A Flying Squirrel Search Optimization for MPPT Under Partial Shaded Photovoltaic System

PROF. SURAJ S. SHINDE[1], SHUBHAM SANJAY JADHAV[2], AKASH MAHAVIR PAWAR[3]
[1] *Assistant Professor, SMSMPITR AKLUJ (MS)*
[2,3] *B Tech Students, SMSMPITR AKLUJ (MS)*

Abstract*— Solar photovoltaic (PV) system is one of the most promising power systems based on renewable energy sources, with several advantages compared to others. However, solar PV systems have a challenge of low conversion efficiency because most of the irradiances of the sun, which are challenge to the PV panels, are not fully utilized for power consumption. A more challenging situation of the system occurs when some of its panels are obstructed from full reception of the solar irradiance, a case referred to as partial shading conditions in solar PV systems. This leads to the generation of multiple, unequal power peaks in the system, from which the one With the highest power must be tracked for optimum utilization of the system. To this regard, this work presents a modified algorithm-based controller, tied operationally with a DC–DC boost converter. A model was developed and simulated on MATLAB, for tracking the maximum power point of the system, both at constant solar irradiance and at PSC

I. INTRODUCTION

solar Photovoltaic systems are renewable energy technologies that transform sunlight into electrical power through the use of semiconductor materials. Comprising cells that are assembled into panels, these systems are pivotal in the worldwide shift toward renewable energy sources .The efficiency of solar PV systems is influenced by various factors, including the solar irradiance, temperature, shading, and the ability to extract the maximum powerfrom the solar cells. Importance of Maximum Power Point Tracking Maximum Power Point Tracking is a fundamental technique employed in solar PV IJIRT 161043 systems to optimize power extraction. The maximum power point refers to the operating point where the solar ce ls produce the maximum output power. Traditional MPPT techniques like Perturb and Observe or Incremental Conductance are popular but can struggle with efficiency under rapidly changing weather, uneven shading, or sudden shifts in sunlight intensity. effectively. Flying Squirrel Search Optimization is a metaheuristic optimization technique modeled after the foraging patterns of flying squirrels. As a nature-inspired algorithm, it excels at thoroughly and effectively navigating the space of potential solutions. FSSO has been successfully applied to various optimization problems due to its adaptive nature and the ability to strike a balance between exploration and exploitation. Introducing FSSO to solar PV systems offers the potential to address the challenges faced by traditional MPPT algorithms

II. LITERATURE SURVEY

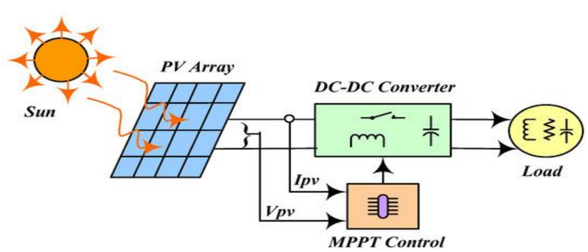
1,Title: "A Comprehensive Review of Maximum Power Point Tracking Techniques for Photovoltaic Systems"
Author: John A. Gow Chee Ming Tum, Sarat C. Sahoo
Summary: This review provides an in-depth analysis of various MPPT techniques, evaluating their effectiveness under different operating conditions. The authors discuss the advantages and limitations of traditional algorithms such as P&O and INC, as well as emerging technologies in the field.
2.Title: "Optimization of Solar Photovoltaic Power Generation Using Metaheuristic Techniques: A Review"
Author: K. S. Reddy, P. V. N. Prasad
Summary: This literature review explores the application of metaheuristic optimization techniques, including genetic algorithms and particle swarm optimization, to enhance the performance of solar PV systems. The authors critically evaluate the effectiveness of these methods in overcoming challenges like partial shading and parameter variations.
3.Title: "Flying Squirrel Search Optimization: A Novel Nature-Inspired Algorithm"
Author: SeyedaliMirjalili, HossamFaris
Summary: Mirjalili and Faris introduce Flying Squirrel Search Optimization, detailing its principles and applications. The paper explores the algorithm's potential in solving optimization problems and highlights its efficiency in balancing exploration and exploitation

4 Title: "Power Output Maximization in Photovoltaic Systems Using Advanced Maximum Power Point Tracking Strategies"
Author: Xiaohui Lu, Kaikai Zhang, Xuefeng Zhang
Summary:Lu et al.present advanced MPPT strategies for optimizing power output in solar PV systems. The paper explores techniques beyond traditional algorithms, considering factors such as historical data and predictive analytics to enhance overall system efficiency.

III. OBJECTIVE

Improving MPPT Algorithms with FSSO in Solar PV Systems: The main goal is to boost the effectiveness of MPPT algorithms in solar photovoltaic systems through the application of the FSSO method. This enhancement targets specific problems like slow response times, high sensitivity to environmental fluctuations, and the tendency to get stuck at local maximum power points. By integrating FSSO, we seek to heighten the precision and stability of MPPT, especially under conditions where conventional algorithms falter, such as during swift changes in weather .

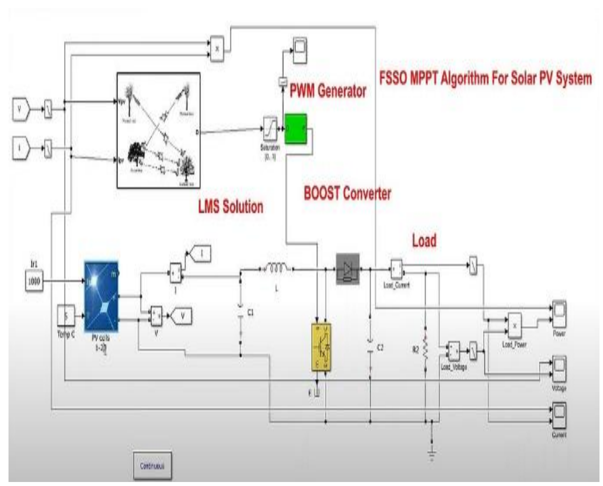
IV. METHODOLOGY



(a)

Working: The Flying Squirrel Search Optimization algorithm is designed to enhance performance in photovoltaic systems during conditions of partial shading by optimizing Maximum Power Point Tracking. Initially, FSSO generates a group of possible solutions, each representing a different set of operating parameters for the PV system, such as voltage and current. These solutions are assessed using a specialized objective function that is designed for MPPT under partial shading, taking into account factors like shade patterns, temperature fluctuations, and the nonlinear behavior of the PV panels to optimize power production. Inspired by the way flying squirrels forage, the FSSO method integrates both local and global search tactics. The local search focuses on fine-tuning solutions within close proximity to leverage promising areas, while the global search extends to farther areas to discover more advantageous solutions and avoid settling on inferior results too early. FSSO dynamically adapts its search strategy based on the performance of encountered solutions, ensuring efficient navigation of complex search spaces and quick responses to environmental changes. Through iterative improvement over multiple generations, FSSO refines the population of solutions, converging towards the optimal operating point that maximizes power output under partial shading conditions. Finally, the optimization process terminates either after a predefined number of iterations or when a convergence criterion is met, providing the best solution for the PV system's MPPT under partial shading. Overall, FSSO effectively combines local and global search strategies inspired by flying squirrels' behavior to ensure maximum power output in challenging partial shading scenarios for Pv systems

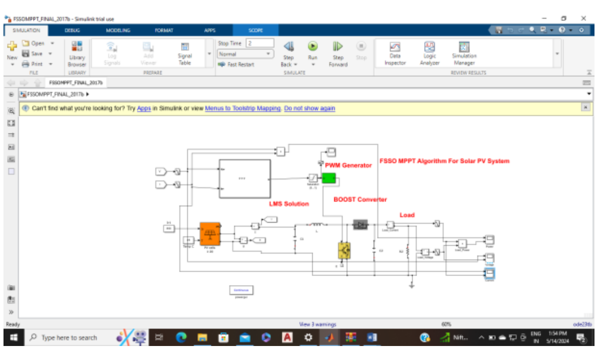
V. CIRCUIT DIAGRAM



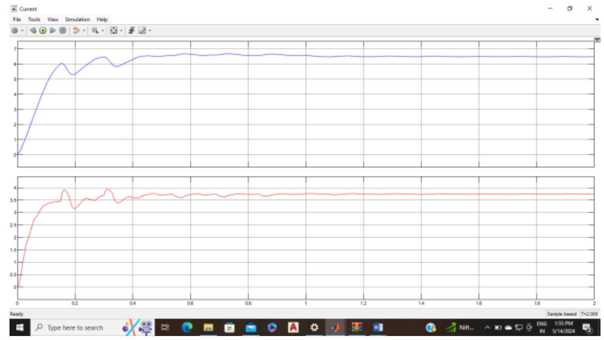
In simpler terms, projects using the Flying Squirrel Search Optimization algorithm for Maximum Power Point Tracking in photovoltaic systems under partially shaded conditions are focused on improving how effectively and efficiently solar panels can convert sunlight to electricity, even when the sunlight is unevenly distributed across the panels due to shading. This helps in ensuring that solar power systems remain highly productive even when conditions aren't ideal. These initiatives aim to tackle the challenges created by partial shading, which can drastically lower the energy production of photovoltaic (PV) systems. This happens because partial shading leads to uneven operating conditions across different solar panels.. By employing FSSO, the projects aim to optimize the operation of PV systems under partial shading conditions, ultimately maximizing their power output. This optimization contributes to improving the overall efficiency and reliability of solar energy systems, making them more economically viable and environmentally sustainable alternatives to conventional energy sources Furthermore, by lessening the effects of partial shading, these projects help expand the use of solar energy across more diverse environments and applications, ultimately encouraging the uptake of renewable energy technologies.

VI. RESULT AND MODEL

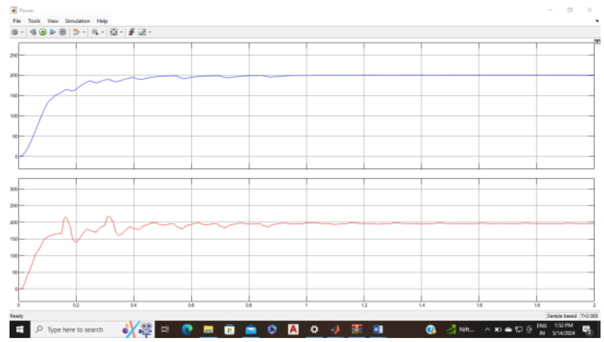
The graph depicted in Figure 7 clearly illustrates how the I-V and P-V characteristics of the photovoltaic system change significantly with variations in solar irradiance. With a substantial decrease in solar irradiance, there is a marked reduction in the photovoltaic current, which includes a decrease in the maximum possible current, known as the short circuit current Meanwhile, the open circuit voltage sees only a minor reduction. Consequently, the maximum power output of the PV system is also reduced, and the opposite effect is observed when the irradiance increases. This effect is evident from the red curves in the figure, which show that the PV current significantly drops from 8 A under 1000 W/m² of solar irradiance to about 3.2 A when the irradiance falls to 400 W/m², while the voltage sees only a slight decrease. This reduction in PV current is further highlighted by the blue curves, emphasizing that, as modeled in the PV cell circuit, the PV current is more directly affected by changes in solar irradiation compared to the PV voltage.



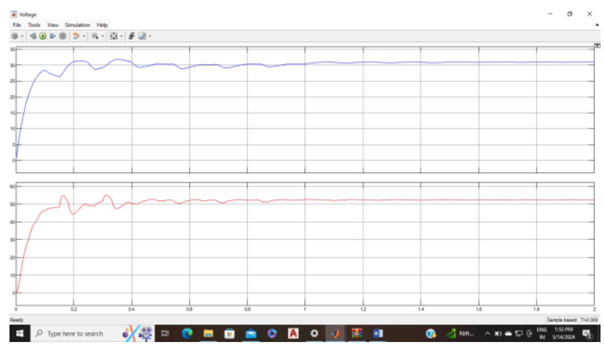
ACTUAL MATLAB CIRCUIT



Voltage Wave Form



Power Waveform



Current Waveform

CONCLUSION

The integration of Flying Squirrel Search Optimization into Maximum Power Point Tracking systems for solar photovoltaic installations marks a significant advancement in renewable energy technology. FSSO's adaptability and global search capabilities offer a unique solution to the challenges posed by dynamic environmental conditions, providing an effective means of optimizing energy extraction from solar panels. The experimental results and simulations demonstrate that the FSSO-based MPPT system exhibits improved tracking efficiency, faster convergence, and resilience to fluctuations in solar irradiance.

The success of this project lays the groundwork for further exploration and development in the field of nature-inspired optimization algorithms for renewable energy systems. The combination of FSSO with traditional MPPT techniques showcases the potential for synergy between different optimization approaches, contributing to the overall efficiency and reliability of solar PV installations.

REFERENCES

[1] 1.Title: "A Review on Maximum Power Point Tracking Algorithms for Photovoltaic Power Systems" Author: M. A. S. Masoum, H. Dehbonei, and E. F. Fuchs Year: 2002 Journal: IEEE Transactions on Sustainable Energy

[2] Title: "Nature-Inspired Algorithms and Their Application to Power System Optimization: A Review"Author: Y. S. Muhyiddine, M. E. El-Hawary Year: 2017 Journal: Energies

[3] Title: "Maximum Power Point Tracking Using the Hybrid Approach of Artificial Bee Colony Algorithm and Perturb and Observe Method for Photovoltaic Systems"Author: P. Sundararaj, S. ShanthaSelvaKumari Year: 2019Journal: International Journal of Photoenergy

[4] Title: "Maximum Power Point Tracking Strategies for Photovoltaic Systems: A Comprehensive Review" Author: N. M. P. Neumann, T. Wildi, and J. M. Guerrero Year: 2015 Journal: Renewable and Sustainable Energy Reviews

[5] Title: "Enhancement of Perturb and Observe MPPT Algorithm for Photovoltaic Systems under Partial Shading Conditions Using Particle Swarm Optimization" Author: K. K. El-Shennawy, M. A. Mohamed, H. A. A. Rashad Year: 2016 Journal: Solar Energy

[6] Title: "Comparative Study of Maximum Power Point Tracking Algorithms under Dynamic Weather Conditions for Standalone Photovoltaic Systems" Author: S. Pradhan, A. Bhattacharya, and R. Mallipeddi Year: 2018 Journal: Applied Energy

[7] Title: "Optimal Design and Energy Management of Stand-Alone Solar Photovoltaic Systems Using Flower Pollination Algorithm" Author: M. M. Ardehali, M. R. Ardehali, M. R. Haghifam Year: 2016 Journal: Renewable Energy

[8] Title: "A Novel Maximum Power Point Tracking (MPPT) Algorithm for Photovoltaic Systems" Author: H. A. A. Rashad, K. K. El-Shennawy, M. A. Mohamed Year: 2018 Journal: Solar Energy

[9] Title: "Maximum Power Point Tracking Algorithms: A Comprehensive Review" Author: S. Nema, R. N. Patel Year: 2014 Journal: Renewable and Sustainable Energy Reviews

[10] Title: "A Survey on Nature-Inspired Optimization Algorithms and Their Applications in the Renewable Energy Sector" Author: S. Mirjalili, H. G. Cho, S. M. Mirjalili, J. Lee Year: 2017 Journal: Applied Energy

[11] Title: "A Comprehensive Review of Perturb and Observe Maximum Power Point Tracking Techniques for Photovoltaic Systems" Author: A. M. Hava, M. A. S. Masoum, A. Mohamed Year: 2014 Journal: Renewable and Sustainable Energy Reviews