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A Constrained Low-Rank Sparse Decomposition for Anomaly Detection in Photovoltaic Systems

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Recently, low-rank sparse decomposition methods such as Smooth-Sparse Decomposition and Robust PCA have been widely applied in various applications for their ability to detect anomalies. The essence of these methods is to break down the signal into a low-rank mean and a set of sparse components that are mainly attributed to anomalies. In many applications, a simple decomposition of the signal without accounting for the signs of low-rank and sparse components would violate the physics constraints of the signal or system. In addition, often times, the time-series signals collected for a long duration exhibit smooth temporal behavior within and between days. As an example, the power signals collected in a photovoltaic (PV) system are cyclo-stationary, exhibiting these characteristics. Neglecting the smoothness of signals would result in miss detection of anomalous signals which are smooth within a day but non-smooth between days and vice versa. In this talk, a new signal decomposition approach for the purpose of anomaly detection in PV systems is proposed to address these drawbacks. This unsupervised approach for fault detection eliminates the need for faulty samples required by other machine learning methods, and it does not require the current vs. voltage (I-V) characteristic curve. Furthermore, there is no need for complex modeling of PV systems as in the case of power loss analysis. Using Monte Carlo simulations and real power signals obtained from a PV plant, we demonstrate the ability of our proposed approach for detecting anomalies of different duration and severity in PV systems.

Keywords

Physics-based Decomposition, Optimization, Monitoring

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