: Block Diagram of Automatic Solar Tracking System

IV. CONCLUSION

In conclusion, solar tracking systems have emerged as essential components in the global transition towards sustainable and renewable energy sources. The advancements in sensor technology, control algorithms, and motor components have significantly improved the efficiency and reliability of solar tracking systems, making them more accessible and cost-effective. By maximizing the capture of solar energy, these systems play a crucial role in shaping the future of renewable energy utilization.As the world continues its pursuit of sustainable energy solutions, the role of solar tracking systems in maximizing the potential of solar energy cannot be understated. The continuous advancements in this field pave the way for a more sustainable and efficient energy landscape, offering immense potential for the widespread utilization of renewable energy sources.

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