Chapter 19
Solar Photovoltaic Servo Tracking Controlled System

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ABSTRACT

Renewable energy has known a great interest during the last two decades. Solar energy is viewed as the cleanest renewable source of energy for the future since it is the least polluting and the most inexhaustible of all known energy sources. Subsequently, technologies that enable the use of solar energy focus on solar thermal collectors and on the photovoltaic effect of semiconductors to generate electricity directly from sunlight. In the case of solar energy, it is shown that optimal energy is obtained when the rays of the sun are incident normally on the collecting surface. Therefore, several techniques and experiments have been conducted recently to develop efficient solar tracking systems. Solar panel tracking systems optimize energy output of photovoltaic panels by positioning them to follow the sun's path throughout the day. The sun's position in the sky varies both with installation location, the seasons, and the time of day.

OBJECTIVES

Currently, most solar panels have fixed orientation to the sky and do not turn to follow the sun. To increase the unit area illumination of sunlight on solar panels, a solar tracking electricity generation system is designed. The design mechanism holds the solar panel and allows the panel to track the sun's movement during the day and improve the overall electricity generation. This system can achieve the maximum illumination and energy concentration and cut the cost of electricity by requiring fewer solar panels, therefore, it has great significance for research and development. Moreover, Electro-optical control unit tracks the sun by a solar detecting device that is sensitive to solar radiance. Simple equipment such as phototransistors and DC motor are employed in the device of our working station. Furthermore, an analog operational-amplifier PD based controller is implemented to improve the time response of

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the tracking system. Finally, simulation and experimental results are demonstrated to verify the effectiveness of the light tracking servo system.

The major objective is to design an electro-optical solar servo tracking system of photovoltaic panel in order to increase its overall efficiency using phototransistors, DC motor and PD controller such that

1. Derive the overall closed-loop controlled dynamical model.
2. Obtain all parameters related to electro-optical system.
3. Design a PD controller such that the settling time of the overall system does not exceed three seconds with a maximum overshot of 50%.
4. Design a Lag Compensator.
5. Demonstrate the design using both simulation and experimental implementation.

INTRODUCTION

An optimal control on two axes and design for solar tracker which called altitude and azimuth is challenge. The phototransistor with the shade that blocks the screen was employed by Singthong as a detector of solar beam radiation (2010). The height of the screen determined the sensitivity operation or period of tracking in this solar tracker. The phototransistor is particularly designed to detect solar bean radiation thoroughly through the two axes with the operating time. The mechanism of this solar tracker is that it has a capacity of solar tracking in every 10 min, approximately, which respond in terms of time at about 37°/sec with and operating point at 0.3 sec. The solar tracker obtained an average deviation at about 2.5°/hour. In weak sunlight however, the value varies and fluctuates rapidly depending on sky condition. There is only average of 2.5° error shown. The experiment also shows that the error rate diminishes as the solar radiance expand.

A low cost and an easy to implement solar tracker system is presented by Louchene, Benmakhlouf and Chaghi (2007). The design of the system is based on the fuzzy reasoning applied to crisp sets. In this case, it can be easily implemented on general purpose microprocessor systems. Four light sensitive devices, such as LDR, photodiodes or phototransistors are mounted on the solar panel and placed in an enclosure. The four light detectors are screened from each other by opaque surfaces. Each pair of the light sensors is used to inform the controller on the orientation of the solar panel vertically and horizontally respectively.

A two-axes equator based tracking mechanism with computer control for solar photovoltaic modules has been designed, fabricated and tested by Patil, Nayak and Sundersingh (1997). The performance of the system is quite satisfactory; the tracking error is quite small. Tracking leads to an increase in the output of the PV modules typically by about 30%. The operation of the tracker is found to consume a very small fraction of the output power.

A solar tracking generating power system is designed and implemented in the work of Huang, Kuo, Chen, Chang, Wu, and Wu (2009). A tracking mechanism is integrated with an expert controller, sensors and input/output interface, that it can increase the energy generation efficiency of solar cells. In order to track the sun, cadmium sulfide light sensitive resistors are used. To achieve optimal solar tracking, a fuzzy algorithm is developed and implemented. A field programmable gate array is applied to design the controller so that the solar cells always face the sun in most of the day time.

The design and construction of a prototype for solar tracking system with two degrees of freedom, which detects the sunlight using photocells is described in research of Barsoum and Vasant (2010). The control circuit for the solar tracker is based on a PIC16F84A microcontroller (MCU). This is programmed to detect the sunlight through the photocells and then actuate the motor

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