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A Deep Learning-based Approach for Detecting Dust on Solar Panels

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Abstract

Solar energy has emerged as a crucial alternative to conventional power sources, but the accumulation of dust particles on solar panels poses a significant challenge to their efficiency. Frequent cleaning of the panels is also essential to optimize photovoltaic generation, but manual cleaning in these areas is challenging. Research indicates that if solar panels are left uncleaned for six months, they can have adverse effects. The dirt can lead to a 35-40% drop in power generation. The ability to detect dust is critical to ensuring that panels are clean. We propose a novel approach for dust detection on solar panels to address this issue, utilizing deep learning techniques. This research paper presents a comprehensive investigation into developing and implementing a deep learning-based model to identify and classify dust particles on solar panels automatically. The proposed methodology uses a Convolutional Neural Network (CNN) architecture, showing remarkable success in various computer vision tasks. The critical stages of this approach include data acquisition, pre-processing, and model training-collected dataset. This model has three main classes: dust >50%, dust, and clean. Improved accuracy of CNN model using data augmentation, preprocessing, deep learning, cross-validation, hyperparameter optimization, and performance metrics like precision, recall, and F1 score. The project aim is to develop an automated dust detection system for solar panels to improve accuracy, enable real-time monitoring, reduce maintenance costs, evaluate environmental impact, analyze long-term performance, ensure adaptability, provide a user-friendly interface, and assess cost-effectiveness.

Keywords: *Dust detection, Solar panels, Deep learning, Convolutional Neural Network*