Skysong Innovations
Advancing the Arizona State University Knowledge Enterprise

1475 N. Scottsdale Road, Suite 200
Scottsdale, AZ 85287-3538
Phone: 480 884 1996 Fax: 480 884 1984

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Inventors

Vivek Sivaraman Narayanaswamy
Rajapandian Ayyanar
Cihan Tepedelenlioglu
Andreas Spanias

Contact

Physical Sciences Team

Optimizing Solar Power using Array Topology Reconfiguration and Deep Neural Network

Photovoltaic (PV) energy systems have played a major part in meeting renewable energy requirements. However, power production from PV systems faces impediments such as partial shading due to environmental and man-made obstructions. Shading causes voltage and current mismatch losses that can significantly reduce the power supplied to the grid. Reconfiguring PV array connections is a powerful strategy to mitigate the impact of shading. Conventionally, PV arrays rely on fixed connections or topologies to generate power required by the grid. Under partial shading, alternate topologies such as series-parallel (SP), bridge-link (BL), honeycomb (HC), or total cross tied (TCT) can lead to improved power production motivating the need for a systemic approach to perform reconfiguration based on the extent of shading on the panels.

Some reconfiguration approaches rely on by-passing shaded modules in an array by connecting auxiliary unshaded panels through complex control mechanisms or utilizing a simulator driven approach to predict the best topology. However, these solutions are not scalable and incur significant installation costs and computational overhead. There is a need to develop a smart and automated method for topology reconfiguration.

Researchers at Arizona State University have developed a neural network-based algorithm that leverages panel level sensor data to reconfigure the photovoltaic (PV) array to a topology that maximizes the power output. This algorithm can be easily deployed in any PV array with reconfiguration capabilities and is scalable.

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

Potential Applications:

- Photovoltaic energy systems
- Renewable energy systems
- Solar Arrays

Benefits and Advantages:

- Ease of adoption in a solar array
- Optimizing across four PV topologies: series-parallel (SP), bridge-link (BL), honeycomb (HC), or total cross tied (TCT)
- Experimentation yielded an average power improvement of ~11% when switching topologies via neural network-based algorithm
- Neural network architecture is regularized offering parameter efficiency and is less prone to overfitting issues

- Can be used in scenarios where there is support for static reconfiguration