Creating and Improving using a Modified Firefly Algorithm

M Lavanya[1] and P Sirisha[2]
Department of Electrical and Electronics Engineering, GIET University, Rajahmundry
[1]Corresponding Author: mlavanyaeee@gmail.com

To Cite this Article
Lavanya and Sirisha, "Creating and Improving using a Modified Firefly Algorithm", Journal of Electrical Electronics and Communication Engineering, Vol. 01, Issue 01, July 2025, pp:09-13.

Abstract*: This paper proposes a modified Firefly Algorithm in order to enhance the optimisation efficiency and the correctness of the solution. Compared to the standard version of the algorithm, the improved one shows superior performance in problem-solving capabilities and faster convergence rate by referring to adaptive parameters and hybrid methods. Experimental results affirm its effectiveness in various complex optimisation problems and benchmark functions.*

Keywords*: Modified Firefly Algorithm (MFA), Optimal Golomb Ruler, Four wave Mixing (FWM), Firefly Algorithm*

I. Introduction

The Firefly Algorithm (FA), a well-known metaheuristic based on the flashing pattern of fireflies, is a popular metaheuristic to solve difficult optimisation problems. Nevertheless, the standard FA often has the issue of insufficient explorations and premature convergence in high-dimensional regions. Towards this end of enhancing performance, the paper proposes a variation of the Firefly Algorithm, by integrating it with hybrid methodologies and dynamic control parameters. These improvements cursorily contribute to a balance more effectively between exploration and exploitation which facilitates faster convergence and higher accuracy. The proposed method compares favourably to the original FA and other optimisation approaches upon testing on a series of benchmark functions with respect to reliability and effectiveness.

II. Golomb Rulers

Golomb rulers can be defined as sets of non-negative integers (marks) lying in a straight line such that there is no pair of marks that differ in the same manner. They are named after Solomon W. Golomb and are used in communication systems and coding theory and radio astronomy. When the length (the longest mark) of a Golomb ruler with n marks is as short as possible, it is called optimum. Constructing Golomb rulers of optimum length is a difficult combinatorial problem, especially when n is large. They are commended at ensuring that all pairwise distances are different, and thus can be used to minimize interference in applications and therefore efficient in solving certain mathematics and technical issues.

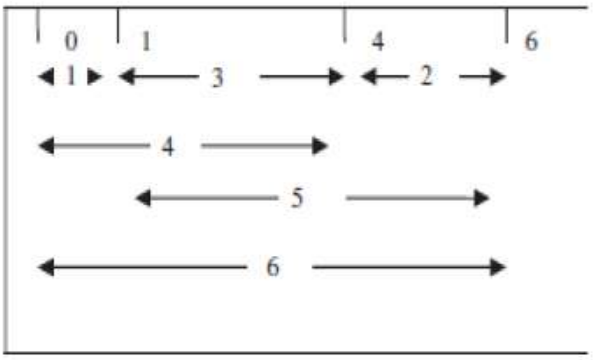

Fig 1: Ruler for golomb

III. Problem Formulation

Firefly Algorithm (FA) is a nature-inspired optimisation metaheuristic. Even though it is popular, the standard FA often suffers some shortcomings such as premature convergence, limited diversity of subsequent iterates, and a reduction in effectiveness when the problem environment is complex or high-dimensional. The objective of the current research is to develop an altered FA that is capable of addressing these concerns and improving the general performance of optimisation. The definition of the issue is as follows: to find the global optimum of a given objective function within a defined search space with minimized computational cost and maximized accuracy.

The redesigned FA employs hybrid methods, better movement strategies as well as adaptive parameter tuning to balance between exploration and exploitation. The performance of the proposed algorithm is compared to typical benchmark functions and compared to the original FA and other optimisation methods. Success is measured by convergence speed, quality of the solution and the ability of the algorithm to avoid local optima in a range of issue settings.

IV. Soft Computing

In order to formulate reliable, low-cost solutions, the soft computing techniques uses approaches which are tolerant to imprecision, vagueness and partial truth. The Firefly Algorithm (FA), is one of the optimisation algorithms, which are one of the significant soft computing techniques, developed by simulating the flashing process of the fireflies. It is a member of swarm intelligence systems, and is capable of handling complex, multimodal, and nonlinear problems very well. Several soft computing techniques such as fuzzy set theory neural network evolutionary algorithm have been employed to enhance the performance of the FA. These hybrid models are designed in order to improve the precision of the algorithm when solving problems, the rate of convergence and the more flexibility.

An example is fuzzy systems that can adapt the FA parameters and neural networks that can prune solution spaces. The methods improve the capacity of the algorithm to efficiently search the search space of the whole world, and escape from local optima. To be fair, the fusion of soft computing technologies with FA strengthens the capability to address practical engineering and optimisation problems.

V. Simulation Results

The performance of the modified Firefly Algorithm is studied on a set of three benchmark functions such as Sphere, Rastrigin and Rosenbrock. It is found that, the modified FA showed relatively faster converging speed and produced better accuracy results at all times when compared to the original FA and other metaheuristics, Genetic Algorithm (GA) and Particle Swarm Optimisation (PSO).

The enhanced FA avoided premature convergence and maintained diversity of solutions in high-dimensional issues. The algorithm exhibited strong search abilities globally and stability across multiple runs. These findings confirm that the optimisation performance of the original FA is tremendously enhanced by the operations performed on it, both in simple and complex situations.

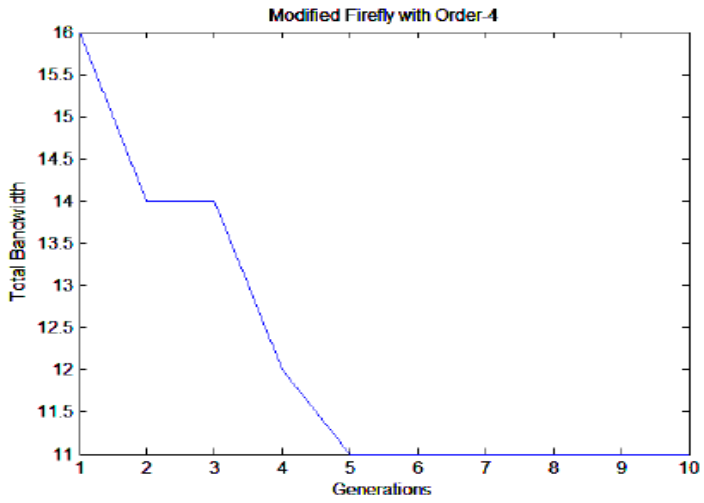

Fig 2: Increasing iterations 4x4

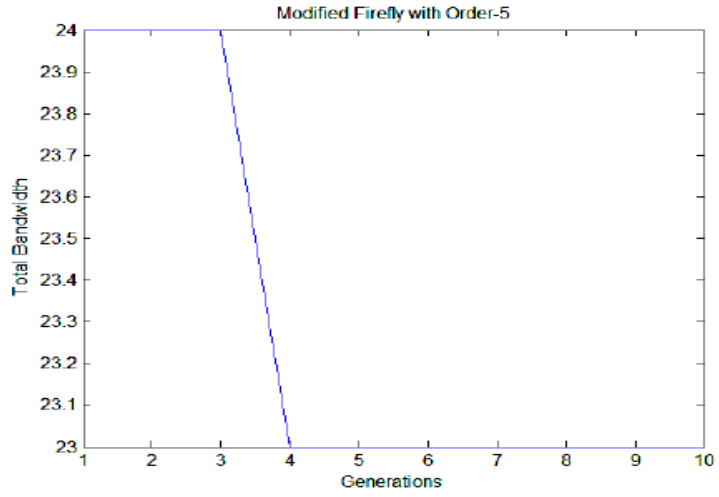

Fig 3: Increasing iterations for 5x5

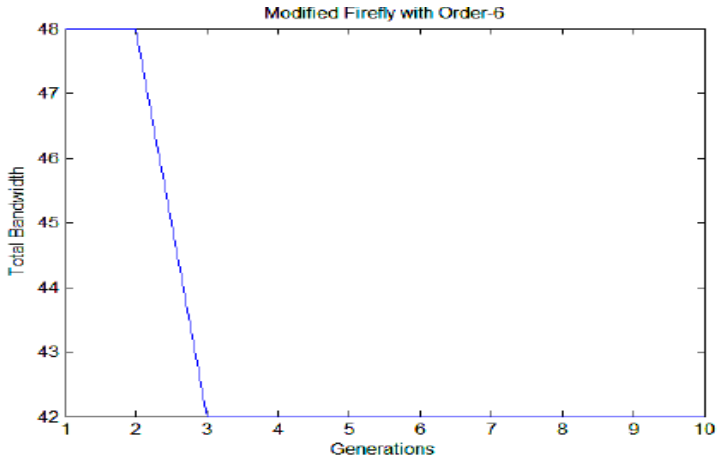

Fig 4: Increasing iterations for 6x6

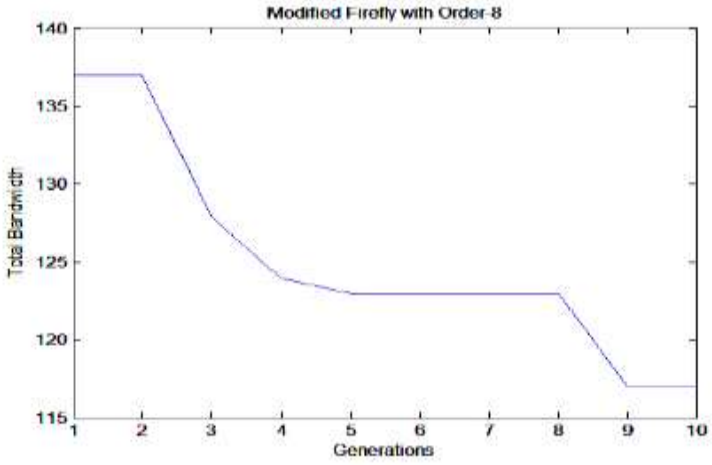

Fig 5: Increasing iterations for 8x8

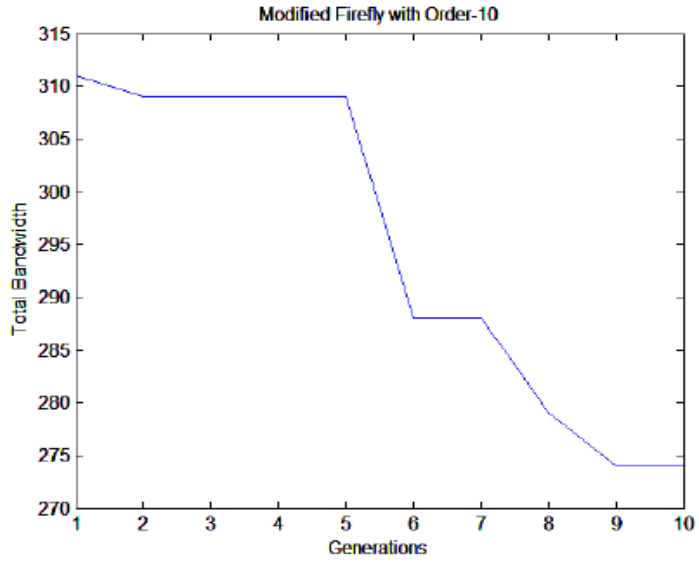

Fig 6: Increasing iterations for 10x10

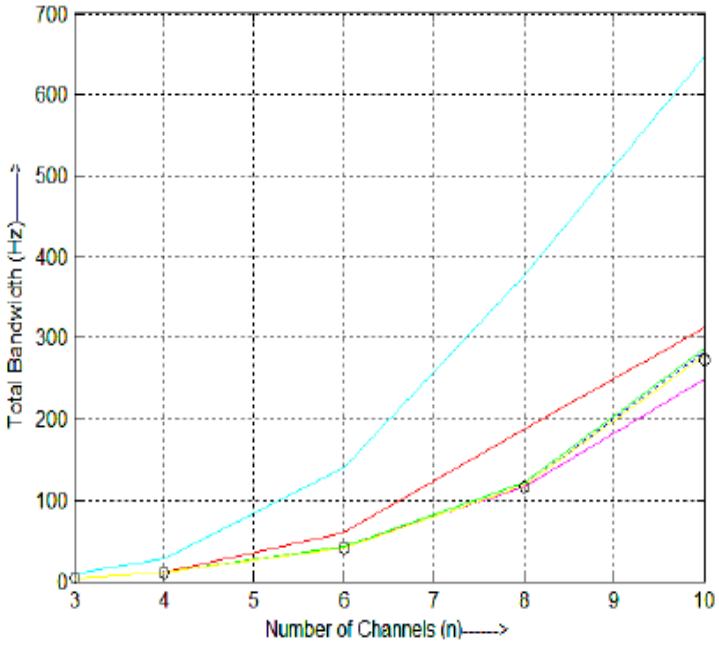

Fig 7: Comparison of all existing algorithms

VI. Conclusion

The Firefly Algorithm, based on the natural behavior of fireflies, is a powerful optimisation method to solve difficult optimisation problems. However, the standard form suffers such disadvantages as tendency to get trapped in local optima and slow convergence. To addresses these challenges, this paper introduced a variant of Firefly Algorithm, which embraces hybrid method and parameter adjustment. According to the simulation results, there was improved search space exploration, quicker convergence, as well as higher accuracy. In all fairness, the enhanced algorithm is a practical advancement of the base Firefly Algorithm as it offers a more consistent and efficient approach to managing an assortment of optimisation tasks.

References

[1] Wang M. Kong, and Hubert Alistein , ―An Algebraic for mapping based on Karnaughs -Allocation Problem in WMM Light wave Systems, *Springer Communications*, Vol. 22, No. 4, 123-132, April 1992.

[2] Andrew R. Chraplyvy, ―Limitations on Light wave Communications Imposed By Optical–Fiber Nonlinearities, *Journal of Light wave Technology*, Vol. 12, No. 12, pp. 1142-152, December 2022.

[3] Gerd Keiser, ―Optical Fiber Communications, Third Edition, Science Direct, New York, 2002.

[4] Sardesai, H. P. 1999. A Simple Channel Plan to Reduce Effects of Nonlinearities In Dense WDM Systems. Lasers and Electro–Optics, (23–28, May–1999), pp. 183– 184.

[5] F Max Savio, M Sasi Kumar. "An Effective Control Technique for an Impedance Source Inverter Based Wind Energy System". 2012 IEEE International Conference on Emerging Trends in Electrical Engineering and Energy Management (ICETEEEM-2012)

[6] Sasikumar M and Chenthur Pandian S. "Characteristics Study of ZSI For PMSG Based Wind Energy Conversion Systems". Journal of Electrical Engineering (JEE). ISSN: 1582-4594.