SMART HYDROPONICS: SOLAR POWERED HYDROPONICS SYSTEM USING DUAL AXIS SOLAR TRACKER

Savitha Shetty [1], Saritha Shetty [1], Joshva Rodrigues [1],
Priya Kamath B [2], and Sowmya M R [3]

[1] Department of CSE, NITTE, Bangalore, India
[2] Department of CSE, Manipal Institute of Technology, Manipal, India
[3] Department of CSE, NMIT, Bangalore, India

ABSTRACT

The solar-powered hydroponics system which is equipped with a dual-axis solar tracker is developed to optimize energy capture for sustainable plant growth. The system utilizes the sunlight through photovoltaic panels, it converts it into electricity to power the hydroponics system. Light Dependent Resistors (LDRs) are utilized to detect the sun's position, and DC motors adjust the orientation of the solar panels, to ensure the optimal sunlight exposure throughout the day. By maximizing the energy capture through automated tracking, the entire system provides a continuous power supply which eliminates the need for grid electricity. The principles of photovoltaic conversion and automated solar tracking is the key to achieve efficient energy utilization and plant growth, which provides eco-friendly solution for modern agriculture. The outdoor experiment is conducted for 10 days, from morning 8:00AM TO 6:00PM.

KEYWORDS

hydroponics, LDR, solar tracker, plant growth

1. INTRODUCTION

Owing to a shortage of electricity, human beings has long looked for the most easily available and ecologically friendly form of electricity to advance [1]. For improved environmental control and quicker crop growth, this system uses hydroponics, as contrasted to regular smart farms that rely on soil cultivation [2].Energy that derives from renewable natural resources includes solar power, wind, tides, hydropower, biomass, and geothermal energy which resupply naturally [3].A solar tracking is a device designed to track the sun's motion in order to collect as much energy as possible. It contributes to reducing the incidence angle, which improves photovoltaic panel performance. A solar-powered device can be finished with the PLC, worm gears, servo motors, encoders, power relays, and photosensors.

One of the most effective sources of electricity is solar energy because it comes from the sun and doesn't pollute the environment. The photoelectric effect is the mechanism by which energy from sunshine is converted into electrical current. This green energy has been put to useextensively and is still getting better. Even though solar energy is an excellent source of energy, methods for harnessing it still need to be improved. The tracking system with two degrees of independence that function as rotational axes can be used to accomplish this. A primary axis is one that remains stationary with regard to the ground, and a secondary axis which refers to the main axis[4].

2. LITERATURE SURVEY

The authors compares two generic systems employing realistic restoration distributions and universal failure probabilities for mechanical hardware. Apart from that, the analyses incorporate sensitivity tests of the interruptions distributions and indicate that the power production is affected by the quantity of hardware that is rendered unavailable during recovery for the linked-rows architecture [5]. The authors uses a servo motor, two dependent resistors (LDR), and a microprocessor, the Atmega328P, to construct one axis [6].

The aim is to compare the voltage readings from tracking and stationary solar panels. Next, a dual axis monitoring method was developed in paper to track the greatest amount of sunlight that will shine directly on the display at any given moment of the week or year [7]. A solar tracker system is designed to make sure that conversion is optimized by correctly moving and orienting the PV panel to face the actual location of the sun [8].

3. METHODOLOGY

Photovoltaic panels are used in the solar-powered growing equipment with a dual-axis tracking solar panel to capture sunlight and transform it into electrical energy. This automated tracking guarantees continuous power offer for the hydroponic farming system, promoting effective plant development without dependence on grid electricity.Light Dependent Resistances (LDRs) observe the sun's status, and DC engines adjust the solar sections to face the sun for greatest energy capturing. One of the basic concepts used is photovoltaic conversion. The automated sun tracking system, which adjusts the panels' position to capture as much energy as possible during the day.The experiment is conducted for 10 days from morning 8:00AM TO 6:00PM. Three kind of plants namely Tulsi plant, Pudina plant and medicinal plant.Figure 1 indicates the methodology diagram for the system. It represents each step in the process, from designing the structure for mounting solar panels to connecting the hydroponics system to the solar power supply.

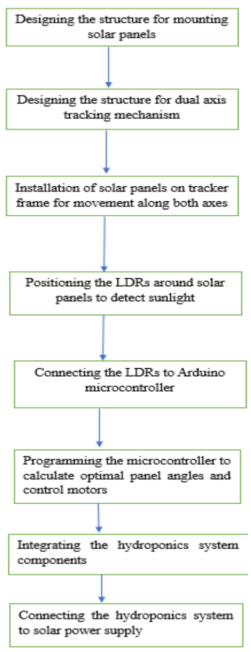

Figure 1. Block diagram of the overall system

4. Hardware Components Used

- Arduino Uno: The dual-axis sunlight tracking device uses the Arduino Uno microcontroller board to process sensor inputs and regulate outputs like motors.

- Light dependent resistor (LDR): To determine the sun's position, four LDRs are used. The Arduino Uno uses this information to change the orientation to get the maximum amount of sunlight.

- IR sensor [4 units]: To ensure appropriate management of water and growth monitoring, four IR sensors are employed to track the amount of water in the growing system and identify plant development. The sensors then send data to the Arduino Uno.

- 10 revolutions per second (RPM) DC motor: The dual 10 RPM DC motors are used to tilt panel to enable the dual-axis tracking solar system.

- Motor Controller: The motor driver acts as an interface between the DC motors and the Arduino Uno, supplying the power along with the control signals required to run the motors.
- Solar panel: The growing system and other parts are powered by the solar panel, which uses sunshine to create electricity.

- 9V battery: During times when solar output is low or at night, a 9V battery supplies backup power to keep the computer system and sensors running continuously.

- Wires: By joining all the parts, wires allow power and communication signals to move freely throughout the system.

5. Software Components Used

Arduino compiler: This tool allows the automation and management of the powered by sunlight hydroponics system by translating typed code for the Arduino into a form that the embedded system can understand.

6. Results and Discussions

The framework is intended for mounting solar panels and the dual-axis tracking mechanism. The solar panels is installed on the tracker frame, allowing for movement along both axes. The Light Dependent Resistors (LDRs) is positioned strategically around the solar panels to detect sunlight. The LDRs are connected to an Arduino or microcontroller for processing. The microcontroller is programmed to calculate optimal panel angles based on LDR inputs and control the motors accordingly. The hydroponics system components are integrated including plants, pumps, and sensors.The hydroponics system is connected to the solar power supply, ensuring efficient energy capture and distribution. This solar-powered hydroponics setup with a dual-axis solar tracking device is special because it can continuously shift the solar panels toward the sun right away, maximizing solar energy capture and improving energy efficiency greatly over fixed-panel systems. Because of its higher efficiency, the hydroponics system will have a more dependable power source, which will support ideal plant development and resource management regardless of the weather. By utilizing the most solar energy possible, this technology lowers operating costs and environmental effect while ensuring that hydroponic enterprises may operate more sustainably and efficiently. Furthermore, it makes hydroponic systems more feasible in places where access to conventional power sources is restricted by improving energy utilization.

The system's figures are presented below. Figure 2 shows the initial design before growing the plants. figure 3 indicates the system after the plants are grown. Three different medicinal plants are grown in the system. The figure 4 indicates the circuit connections. The figure 5 indicates the initial design of solar tracker (Side View). The figure 6 indicates the two-axis solar tracking device(side view) along with the circuit connections. The figure 7 indicates the dual axis solar system (front view). The figure 8 indicates the final system of plants grown along with the dial axis solar panel system.

Figure 2. Initial design of the hydroponic system to grow the plants.

Figure 3. The system after the plants are being grown

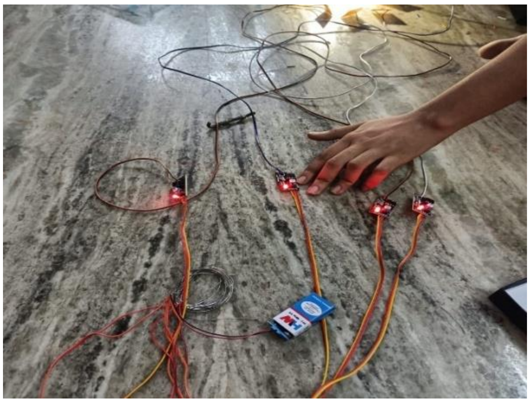

Figure 4. The circuit connections

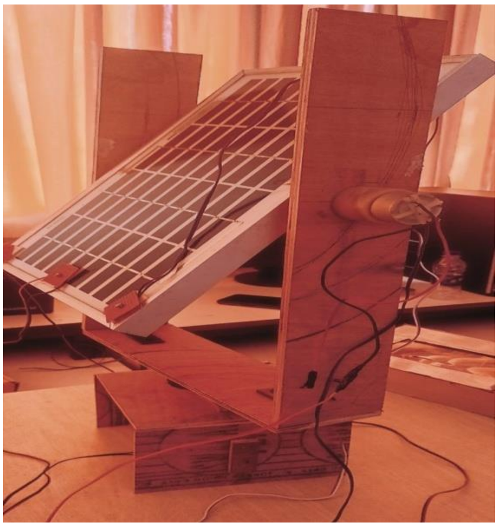

Figure 5. Figure Initial design of dual axis solar tracking system(Side View)

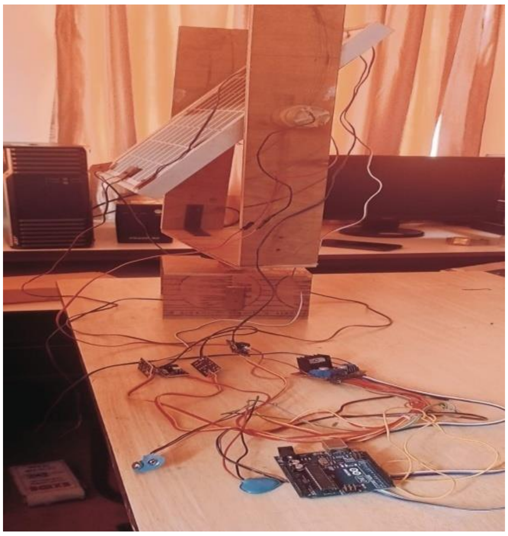

Figure 6. Dual axis solar tracking system(side view) along with the circuit connections

Figure 7. The dual axis solar panel (front view)

Figure 8. Final system of plants grown along with the dial axis solar panel system

7. CONCLUSION

The two-axis solar tracking device powered by solar radiation has demonstrated great promise for maximizing energy capture and encouraging long-term plant growth. Without depending on grid power, the system uses photovoltaic panels, automatic sun monitoring using Light Dependent Resistors (LDRs), and DC motors to provide a steady supply of energy throughout the day. The trial outside, which lasted for more than ten days from eight in the morning to 6:00 PM, verified that the system is successful in preserving the ideal amount of sunshine and energy production. This method shows the benefits of combining renewable energy with cutting-edge automation for profitable agricultural operations, while also improving energy efficiency and offering an environmentally responsible alternative for contemporary agriculture.

REFERENCES

[1] S. A. Sadyrbayev, A. B. Bekbayev, S. Orynbayev, Z. Z. Kaliyev., "Design and research of dual-axis solar tracking system in condition of town almaty. Introduction at present the share of solar energy in the energy," Middle-East J. Sci. Res, vol. 17, Vol. 12, pp. 1747–1751, 2013.

[2] Kim, H., Kim, I., Seo, J. W., & Ko, J. (2024). Smart Farm for Hydroponic Cultivation Using Integrated Renewable Energy Systems. IEEE Sensors Journal.

[3] M. Zolkapli, S. A. M. Al-Junid, Z. Othman, A. Manut, M. A. Mohd Zulkifli., "High-efficiency dual-axis solar tracking developement using Arduino," Proc. 2013 Int. Conf. Technol. Informatics, Manag. Eng. Environ. TIME-E 2013, pp. 43-47, 2013.

[4] Ceyda Aksoy Tirmikci & Cenk Yavuz, "Comparison of solar trackers and application of a sensor less dual axis solar tracker," J. Energy Power Eng., vol. 9, Vol. 6, pp. 556-561, 2015.

[5] P. Shubhangini & S. Kamble, "Solar tracker with improved efficiency using power saving," pp. 439-443, 2017.

[6] Aloka Reagan Otieno,. "Solar tracker for solar panel. Faculty of engineering department of electrical and information engineering,". Universiti of Nairobi, 2015.

[7] Ayushi Nitin Ingole., "Arduino based solar tracking system," International Conference on Science and Technology for Sustainable Development, Kuala Lumpur, Malaysia, May 24-26, 2016.

[8] Tiberiu Tudorache, L. K., "Design of a solar tracker system for pv power plants," Acta Polytechnica Hungarica, Vol. 7, No. 1, pp. 17, 2010.