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Automated Solar Tracking System for Efficient Energy Utilization

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Abstract: *This paper proposes a project that involves an automated solar tracking system which will make use of LDR's to track the position of sun. The output of LDR's will be compared and analyzed to provide correct alignment of the solar panel. Also another tracking technique is being implemented along, which uses the relation of sun earth position at a given location. This telemetric data is given to microcontroller which will drive the motors to align the solar panel. This is useful during cloudy weather and rainy days when it is difficult to check the position of sun. Solar panels give output efficiency of around 15% to 20% based on the type of panel. The use of solar tracking system increases it to a range of about 30% to 35%. This project further involves use of reflective sheets on the sides of solar panel which will concentrate the reflected rays on the panel. Due to this the efficiency is further increased around 40%. This project is a cost effective solution for stationary solar systems to increase efficiency.*

Keywords – *Solar, Tracking, LDR, Dual-axis, Electricity*

1. INTRODUCTION

Solar Energy is a clean energy source available in abundance throughout the world. This energy can be converted to electrical form by means of Solar panels. The conversion efficiency of solar panels is about 20%. The use of solar trackers raise the efficiency to around 35%-40%, thereby providing more output power [1]. Solar trackers are devices, which align the panels almost perpendicular to the direction of falling sun-rays. This is done because of the fact that solar panels give out maximum output only when incident rays are perpendicular to them.

The basic types of Solar tracking system include single axis and dual axis. Single axis system provide movement only in one direction i.e. either horizontal or vertical [3]. Dual axis systems provide movement in both the directions and are hence more efficient and reliable. Both these systems work on the outputs provided by the photo sensors which are compared and analyzed to provide the necessary data for the correction of alignment.

Another type of tracking system is independent of photo sensors. Instead they work based on the telemetry data of the sun earth position [21]. This data is stored in the micro-controller and is used to provide alignment. Solar energy provides suitable solution to meet the growing need of electricity [13].

2. BACKGROUND

Before proceeding with the design of a tracking system, it is a dominant step to determine the background data on solar panels and the techniques to harvest the solar energy. To get relevant data about the same, a brief review of solar systems with the losses incurred as well as an examination of the current tracking systems was done. The review showed that there are two tracking techniques that are in practice based on the way the path of the sun is determined [19]. These techniques are fixed control algorithms and dynamic control algorithms.

The fixed tracking system passively determines the path of the sun based on the time, day, month and year of the location where it is used. The dynamic tracking algorithm works by actively calculating the position of the sun with the help of sensors. Both systems have a similar control system consisting of motors, sensors which are directed by some analog or digital control circuitry [17].

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3. DESIGN METHODOLOGY

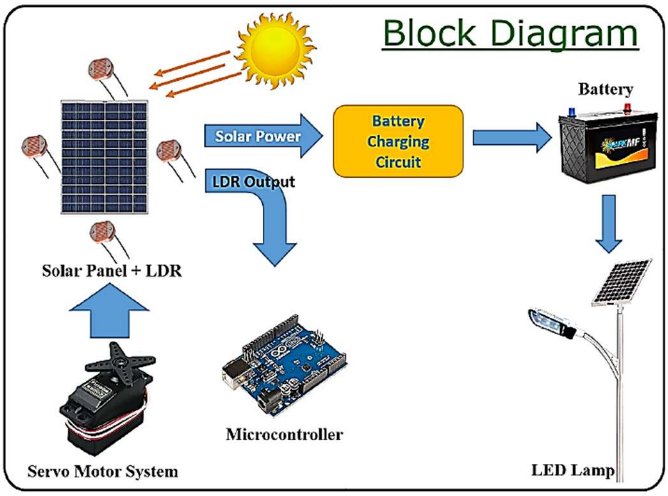

Fig. 1 Block diagram of the system

The design methodology of the system starts by determining the application purpose. Once the application purpose of the system is fixed, the power requirements of the entire system is calculated. This helps to select the appropriate solar panel that scan drive the entire system. While doing this, power required by the motors used; the load connected to the supply as well as the battery ratings are considered. Another crucial parameter is the time duration for which the power is required. The proposed system consists of a Solar panel, photovoltaic sensors, battery, motors, microcontroller and the appliance to be used.

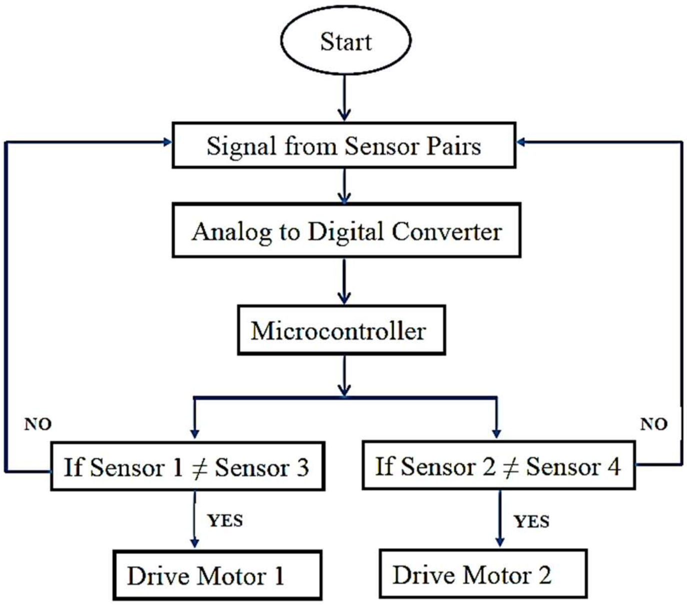

Fig. 2 Flowchart for active mode

The solar panel will be placed on a movable frame attached to the servo motors. On each edge of the solar panel, a LDR will be placed at the centre. The output power of Solar panel is given to a battery charging circuit, which is further connected to a battery for storage of power. This stored power is used to drive the motor systems, the microcontroller as well as the lamp. The output of LDR’s is given to the microcontroller where processing and comparison of data will take place. Based on the output of processed data, the microcontroller will provide command to drive the motor system for correction of position of the solar panel. The microcontroller will continuously keep on checking for the LDR outputs and the entire cycle keeps on repeating.

4. WORKING

For the active mode, Output data from Sensor pairs is taken as input. This data is converted from analog to digital so that it can be processed. This data is given to microprocessor where it will compare the output readings. If the output of both the LDR's in sensor pair is same, it will remain static and keep on continuously checking the output data from LDR's. If the output of both the LDR's in sensor pair is not same, it will drive the corresponding motor to correct the position.

For the passive mode, firstly the location where the system is to be used is decided. Based on the location the telemetric data of the sun earth position which includes the azimuth and elevation angle is sought for and fed to the microcontroller. This telemetric data is used to degree of movement of the solar panel. For Mumbai location the value is around 19 degrees. So after every predetermined time duration, the microcontroller will command the motors to provide a movement of 19 degrees from east to west side. This is continued until sunset. After sunset, the panel is again positioned facing east side, which is towards the sunrise for the next day.

5. RESULTS

The experimental results of the LDR tracking for the active mode of operation is given below. Based on the output readings of the LDR, motors are accordingly driven until the point when both the LDR pairs have same output. The table shown below gives an estimate of how the tracking system is implemented.

Table 1: Motor driving in North-South direction

LDR 1-North	LDR 2-South	Motor drive direction
495	444	South
364	393	North
352	344	South
336	342	North
327	327	No Change
459	383	South
529	580	South

Table 2: Motor driving in East-West direction

LDR 1-East	LDR 2-West	Motor drive direction
347	369	East
382	371	West
355	363	East
396	396	No Change
401	405	East
411	411	No Change
422	427	East

6. MERITS OF SOLAR TRACKING SYSTEM

1. Improved solar panel output and efficiency.
2. Electricity generated using tracking system is higher than stationary systems
3. Multiple types of tracking systems are available based on the application needs.
4. Space requirement of tracking system is very less.
5. Advancements in technology has minimized the maintenance required
6. Generation of more electricity means cost to be paid for electricity service is reduced.

7. LIMITATIONS OF SOLAR TRACKERS

1. Expenditure for maintenance is slightly expensive.
2. Not suitable for regions which receive snowfall for most time of the year.
3. Initial setup cost is high for tracking systems and solar panels
4. Higher accuracy leads to higher system complexity affecting performance.
5. Timely human inspection is required.

8. FUTURE SCOPE

The algorithm proposed in this paper can be extended to real time monitoring by keeping an account of all the readings and data in different weather conditions. This will aid performance improvements and help to determine efficiency in various regions of installations. Also use of high end solar panels such as concentrated photovoltaic cell panels can be used to further improve efficiency [15]. Concentrated photovoltaic panels provide around 35-40% efficiency which is better than the normal panels. The various loss factors in the system resulting from shadows and dust can be analyzed to resolve them.

Cost efficiency and durability of the system can be analyzed by research on the advancements of the components used. Future work can also include use of hybrid systems collectively to overcome the drawbacks of one another. This will ensure minimal system losses as well as better compatibility to application usage and maintenance resulting in improved efficiency. The various hybrid systems that can be fused with solar energy are wind energy and tidal energy. Hybrid systems will collectively enhance the system performance leading to increased number of applications [16].

9. CONCLUSION

In this thesis, we are proposing a sun tracking system. After examining the information obtained in the literature survey section, it can be said that the proposed sun tracking solar array system is a feasible method of maximizing the energy received from solar radiation. The controller circuit used to implement this system has been designed with a minimal number of components for simple assembly. By using stepper motors, accurate tracking of the sun is achieved by keeping a track of the current solar position with respect to its original position.

Automated solar tracking systems acts as an efficient means of harnessing the solar energy. It is also observed that about 8% of more energy is harvested by using a tracking system compared to a fixed system. This percentage can be improved by considering and resolving various loss factors by means of hybrid systems.

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