**Automated Detection of Solar Panel Defects Using Deep Learning**

**Bahaa ALBUARAB**

**Computer Engineering, Karabuk University, Karabuk, Turkey**

**0009-0002-1399-6858**

**Hakan KUTUCH**

**Software Engineering, Karabuk University, Karabuk, Turkey**

**0000-0001-7144-7246**

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| **ABSTRACT**  In the solar energy sector, the production process of photovoltaic (PV) cells frequently grapples with the issue of micro-crack formation. These defects, predominantly resulting from high temperature differentials and external pressures during the manufacturing process [1], have traditionally been identified through manual inspection. However, this manual approach is fraught with challenges such as susceptibility to human error, fatigue, and consequent elevated costs [4]. In response to these issues, our study delves into the application of deep learning techniques for the automated detection of defects in PV modules. We have developed and rigorously evaluated two distinct models: a custom-designed Convolutional Neural Network (CNN) and an adapted, pre-trained InceptionV3 model. Our experimental analysis utilized a dataset consisting of 2,624 electroluminescence (EL) images [2, 3], focusing on a binary classification task to differentiate between functional and defective PV cells. The outcomes reveal that the custom-built CNN, noted for its simpler architecture, achieved an accuracy of 88.5%. In contrast, the InceptionV3 model, recognized for its complexity, attained a marginally higher accuracy of 90.88%. These results underscore the efficacy of both bespoke and pre-trained deep learning models in detecting defects in PV modules, illustrating their potential viability considering the available resources, computational capacity, and specific application requisites. This research highlights the escalating significance of machine learning applications in the progression of renewable energy technologies, particularly in enhancing the quality and reliability of PV cells.    **References:**  [1]. Dhimish, M.; Mather, P. Development of Novel Solar Cell Micro Crack Detection Technique. IEEE Trans. Semicond. Manuf. 2019, 32, 277–285.  [2] Buerhop-Lutz, C., Deitsch, S., Maier, A., Gallwitz, F., & Brabec, C. J. (2018). A Benchmark for Visual Identification of Defective Solar Cells in Electroluminescence Imagery. 35th European PV Solar Energy Conference and Exhibition, 1287–1289.  [3] Deitsch, S., Christlein, V., Berger, S., Buerhop-Lutz, C., Maier, A., Gallwitz, F., & Riess, C. (2019). Automatic classification of defective photovoltaic module cells in electroluminescence images. Solar Energy, 185(February), 455–468. https://doi.org/ 10.1016/j.solener.2019.02.067  [4] Akram, M. W., Li, G., Jin, Y., Chen, X., Zhu, C., Zhao, X., & Ahmad, A. (2019). CNN based automatic detection of photovoltaic cell defects in electroluminescence images. Energy, 189. https://doi.org/10.1016/j.energy.2019.116319 |

# Keywords: CNN, Photovoltaic (PV), InceptionV3, Electroluminescence (EL), Defect detection