FUSION OF HARRIS HAWK'S AND PARTICLE SWARM OPTIMIZATION TO IMPROVE PERFORMANCE IN WIRELESS NETWORK

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Abstract: Wireless networks will develop as multi-hop transmission exploits among mobile nodes to communicate data packets. The unique features of wireless networks make it difficult for mobile nodes to communicate reliably. Most physical routing systems do not consider stable connections during packet transmission to manage high mobility and environmental impediments, which results in increased network latency and packet loss. This paper describes a Fusion of Harris Hawk's and Particle Swarm (HHPS) Optimization algorithms to improve performance in wireless networks. This mechanism uses Harris' hawk optimization (HHO) to select the better Group head (GH) by applying energy, link quality, and connectivity parameters. Then, the CH forms the groups based on the Particle Swarm Optimization (PSO) algorithm. To simulate tests of HHPS performance, Network Simulator NS-3 is used. Comparing HHPS to the baseline technique, the routing performs better. Simulation findings demonstrate that the proposed HHPS mechanism increases connectivity and coverage based on iteration.

Keywords: Harris Hawk's algorithm, wireless network, particle swarm optimization algorithm, coverage and connectivity, quality-of-service.

I. INTRODUCTION

The wireless network is a wirelessly connected, multi-hop temporary autonomous system comprising mobile nodes [1]. Nodes in the network have the ability to join and depart the network on demand. It is frequently employed in military and civilian applications because of its adaptable network capabilities and lack of infrastructure. Any node within a node's communication range may communicate with that node. However, a node utilizes the assistance of other nodes that act as bridges to receive and pass messages to connect with nodes outside its communication range [2]. The revolution in wireless communication is bringing about major changes to data networking as well as telecommunication.

PSO is a metaheuristic optimization method that takes its cues from the social behavior of animals, such as fish schooling or birds flocking together [3]. It may be used to generate grouping in wireless networks by optimizing the positioning of GHs and assemblage network nodes into groups. Grouping can be formed in wireless networks by using this method. Using PSO in a grouping capacity inside a wireless network may be approached in the following way:

Define the goal function and the restrictions for cluster formation in the wireless network [4]. Optimizing network coverage, decreasing energy usage, or balancing the load across GHs might be the aim function. Some examples of limitations are maximum distance limits between nodes and GHs, restrictions on available energy, and needs for network connection. Particle Initialization initiates a particle population, where each particle represents a possible grouping solution. This is known as the "Particle Initialization." Each particle comprises a position vector that records the locations of the GH and the distribution of network nodes throughout the various groups. The direction in which its velocity vector may represent each particle moves.

Using the objective function outlined in the issue formulation, evaluate the level of fitness possessed by each particle in the population. The fitness value represents how well the grouping problem is solved. The HHO algorithm was developed after the hunting techniques of Harris's hawks served as its primary source of inspiration [5]. It does this by simulating the tactics of these birds while they hunt together to address optimization challenges. Although HHO has generally been used for issues involving continuous optimization, it can also be adapted to increase throughput in wireless networks. An example of a generic strategy for employing HHO to optimize throughput is as follows:

Formulation of the Problem: Determine the Objective Function and Constraints for Optimum Throughput in a Wireless Network. Maximizing the overall throughput is the goal function, and the constraints include requirements. Initialization of the Population: Establish a population of Harris hawks as a possible solution to the problem [6]. Each Harris Hawk illustrates a different approach that may be used to solve the optimization challenge. It is important to have a varied population so that you may look in various parts of the search space. In the HHO algorithm, hawks behave similarly to hunters, including engaging in activities such as exploration, exploitation, and teamwork. Iteratively performing the following steps is the responsibility of every Harris Hawk in the population:

Exploration is making arbitrary changes to the location of the hawk to investigate a wider variety of potential answers inside the search space. This action motivates the hawks to look for better setups of the wireless network characteristics and encourages them to do so. Exploitation: Using the objective function, determine how well the hawk's position is doing. If the location of the hawk increases throughput, the position should be updated correspondingly. This stage implements the most effective of the previously discovered solutions. Collaboration is sharing information across different parties to increase overall performance and depth of knowledge. This may be accomplished by exchanging information on positions, velocities, and other data useful to the other hawks.

II. RELATED WORKS

The HHO method, which gets its name from the hunting behavior of Harris's hawks, is used to determine where the network mesh nodes should be placed for the best possible performance [7]. The optimization model considers various characteristics, including signal strength, node connection, and obstructions in the surrounding environment. After that, the HHO method is used to solve the optimization issue and establish the most effective configuration for the mesh nodes.

The Discrete HHO method is an improved variant of the HHO algorithm that was developed with the express purpose of tackling discrete optimization issues [8]. To handle the workflow scheduling issue that arises in multi-fog computing, the DHHO algorithm is used. The decision variables in this context reflect the assignment of jobs to fog nodes. This approach considers various restrictions, including the availability of resources, the task dependencies involved, and communication delays. After then, the DHHO method is used to search for the best task allocation, with the goal being to reduce the total makespan of the process as much as possible while still adhering to the limitations.

Selecting valuable features from a high-dimensional dataset is known as feature selection. The goal of feature selection is to increase the effectiveness and precision of machine learning models [9]. To achieve maximum effectiveness in the feature selection procedure, the improved HHO algorithm is used. It does this by using the exploration and exploitation capabilities of the HHO algorithm. The goal is to find the best possible subset of characteristics that will optimize the classification performance. The HHO technique is used in order to investigate the search space and locate the ideal feature subset that yields the highest possible degree of classification precision.

Load balancing is dispersing the workload over numerous virtual machines to optimize resource consumption, boost performance, and reduce response times [10]. The authors discuss the load balancing issue and provide a solution in the form of an improved algorithm. Their solution incorporates both the HHO method and multi-objective optimization. This mechanism reduces the time needed to respond while making the most efficient use of resources. It takes into account several parameters all at once to determine the best way to distribute the load.

The hunting behavior of Harris's hawks inspired the development of the HHO algorithm [11]. This method is used to optimize the control parameters of the MPPT algorithm and increase its tracking efficiency while operating in partial shade situations. The paper approaches the topic of MPPT control as an optimization job to achieve maximum power output. The HHO method searches for the optimum control parameters that allow precise tracking of the maximum power point despite partial shading.

Early stage prediction mechanism based on the Harris Hawk Optimizer and focuses on constructing behavior-based Deep Neural Networks [12]. This HHO model is used to fine-optimize the parameter values of a deep neural network in conjunction with its prey-seeking technique.HH-RF is an algorithm that is a mix of Harris Hawk Optimization and Random Forest and is mainly based on the ensemble learning technique [13]. This study presents a prediction of accurate data and a reduction in the amount of error in WSN nodes. To analyze the data coming from the sensor network, a model based on Principal Component Analysis has been presented as an effective means of data reduction.

The HHO algorithm is a population-based metaheuristic algorithm that takes its cues for its hunting strategy and cooperative behavior from the behavior of Harris hawks [14]. In this investigation, HHO is hybridized with ten distinct chaotic maps to fine-tune the system's essential parameters. Four distinct approaches may be used while carrying out hybridization.

Fuzzy-based Improved In order to choose a capable GH for data transfer, the HHO Algorithm (IHHO) is offered as a solution [15]. The fuzzy inference model considers balancing energy, distance from self to sink node, and proximity of nodes from GH as input inputs. Based on these considerations, the model evaluates whether or not a candidate node is qualified to become a GH . The IHHO simplifies and streamlines the logic, transforming it into a network that uses less energy and operates more effectively.

The HHO method is a recently suggested meta-heuristic optimization algorithm [16]. It mimics the hunting behavior of Harris hawks and aims to improve algorithmic performance. It has the qualities of fewer adjustment parameters and a significant optimization impact, both of which contribute to its excellent competitiveness compared to other optimization algorithms. However, when dealing with certain difficult optimization issues, HHO is prone to premature convergence and has poor convergence accuracy. K-medoids with HHO routing improve routing efficiency in [17]. The goals of this work are to increase QoS performance. This mechanism is used to reduce the amount of time that network transmissions are delayed and the amount of power used [18]. Ant based routing to optimize the path. This routing mechanism minimizes the extra energy consumption and balances the network load [19].

III. PROPOSED SYSTEM

The proposed system assumes that a certain mix of mobile nodes is scattered around in a rectangular space in a random fashion. The structure of the wireless network is shown in Figure 1.

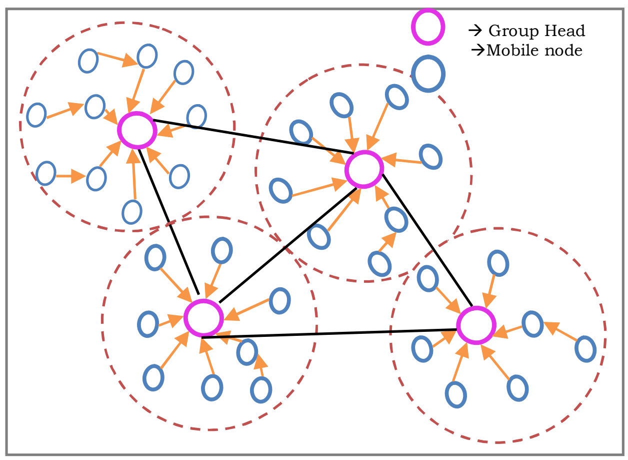

Fig. 1 Structure of the proposed system

Every mobile node has no idea where it is in the network. The features of the mobile nodes dispersed over the network are consistent across all. The size of the nodes included inside the covered areas is used to quantify the level of coverage provided by the wireless network. On the other hand, the connectivity is determined by adding up the number of nearby nodes that create the group within their transmission range. This is done to determine which nodes are connected. The QoS may be determined primarily by these two primary elements. The fundamental objective of the HHPS mechanism is to optimize the wireless network and, therefore, to enhance the network coverage, leading to a reduction in network congestion. Figure 2 illustrates the block diagram of the HHPS system.

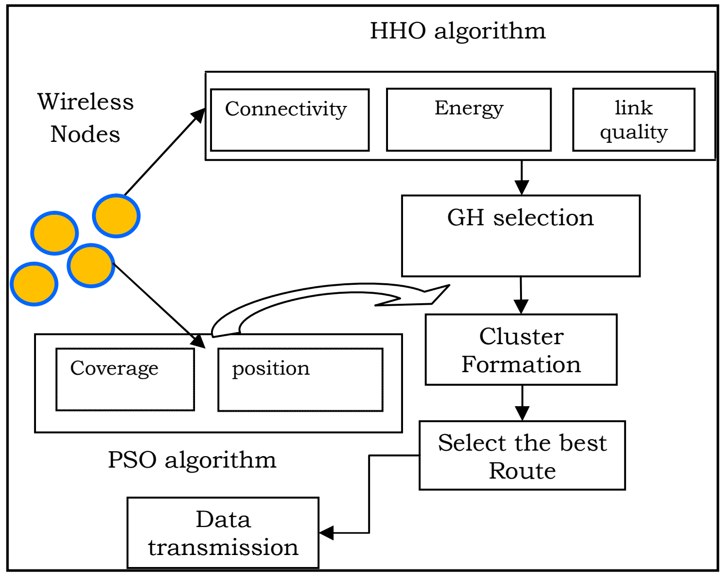

Fig. 2 Block Diagram of the HHPS system

The HHO is conceptualized by observing the hunting techniques of Harris's hawk. These birds choose a land in the air, survey their surroundings for potential prey, and launch a concerted assault on the target. In HHO, the behavior of hawks when they are perched is treated as the scouting phase, whereas hawks' behavior while foraging is modeled as the exploiting phase.

Exploration Phase: Optimization techniques need an exhaustive exploration of the issue landscape to identify the most effective and generally applicable solution to a problem. During the exploration phase of the algorithm, the met heuristic search procedure initiates the search to locate the optimal point in the search space, which is between hills and valleys.

Exploitation Phase: The term "exploitation" refers to the process whereby several possible solutions for a problem converge on previously determined promising spots in the search space. After a few cycles have been completed, this phase is initiated to investigate the issue landscape. When a possible neighborhood has been found thanks to the combined knowledge of the search agents, the next step is to devise tactics that will help candidate solutions progressively. HHO offers a number of different exploitation tactics geared at different eagle-hunting scenarios to overcome this problem.

A method that selects accurate and efficient data-transmission pathways using an algorithm modeled after natural processes and a novel probabilistic decision-rule function has been suggested. This method utilizes the natural world as its primary source of inspiration. The recommended optimization technique opts for GHs after considering both the exploration and exploitation stages. When selecting a GH, some factors to consider are the amount of energy still available, the connectivity, energy, and the link quality.

Group Formation: Determine the termination condition for the algorithm, such as when the maximum number of iterations has been reached or when a sufficient clustering solution has been found. This is part of the termination criteria. The grouping solution is indicated by the particle's location with the greatest fitness value (gbest), which is the output after the algorithm has completed its execution. From the gbest position, it is possible to extract the GHs as well as the distribution of network nodes among the groups.

PSO is a contemporary example of a random search algorithm that bases its approach to the problem-solving process on the idea of social communication. It employs a number of particles that get together to form a predetermined swarm (group), which then travels all over the network space d in search of the optimal solution. These solutions each have a fitness value determined by the fitness function. Here, pbest (PB) denotes the coverage of one's previous best, while gbest (gb) denotes the coverage's of the whole swarm.

The particular use of PSO for grouping in wireless networks could call for considering network-specific factors like coverage and velocity. In addition, the algorithm should have suitable methods for group creation and group maintenance in order to guarantee the construction of effective and reliable groups.

Data transmission Path: Although it lengthens the distance between GHs and the nodes they correspond to in the group, doing so requires extra energy so that CHs can communicate with one another. Therefore, efforts should be made to reduce the energy required for intra-cluster communication.

III. RESULTS AND DISCUSSIONS

This section describes the process of the HHPS mechanism using NS3 simulations to measure the performance. The NS3 simulator's major language is C++ and Python. Here, the 100 mobile nodes are distributed in a rectangle region. Each node's communication range is 250 metres, and the packet size is 1024. Variable Bit Rate traffic flow is utilized. The Transmission Control Protocol is used to transmit the data. The coverage of HHRF and HHPS mechanisms based on iterations are explained in Figure 3.

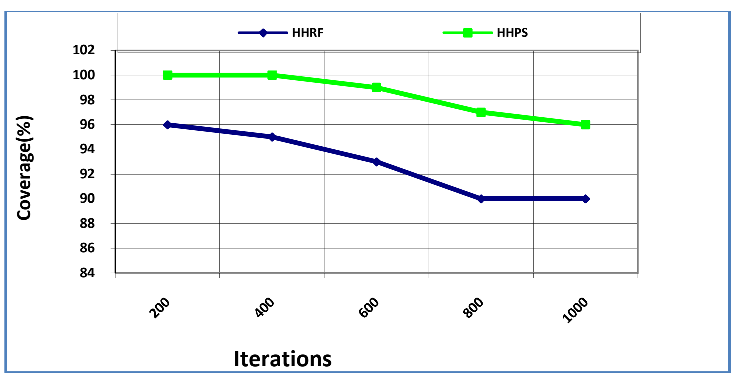

Fig. 3 Coverage based on Iterations

Figure 3 illustrates how much better the coverage performance of HHPS is compared to HHRF algorithms. The proposed system attains more excellent coverage and a higher decrease in congestion for optimum deployment. A coverage rate of 99% is produced using the HHPS method. Figure 4 illustrates the network size of HHRF and HHPS mechanisms based on iterations

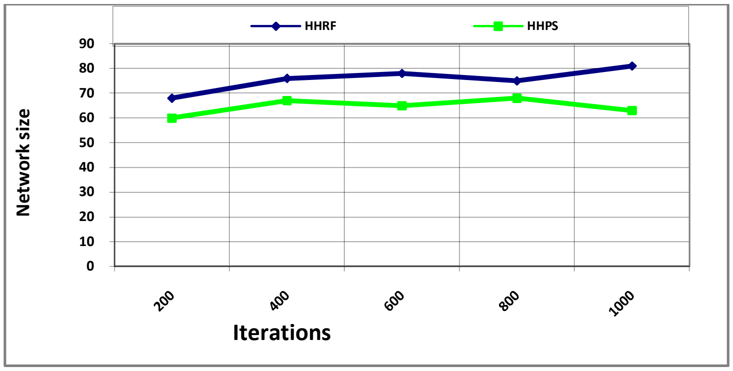

Fig. 4 Network Size based on iterations

Figure 4 illustrates how well the HHPS performs when evaluated based on iterations compared to the HHRS mechanism. The HHPS method successfully decreased the network size based on 100 to 1000 iterations, respectively. However, the current approach causes the network size to grow whenever iterations increase. Figure 5 explains the HHRF and HHPS mechanisms based on iterations.

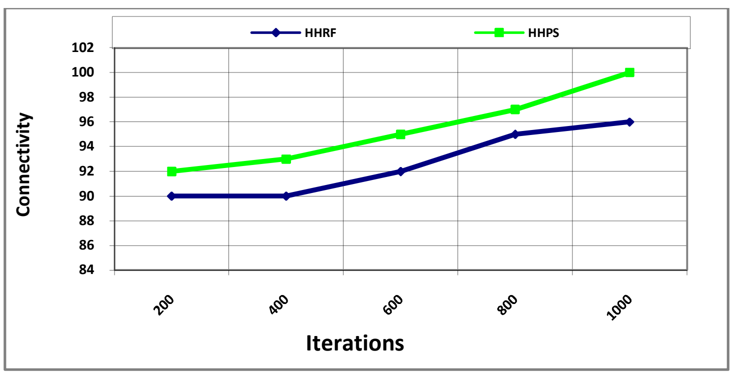

Fig. 5 Connectivity based on iterations

The proposed HHPS mechanism also raised the connectivity when the iteration count is raised. Due to this, the HHPS mechanism selects the GH by applying the HH algorithm and forms the group based on the PS algorithm. But, the HHRF mechanism has the lowest connectivity percentage because the HHPS mechanism creates congestion.

IV. CONCLUSIONS

In recent years, wireless networks have focused on many industrial and real-time applications. This article introduced a Fusion of Harris Hawk's and Particle Swarm Optimization algorithms to improve performance. The clustering concept is used to increase energy efficiency and network reliability. This mechanism uses Harris' hawk optimization to select the better GL and forms the grouping by applying the PSO algorithm. Through optimization of the wireless network, the primary objective is to improve the network's connection and coverage; hence, increasing the performance Simulation findings demonstrate that the proposed HHPS mechanism increases the connectivity and coverage based on iteration. Furthermore, it minimizes the utilization of network resources in the wireless network. To further improve the wireless network's performance, an obstacle avoidance model and resource allocation is a significant contribution that should be considered.

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