Solar Array Fault Detection using Neural Networks

Sunil Rao, SenSIP Center, School of ECEE, ASU

***Abstract*—we describe a Cyber-Physical system approach to fault detection in Photovoltaic (PV) arrays. More specifically, we explore customized neural network algorithms for fault detection from monitoring devices that sense data and actuate at each individual panel. We develop a framework for the use of feedforward neural networks for fault detection and identification. Our approach promises to improve efficiency by detecting and identifying eight different faults and commonly occurring conditions that affect power output in utility scale PV arrays.**

I. Project Description

The efficiency of solar energy systems requires detailed analytics for each panel including voltage, current, temperature and irradiance. Solar power output is affected by factors such as cloud cover, soiling of modules, short circuits between panels, unexpected faults and varying weather conditions. We describe machine learning and neural network approaches for Fault Detection and Classification. These approaches are aimed at improving the reliability and efficiency of utility scale solar arrays. We describe theoretical, experimental, and implementation aspects of this comprehensive cyber-physical system (CPS) approach.

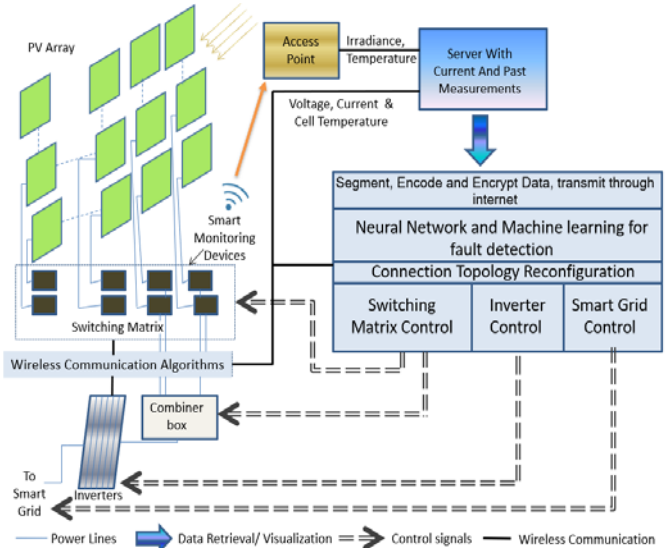

Figure 1. Overview of the CPS Solar System for monitoring.

We improve solar panel efficiency using machine learning techniques to learn and predict multiple system parameters using sensors and sensor fusion. Training and test data are acquired through cyber-physical methods including sensors and actuators. We also use machine learning and deep learning algorithms for fault detection which improve efficiency. We describe these in depth below. An overview of our research is shown in Figure 1.

Parameter sensing at each solar panel provides information for fault detection and power output optimization. Neural networks and sensor fusion enable us to implement robust shading estimation and fault detection algorithms. We have developed Smart Monitoring Devices (SMDs) with sensors that measure current, voltage and temperature. The data obtained from these sensors will be used for fault diagnosis in PV arrays. The SMDs also have relays that enable dynamical reconfiguration of connection topologies [1].

Previously, we have worked on signal processing and machine learning algorithms for PV monitoring which can be found in [2-8]. The MLP architecture used for Fault Classification is shown in Figure 2. We use a 5 layered neural network with backpropagation to optimize the weights used in each layer. Each layer uses 6 neurons. A detailed description of the method is presented in [9].

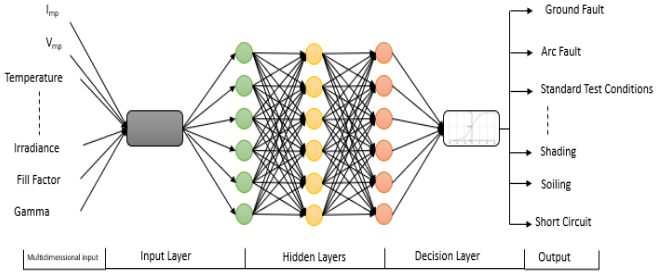

Figure 2: Neural Network Architecture used for Fault Detection and Classification.

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