

Optimizing MPPT Control Methods Using Nature-Inspired Metaheuristic Algorithms To Maximize The Use Of Renewable Energies

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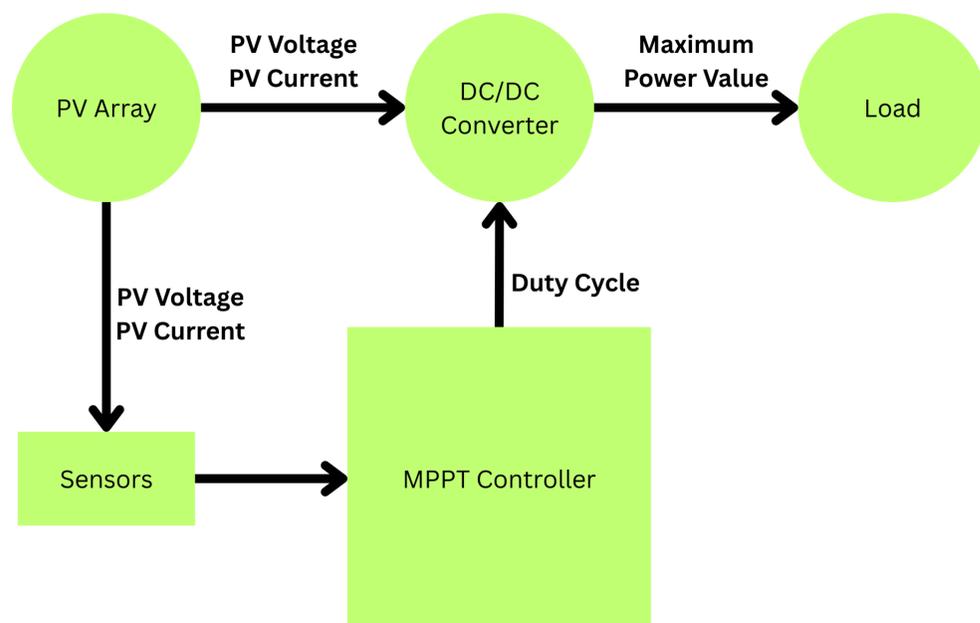
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INTRODUCTION & AIM

Photovoltaic systems in islanded microgrids require efficient MPPT to maximize energy extraction under changing conditions. Conventional methods, including PSO and GA, often suffer from slow convergence and poor global MPP detection under partial shading. This work evaluates recent nature-inspired metaheuristic algorithms to improve MPPT performance and reliability in isolated PV-based microgrids.

METHOD

Classical (PSO, GA) and recent metaheuristics are implemented as MPPT controllers for a 50W PV system. Algorithms are evaluated under dynamic irradiance based on convergence speed, accuracy, and energy yield.



RESULTS & DISCUSSION

Initially, three traditional tracking methods (P&O, Incremental Conductance, and Fuzzy Logic) were compared; since Incremental Conductance and Fuzzy Logic yielded identical results, the Incremental method was selected due to its superior simulation efficiency and lower computational time. The results are presented in **Figure 1**.

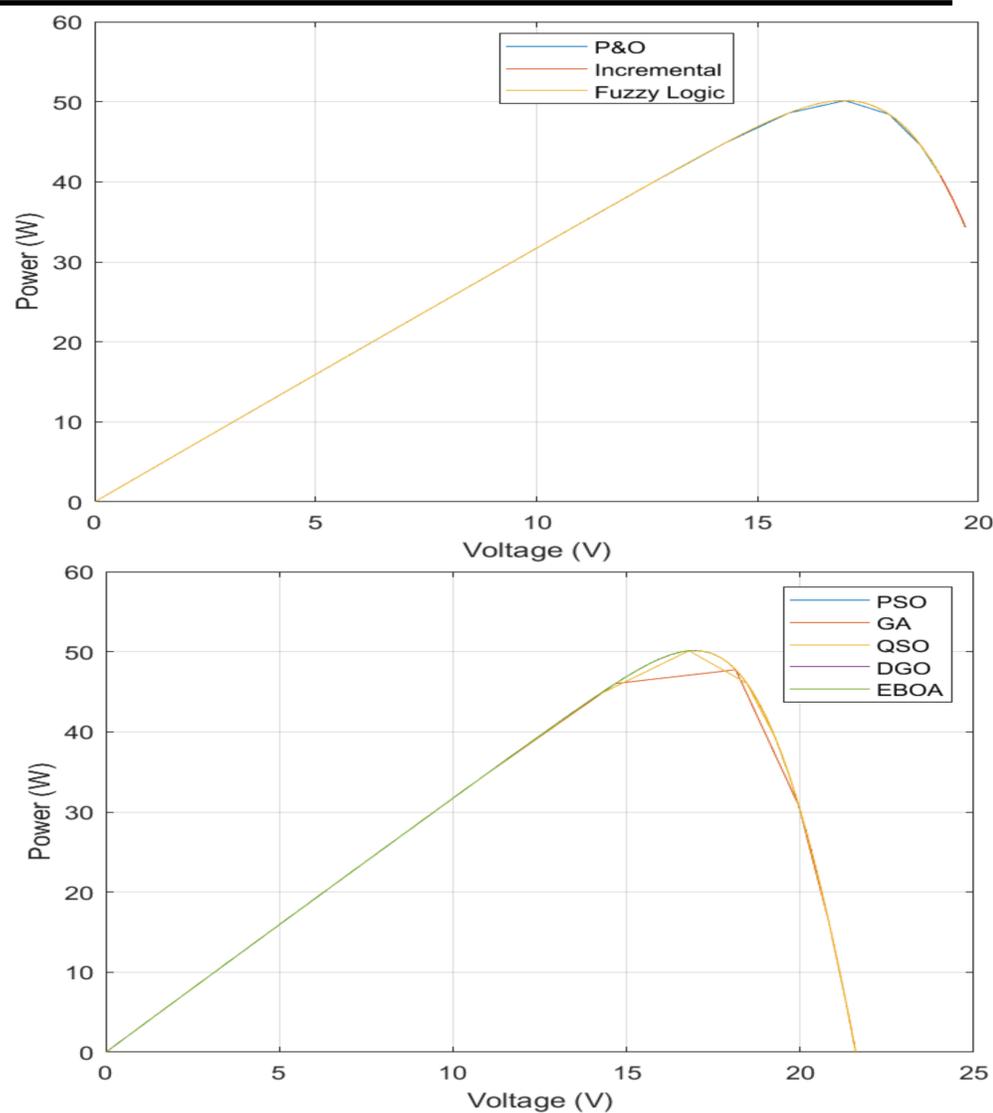


Figure 2 demonstrates the results of a comparison between five nature-inspired algorithms for a 50W PV system. DGO, EBOA, and PSO successfully reach the 50W peak with high precision. Conversely, GA settles at a lower power point (approx. 47W), and QSO exhibits a less stable tracking path compared to the smoother convergence of DGO and EBOA.

CONCLUSION

Incremental Conductance is the most efficient classical baseline, matching Fuzzy Logic's accuracy with lower overhead. Among metaheuristics, DGO, EBOA, and PSO are superior, successfully reaching the 50W peak, while GA and QSO demonstrate lower precision and stability.

FUTURE WORK / REFERENCES

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- [2] J. H. Kirchner, L. Euler, I. Fritz, A. Ferreira Castro, et J. Gjorgjieva, « Dendritic growth and synaptic organization from activity-independent cues and local activity-dependent plasticity », *eLife*, vol. 12, p. RP87527, feb. 2025, doi: 10.7554/eLife.87527.