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Development of Automatic PV Power Pack Servo Based Single Axis Solar Tracking System

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Abstract:*Solar Energy consists of abundant amount of energy. To utilize this energy for electrical applications PV panels were introduced. Panels can generate DC electricity directly through sunlight. Spectrum of sun is quite wide which varies according to the geographical location. To harness maximum amount of energy from available sunlight tracking of PV panel was introduced. In this paper A PV power pack based single axis solar tracking system prototype is developed. The overall solar tracking system consists of a mechanism that enables the PV panels to follow or track the sun. The mechanical structure consists of one servo motor that drives the mechanism, LDR sensors for measuring light intensity and a programmable microcontroller responsible for giving electric signals to the motors in accordance to the sun angle in order to achieve solar tracking (keeping the PV panel perpendicular to the sunlight). Based on the system requirement tilt angle is provided of 25 angle southwards. The feedback control system operation is based on servo mechanism principles and the controller is responsible for the solar tracker motion. The controller coding and servo mechanism is simulated in PROTEOUS 7.*
Keywords: *Tracking, Microcontroller, LDR, Servo motor, single axis, simulation.*

I. Introduction

Energy is the prime factor for the development of a nation. An enormous amount of energy is extracted, distributed, converted and consumed in the global society daily. 85% of energy production is dependent on fossil fuels. The resources of the fossil fuels are limited and their use results in global warming due to ^{0}emission of greenhouse gases.(1) To provide a sustainable power production and safe world to the future generation, there is a growing demand for energy from Renewable sources like solar, wind, geothermal and ocean tidal wave.

Renewable energy sources are the best proven sources of energy. Solar energy is one of abundant resource of renewable energy. Energy from sun is obviously environmentally advantageous from all aspects. There are many different ways of generating electricity from the sun's energy. The most popular are Photovoltaic (PV) Panels, where silicon solar cells convert solar radiation to electricity.(2) Keeping the PV-panels perpendicular to the sun’s radiation maximizes the output. The systems that are utilized for this movement are called Solar Trackers. The solar trackers are also a required for concentrating solar power applications to function.

The power incident on a photovoltaic (PV) module depends not only on the power contained in the sunlight, but also on the angle between the module and the Sun. When the absorbing surface and the sunlight are perpendicular to each other, the power density on the surface is equal to that of the sunlight (in other words, the power density will always be at its maximum when the PV module is perpendicular to the Sun). However, as the angle between the sun and a fixed surface is continually changing, the power density on a fixed PV module is less than that of the incident sunlight.(2) The amount of solar radiation incident on a tilted module surface is the component of the incident solar radiation which is perpendicular to the module surface.

This mechanism deals with the open loop tracking system in which sensors detects the higher light intensity. The motor actuates in the direction where the sunlight is more. Such type of tracking mechanism is called servo mechanism and also known as real-time tracking.(3) It was resolved that real-time tracking would be necessary to follow the sun effectively, so that no external data would be required in operation. The open loop type is simpler and cheaper but it could not compensate for disturbances in the system and has low accuracy.(4) On the other hand for the closed-loop tracking, the sun tracker normally sense the direct solar radiation falling on a photo-sensor as a feedback signal to ensure that the solar collector is tracking the sun all the time and keep the solar collector at a right angle to the sun’s rays for getting the maximum solar insolation. (5)The closed loop tracking mechanism and overcome the issues related to (cloudy, rainy) weather conditions using AC antenna motors, and power electronic control circuit to convert DC into AC. However, it causes more losses in the system. (2)

Since PV module has nonlinear characteristics, it is necessary to model it for the design and simulation of PV system applications. Recently, a number of powerful component-based electronics simulation software package have become popular in the design and development of power electronics applications. It is difficult to simulate and analyze in the generic modeling of PV power system. To test the operation logic code there is one more software to simulate the servo mechanism i.e. PROTEUS 7. Generally most of the parameters are given in manufacturer's specification but sometimes some parameters (like ideality factor, series resistance etc.)(6)may not be given and may change due to aging and other environmental factors. Hence, it is necessary to develop relations to find these parameters.

In summary, this paper presents simulation and development of prototype of a single axis automatic solar tracking system using servo mechanism. The Simulation for servo mechanism using PROTEUS 7.0 is described in Section 2. This is followed by the description of development of proposed solar tracking system in Section 3. Lastly, conclusions are drawn in Section 4.

II. Simulation for Servo Mechanism

The working of microcontroller and servo is first simulated in PROTEUS 7.0 software. The servo mechanism of the solar tracker is first simulated in software to determine whether the code generated for servo controlling is correct. This provides the working of servo mechanism before actual implementation.

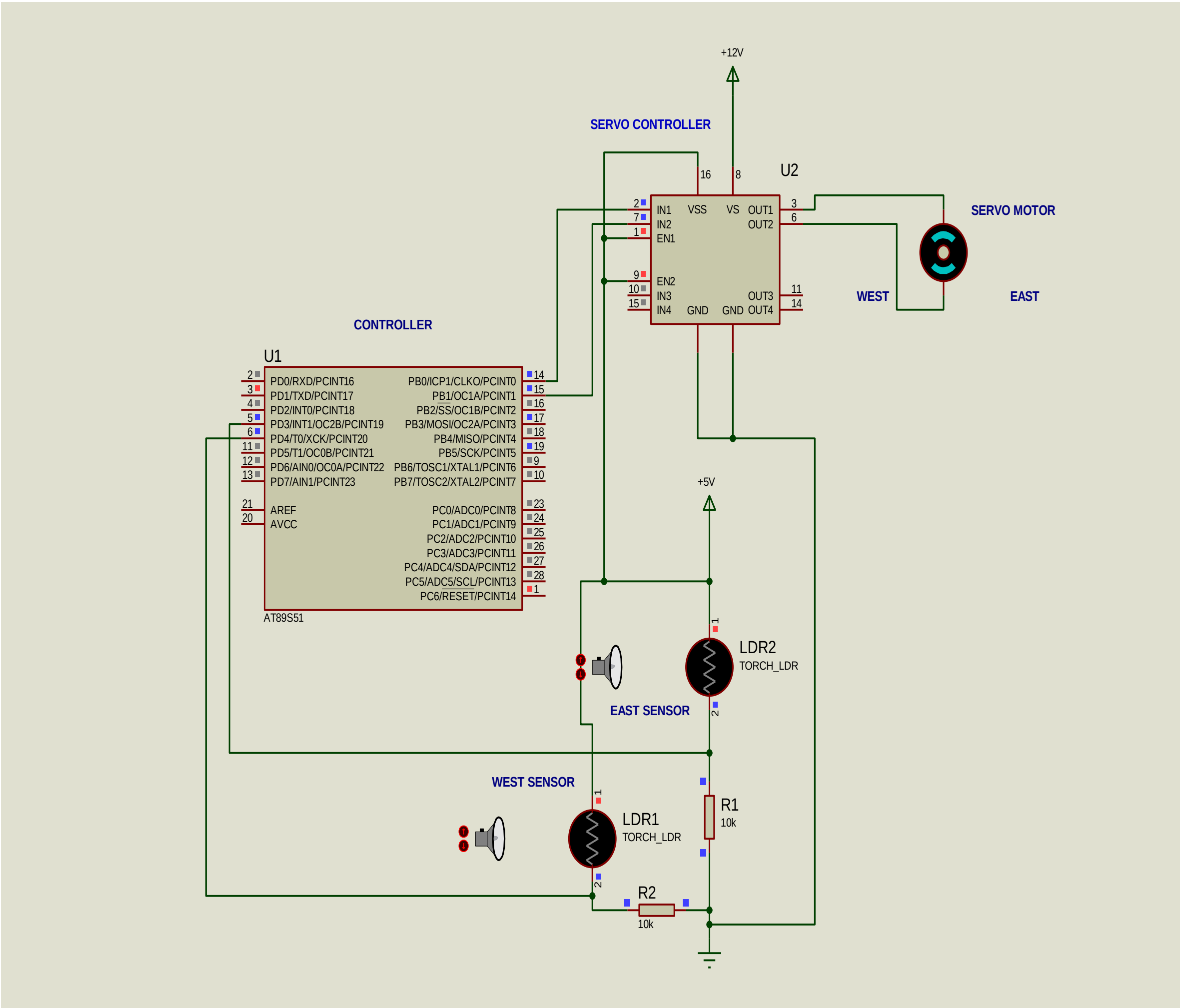

Figure 1: simulation circuit layout in PROTEUS 7.0

III. Solar Tracking System Description

Development of tracking system is carried out through following two major steps which were:

a. Mechanical structure design.
b. Control system design.

2.1 Mechanical structure: The structure of prototype prepared using CAD Solid Works 2013 to check the free movement of panel in east-west direction. Realization is accomplished at workshop of renewable energy engineering department. Fig shows the design prepared for tracking system.

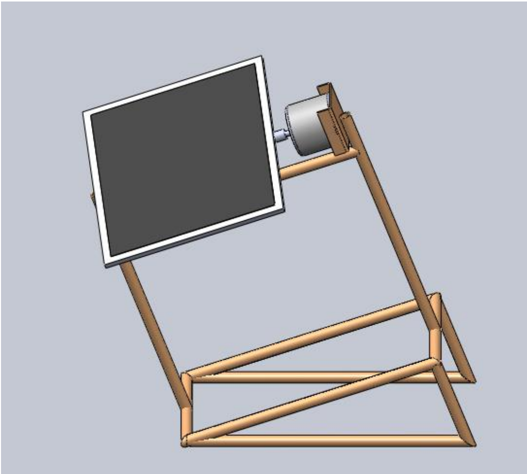

Figure 2: Design prepare in Solid Works 2013.

2.2 Control system: this can be understood in two parts. First one is working with active components, which controls the system automation. Another is to prepare circuit using passive components for charge controller, voltage regulation and connections of all components.

Active components required are described below:

a. **LDR (Light Depending Resistance)**: it is light depending resisters that have particular property that they can detect lightning intensity in which they have been stored. The cell resistance falls with increasing light intensity. The sensitivity of a photo detector is the relationship between the light falling on the device and the resulting output signal. In the case of a photocell, one is dealing with the relationship between the incident light and the corresponding resistance of the cell.

b. **Microcontroller:** The micro-controller is the brain of the tracker, and it controls the tracking system. Basically, it receives input from the sensors, specifying the position of the sun and in response, it sends signal to the motors that are connected to the solar panel to move to the panel to the position of the sun in which optimum solar rays could be received. The micro-controller is made up of software and hardware components. The software component is basically computer programs that decode the input signals and sends out appropriate signal in response to the inputs to control the tracking system. It is connected to the sensors and the motors. The hardware executes the command. It requires 5V DC.

c. **Servo Motor:** Servomotors are handy and practical in today's robotic and mechatronic systems as they provide a high level of accuracy, are simple to wire up and relatively simple to control. They are also more applicable for certain applications then standard D.C. motors as they are position controlled rather than rotation controlled. A good application for servomotors is a sun tracking system for solar panels. The system requires a fairly high positional accuracy so servomotors are ideal for the job. The motor used here requires 4.8V and operating speed 0.18sec/60 degrees at no load.

d. **Battery:** The tracker needs a power source to keep it running due to the irregularity of the power received from the solar panel. A 6V and 4.5 Amp rechargeable battery is used; the battery as it is connected to the tracking system is also connected to the output of the solar panel to keep it charging. Figure shows the working of controlling components.

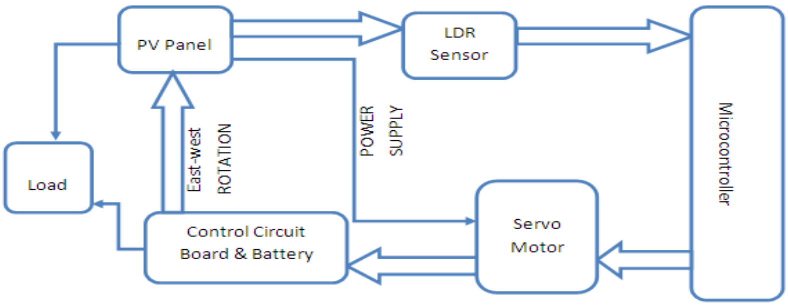

Figure 3: Block diagram for working of tracking mechanism

Figure 4: Developed tracking system

IV. Conclusion

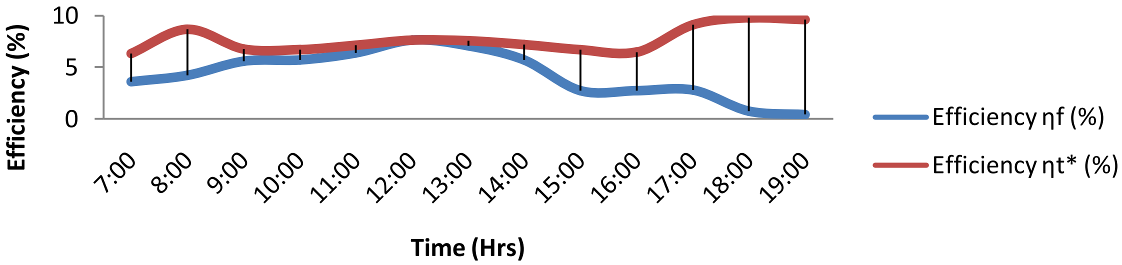

Figure 3: Efficiency comparison between fixed and tracking pane

In the proposed design and operation of the solar tracker system, the sun was not constantly tracked based on the irradiation. This helps to prevent unnecessary energy to be consumed by the devices and the system stops moving when the night falls.Simulation result shows that the codes generated for servo controlling are working accordingly. The developed system was also tested for performance evaluation. The collected data provides the average efficiency gain from fixed panel of about 7.67%, represented in Figure 3. Also when data was taken for cloudy condition it was occurred 7.27%. Hence the proposed control structure provides the flexibility to accommodate different weather conditions.

References

[1]. Adhikari, N., Singh, B., Vyas, A., L.,Chandra, A. and Haddad K., A. 2011.Analysis and Designof Isolated Solar-PV Energy Generating System, IEEE.
[2]. Ajayi, A., B., Majekodunmi O., A. and Shittu A., S. 2013 Comparison of Power Output fromSolar PV Panels with Reflectors and Solar Tracker, Journal of Energy Technologies and policy**.** **3**:70-77.
[3]. Aleksandar, S., Sladjana S., Ferid S. and Zlatko B. 2009. Microcontrollerbased solar trackingsystem. 518-521.
[4]. Alexandru, N., T. and Cătălin. 2011. Designing the tracking system for a string ofphotovoltaicmodules, International Conference on Optimization of the Robots and Manipulators.
[5]. Ansari, F., Chatterji, S. and Iqbal, A. 2010. Automatic maximum power point tracker for solarPV modules using dSPACE software, International Journal of Sustainabl.**29**(3).
[6]. Arsalan, S. 2013. Sun Tracking System with Microcontroller 8051, International JournalofScientific & Engineering Research.**4**:2998-3001.
[7]. Ashraf, B., Ahmad, A., M. and Farhan, A., S. 2013. Design and Performance of Solar Tracking Photo-Voltaic System;research and education. international journal of control, automation and systems**.1**:49-55.
[8]. Balasubramanian, K., Koyuncu, B. 1991. A Microprocessor Controlled Automatic Sun Tracker,
[9]. Panwar, S. and Saini, R., P. 2012. Development and Simulation of Solar Photovoltaic model usingMatlab/simulink and its parameter extraction. Coimbatore Instituteof InformationTechnology.
[10]. Roger, L., G., Dougal, A., Liu, S. and Iotova, A., P. 2009. Parallel-Connected Solar PVSystemto Address Partial and Rapidly Fluctuating Shadow Conditions, IEEE transactions on industrial electronics.**56**(5):1548-1556.
[11]. Tudorache, T. and Kreindler L. 2010. Design of planta Solar Tracker System for PV Power, Acta Polytechnica Hungarica.**7**(1): 23-39.
[12]. Wasfi., M. 2011. Solar Energy and Photovoltaic Systems, Multidisciplinary Journals inScience and Technology.
[13]. Yazidil, A., Betin, F., Notton, G., and Capolinol, G., A. 2006. Low cost two-axis solar trackerwith high precision positioning, 211-216.
[14]. Zubair, S., Suleiman, A., Abdulazzez, H., T., Salihu, B., A. 2011. Design and construction of amicrocontrollerbased singleaxis solar tracker. Innovations in Science andEngineering. **4**(1):41-47.