The 4th International Electronic Conference on Processes
Sustainable Process Design, Engineering, Control and Systems Innovation
20–22 October 2025 | Online

Optimizing Photovoltaic Parameters Using the Laguerre Method

Fatima WARDI [1], Oussama KHOUILI[2], Mohamed LOUZAZNI [1], Mohamed HANINE[2]

[1]Science Engineer Laboratory for Energy, National School of Applied Sciences, Chouaib Doukkali University of El jadida,Morocco
[2] information technology laboratory, National School of Applied Sciences, Chouaib Doukkali University of El jadida,Morocco

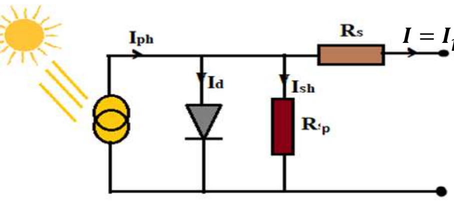
INTRODUCTION

Photovoltaic (PV) energy has become a central pillar in the global transition toward clean and sustainable power sources, offering a renewable and environmentally friendly alternative to conventional electricity generation. This study focuses on optimizing the parameters of a single-diode photovoltaic model to improve its accuracy in representing real-world behavior. A Laguerre-inspired optimization (LO) method is employed, which adjusts each parameter individually. The optimization process relies on minimizing the mean squared error (MSE) between the experimental current values and those predicted by the model, using the first and second derivatives of the objective function. The Laguerre approach's parameters are contrasted with those found in current research using analytical methods, iterative approaches, and metaheuristic algorithms. The root mean square error (RMSE), and individual absolute error (IAE) are among the statistical error metrics that are computed to evaluate the performance of the suggested technique. The efficiency of the Laguerre technique in photovoltaic parameter extraction is demonstrated by this methodical approach, which enables perfect calibration of the model in line with experimental data. The suggested LO technique's robustness and dependability in this field are confirmed by the comparison study, which shows that the results produced by this approach have lower error rates than those obtained by other optimization methods.

Electrical Model of the Solar Cell

The simple diode model of a solar cell is a simplification of reality. The equation of this model is generally based on the equation of the current-voltage characteristic (I-V) of an ideal diode of ideality factor **n** in parallel with a resistance R_P and in series with a resistance R_s

$$I = I_{ph} - I_{01}\left(e^{\frac{V+IR_s}{nV_t}} - 1\right) - \frac{V+IR_s}{R_P}$$



Employing the innate foraging abilities of earthworms as inspiration, the algorithm is crafted to capitalize on this insight. This methodology facilitates the precise extraction of solar cell properties. Here is a summary of the algorithm

REFERENCES

[1]:]: J. A. Jervase, H. Bourdoucen, et A. Al-Lawati, « Solar cell parameter extraction using genetic algorithms », *Meas. Sci. Technol.*, vol. 12, nº 11, p. 1922-1925, nov. 2001, doi: 10.1088/0957-0233/12/11/322.

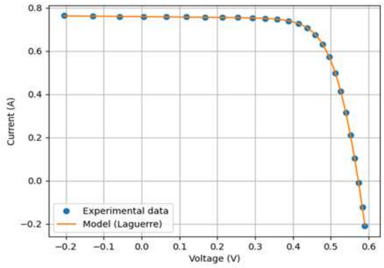
[2]:S. Mirjalili et A. Lewis, « The Whale Optimization Algorithm », Advances in Engineering Software, vol. 95, p. 51-67, mai 2016, doi: 10.1016/j.advengsoft.2016.01.008.

[3]:M. Ye, X. Wang, et Y. Xu, « Parameter extraction of solar cells using particle swarm optimization », Journal of Applied Physics, vol. 105, no 9, p. 094502, mai 2009, doi: 10.1063/1.3122082.

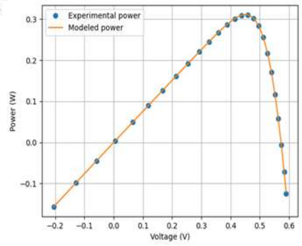
RESULTS & DISCUSSION

Table of optimal parameters

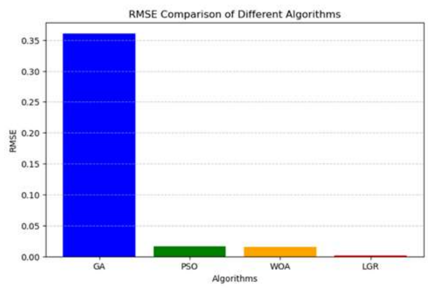
Parameters / Algorithm	I_{ph}(A)	$I_{01}(\mu A)$	$I_{02}(\mu A)$	n_1	n_2	$R_s(\Omega)$	$R_P(\Omega)$
LGR	0.76	1e-8	1.748	1.7278	1.4998	0.00394	58.166
WOA[2]	0.7658	0.29957	1.4795	0.39438	1.9201	0.0493	59.0196
GA[3]	0.7608	0.0001	1.3355	0.0001	1.481	0.0364	53.7185
PSO[4]	0.7623	0.4767	1.5172	0.01	2	0.0325	43.1034



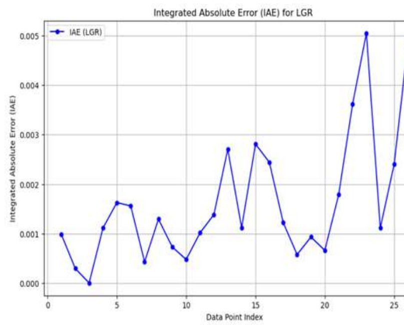
Current curve as a function of voltage



Power curve as a function of voltage



The Root Mean Square Error (RMSE) for the LGR algorithm, the genetic algorithm[1], the whale optimization algorithm[2], and the PSO[3] algorithm



The Absolute Integral Error (IAE) for the LGR algorithm

CONCLUSION

This study suggests extracting the intrinsic electrical parameters of double-diode photovoltaic models using the Laguerre Technique Optimization (LGR). Because solar cell equations are complicated and nonlinear, LGR provides an effective solution by reducing the error between simulated and observed current levels. The accuracy of the method is compared to modern methods from the literature, such as analytical, iterative, and metaheuristic approaches. Statistical measures like Individual Absolute Error (IAE) and Root Mean Square Error (RMSE) are used to assess its efficacy and verify the dependability of the derived values.