Design, Implementation & Performance Analysis of Solar Tracking System on Simulink Platform

Udit Mamodiya*, Neeraj Tiwari
Poornima University, Jaipur

* Corresponding author: udit.mamodiya@poornima.org

Abstract. This paper presents the idea of tracking framework which was executed on Simulink stage. The variety in current and voltage for static and tracking SPV power plant are appeared in this paper. The relative study at various situating of panel (static force plant) is additionally appeared in this paper. The entire model like sun tracking model, static SPV model, LDR sensor model, DC motor model additionally appeared in the paper. The primary goal of this paper is to break down the outcomes concerning static force plant. The tiltation edges are 30°, 60° and 90° static force plants. The simulation results and the impact of tiltation point are additionally introduced in this paper. In the closing comment, the improved effectiveness because of tracking method is appeared.

Keywords: Simulink Model, SPV System, Solar tracking system, Photovoltaic, LDR, Solar Board

1. Introduction
In the current situation, each country is focusing on sustainable power sources since it is nonpolluting wellspring of electrical vitality. The sun based photovoltaic cells are assuming fundamental part for changing over light vitality to electrical vitality. At the point when the light beams falls on the silicon sun oriented cells. The peripheral orbital electron will free. The progression of electron in the heap associated circuit will proceeds as the light falls on the board surface. Means age of electron relies upon the measure of light vitality. It has been introduced in different paper about the impact of light power on sun oriented cells. The irradiance esteem is legitimately relative to the current produced by sun based cell. As the irradiance esteem builds the yield current likewise increments however the voltage esteem diminishes as the temperature of sun powered cells increments. In this manner the creation of intensity produced by means of SPV power plant is more prominent in the period of November when contrasted with June. As the output current depends on sun light intensity therefore sun tracker plays vital role for improvement of SPV efficiency. There are many papers presented by the authors some are explained active sun tracking system, while some authors presented the passive tracking system, but most of the authors suggested active tracking system because it is easy to maintain and provide accurate tracking of sun position. Also the construction cost of active tracking system is low. In Active tracking system electromechanical system are used. Electromechanical word implies electrical and mechanical system. Mechanical system means gear system, steel structure and bearing. Under electrical system come motor, control circuit and LDR sensor. Alberto Dolara.et.al, [5] explained the different techniques for the improvement of solar power plant efficiency. In the research paper many authors giving the concluding remark that improved efficiency of the sun tracking system is 37%. This paper presents the results obtained from SIMULINK based model. The comparative results are also shown in the result section.
2. Necessity of Sun Tracker
The direction of sun regarding the earth is depicted in figure 1. The sun rotates from east to west per
day while the variation in the position of the sun towards the elevated direction is 47° during the whole
year [3].

![Figure 1. The SUN Trajectory](image1)

Figure 1. The SUN Trajectory

Figure 2 shows the variation in current due to irradiance value variation. Because the current
delivered by sunlight based cell is directly proportional to the irradiance value [5].

![Figure 2. Variation in current vs Voltage at different irradiance value.](image2)

Figure 2. Variation in current vs Voltage at different irradiance value.

Form the above figures it can be observed that sun tracker plays vital role for the improvement of
output power generated by solar cells.

3. Simulink Model
For the investigation of improved efficiency by implementing the sun tracking concept, the
SIMULINK model is designed for the SPV power plant without tracking system and with tracking
concept.

4. Simulink Model of Ldr
LDR is a variable resistance and its value depends on the intensity of light, known as a light dependent
resistor. As the power of light changes, the resistance and voltage value of sensor change [2]. This
concept is implemented in SIMULINK based LDR model as shown in figure 3.
5. Tracker Control Circuit Model

The change in voltage due to light across the LDR sent to comparator based control circuit which will give the signal to DC motor to rotate the tracker system. DC motor start to rotate the tracker till the output of comparator does not reach to zero. The control circuit was designed with the use of different logic gates (NAND, OR, and XOR).

Figure 4 shows the designed control circuit, was implemented in SIMULINK platform. AND and XOR logics are used so that both control circuit did not receive the signal at the same time. In this circuit four NAND and two XOR logic gates are used.

6. Overall System Model in Simulink

So as to support the proposed genuine framework manufacture, it is important to look at the Simulation results for the Static board PV framework with the sun oriented tracker PV framework [2]. Figure 5 shows the square graph of the proposed Overall framework model actualized in SIMULINK stage. Also, a simulation was performed by considering the static SPV system at different elevated angle.
Figure 5. Simulate Model of Overall SPV System

Figure 6 shows the effect on the static SPV system current due to changes in angular position of the fixed panel. From this simulation results it can be concluded that the static PV system angle, making from a horizontal direction plays a significant job for maximizing the energy efficiency of the static PV system [1]. When the panel was fixed at 90° degrees it will give maximum current and efficiency. Simulation result shows the variation of current at different angles (45, 60 and 90 degree).

Figure 6. Static Panel Position Mounted At Different Angles (450, 600 And 900)

7. Simulation Results

Figure 7 shows, the variation of LDR resistance as the intensity of the sunlight varies. In the brightest hours of the day when the value of solar radiation is high, LDR shows low resistance. It can be seen in the figure 10 at point 2800 second.
Figure 7. Simulation Result of LDR Resistance (Left and Right) Vs Time

The Simulation was also performed for the analysis of the tilted effect on SPV system. The thick green line shows the variety in current originates from sun tracker SPV power plants and slim green speak to the current qualities when static SPV framework mounted at 90°. Blue line shows the variety in current when Static SPV board is mounted at 60°. While the red line shows to the variety in current when board is mounted at 30°. Here in the simulation results it can be seen that the efficiency of solar photovoltaic power plant with tracking system is greater than the static power plant.

Figure 8. Variety in Static Current Due To Changes in the Angular Position of Fixed Panel

7.1. Elevated Tracking Results

Figure 9, 10 and 11 shows the reenactment results got because of variety in the sun way the raised way (North-South). The static board was fixed at 29° towards south for getting the greatest irradiance from the sun. Here we dismissed the impact of azimuthal tracking. Figure 9 shows recreation results between tracker and static board current accept that a static board was inclined at 29 degree south-bound. [1]
Figure 9. Comparative Studies between Tracker and Static Panel Current

Figure 10. Variation in Static Current Due To Change in the Angular Position of Fixed Panel

Figure 11. Variation in Instantaneous Tracker Panel Efficiency Compared To Fixed Panel

Figure 11 shows the efficiency of tracker current is maximum at 12:00 PM after that it starts to decrease due to change the position of the SUN results decrease in Irradiance value. The increase in efficiency due to solar tracker PV System is 12 % to elevated tracking.

8. Conclusion
The results shown above represent the importance of sun tracking system. When panels are mounted at 30° tiltation angle, the energy getting from SPV system with tracking system is maximum while the power getting from static SPV system is lesser.

9. References
[1] Udit Mamodiya, Dr. Neeraj Tiwari, “The Performance Enhancing Technique Analysis for Automatic Tracking Tilt Angle Optimization of the Solar Panel with Soft-Computing Process”, International Journal of Advance Science and Technology, Vol. 29, Issue. 10S, pp.3587-3601, 2020

[2] Udit Mamodiya, Neeraj Tiwari, “Investigation of SPV Power Plant with Dual Axis Sun Tracker”, Test Engineering & Management, Volume 81, pp 2621-2626, November-December 2019

[3] Deepak Purohit, Goverdhan Singh, Udit Mamodiya, “A Review Paper on Solar Energy System”, International Journal of Engineering Research and General Science, Volume 5, Issue 5, SeptemberOctober 2017

[4] Atul Patni, Dinesh Singh Rajpurohit, Udit Mamodiya,”Method to Improve the Efficiency of Solar Power Generation”, INROADS-An International Journal of Jaipur National University”, Volume5, Issue 1s, pp 125-130, 2016

[5] Alberto Dolara, Marco Mussetta, “Performance Analysis Of A Single-Axis Tracking PV System”, IEEE JOURNAL OF PHOTOVOLTAICS, VOL. 2, NO. 4, OCTOBER 2012

[6] S. Abdallah, S. Nijmeh, Two axes sun tracking system with PLC control, Energy Conversion and Management 45 (2004) 1931-1939.

[7] V. Poulek, M. Libra, New solar tracker, Solar Energy Materials and Solar Cells 51 (1998) 113-120.

[8] T. Tomson, Discrete two-positional tracking of solar collectors, Renewable Energy 33 (2008) 400-405.

[9] M.J. Clifford, D. Eastwood, Design of a novel passive solar tracker, Solar Energy 77 (2004) 269-280.

[10] G.C. Bakos, Design and construction of a two-axis Sun tracking system for parabolic trough collector (PTC) efficiency improvement, Renewable Energy 31 (2006) 2411-2421.

[11] P. Roth, A. Georgiev, H. Boudinov, Cheap two axis sun following device, Energy Conversion and Management 46 (2005) 1179-1192.

[12] A. Mellit, S.A. Kalogirou, Artificial intelligence techniques for photovoltaic applications: A review, Progress in Energy and Combustion Science 34 (2008) 574-632.

[13] F.R. Rubio, M.G. Ortega, F. Gordillo, M. Lo´pez-Martínez, Application of new control strategy for sun tracking, Energy Conversion and Management 48 (2007) 2174-2184.

[14] Tiwari N., Soni R., Saraswat A., Kumar B. (2020) Comparative Simulation Study of Dual-Axis Solar Tracking System on Simulink Platform. In: Kalam A., Niazi K., Soni A., Siddiqui S., Mundra A. (eds) Intelligent Computing Techniques for Smart Energy Systems. Lecture Notes in Electrical Engineering, vol 607. Springer, Singapore