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Defect detection and quantification in electroluminescence images of solar PV modules using U-net semantic segmentation

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Abstract

Electroluminescence (EL) images enable defect detection in solar photovoltaic (PV) modules that are otherwise invisible to the naked eye, much the same way an x-ray enables a doctor to detect cracks and fractures in bones. The prevalence of multiple defects, e.g. micro cracks, inactive regions, gridline defects, and material defects, in PV module can be quantified with an EL image. Modern, deep learning techniques for computer vision can be applied to extract the useful information contained in the images on entire batches of PV modules. Defect detection and quantification in EL images can improve the efficiency and the reliability of PV modules both at the factory by identifying potential process issues and at the PV plant by identifying and reducing the number of faulty modules installed. In this work, we train and test a semantic segmentation model based on the u-net architecture for EL image analysis of PV modules made from mono-crystalline and multi-crystalline silicon wafer-based solar cells. This work is focused on developing and testing a deep learning method for computer vision that is independent of the equipment used to generate the EL images, independent of the wafer-based module design, and independent of the image quality.