Fuzzy-Logic Based MPT for Photovoltaic Based Power System

Gaurav Kalotra, and Rakeshkumar Mahto
Computer Engineering Program,
California State University, Fullerton, CA 92831

Introduction:

- Wireless sensor networks (WSNs) have garnered much interest among researchers.
- One of the critical applications of WSNs is in the detection and mitigation of forest fires. WSNs can be used in mobile ad-hoc networks to detect fires in forests.
- Such networks when equipped with WSNs on each node can provide data about the environmental conditions like temperature, humidity, lighting conditions, atmospheric pressure ,etc.
- These sensor nodes use batteries as their primary power source and replacing the batteries in the nodes can be a tedious task.
- PV cells can be used as an efficient alternative to power up these sensors.
- The PV based power source can charge the battery and power the sensors in the daytime, while during the nighttime, the charged battery can provide the necessary power to the sensor network.
- However, since the terrain can be unpredictable with varying flora and fauna, it is hard to say whether the solar cells may receive enough sunlight to produce the required power.
- For this purpose, PV modules integrated with a silicon switch are used as they are durable and provide optimum results in different light conditions.
- This poster presentation mainly focuses on improving the maximum power transfer during shading conditions by using fuzzy logic.

Concept:

- Algorithms for the silicon switch embedded PV modules compare the computed power and measured power for fault detection.
- The process to detect the failed and/or shaded PV cells to then optimize the configuration of the silicon switch is not very efficient.
- Also, the switching process to switch to the optimum configuration, further degrades the efficiency.
- In this presentation, we present a fuzzy logic-based technique for determining the optimal configuration (number of PV cells in series x number of PV cells in parallel) of the silicon switch embedded PV module.

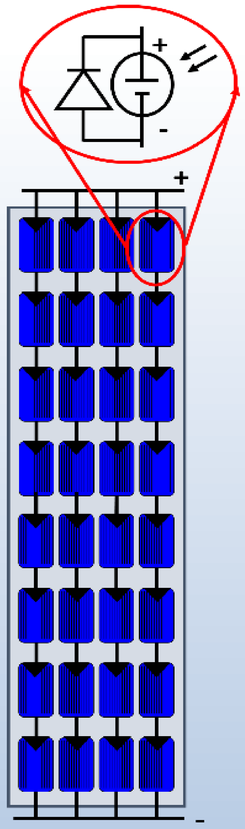

Fig. a) Fixed solar cell module

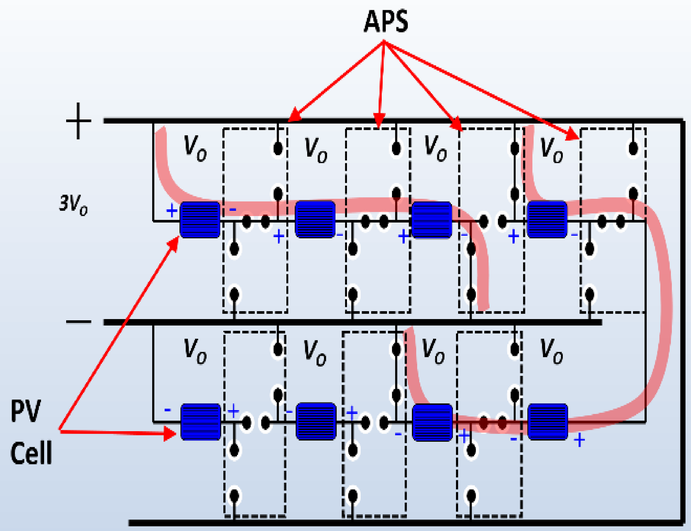

Fig. b) Reconfigurable solar cells embedded with silicon switches which are controlled by Addressable Programmable Switches (APS)

Conclusion:

- Thus, based on the simulations of PV cells in series and parallel configuration we can identify which configuration is best for different conditions of shading and develop an algorithm to switch configurations as per requirement
- The input to the fuzzy logic includes the number of PV cells in series and parallel, the number of healthy PV cells in the panel, and the measurement value of generated power.
- This research work will enable the creation of adaptable PV modules through machine learning (ML).

References:

[1] A. Díaz-Ramírez, L. A. Tafoya, J. A. Atempa, and P. Mejía-Alvarez, “Wireless sensor networks and fusion information methods for forest fire detection,” Procedia Technol., vol. 3, pp. 69–79, 2012.

[2] F. T. AL-Dhief, N. Sabri, S. Fouad, N. M. A. Latiff, and M. A. A. Albader, “A review of forest fire surveillance technologies: Mobile ad-hoc network routing protocols perspective,” J. King Saud Univ. - Comput. Inf. Sci., vol. 31, no. 2, pp. 135–146, Apr. 2019, doi: 10.1016/j.jksuci.2017.12.005.

[3] J. Taneja, J. Jeong, and D. Culler, “Design, Modeling, and Capacity Planning for Micro-solar Power Sensor Networks,” in 2008 International Conference on Information Processing in Sensor Networks (ipsn 2008), Apr. 2008, pp. 407–418, doi: 10.1109/IPSN.2008.67.

[4] M. Minami, T. Morito, H. Morikawa, and T. Aoyama, “Solar biscuit: A battery-less wireless sensor network system for environmental monitoring applications,” in The 2nd international workshop on networked sensing systems, 2005, vol. 2007.

[5] R. Mahto, O. Lavrova, P. Zarkesh-Ha, and L. Lester, “Reconfigurable and Programmable Photovoltaic Power for Micro Autonomous Systems,” ReSpaceMAPLD 2010, 2010.

[6] R. Mahto, “Fault resilient and reconfigurable power management using photovoltaic integrated with CMOS switches,” 2016.