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Solar Tracking Scheme with Panel Cleaning Arrangement for Effectual Power Generation

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ABSTRACT

The main objective of the paper is to give an innovative idea to tackle the energy demand in the growing countries. Renewable sources of energy are solar, wind and geothermal which are inexhaustible. Solar energy is used for several applications indeed which is abundant in nature. Solar energy is harvested using solar panels, but its efficiency can be affected by the factors like dust, temperature and humidity etc., Solar Panel's electrical parameters are more sensitive to dust density formed on the panel surface and will affect the energy transmission thereby reduces the efficiency. To mitigate this problem, it is essential to clean the panels at regular intervals. Hence dust cleaning arrangement is proposed which consists of IR LED, Photo diode is used to remove the dust formed in the panel. By taking voltage and current values of the panel with and without dust for several days, weeks and months. Efficiency comparison is made with the noted values. The proposed cleaning model incorporates effective, non-abrasive cleaning which avoids variances in the solar power generation due to the dust deposition on the panel. By the regular cleaning, the average efficiency is increased around 1.6 to 2.2% is increased. Thus, the proposed model increases the efficiency.

Keywords: Arduino MEGA, Photovoltaic (PV) panel; Solar Tracking scheme, Sensors, Humidity & Temperature (DHT 11) Sensor, NodeMCU (IoT)

INTRODUCTION

Arduino based automatic solar panel cleaning system is for those area where dust effect on solar panel. The reasons the efficiency of solar energy can be decreased is such that dust from environment, bird shit or any other small obstruction. The system will clean the solar panel as per the preprogrammed schedule.

As designed, the motor will convert electrical power into mechanical output which will rotate the iron frame and coupling point. By rotating automatically it will clean the solar panel for a certain period of time. For the first step the wiper will move to forward side of the solar panel and after that it will reverse back to the solar panel. Then it will take a delay time of 24 seconds in our prototype model (which will take 24 hours in real implementation). After that the system will again clean the solar panel by following the above methodology. User can change the delay time of cleaning system as per required time the system will run. The system will run with Arduino based software code in which the delay time can be increased or decreased.

PROPOSED SYSTEM MODEL

The maximum efficiency of a solar panel is extracted using two combined techniques. The first one is to implement with a microcontroller-based Solar-tracking system. The system checks the position of the sun and controls the movement of a solar panel so that radiation of the sun comes normally to the surface of the solar panel and the second is to install an MPPT charge controller which makes the Inverter to work at maximum power point. So that under any climatic conditions maximum power is extracted. By this way efficient use of both solar panel and solar-energy from sun is achieved.

Proposed scheme aims for extracting maximum power from solar panel by using light sensors (LDR'S). From the status of LDRs the panel rotates with the help of 3.5V dc motor to the direction where the sunlight is more. The output from panel is derived to an DC-DC Boost Converter which is used to increase the voltage without change in current rating there by increasing the battery charging condition. The battery storage can be utilized to drive loads in case of failure of supply and used in day times from panel after boost converter. The panel is also provided with temperature and humidity (DHT 11) sensor, Voltage and Current sensors. The sensors sense the respective parameters and the obtained data is sent to the monitoring unit as well as displayed on LCD screen. When the Temperature is high enough the microcontroller switch on the Fan by using the power derived from the solar Panel. The whole setup is provided by a dust sensor which senses the dust on the panel. The dust sensor and LDRs used in the proposed system helps to increase the efficiency of the solar panel.

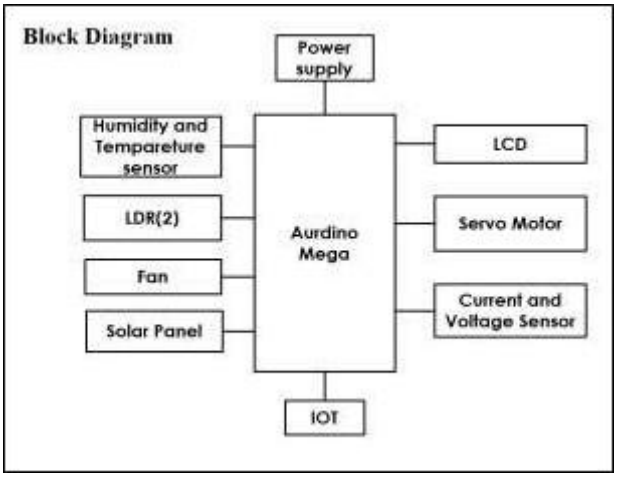

Fig. 1. Block Diagram of the proposed model

PROBLEM STATEMENT AND SYSTEM DESIGN

Solar tracking enables more energy to be generated because the solar panel is always able to maintain a perpendicular profile to the sun's rays. As the sun moves across the sky during the day, it is advantageous to have the solar pane track the location of the sun, such that the panels are always perpendicular to the solar energy radiated by the sun. This will tend to maximize the amount of power absorbed by PV systems. It has been estimated that the use of a tracking system, over a fixed system, can increase the power output by 30% -60%.

Design requirements are:

1) During the time that the sun is up, the system must follow the sun's position in the sky.
2) This must be done with an active control and timed movements are useful. It should be totally automatic and simple to operate. The operator interference should be minimal and restricted to only when it is actually required.

The major components of this system are as follows.

1) Solar Panel
2) LDRs
3) DC motor.
4) Temperature sensor
5) Humidity sensor
6) Aurdino MEGA
7) Voltage and Current Sensor

The different types of solar tracker which can be grouped into single axis and double axis models.

A. Single Axis Trackers:

Single axis solar trackers can either have a horizontal or a vertical axle. The horizontal type have a manually adjustable tilt angle of 0 - 45 degrees and automatic tracking of the sun is from east to west. They use the PV modules to themselves as light sensor to avoid unnecessary tracking movement and for the reliability. At night the trackers take up a horizontal position. This kind of tracker is most effective at equatorial latitudes where the sun is more or less overhead at noon. Due to the annual motion of the earth the sun also moves in the north and south direction depending on the season and due to this the efficiency of single-axis is reduced since the single-axis tracker only tracks the movement of sun from east to west. During cloudy days the efficiency of the single axis tracker is almost close to the fixed panel.

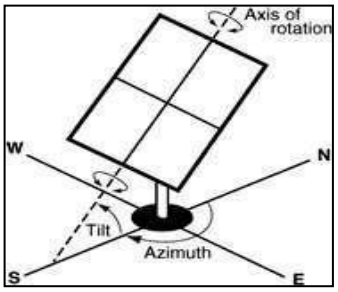

Fig 2. One axis tracking PV array with axis-oriented South

B. Dual Axis Trackers:

In dual-axis tracking system the sun rays are captured to the maximum by tracking the movement of the sun in four different directions. The dual-axis solar tracker follows the angular height position of the sun in the sky in addition to following the sun's east-west movement double axistrackers have both a horizontal and a vertical axle and so can track the sun's apparent motion exactly anywhere in the world. This type of system is used to control astronomical telescopes, and so there is plenty of software available to automatically predict and track the motion of sun across the sky. When the sun moves in the northern direction the tracker has to track the path of the sun in anti-clockwise direction along the horizontal axis (east to west). If the sun movesin the southern direction then the tracker has to track the path of the sun in clockwise

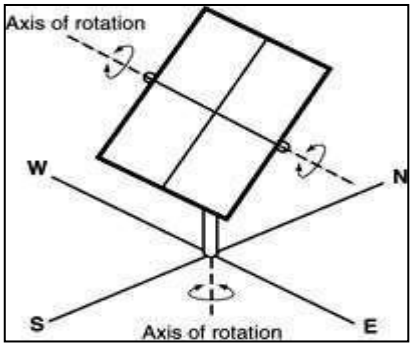

Fig 3. Dual axis solar tracker

Dual axis solar trackers track the sun in both directions i.e., from east to west and north to south foradded output power (approx. 40% gain) and convenience

Sun tracking algorithm: This algorithm calculates the solar azimuth and zenith angles of the sun. These angles are then used to position the solar panel or reflector to point toward the sun. Some algorithms are purely mathematical based on astronomical references while others utilize real-time light-intensity readings.

Control unit: The control unit executes the sun tracking algorithm and coordinates the movement of the positioning system.

Positioning system: The positioning system moves the panel or reflector to face the sun at the optimum angles. Some positioning systems are electrical and some are hydraulic. Electrical systems utilize encoders and variable frequency drives or linear actuators to monitor the current position of the panel and move to desired positions. The effective collection area of a flat-panel solar collector varies with the cosine of the misalignment of the panel with the Sun.

RESULTS AND DISCUSSION

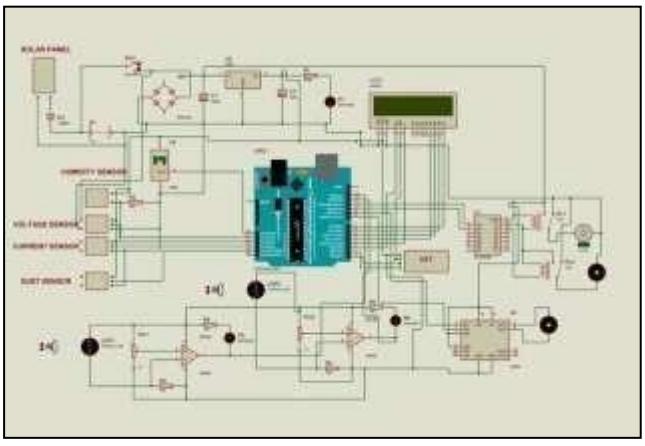

Fig 4. Schematic diagram of the proposed model

The prototype model shown is used to track the sun and the LCD display shows various sensor readings. The tracking improves the solar energy storage and the parameters from the sensors are read from the LCD display. The Cleaning process is simultaneously performed at regular intervals to improve the efficiency.

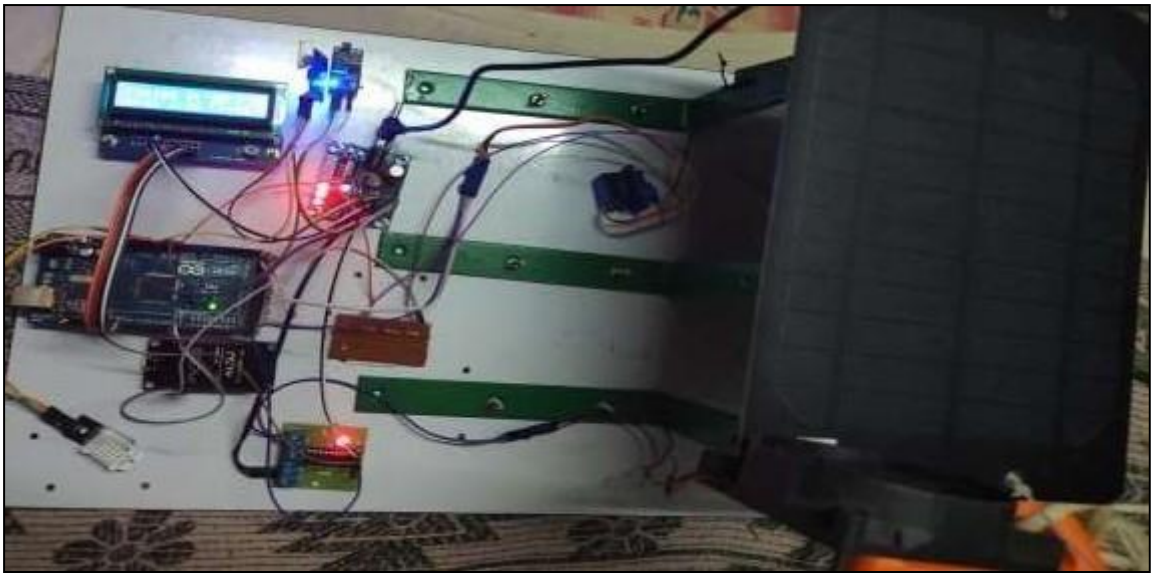

Fig. 5. Solar tracker Prototype

Fig. 6. LCD Display

CONCLUSIONS

This paper gives the perfect solution to the cleaning of a panel from dust. This system can be used in houses, office, solar power plant etc. This method performs both forward cleaning & reverse Cleaning. The Arduino- MEGA board is used for this purpose. This is very beneficial method to use in solar system to get more power from sun and it is more efficient. The 2-channel relay module is used for controlling the motor action both in forward & reverse.

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