Automated Defect Detection Framework for Efficient Photovoltaic Panel Manufacturing

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In the 21st century, the depletion of fossil fuels is one of the most critical issues for industrial development, and solar power is gaining traction as a possible solution. As solar power generation becomes more widespread, reliable, and efficient, operation is becoming more important. However, defects in solar panels can cause catastrophic damage to the operation of the power generation system, so pre-detection during the process is vital. Electroluminescence images are therefore used. They are clear and have high resolution, allowing for the detection of micro-cracks. However, inspecting these images visually is time-consuming and costly, and difficult to apply in mass production. Therefore, in this study, we proposed an efficient automated method for defect detection in electroluminescence images of photovoltaic panels. To construct the dataset, image blending, histogram equalization, Gaussian filtering, and edge enhancement were applied, while defect detection was performed using a convolutional neural network. The convolutional neural network was based on the structure of ResNET and the proposed method was then applied to 2223 images. Our results confirmed that the method had a high accuracy of 91.4%, and this was much higher when compared to previous studies. In conclusion, if this research is applied to the production process, it is expected to be more efficient in terms of time and cost, than the existing visual inspection. Additionally, it will prevent damage to the solar power system in the long run.

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