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Dual Axis Solar Tracking, Harvesting and Measuring Using LPC2148 Microcontroller

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Abstract -*This paper describes the implementation of dual axis solar tracker using ARM processor. In the single axis the tracking was happens in only one direction so it does not obtain the optimum solar radiation from the sun. In dual axis solar tracker, the two servo motors are used to operate the solar panel from east to west and north to south. This tracking system is constructed by using LPC2148 microcontroller. This design of dual axis solar tracker has several main components, such as 4 LDR sensors are used to estimate the position of the sun. The polycrystalline solar photovoltaic (SPV) panel which are connected to the servo motors, and the 500mA rechargeable battery which will store the energy. Voltage sensor will calculate the voltage across the load system and the current sensor is used to calculate current flowing through the load. These sensors are used to analyse and compare the energy production between SPV panel and dual axis solar tracker.*
Therefore, the dual axis solar tracker will increase the capacity of the solar panel generally in the tropical regions.

Key Words: **Dual axis, solar tracker, servo motor, SPV, ARM.**

1. INTRODUCTION

The demand of electricity increases day by day, to solve those electricity problems solar energy is used as an alternative option [13]. The solar energy is more efficient for conversion into electrical energy and hence the sun is the main source of renewable energy [15]. The conventional solar panel system built at fixed position hence the system cannot track the sun rays. Therefore, the efficiency of the system is low. [7] The conventional solar panel does not give maximum harvesting of solar energy and this conventional solar panel system fixed at certain angle limits. In the cloudy and foggy weather conditions the minimum energy is stored so to overcome this condition we are implementing solar panel tracking, harvesting and measuring system with the help of dual axis solar panel to extract maximum energy from the sun. The two-axis solar tracker system is capable of collecting maximum solar energy with reduced cost and improve efficiency. The aim of this paper is to implement dual axis sun tracker and analyse the maximum energy gain. [1] The C programming language is used to interface the LPC2148 microcontroller with two axis solar tracking system [2]. In the proposed system, the energy harvesting system is operated on the two servo motors holds the flexible solar panel and operate it from east to west and north to south and stores the energy in rechargeable lead acid battery. This energy measured by data logger and stored into SD card.

In the single axis sun tracker, the solar panel is rotate only in the only one direction but in dual axis solar tracker it will moves from east to west and north to south. The SPV panels are installed on a mechanical structure with the certain angle.

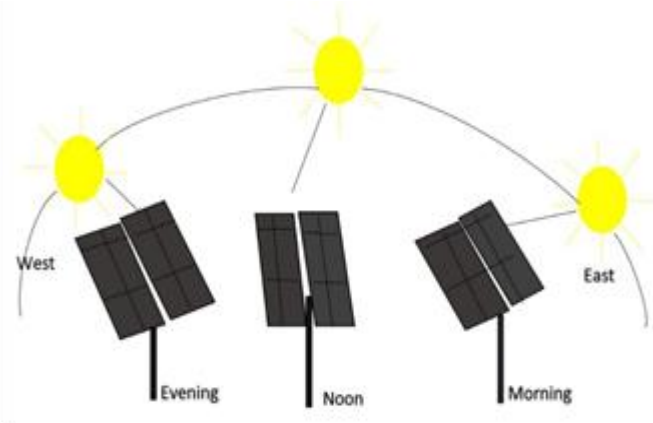

Fig1. Dual axis solar tracking

The design of the dual axis solar tracker is using the four LDR sensors to detect the sun light from the sun and the two servo motors to rotate the solar panel in 4 directions. The four sensors are used to actuate two vertical servo motors and horizontal servo motor controlled using LPC2148 microcontroller. [3] The tracking system allows the solar panel to fixed the sun's position and move the panel perpendicular to sun rays. The proposed system of energy harvesting and tracking has high efficiency, high reliability and non-noisy aspects [6]. the PV panel operating point is set

by the storage device and thus is not match the maximum power point [12]. Under the partial shading also solar panel consumes the power generated by non-shaded panels and dissipate heat [11].

2. LITERATURE SURVEY

Normally, solar tracking system classified into single axis and dual axis tracker system. However, this paper focuses on the design and performance dual axis tracker system [3]. The system analyses the energy gain which is track by solar panel [1]. This paper is aim to design the horizontal and vertical tracking system to harvest maximum energy. The position of the solar panel is perpendicular to sun rays to generate more energy [3]. The system tracks the sun in direction East-West and North-South. In addition, the use of dual axis sun tracker can provide a high energy as compared to single axis tracker [7].

Active tracking method is implemented to determine position of sun and the output signal received from the light detecting sensor [3]. The control system is based on the use of an LPC2148 microcontroller and light detecting sensors [8]. The proposed system is controlled by microcontroller and interfaced with C programming language. The dual axis sun tracking is constructed with two servo motors [2].

To determine the charging rate of the battery can be used the voltage sensor and current sensor ACS712. The generated power can store on the SD card [8]. The LPC2148 microcontroller unit is used to control the servo motor by means of receiving the input data from a light detecting sensor. The tracking can be done more precisely by using servo motor instead of stepper motor and gear motor [4]. The servo motor is attached to horizontal and vertical axis to turn the solar panel towards the sunrays [1]. The dual axis sun tracker system does not affect by cloudy, foggy weather [5].

In [11] shows the algorithm can efficiently track the maximum energy of a solar panel under shading conditions. [9] presents a highly efficient energy tracker based on embedded system. In this paper light detecting sensors used to produce control signal. To activate PWM signal of servo motor the signal is processed in the microcontroller. Interfacing of servo motor has bidirectional rotating capability for clockwise and anticlockwise [1]. The paper presents the Maximum Power Point Tracking (MPPT) implementation of dual axis tracking system using charge controller. The motor movement can control by using four limit switches adjusted in the programming of servo motor [14]. The data logger is used to track of discharging or charging voltage of battery and the light detecting sensor is necessary tracking system. The temperature and panel output voltage are recorded on the data logger and is stored in SD card [15].

3. Structure of Dual Axis Sun Tracker

The dual axis sun tracker requires the different components which are co-related to the design. The components which are used for the sun tracker are SPV panel, 2 servo motors, servo motor driver, 4 LDR sensors, voltage sensor, current sensor, 500mA battery, data logger and SD card.

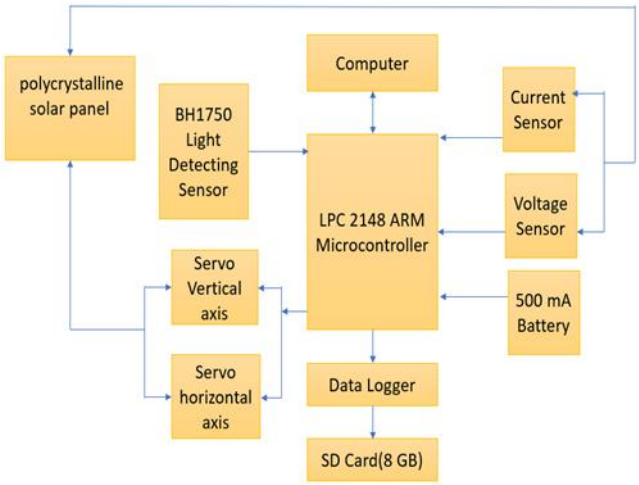

Fig2. Block Diagram of Dual Axis Sun Tracker

The dual axis solar tracker system will change the horizontal and vertical degrees of solar panel. The block diagram is shows that the tracking system [7].

The Light sensing device that is 4 LDR sensors are connected pointing towards the sun named as LDR1, LDR2, LDR3, LDR4. The two servo motors are connected that is one for vertical axis and second for horizontal axis to orient the SPV panel towards the sun [1]. the servo motors are connected to the servo motor driver and these drivers is connected to the microcontroller.

The paper is also determining the energy gain achieved by the by the SPV panel with sun tracker. The load is connected in between solar panel and the voltage sensor and current sensor. The voltage sensor is use to determine the voltage across the load and the current sensor is use to find the current from the load in order to find out the energy conduction between the SPV panel and dual axis sun tracker. The data logger is use to collect the measurement data of load current and voltage at particular time interval [8]. These measurement data are stored in the memory card. Also, the measured value we can see on the computer. And these all components are connected to the microcontroller which is operate.

Control circuit is powered by a 500mA, 4V battery and this battery is charged by the solar panel. Thus, tracking system does not require any external power source [7]. The components which are used for this project are simple and

easily available in the market. in dual axis solar tracker there are many losses because of control in two directions require more power and extra components, but in this system losses and power required for the tracking is very low. Maximum energy harvesting is the objective of dual axis tracking system not only for the single day but also for the season of the years [14]. The maintenance cost of the dual axis solar tracker is less as compare to the conventional solar trackers [10]. Small solar panels sufficient to ensure continued several photovoltaic harvesting operations [9].

A. Light Detecting Sensor

LDR, phototransistor, photodiode and BH1750 are the sensors used as the light detecting sensors. In this paper BH1750 light detecting sensor is utilized because it has high sensitivity, affordable and easy to use. Four BH1750 light detecting sensors were used and it has been mounted on the surface of solar panel. The sensor will trigger the servo motor to move solar panel towards sunrays. The working system of the sensor is that when the sun directs towards the west then the horizontal servo will move from east to west until all sensors gain equal light intensity and that the sensor is perpendicular to sunrays. Similarly, other three direction uses same principle to previous one [3].

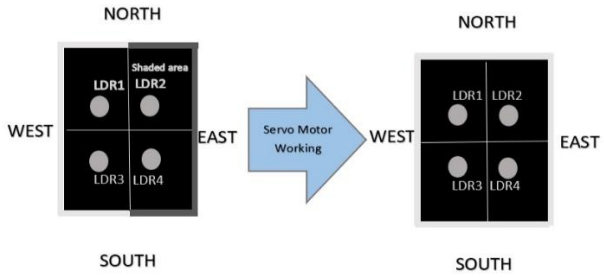

Fig3. LDR sensor for sun tracker

B. Servo Motor

The servo motor is the electric DC motor which is use for the sun tracking and in this project, the design system requires two servo motors one for the horizontal axis which will move from east to west. And one for the vertical axis which is move from north to south. The servo motor drivers are used to move the motor from the direction where the sun is located [5].

The servo motor design has ability of driving SPV panel at 90 degree clockwise and 90 degree anticlockwise to track the sun movement from east to west and north to south.

Fig4. Servo motor

C. Energy Controlling and computation of system

The voltage sensor and the current sensor are used to calculate the current and voltage between the load and find the energy production in between solar panel and solar tracker.

The data logger is used to store the calculated energy in the SD card and then it will show on the computer.

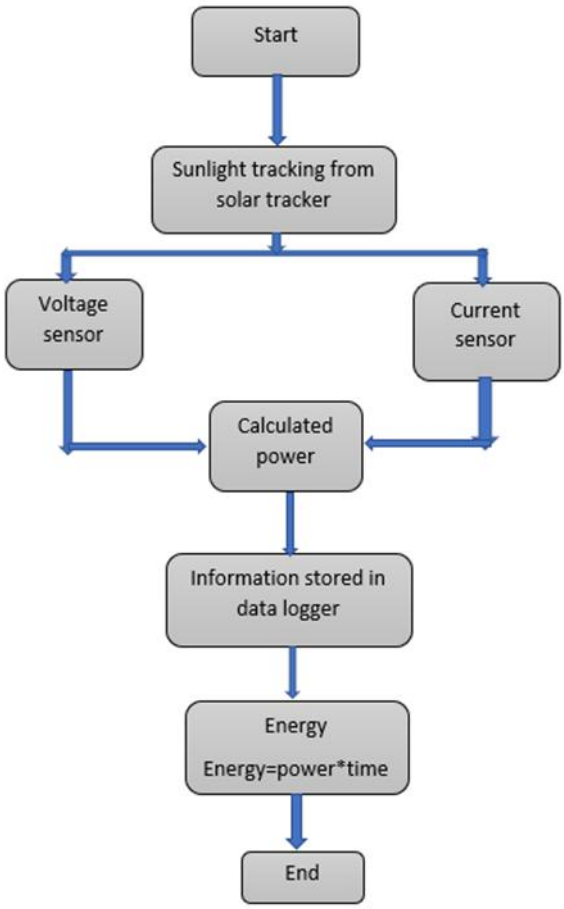

Fig5. Flow chart of energy controlling system

4. CONCLUSION AND FUTUR WORK

In this paper, tracking, harvesting and measuring integrated with solar panel based on LPC2148 microcontroller has been successfully designed and built. The designed dual axis tracker worked properly and it has been shown that sun tracking based on four BH1750 light detecting sensors has capability to control system to move solar panel towards the sunshine. It has been concluded that the solar panel tracking, harvesting and measuring using LPC2148 microcontroller is more efficient in harvesting maximum electrical energy as compared to conventional solar panel system. Also, the components are required for this project is very low cost and reliable as compare to conventional and it access all the sides where the sun will rotate so it will collect more energy,

The energy gain generated by solar panel can be efficiently used for various applications like water heating, etc. For further work and study, it is suggested that to add Global System for Mobile Communication (GSM) to improve sun tracking system and that could be monitored from long range. The tracking system could be used GPS for fixing the time and location.

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