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PLC based Solar Panel Tracking System with Automatic Tilting Arrangement and Tilt Angle Optimization

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Abstract: Improving the conversion efficiency of solar panel has become a challenging area of study for researchers. Solar trackers are an alternative to reach this goal, by tracking the position of the sun changes, the productivity of the panel increases. The variation of the tilt angle changes solar radiation that reaches to the surface of the collector. Hence tilt angle is the important factor that affects the performance of a solar collector. This paper presents a new design of a Three-axis solar tracking system which will be based on Programmable Logic Controller (PLC). The automatic tracking system of solar radiation will be done on the basis of tilt angle. In the optimization procedure the objective procedure function is evaluated by using the model of available solar radiation, tracking system consumption and efficiency of solar cell. So with the implementation of the optimization of the tilt angle of solar panel will maximize the power generation.

Keywords: Solar panel, Three-axis tracker, optimization method, PLC.

I. INTRODUCTION

The increasing energy dependence limited source of the fossil fuels, their increasing price and negative environmental impacts force mankind to improve the utilization of the available renewable energy sources. Renewable sources represent an inexhaustible potential of energy for the future. Among renewable sources solar energy is one of the most promising now days. The sun's position tracker mechanism is to be composed of the PLC, DC Motor, worm gear, photo sensor, encoder, power relay and inclinometer. The program to tilt the panel according to sun's position is to be feed on PLC. An inclinometer fixed behind the panel measure the angle of panel and it gives feedback to PLC [1-2].An overview of the solar cell technologies and their efficiency of this conversion depends on solar radiation that reaches the surface of the solar cell. Another option is to track the sun's path in daylight hours. Some researchers have conducted various studies to establish the optimal degree of tilt solar panel to increase the output power. Because the position of the sun changes during the courses of the day the implementation of the solar tracker is the best solution to increase the energy production [3].the performance of a solar collector is highly influenced by its orientation (regarding the Equator) and its tilt angle (regarding the ground).this can be achieved by proper design, construction, installation and orientation [4]. In PV cell shadows are known to damage the solar cell due to the creation of the hot spot to the panel. From the reference study it can be seen that optimization of tilt angle of the solar panel can be done by using Soft-Computing technique [5]. Depending on number of axis the panel can be move and tracking can be differentiated. Knowledge of these angles would further allow us to track the sun on a monthly basis rather than daily hour based tracking.

II. LITERATURE SURVEY

The literature survey describes the various method of solar tracking system with PLC considering tilt angle optimization parameter. A brief description of various methods given by different authors is given below.

A.Nataranjan et al. (2016) proposed a design of Programmable Logic Controller (PLC) solar panel tilting system. From this concept a uniform and higher power generation can be obtained when compared to solar panel placed in fixed position. The solar panel frame is majorly affected by the various factors such as wind force, rain, fog etc. Among them the major factor affecting the solar panel frame is high wind force. Various frame structures were designed analyzed by subjecting it again various wind force to select the suitable frame structure which with stand for maximum wind force with less deflection.

Betha Karthik et al. (2016) proposed automatic solar tracking system was implemented using Delta PLC which tracks the sun more effectively which tracks the sun more effectively with its simple and precise control structure in all

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environmental condition. The automatic solar tracker maneuvers solar panel towards the sun to extract maximum energy during day time. The tacking was done by programmed light intensity of the panel with help of LDR sensors and magnetic reed switch which controls the speed and direction of DC motor attached and gear arrangement by programming in PLC. The power generation obtained from the proposed PV system increased about 25%as compared to conventional solar PV system.

Carlos Robles Algarin et al. (2017) presented a new design of a dual axis solar tracking system based on a real-time measurement of solar radiation in order to improve the conversion efficiency. The dynamic models for solar radiation, solar panel and electromechanical system were obtained using Mat lab Simulink. A High Performance 16 bit Digital signal controller DSPIC33FJ202MC was used for capturing the signals from radiation sensors and an inertial measurement unit. The acquired data were compared with a mathematical algorithm to calculate sun's position and set the control action to orient the panel.an embedded system either real-time sampling was developed. The tests were performed using two solar 200w panels operating simultaneously under the same climatic condition.

Farnaz Safdarian et al. (2015) proposed a mathematical model for estimating the solar radiation on a tilted surface, which determines the optimum tilt angle of solar collector and its orientation (surface azimuth angle) in a specific period of time during a clear day. The optimum tilt angle was calculated using GSA (Gravitational Search Algorithm) for the value of which the radiation on the collector surface is at the maximum level for different circumstances of the environment. The result revel that setting the tilt angle and surface azimuth angle was necessary in order to reach maximum radiation.

Swarnavo Datta et al. (2016) proposed a study on Optimization of Tilt angle of the solar panel using Soft Computing Technique and Solar Tracking method was presented.in these two phases were studied, in first phase the tilt angle was optimized on a monthly basis using genetic algorithm and it was found that a significant power gain can be obtained. In the second phase of this study, a dual axis solar tracker was developed following soft computing based result. Using the application of this tracker a noteworthy power gain was obtained as compared to the panel which was kept at no tilt angle with respect to ground.

Sebastijan Seme et al. (2011) proposed the two axis sun tracking system for a photovoltaic system. Determination of the tilt angle and azimuth angle trajectories was described as a nonlinear and bounded optimization problem where the objective function is now available in the objective function is not available in the explicit form. A stochastic search algorithm called differential equation was used as an optimization tool.
In that procedure, the objective function was evaluated by using the model of available solar radiation tracking system consumption and efficiency of solar cell with appropriate DC-DC converters. The problem bounds were given in the form of lower and upper bounds for both angles. The result was presented in paper show that the optimal trajectories foe the tilt and azimuth angle depends on the availability of solar radiation, solar cell efficiency, tracking system consumption.

S.Naveen et al. (2016) proposed review on the major work carried out in solar tracking system and a novel method for tracking using GPS based infrastructure. With the rotation of earth, the direction of sun light changes throughout the day. Attempt was being made to rotate the solar panel by various mean to capture maximum sunlight. In these the concept of sunflower is used which rotate over the course of a sunny day, each leaf seeking out as much sunlight as possible as the sun moves across the sky through adaption called heliotropism. This method of power generation is simple and is taken from natural resources for maximum sunlight to generate power.

Zhang Zhen et al. (2017) proposed relationship between solar inter array spacing and the plus irradiance at different times obtained by sun tracking. They had computed and analyzed the different diffuse radiation ratios, the tracking efficiency of the East–West sun-tracking PV system with different interspacing in three different locations. Considering the inclined angle modification of the PV module surface, the power gains Of the PV module with four different glasses were analyzed for their tracking systems in different interarray spacing.

III. CONCLUSION

The major issue which we are facing today in using Solar energy is the placement of Solar Panels. So with the concept of these Three-axis tracking system the power generation will be maximum with greater efficiency as compared to Single and Dual-axis tracking system. With the help of tilt angle optimization maximum solar radiation will be collected on the solar panel which will be favorable according to the different weather condition.

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