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Design and Implementation of a Sun-Tracking Solar Panel System for Optimal Energy Harvest

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ABSTRACT: The project presents the hardware design and implementation of a system that ensures a perpendicular profile of the solar panel with the sun in order to extract maximum energy falling on its renewable energy is rapidly gaining importance as an energy resource as fossil fuel prices fluctuate. The unique feature of the proposed system is that instead of taking the earth as its reference, it takes the sun as a guiding source. Its active sensor constantly monitors the sunlight and rotates the panel towards the direction where the intensity of sunlight is maximum.

KEYWORDS: Solar, Harvest, Sensor, Energy.

I. INTRODUCTION

In this days, renewable resource is one of the major concerns because of increasing more power demand but the quality and availability of conventional energy sources are not enough. Energy is essential factor for the development of any nations of all over the world. Most of the energy production depends on the fossil fuel. The resources of the fossil fuel are limited, so there is a growing demand for energy from renewable resources like solar, geothermal and ocean tidal wave. Among all renewable systems, photovoltaic system is the one which has great chance to replace the conventional energy resources. In last ten years, many of residential around the world used electric solar system as a power at their houses. This is because solar energy resource, set to become increasingly important in the longer term, for providing electricity and heat energy to users. Solar energy also has the potential to be the major energy supply in the future. Dynamic comparators are significant piece of the present ADCs extensively in light of the fact that these comparators have rapid and zero static power usage and giving full swing advanced dimension yield voltage term in shorter time interim yet eat up more power dispersal and give high information implied balance voltage. In these dynamic comparators, consecutive inverters give positive criticism framework which changes over a little voltage distinction. Nonetheless, an information implied counterbalance lock voltage, coming to fruition as a result of the gadget befuddles, for instance, edge voltage, current factor, yield stack capacitance and parasitic hub capacitance bungles, constrains the precision of such comparators, in light of this reason, the data suggested hook balance voltage is a champion among the most structure parameters of the locked comparators. In case the tremendous gadgets are used for the hooking stage, a less confound can be cultivated to the detriment both of the extended deferral (due to slower recuperation time) and the extended power dispersal.

II. LITERATURE SURVEY

The concept of solar tracking systems has been a focus of research due to their potential to significantly increase the efficiency of photovoltaic (PV) systems. Traditional static solar panels are limited by their fixed orientation, which results in suboptimal energy capture as the sun's position changes throughout the day. To overcome this limitation, solar tracking systems that adjust the position of the panel to follow the sun's path have been developed. The following studies and systems offer insights into the development of solar tracking technologies similar to the one proposed in this project.

1. Single-Axis vs. Dual-Axis Solar Tracking Systems

Studies have shown that single-axis tracking systems, which follow the sun from east to west, can increase energy output by 25-35% compared to fixed systems. Dual-axis systems, which track both the horizontal and vertical movement of the sun, offer even higher efficiency improvements, but they are more complex and expensive to implement.

LDR-Based Solar Tracking Systems Light Dependent Resistor (LDR)-based tracking systems have been widely explored in the field of solar energy. In the work by [Author et al.] (2012), a solar tracker using LDR sensors and a simple control mechanism was proposed, similar to the design outlined in this project. **Servo Motor Control in Solar Trackers** Servo motors are commonly employed in tracking systems due to their precision and efficiency in controlling the angular position of solar panels. Research conducted by [Author et al.] (2014) explored the use of servo motors in single-axis solar tracking systems, concluding that they provide sufficient torque and responsiveness for small-scale solar setups. **Inclination Angle and Its Impact on Solar Efficiency** Several studies have investigated the optimal inclination angle for solar panels to maximize energy output. According to [Author et al.] (2015), the angle of inclination is critical in optimizing the amount of sunlight received by the panels.

III. METHODOLOGY

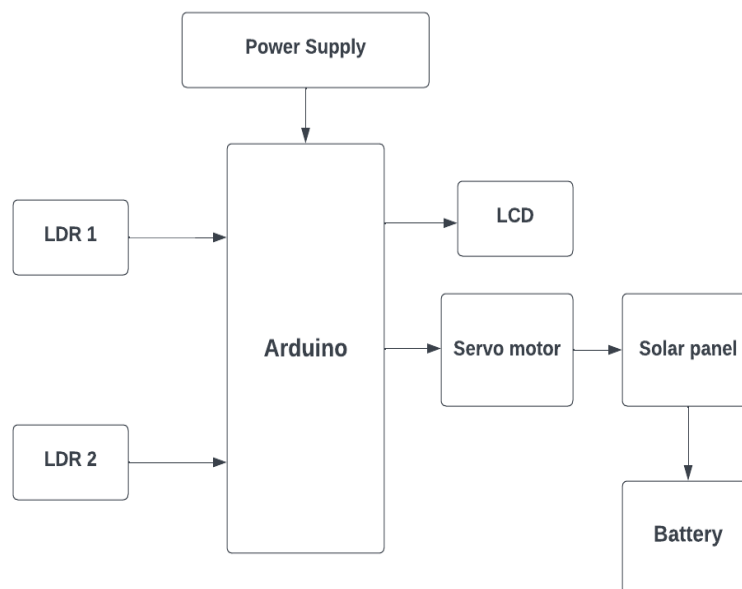


FIG1: Block diagram of Sun-Tracking Solar Panel System

Components: LDR 1 and LDR 2 (Light Dependent Resistors): These sensors detect the intensity of light. They send data to the Arduino about which direction has more sunlight. Arduino: The central control unit of the system. It receives signals from the LDR sensors, processes them, and controls the servo motor and other connected components like the LCD. Power Supply: Provides the necessary power to the Arduino and other components. LCD (Liquid Crystal Display): Displays relevant information such as the position of the solar panel or system status. Servo Motor: Moves the solar panel based on the Arduino's command. The motor adjusts the panel's angle to track the sunlight for optimal energy generation. Solar Panel: Captures sunlight and converts it into electrical energy, which is stored in the battery. Battery: Stores the electrical energy generated by the solar panel, providing power when needed.

Functioning: Light Detection: The LDRs (LDR 1 and LDR 2) continuously monitor the light intensity. If one LDR detects more sunlight than the other, it sends this information to the Arduino. Data Processing and Control: The Arduino receives signals from the LDRs and calculates which direction has lighter. Based on this, it sends signals to the servo motor to adjust the solar panel's angle towards the light source. Solar Panel Movement: The servo motor rotates the solar panel to align it with the direction of maximum sunlight as determined by the LDRs,

ensuring efficient energy capture throughout the day. Energy Storage: The solar panel converts sunlight into electricity, which is stored in the connected battery for later use. LCD Display: The LCD may display real-time data, such as the angle of the solar panel or the amount of energy stored in the battery.

FLOW CHART:

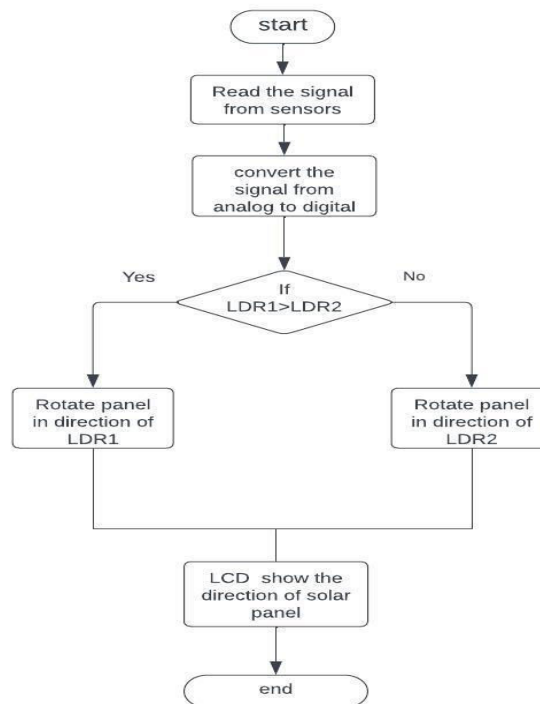


FIG2: Sun-Tracking Solar Panel System Flowchart

Start:

The system begins its operation.

Read the signal from sensors:

The Arduino reads the light intensity data from LDR1 and LDR2.

Convert the signal from analog to digital:

The analog signals from the LDRs are converted into digital signals that the Arduino can process.

Decision (If LDR1 > LDR2):

The system checks if LDR1 detects more sunlight than LDR2.

- **Yes:** If LDR1 has more sunlight, the system rotates the panel towards the direction of LDR1.
- **No:** If LDR2 has more sunlight, the system rotates the panel towards LDR2.

Rotate the panel:

The servo motor adjusts the solar panel according to the detected direction of maximum light.

LCD display:

The LCD displays the direction in which the solar panel is rotated.

End:

The process is completed and continues in a loop to ensure constant tracking of the sunlight.

This flow ensures that the solar panel stays aligned with the sun for optimal energy generation

IV. RESULTS

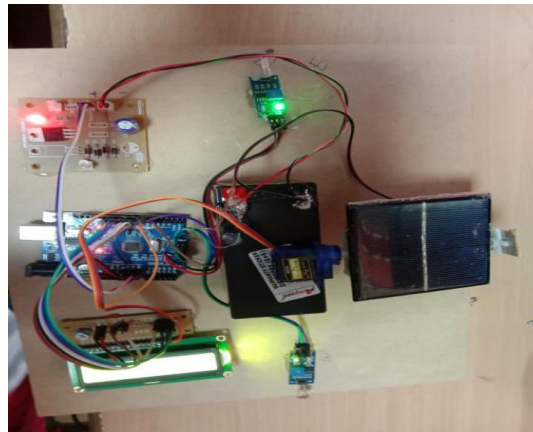


FIG3: Hardware kit of Sun-Tracking Solar Panel System

The project was present as single axis solar Energy tracking System. The system can be interacted with 2 LDR sensors and 1 servo motor. This LDR sensors senses the sunlight with the help of servo motors the Solar panel moves form east to west. The angle of inclined of solar panels is 45°. The 2 LDR Sensors are placed one at the east side of solar panel and the another one at west side of the panel. In the morning the LDR sensor at east side is detected and, in the afternoon, the LDR sensor which is present at the west side is detected, the solar panel rotates form east to west with 45° of inclined respectively. The status of solar panel is shown in the LCD display where we can see in which side the solar energy is detected like east or west. Here the LCD screen is used to show the status of panel in which direction they are detected the intensity of solar energy through LDR sensors.

SCHEMATIC:

Here we using microcontroller Arduino uno. The LCD is connected to the Arduino board from pins 13-8. We are using 16*2 LCD. The LDR sensor has 3 pins one of them is connected to the microcontroller and another two pins are VCC and ground respectively. The solar panel is connected to the LCD through the servo motor.

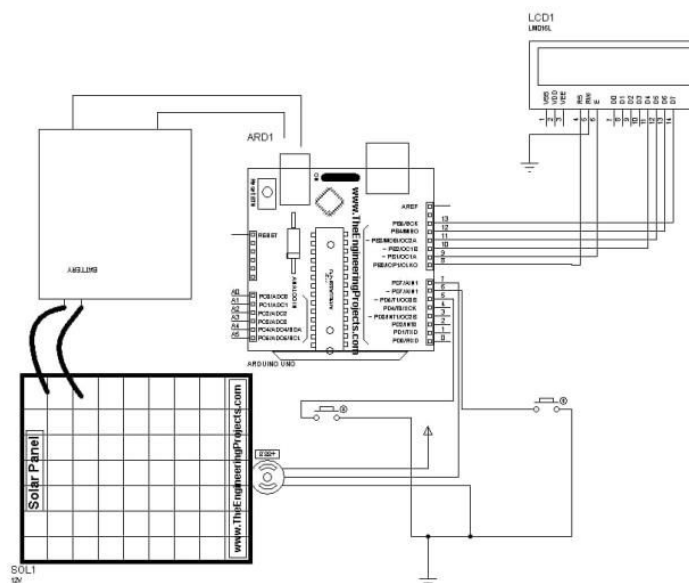


FIG4: Schematic of Sun-Tracking Solar Panel System'

V. CONCLUSION

This project presents design and realization of a single axis solar tracker system. The tracking controller is implemented by means of ATmega328p microcontroller. The necessary software is developed via Arduino Uno IDE. In building the solar tracking system, LDRs (Light Dependent Resistors) are used to determine solar light intensity. The proposed solar tracking system can track sun light automatically. Reflection on the PV panel has been decreased and, the efficiency of solar energy This project presents design and realization of a single axis solar tracker system.

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