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Connection Topology Optimization of Photovoltaic Arrays Using Neural Networks

The production of photovoltaic (PV) energy is affected by numerous external factors such as varying temperatures, soiling of PV panels, and partial shading which can significantly reduce power generated. Off-the-shelf PV arrays are typically connected in a series-parallel (SP) topology, featuring parallel-connected strings of series-connected panels. Cross-tied topologies represent another type of scheme which includes total cross tied (TCT) and bridge link (BL) configurations. Under ideal illumination scenarios without shading, these three configurations—SP, TCT, and BL—perform similarly, delivering comparable figures for maximum power point (PMP) and corresponding voltage. However, with electrical mismatching and partial shading, performance can vary between topologies. Therefore, a PV array that efficiently and intelligently switches topologies can maximize power generation under dynamic conditions.

Using neural networks, researchers at Arizona State University have developed a novel topology reconfiguration algorithm for photovoltaic (PV) arrays that maximizes power output. The network consists of a multi-layer perceptron that selects from SP, BL, or TCT topologies to optimize power production for a given set of irradiance profiles. An overall classification accuracy of 96.2% and a 12% improvement in average power was demonstrated by a simulated model.

Related publication: Connection Topology Optimization in Photovoltaic Arrays using Neural Networks

Potential Applications:

- Solar farms
- Solar monitoring systems

Benefits and Advantages:

- Intelligent – Learns irradiance profiles to arrive at optimal array configuration
- Versatile – Simple to implement in any cyber-physical PV system with switching capabilities