論　文　要　旨
Thesis Abstract

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主論文題名　（Title）

Global Maximum Power Point Tracking under Shading Condition and Hotspot Detection Algorithm for Photovoltaic System

内容の要旨　（Abstract）

Renewable energy becomes an emerging trend in many countries. Photovoltaic (PV) technology has been gaining an increasing amount of attention due to unlimited power resources, unpolluted operation, and installation flexibility. Irradiation and temperature are the two main factors which impact on PV system performance. Diminishing of irradiation from weather conditions reduces the generated power. Shading also reduces the efficiency of the maximum power point tracking system by distributing non-uniform irradiation, leading to more than one power peak on the PV characteristic curve.

Designing the effective maximum power point tracking algorithm is a promising solution for enhancing the efficiency of the PV system. To overcome the problem of the multiple power peaks existence, the solution is to locate the local and global maximum power points in the characteristic curve. Therefore, the proposed algorithm is de- signed to track accurate global MPPT under shading conditions. The algorithm is distributed into three parts, (1) the Main Program (2) Shading Detection and Irradiance Estimation, and (3) Global MPPT using Slope Calculation. Details of the algorithm are shown by the full mathematical equations. The performance is verified by the sim- ulation tests with the real weather data. Graphical and numerical results from the dynamic case study prove the effectiveness of track- ing time within 3.40 seconds and the accuracy of 98.62%. Also, the long-term test results show an accurate tracking result, and the system can enhance the total energy generated by 8.55% compared to the conventional scanning method. The experimental test using the DC-DC boost converter proves the success of the proposed algorithm.

In consequence of partial shading, a problem of the hotspot is investigated. Hotspot takes place with the mismatch in the irradiation of the cells in the PV module. Under this condition, the unshaded part of the module operates at a current level higher than the shaded cells. As a result, the affected cells start to dissipate power leading to an increase in the temperature. Hotspot reduces performance and brings damage to the PV module. Conventionally, the detection uses the infrared camera to detect the hotspot; however, the high cost and workforce are necessary.

The algorithm is designed based on the simplified PV module structure, before improving by the practical PV cluster model. The method uses the concept of characteristic curves analysis and the rate of current changes under reversed bias condition to detect the hotspot. Apart from detection, the algorithm presents the status

indicator to show the PV system's status after detection completes. Not only detecting the hotspot but the proposed algorithm can also differentiate the hotspot from the shading conditions. The proposed method provides collaboration between the detection and proposed global MPPT into one system. The implementations in different cases, including sizing, irradiation levels, and defection rates, prove the efficiency of the hotspot detection algorithm. Results confirm the performance of the proposed algorithm, showing the accuracy with fast detection. Furthermore, the discussion of temperature estimation is shown for representing the potential step after detecting the hotspot, also providing further understanding of the thermal model from material science's perspective.

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