ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology
(IJARTET) Vol. 10, Issue 7, July 2023

A Nature Inspired Optimization Algorithm for VLSI Fixed-Outline Floor Planning

Aravindh Kumar.S[1], Umma Habiba.H[2]
1- PG Student, M.Tech, Embedded System Department of Electronics and Communication Engineering, Bharath Institute of Higher Education and Research,Chennai,Tamil Nadu-600 073.
2- Professor, Department of Electronics and Communication Engineering, Bharath Institute of Higher Education and Research, Chennai,Tamil Nadu-600 073.

Abstract: The Proposed is an optimization algorithm Spotted Hyena Optimizer (SHO) for Floor Planning in Manufacturing Process of Semiconductor Chips to determine Size, Module Locations and Shape in a Chip for estimating absolute chip area optimization. The method that has been proposed is the social interactions of Spotted Hyenas using the Universal Law of Gravity as its foundation. In this article, a mathematical model of SHO's three primary stages—namely, Looking For Prey(LFP), Surrounding Prey(SP),and Attacking Prey(AP)—is explored, and the first of these stages is modelled. With the fixed out line as a limitation, the goal is to optimize both the area and the wirelength as much as possible.This optimization is achieved by SHO algorithm. These timings were determined by measuring the amount of time required to track the global convergence for each pattern. In addition, in order to show its applicability, a hardware prototype is constructed and put through a series of tests under a variety of different operational situations. The simulated values and the experimental findings are comparable and accord with one another rather well.

Keywords: Optimization; Floor planning; Spotted Hyena Optimization (SHO)

I. INTRODUCTION

The design process for Very Large Scale Integrated circuits (VLSI) includes a step called floor planning, which is very critical to achieve minimized delay. In order to achieve the goal of reducing the total area that is taken up by the circuit, it is necessary, after the layout has been partitioned, for decisions regarding the relative positioning of the various modules to be made prior to the stage of placement. This process entails positioning the cells in their precise locations. The floor planning process was found to be NP difficult [7]. Simulated Annealing (SA), Genetic Algorithms(GA) and Particle Swarm Optimization(PSO)are just some of the algorithms that have been created over the years using aleatory search techniques. However, only a selected number of these algorithms operate explicitly on multi objective optimization [6,4]. The weighted sum technique was used in the majority of the published works in order to concurrently reduce both the area and the wire length.

This strategy will inevitably make it difficult to assign weights, which might lead to an undesired bias toward a certain goal. In a general sense, metaheuristics may be divided into two types [5], which include Population-Based Algorithms and Single-Solution Algorithms. Generally the Single solution-based algorithms are distinguished from population-based algorithms by the fact that single solution-based algorithms only generate one solution at a time. The VLSI floor planning problem has two main goals: to reduce the area as much as possible and to shorten the wires as much as possible. However, algorithms that are based on a single solution have the potential to become stuck in a local optimum, which might burdensome us from finding a global optimum. This is because these algorithms produce only a single answer and randomly chosen for a specific issue. Population-based algorithms have an innate capability that enables them to avoid reaching a local optimal solution [6]. As a consequence of this, several academics in the modern day are paying more attention to algorithms that are based on populations. The newly created bio-inspired metaheuristic algorithm for optimizing restricted problems is referred to as the SHO, and it is presented here in this work. As its name suggests, SHO attempts to simulate the social characters of spotted hyenas that are seen in their natural habitat.

The effectiveness of the SHO algorithm is examined via its application to the construction of optical buffers and airfoil issues. According to the findings, the performance of SHO is superior to that of the other algorithms that are currently in use.

II. Spotted Hyena Optimization

Spotted Hyena Optimizer is a metaheuristic optimization technique that was created by Dhiman et al. [7,8,9]. It was inspired by biological systems. This algorithm's overarching goal is to recreate the social interactions seen in spotted hyenas as accurately as possible. The SHO algorithm is broken down into four primary processes that get their motivation from the surrounding, hunting, attacking, and searching actions.

2.1 Objective function - Encircling Prey of proposed SHO

It is decided that the target prey or objective is the finest solution, and the remaining search agents are allowed to adjust their stand as per the best solution that has been obtained. Equations (1) and (2) represent the mathematical model of this behaviour, which can be written as follows: is subsequent to

$$\vec{D}_h = | \vec{B} \times \vec{P}_p(x) - \vec{P}(x) | \quad \ldots (1)$$

$$\vec{P}(x+1) = \vec{P}_p(x) - \vec{E} \times \vec{D}_h, \quad \ldots .(2)$$

Where Pp is the prey's position vector, P is the spotted hyena's position vector, B and E are vectors representing the co-efficients, and x is the current iteration number. The variable N represents the overall count of spotted hyenas, which may be determined using Equation (9).

2.2. Pursuing and Killing Its Prey

The mathematical framework for assaulting the prey is described by Equation (10) .E, the variable that determines whether a solution is higher than 1 or less than 1, is responsible for the search for the optimal solution (3). When it comes to exploration, the epsilon (B) component is yet another essential part of the SHO algorithm. As can be seen in Equation, it is made up of random numbers that represent the random prey weights (3). To emphasize the significance of the distance, suppose that the vector B > 1 has precedence over the vector B 1. A more chaotic behaviour of the SHO algorithm will be brought to light in this way. The SHO method is able to tackle a wide variety of high-dimensional problems while simultaneously avoiding the challenge of finding the local optimal solution. In the Algorithm, you may get a description of the pseudo code that the SHO algorithm uses.

Convergence analysis of the SHO method is shown in a 2D setting using the three metrics shown in Figure 1.These metrics are displayed in the figure. The following is a discussion of the metrics that were utilized:

a) The search history displays the history of the locations of spotted hyenas when optimization is being performed.

b) The value of the first variable is shown by Trajectory at each iteration of the algorithm. The trajectory curves show that during the early phases of optimization, spotted hyenas undergo dramatic and unexpected changes in behaviour. This phenomenon, as described by Berg et al., may ensure that a Swarm-based technique would ultimately converge to a point in the search space.

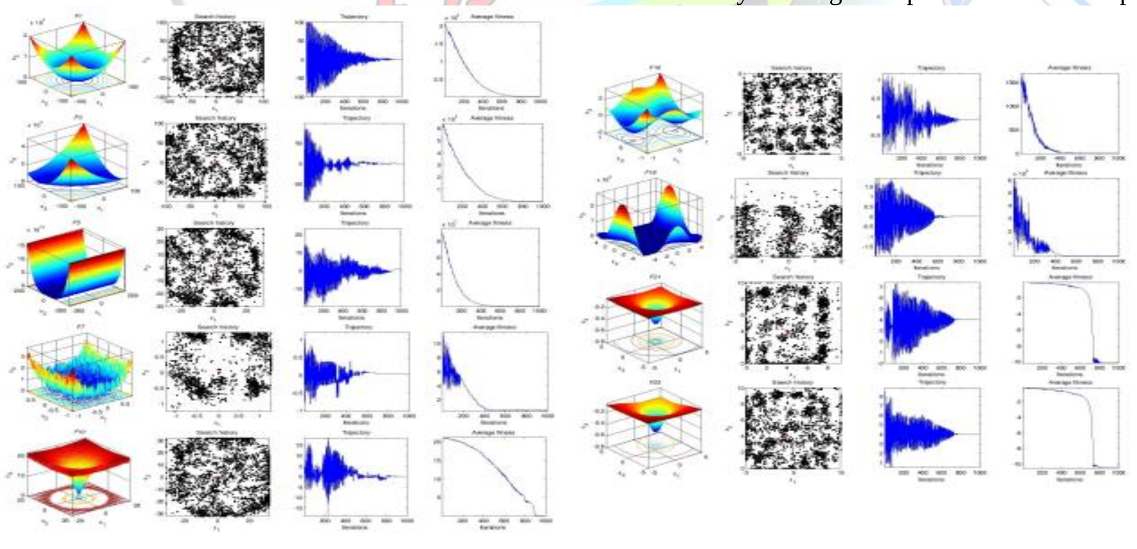

Figure.1. The search history, trajectory, and average level of fitness of SHO

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET) Vol. 10, Issue 7, July 2023

c) An individual's average fitness level is their overall average objective value throughout all iterations of the test. All of the test functions exhibit a declining trend in the behaviour of the curves. This demonstrates that using the SHO approach results in a more accurate approximation of the optimal solution while running simulations. As a result, the SHO method has a high success rate when it comes to the computational aspects of addressing optimization issues.

III. SHO FOR FLOOR PLANNING OPTIMIZATION

This issue is a case of nonlinear mixed integer programming, and it involves a total of five subsystems. The mathematical formulation can be described in the following manner:

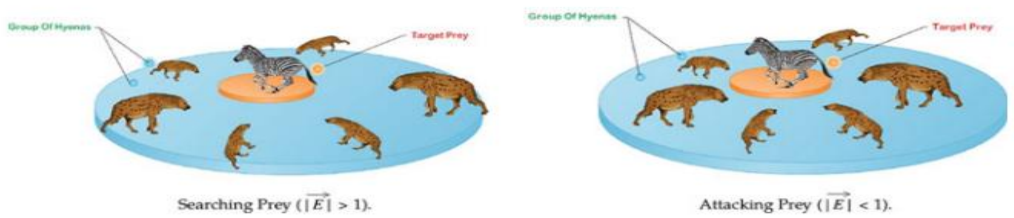

Figure.2. The spotted hyena's hunting and attacking behaviours

The characteristics of the spotted hyena's is shown in figure 2.

A flowchart of the suggested SHO algorithm may be seen in figure 3, which can be found below.

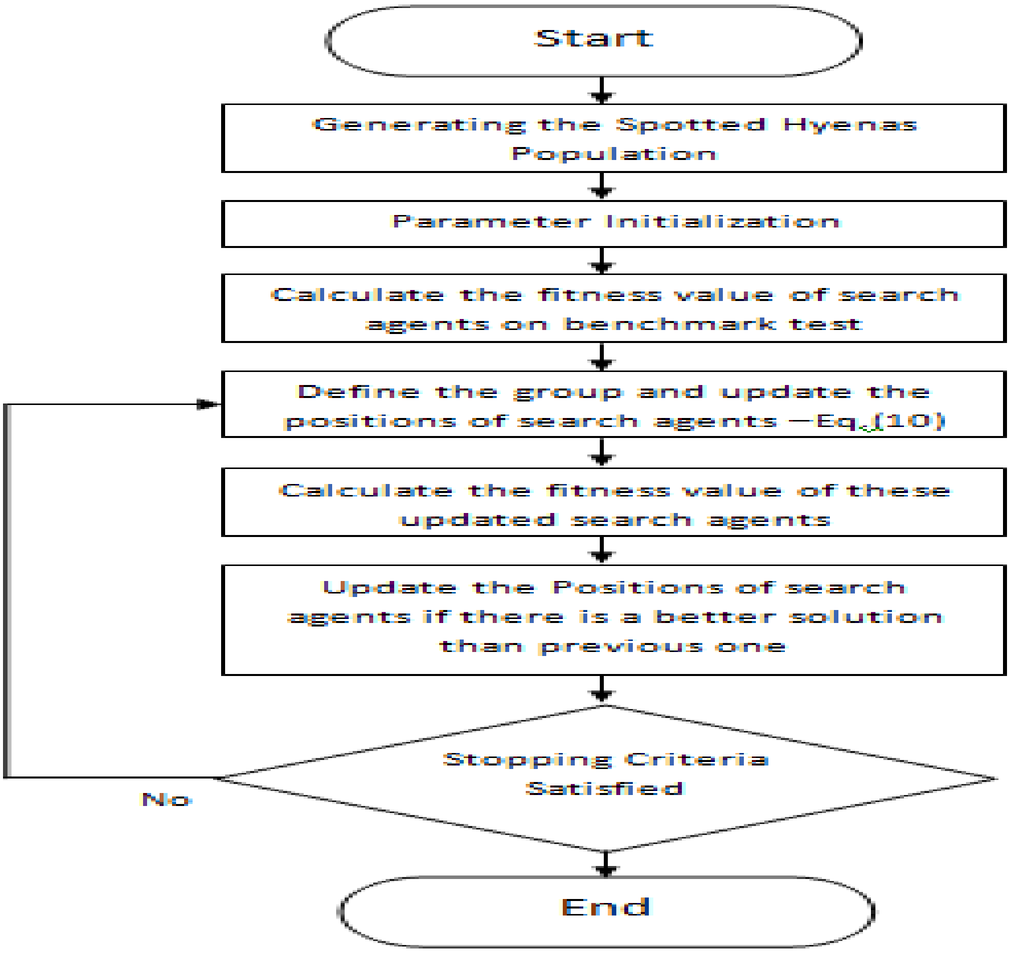

Figure.3. Optimization flow chart

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 10, Issue 7, July 2023

The capacity of an algorithm to explore its environment is referred to as its searching mechanism. The SHO technique that has been presented assures that this capacity is met by utilizing E with random values that are higher than. It is the responsibility of vector B to validatea more randomized behaviour of SHO and to prevent reaching a local optimum (Fig. 3). The many aspects of this issue are laid forth in a table. On display here are the most optimum outcomes produced by the suggested SHO as well as other competitor techniques. The results demonstrate that the SHO approach can handle this nonlinear mixed integer programming challenging bridge system problem in a reasonable period and delivers the most optimal solution, as illustrated in figure 4.

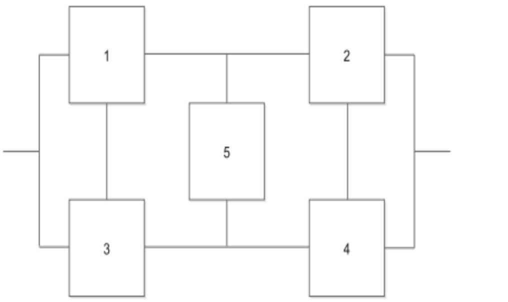

Fig. 4. Schematic viewof Floor planning

Maximize f = C1C2 + C3C4 + C1C4C5 + C2C3C5 − C1C2C3C4 − C1C2C3C5 − C1C2C4C5 − C1C3C4C5 − C2C3C4C5 + 2C1C2C3C4C5subject to:

$$r_1 = \sum_{k=1}^{m} w_k v_k^2 n_k^2$$

$$r_2 = \sum_{k=1}^{m} \alpha_k \left(-\frac{1000}{ln(r_k)} \right) [n_k + exp(0.25 n_k)] - D \leq 0$$

$$r_3 = \sum_{k=1}^{m} w_k n_k exp(0.25 n_k) - W \leq 0$$

$$0 \leq r_k \leq 1, \quad n_k \epsilon Z^+, \quad 1 \leq k \leq m.$$

----

(3)

where m is the number of subsystems, while k represent the physical characteristics of system components. where m denotes the number of subsystems and nk denotes the number of components. The maximum allowable cost is denoted by the letter D, while the maximum allowable weight is denoted by the letter W.

3.1.1 Genetic Variation (Mutation)

The classification of population-based algorithms is built on the theoretical underpinnings of evolutionary algorithms, algorithms that are based on the laws of physics, algorithms that are based on the swarm intelligence of particles. These are the foundations upon which the classification is built.The many stages of evolution, including reproduction, mutation, recombination, and selection, serve as an inspiration for the development of evolutionary algorithms. This survival fitness is measured in terms of the candidate's ability to solve a problem. The physical processes that are governed by certain physics principles. The collective intelligence of swarms serves as an inspiration for the algorithms that are based on swarm intelligence.

IV. Experimental Results and Discussions

The SHO method must adhere to these five criteria in order to successfully solve this issue. The procedure is iterated for a total of thirty times, and the results

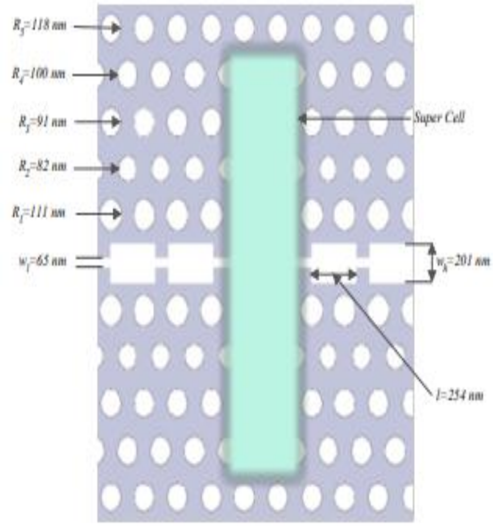

Figure.5. Optimized floorplan using the SHO algorithm

that are produced are presented in Figure 5. In contrast to the previous findings, the new ones show that using the SHO technique led to significant gains in bandwidth of 99% and 10% respectively.

V. Conclusions

The Bio-inspired optimization technique known as the Spotted Hyena Optimizer (SHO). Analyzing the social order and hunting activities of spotted hyenas is the primary objective of the SHO algorithm. In addition, the SHO technique is used in the solution of two real-life restricted engineering design problems, namely those pertaining to the design of an optical buffer and an airfoil, respectively. The findings that were achieved are then compared to the outcomes of other competing algorithms. The SHO algorithm is a powerful optimizer that, according to the results of engineering design problems, is capable of resolving these challenges and providing solutions that are

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 10, Issue 7, July 2023

virtually as good as the best possible ones.The design, implementation, and testing of a solution to the 2D rectangle packing problem (floor planning) are all done.

REFERENCES

1. Andrew Kahng, Jens Leinig, Igor L.Markov, and Jin Hu, "VLSIPhysical Design: From Graph Partitioning to Timing Closure," Springer, ISBN 978-90-481-9590-9, May 2011
2. B.Sowmya, Sunil M.P., "Minimization of Floor planning Area and Wire Length Interconnection Using Particle Swarm Optimization," International Journal of Emerging Technology and Advanced Engineering, vol. 3, Issue 8, August 2013
3. Jianli Chen, Wenxing Zhu, and M.M.Ali, "A Hybrid Simulated Annealing Algorithm for Nonslicing VLSI Floor-planning," IEEE Trans.onSystems,Man and Cybernetics, Part C, vol.41, No.4, pp. 544–553, July 2011.
4. P.N.Guo,C.K.Cheng, and T.Yoshimura, "An O-tree representation of non-slicing floorplan and its applications," Proceedings of 36th ACWIEEE Design AutoNation Cont., 1999, pp.268-273
5. Dhiman, G.; Kaur, A. A Hybrid Algorithm based on Particle Swarm and Spotted Hyena Optimizer for Global Optimization. In Advances in Intelligent Systems and Computing; Springer: New York, NY, USA, 2018; in press.
6. Dhiman, G.; Kumar, V. Multi-objective spotted hyena optimizer: A Multi-objective optimization algorithm for engineering problems. Knowl.-Based Syst. 2018, 150, 175–197.
7. Dhiman, G.; Kumar, V. Spotted hyena optimizer: A novel bio-inspired based metaheuristic technique for engineering applications. Adv. Eng. Softw. 2017, 114, 48–70.
8. Dhiman, G.; Kaur, A. Spotted Hyena Optimizer for Solving Engineering Design Problems. In Proceedings of the 2017 International Conference on Machine Learning and Data Science (MLDS), Noida, India, 14–15 December 2017; pp. 114–119.
9. Dhiman, G.; Kumar, V. Spotted Hyena Optimizer for Solving Complex and Non-linear Constrained Engineering Problems. In Advances in Intelligent Systems and Computing; Springer: New York, NY, USA, 2018; in press.