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A Study on Solar Tracking Accuracy Improvement Using Image Recognition in Solar Tracking System

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Abstract. More attention is paid to renewable energy worldwide, due to recent Japanese nuclear power plant accident, fossil energy depletion and global warming. Studies to enhance power generation system efficiency are carried out in terms of the study on solar power generation, which is a renewable energy. In this regard, this paper has researched and developed a solar tracking system combining an image recognition type using the difference of brightness to elevate the efficiency of low solar concentrator power generation system and to lower prices and a program type. To this end, this paper has researched a method to enhance low solar concentrator power generation system efficiency using a low priced general photovoltaic module.

Keywords: photovoltaic power generation, difference of brightness, image recognition

1 Introduction

The core technology of solar power generation is the accuracy of a solar tracking system. Among others, the solar tracking system of low solar concentrator type requires very minute and precise accuracy. Existing solar tracking systems can be divided into a program type, a solar sensor using type and an image recognition tracking system using the difference of brightness [1~3]. The method to track the location of the sun includes a sensor using mode and a program using mode. The sensor mode has some demerits such as being weak to weather changes and frequent malfunction by foreign substances. The program mode has such demerits as power supply being essential to PC for management (calculation) for 24 hours a day, and variable setup being required, according to place to be installed and operated. Consequently, this study has developed an image recognition type of tracking device using the difference of brightness that can solve all those demerits [4~6].

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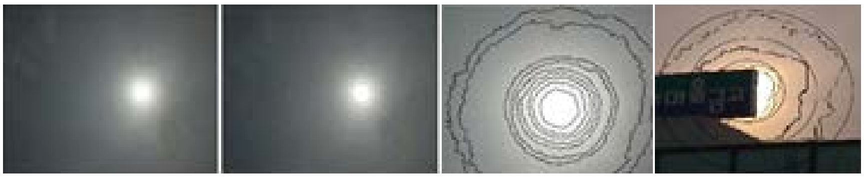
Fig. 1. System architecture

Figure 1 shows a solar tracking system, a representative 2-axis tracking system that can move up and down and left and right. This paper has developed an image recognition tracking system using the difference of brightness that can apply to low solar concentrator type power generation system. Main technology has improved the solar tracking system simultaneously using image recognition device and program calculation type. The system is a solar tracking system making solar tracking accuracy within ±0.1° [7]. This paper consists of Introduction (Chapter 1), Development of Low Solar Concentrator Type Tracking Device and Correction and Monitoring of Tracking System (Chapter 2) and Conclusion (Chapter 3).

2 Development of Low Solar Concentrator Type Tracking Device

Figure 2 shows solar tracking results by the difference of brightness. Each pixel plays a sensor role indicating brightness with 256 levels, and therefore, more accurate data extraction was possible, compared to the sensors used in existing products. The developed image recognition type using the difference of brightness uses a principle that brightness of light emitted from a light source becomes different, according to distance. Figure 2(a) reveals image data obtained from CCD camera module. When the brightness of light emitted from a light source is separated, according to specific scope, distribution as shown in Figure 2(b) is revealed. As revealed in Figure 2(c), the location of the sun can be tracked using a principle that the circle’s center matches the center of light source, when brightness is connected, and a circle is formed internally or externally. When light is covered by an intervention object or cloud from solar light source, the solar light is scattered, and the formation of the circle becomes difficult by contorted distortion, based on the calculated area. In this case, an error finding several inappropriate circles occurs. Therefore, the center of the sun is found through another process in such a case. Light has a feature of going straight, and thus, it is found that light source is located on the intersection, if all rays of light gather, through inverse tracking of the captured rays of light. As such, the location of the sun is tracked using the light's feature of going straight. In this manner, the location of the sun can be tracked, while error scope is minimized, despite clouds, abnormal meteorological phenomenon or physical intervention. Figure 2(d) shows the solar tracking results in improper environment.



(a) (b) (c) (d)

Fig. 2. The image data obtained from the module of CCD camera

The solar tracking device monitoring system is based on network-based light source tracking multi control embedded system. It is a system verifying order implementation results by using the control method driving the multi solar power generation device and collecting power generation device operation result data using the data obtained through a tracking type that tracks light source's center amid the distribution of brightness, while tracking the brightness of light emitted from light source. The solar tracking system consists of a solar tracker, TCU (Tracker Control Unit) and GCU (Group Control Unit). The solar tracker is operated through remote control with a device tracking the sun by collecting the location of the sun with camera images. When the sun is not captured with a camera on a cloudy day, it is designed to operate on the basis of programed expressions, according to latitude and longitude. The TCU (Tracker Control Unit) is installed at the tracking site together with the tracker, and is a device controlling the motor and actuator to track solar light with one axis to two axes. TCU uses a microprocessor, and TCU calculates pan and tilt at the present hour obtained through RTC chip within the unit, and also calculates the angle for the tracker to head using the values. In addition, TCU controls the motor in line with calculated angle, and tracks the sun, according to image tracking value through communications with GCU.

The GCU is a device collecting, managing, storing and controlling the various information and data in the TCU using the RS-485 serial port. GCU plays a role of analyzing the location of the sun and enhancing tracker's tracking accuracy through two imaging devices. The solar tracking error was within ±0.1° as a result of the solar tracking system operation combining the program type and image recognition type. To reduce error scope, this study supplemented the problem of an actuator driving the solar panel location in the solar tracker system. Figure 3 is the graph measuring angle, according to the length of an actuator.

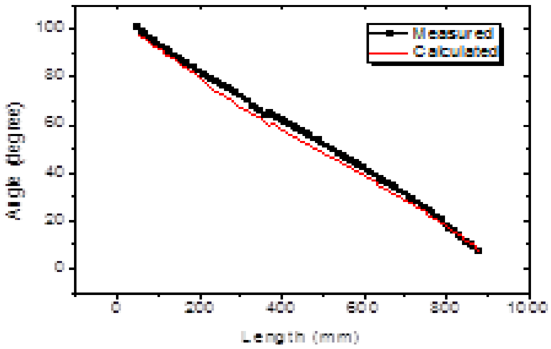


Fig. 3. Angle of the Actuator Length

3 Conclusions

This study has solved the tracking error problems of a sensor type by developing an image recognition type solar tracking system using the difference of brightness. By correcting the operation error of the actuator used in this study in a program type, this study has improved tracking accuracy through minimization of the error within ±0.1°. The mass production of a low solar concentrator type solar power generation system with high efficiency vs cost can be carried out, when using the findings of this study. If efficiency improving technology on low solar concentration technology is developed additionally, a solar power generation system with higher efficiency is considered to be developed.

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