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Design and Implementation of Sun Tracker Solar Panel with Smart Monitoring System

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ABSTRACT: With the dual threats of energy depletion and global warming growing to everyone’s concern, the development of methods for harnessing renewable sources of energy becomes important. Solarenergy is one of the most promising renewable energy resources. Sun trackers cansubstantially improve the electricity production of a photovoltaic (PV) system. The aim of this project is to present a solar energy collection technology by photo voltaic cell. To present this efficient solar power generation system, a dual-axis solar tracker is designed. The tracker actively tracks the sun and changes its position accordingly to give maximum power output. The designed tracking system consists of LDR’s as sensors, micro controller operated control circuits to drive servo motor and geararrangements with supports and mountings. Two servo motors are used to move the solar panel so that sun’s beam is able to remain aligned with the solar panel. An addition of monitoring system enables us to monitor the battery and load information of the battery in an android device interfaced using a Bluetooth module and an android application.

KEYWORDS: Renewable source, solar energy, photovoltaic cell,dual-axis solar tracker, android application, android device, Bluetooth etc.

I.INTRODUCTION

Renewable energy is rapidly gaining importance as an energy resource as fossil fuel prices fluctuate. At the educational level, it is therefore critical for engineering and technology students to have an understanding and appreciation of the technologies associated with renewable energy. One of the most popular renewable energy sources is solar energy. Many researches were conducted to develop some methods to increase the efficiency of Photo Voltaic systems (solar panels). One such method is to employ a solar panel tracking system. This system deals with a RTC based solar panel tracking system. 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. Development of solar panel tracking systems has been ongoing for several years now. As the sun moves across the sky during the day, it is advantageous to have the solar panels 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.

A solar tracker is a device for orienting a solar photovoltaic panel, day lighting reflector or concentrating solar reflector or lens toward the sun. Solar power generation works best when pointed directly at the sun, so a solar tracker can increase the effectiveness of such equipment over any fixed position. The solar panels must be perpendicular to the sun's rays for maximum energy generation. Deviating from this optimum angle will decrease the efficiency of energy generation from the panels. A few degrees of misalignment will only cause 1% to 5% of energy loss, while larger angles of 10° to 20° will significantly decrease the energy generation of up to 35%. Although, this loss is also dependent on the material and pattern of the protective glass that covers the solar panel. An active tracker uses motors to direct the panel toward the sun by relying on a sensing circuit to detect light intensity. There are two main ways to mount a solar panel for tracking; single axis and dual axis. Single axis trackers usually use a polar mount for maximum solar efficiency. Polar trackers have one axis aligned to be roughly parallel to the axis of rotation of the earth around the north and south poles. When compared to a fixed mount, a single axis tracker increases the output by approximately 30% The second way is a two axis mount where one axis is a vertical pivot and the second axis is the horizontal. By

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using a combination of the two axes, the panel can always be pointed directly at the sun. This method increases the output by approximately 36% compared to stationary panels.
The android based application helps to monitor the technical details of the solar panel like output voltage, output current, remaining and battery percentage.

II.SYSTEM MODEL

The model drags the idea of available conventional systems and remodels it with an addition of the implementation of software developed using MIT app inventor. The block diagrams of the model are shown in figure.

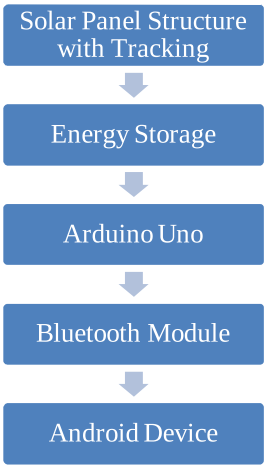

Fig (1). Hardware Block Diagram

The above block diagram shows the hardware model which consists of solar panel mounted upon the dual axis tracking system.

Fig (2). Dual Tracker System

The dual axis system (shown in fig. 2) employs Light dependent resistors and stepper motors which adjusts the system both vertically and horizontally. The output generated is stored in the form of DC current in a rechargeable battery of 12V. Parallel to it, the output of solar panel and the battery is provided to the analog inputs of the Arduino Uno developer board. The developer board is programmed in such a way that it reads the analog values and sends it to mobile device using Bluetooth module.

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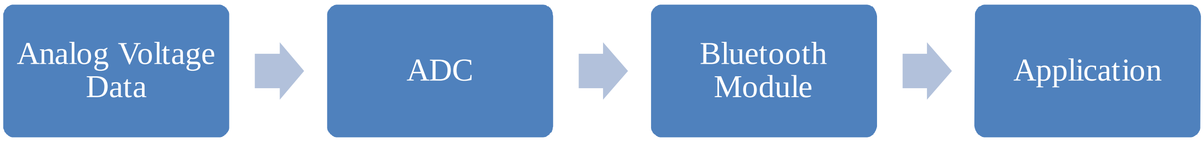

Fig (3).Software Block Diagram.

Figure (3) shows the software block diagram of the system. The output voltage generated by the solar panel is fed to the battery. The voltage information is read by Arduino. The ADC converts the received analog data from the analog pin and converts it into digital data and feds the result to the Bluetooth module. A HC-05 Bluetooth Module is used to transfer the data from the Arduino to the mobile device. The android application developed for this project was named as “Solar Tracker Monitor”. This application was created using MIT app Inventor.

III.CIRCUIT AND EXPLANATION

The hardware structure consists of two servo motors, each responsible for horizontal and vertical movements, respectively. Four photoresistors are connected parallel with four resistors of value 10K Ohm each. The common of the LDR’s are given as analog input to the Arduino in A0, A1, A2, and A3 respectively. Also, four photoresistors crossly divided by each other as shown are used. When the sun light is incident on the LDR’s, their voltage values changes. Depending upon the intensity of light received by each LDR, their voltage value varies and is different by one another. The voltages of those four voltages are used as variables in coding the Arduino namely lt (left top), rt (right top), ld (left down), rd (right down). The main aim is to calculate the “zero” point between the photoresistors, i.e. the differences between the variables must be zero. To verify that, another four variables are defined, avt (average value top) = (lt + rt) / 2, avd (average value down) = (ld + rd) / 2, avl (average value left) = (lt + ld) / 2, avr (average value right) = (rd + rd) / 2. By calculating these values, we get to define the horizontal and vertical rotation angle using the following equations:dvert = avt – avd and dhoriz = avl – avr. These two equations calculate the differences between top, down and left, right values. If the program finds the difference, it compares the tolerance value manually provided using one of the two potentiometers and then provides the signal to the respective servomotor to shift its position horizontal or in vertical direction. The two potentiometers are connected to analog A3 and A4 of the Arduino and is used to set the speed and tolerance of the servomotors. The servomotors are connected to the PWM pins of Arduino 9 and 10 respectively. The “dvert” variable is responsible for vertical rotation and “dhoriz” variable is responsible for horizontal rotation.

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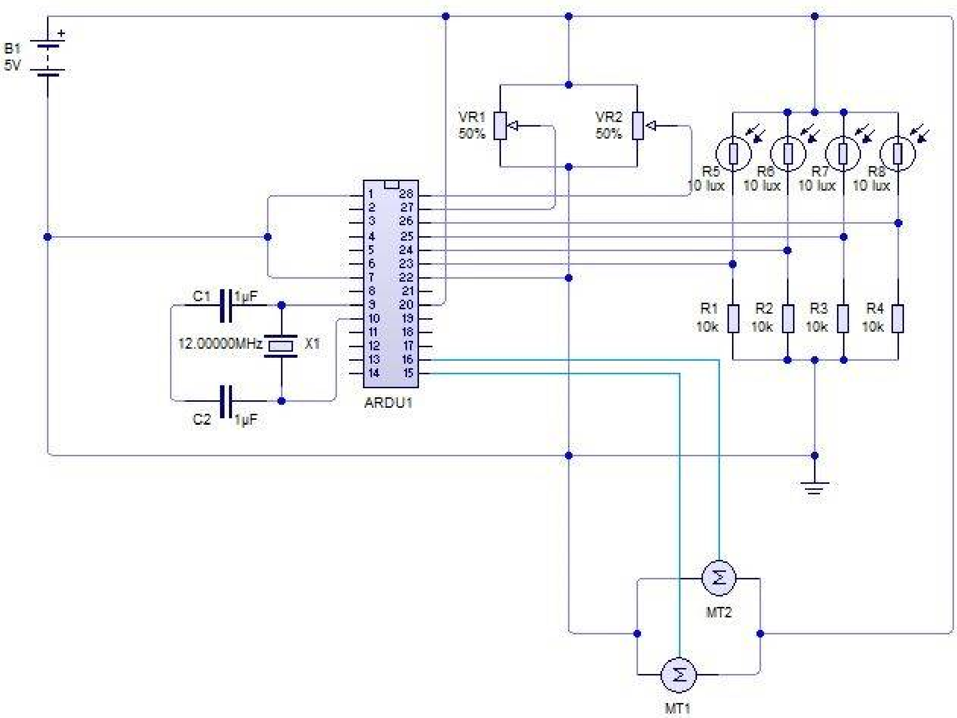

Fig (4). Circuit diagram for Tracking System

Fig. (4) Shows the circuit diagram of the Dual Axis Solar panel. The following circuit diagram is of the implementation of microcontroller with solar panel for tracking system. It consists of a microcontroller based developer board with four LDR's and four resistors connected serially with two servo motors employed.

IV.ANDROID APPLICATION

The software part includes the procedure of transmitting data over Bluetooth to the android smartphone device which analyses the data. A Bluetooth module HC-05 is used to transmit the data from Arduino to the mobile device. A slave module is used here because the modules in mobile devices are Master and Master-Master or Slave-Slave connections are not possible. Four pins of the module are connected to TX, RX, GND, VCC, respectively. The positive terminal of the battery is given as analog input to the A0 port of another Arduino and is converted into digital form using Arduino's inbuilt ADC. This value is then analysed by the code and is transmitted via Bluetooth module.

To create this application, MITAppInventor 2 from Google.Inc is used. The application, compatible with any Android device readily receives the data from the Arduino at a delay of 1 second and displays the values in real-time on the device.

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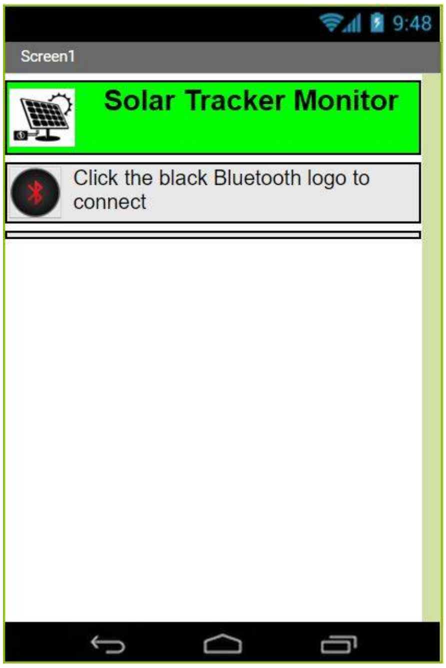

Fig (5).Interface of the Application.

Fig. (5) above shows the interface of the android application developed using MIT app Inventor. It has a basic user interface from which user clicks the black Bluetooth sign to select the device or the Bluetooth module and connect it with the device. Once connected, the information of the solar panel is displayed on the screen.

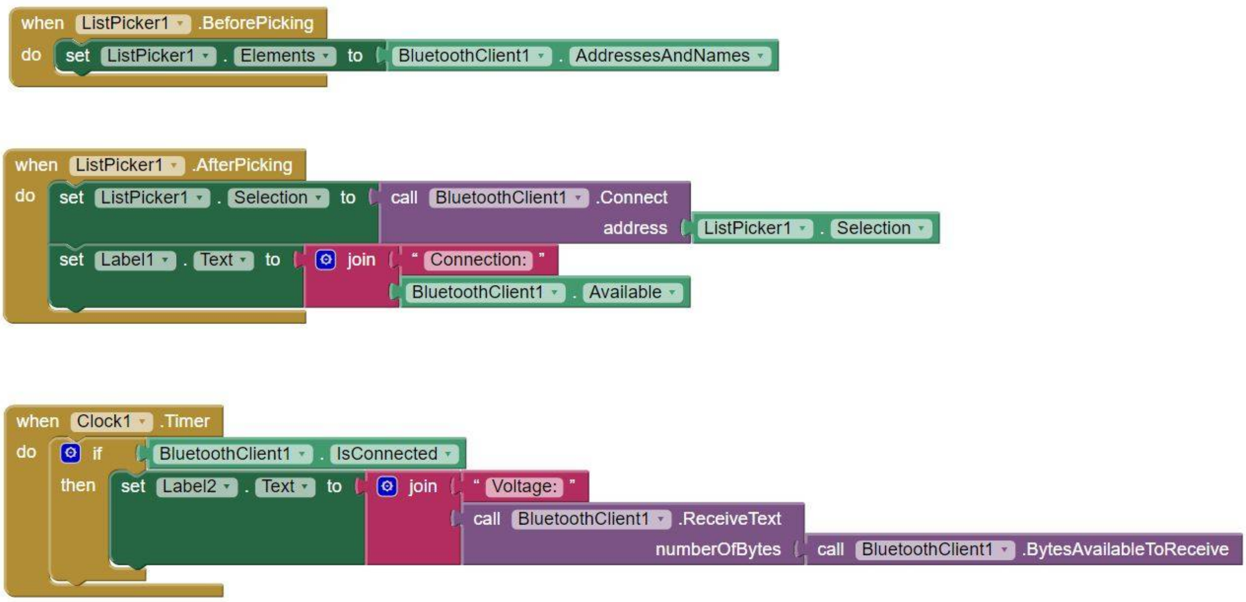

Fig (6). Blocks creation in MIT app Inventor

The figure (6) shows the blocks used in making the application. A clock is user for timer applications while developing the application. By this way, more analog data like current and battery information can be displayed.

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V. ADVANTAGES

Advantages of Dual Axis Solar Panels are:

Solar trackers generate more electricity than their stationary counterparts due to an increased direct exposure to solar rays; Solar trackers generate more electricity in roughly the same amount of space needed for fixed tilt systems, making them ideal optimizing land usage; Uses simple, inexpensive and easier to get components; It requires less maintenance; Reduces the land area required for installation as no additional solar panel is required for maximum efficiency; The tracker not only follows sun from east to west and back to east in a cyclic manner (horizontal motor module), but also tracks the angular movement of the sun with respect to its zenith angle to the horizon (vertical motor module and eye). This is a versatile quality for which the tracker could easily be used in conjunction with solar panels to derive maximum solar energy; The android implementation helps in getting the technical details of the Solar Panel such as energy generation, battery level, etc.

VI. RESULT AND DISCUSSION

The relationship between the suns energy and the earth is a fairly complex one. The earth's path around the sun has been closely mapped and many descriptions of these movements exist. Some are heavy approximations whereas some are very exact and the equations rely on gathering the latest measured constants.

The apparent position of the sun depends on how earth rotates around the sun and how it revolves around its own axis. The path around the sun is not circular, but slightly elliptic which affects the distance to the sun. Also the axis of which earth rotates around is slightly tilted; 23,4 degrees. The tilt is called the obliquity of ecliptic and it causes the seasons in the northern and southern hemispheres.

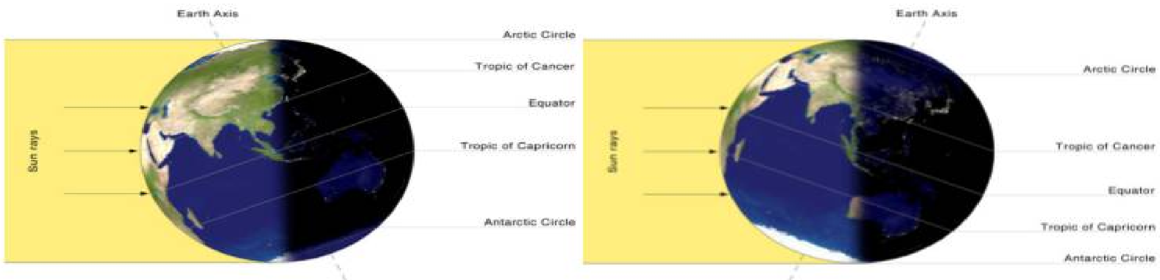

Fig (7).The effect of the obliquity of ecliptic. To the left is the summer season for example Europe. To the right it is the summer season for Australia. (wikimedia commons, 2007)

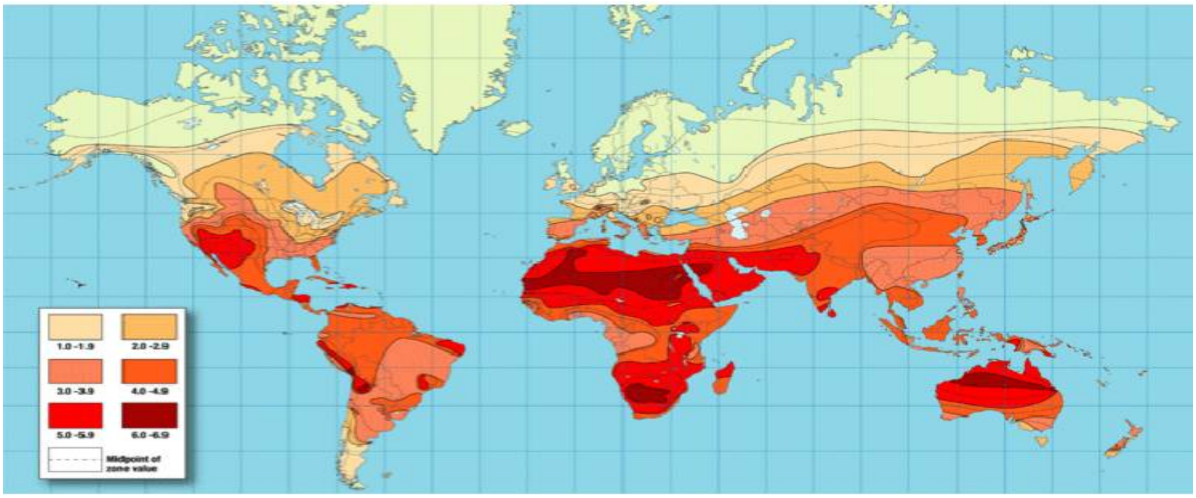

Fig (8). Amount of solar energy in hours, received each day on an optimally tilted surface during the worst month of the year. Source: SunWizeTehnologies.

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The above figure shows the amount of Solar Energy received each day. Thus harvesting the solar energy on a large scale can be very useful alternative to the current available energy sources.

VII.CONCLUSION

Thus the voltage received from solar tracking system is more than the static solar panel. The average voltage in fixed position is 5.03 V and in tracking position is 5.6 V. Comparing the total net electricity generation of the fixed position and smart solar tracking control, the smart system yielded 19.3% greater efficiency than the fixed system.

REFERENCES

[1] Arindam Bose, SounakSarkar, Sayan Das, “Helianthus - a Low Cost High Efficient Solar Tracking System Using AVR Microcontroller”, International Journal of scientific and engineering research, Vol. 3, Issue 10, pp.01-06, 2012
[2] D. A. Pritchard, “Sun racking by peak power positioning for photovoltaic concentrator arrays,” IEEE Contr. Syst. Mag., vol. 3,no. 3, pp. 2-8, 1983.
[3] A. Konar and A. K. Mandal, Microprocessor based automatic sun tracker,” IEE Proc. Sci., Meas. Technol., vol. 138, no. 4, pp. 237-241,1991.
[4] J. D. Garrison, “A program for calculation of solar energy collection by fixed and tracking collectors,” Sol. Energy, vol. 72, no. 4, pp. 241-255, 2002.