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REVIEW OF VARIOUS OPTIMIZATION TECHNIQUES IN MANET

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Abstract: A Mobile Ad hoc Network (MANET) is characterized as an independent, self-organizing, and infrastructure-free system where multiple mobile nodes are interconnected through wireless links. Within MANETs, several routing protocols exist, including AODV, DSDV, TORA, and DSR, among others. The dynamic topology and lack of infrastructure in MANETs present various challenges and limitations that can impact network performance, such as mobility, overhead, battery depletion, latency, and interference. To address these challenges, various optimization techniques can be employed to identify the most effective solutions. Nature-inspired algorithms, which are metaheuristic approaches that emulate natural processes, have emerged as a promising avenue for solving optimization problems in computational contexts.

***Keywords*: Routing, MANET, Optimization Algorithms, Bio Inspired Algorithms**

I.INTRODUCTION

A Mobile Ad Hoc Network (MANET) is made up of independent nodes that can adjust themselves and work together without needing a fixed infrastructure. In a MANET, devices can move around freely in any direction. Some key features that set MANET apart from other wireless networks include dynamic topology, node mobility, lack of infrastructure, and multi-hop forwarding.

In order to create a communication pathway between nodes, it is essential to implement effective routing protocols. In Mobile Ad Hoc Networks (MANETs), several routing protocols exist, which can be classified into three primary categories: Reactive, Proactive, and Hybrid routing protocols. Reactive Routing Protocols identify routes solely on an as-needed basis and do not proactively seek out routes. They do not continuously update their route tables. Examples include AODV, DYMO, TORA, and ARA. In contrast, Proactive Routing Protocols maintain a table for each node that contains the most current routing information to neighbouring nodes, thereby keeping track of their local environment. This involves the periodic exchange of control messages. Examples of proactive protocols are DSDV, OLSR, and WRP. The integration of Reactive and Proactive Routing Protocols is classified as Hybrid Routing Protocols, with examples such as ZRP, FSR, HOPNET, and DDR. Through Optimization, it is possible to identify the most favourable solution among various outcomes. Different Optimization methods can be employed to determine the optimal solution. Among these, biologically inspired algorithms represent a category that mimics natural processes. These algorithms are advantageous for several reasons: firstly, they do not require adherence to traditional mathematical methods to arrive at a solution; secondly, they yield results quickly and with a high degree of accuracy.

Optimization approaches which fall into the category of these algorithms are:

- Ant Colony Optimization
- Particle Swarm Intelligence
- Genetic algorithms
- Artificial Bee Colony Optimization
- Artificial Neural Networks
- Bacterial Foraging Algorithm

II.RELATED WORK

Karthikeyan, D. and Dharmalingam, M [5] present a study on the ant colony optimization (ACO) algorithm, which draws inspiration from natural processes. This methodology facilitates the development of routing algorithms in Mobile Ad Hoc Networks (MANETs). The approach involves autonomous agents that engage with one another, allowing for the analysis of their collective behaviour to identify optimal global solutions. A routing algorithm focused on energy efficiency is proposed for MANETs, aiming to prolong the overall system's lifespan by reducing the energy consumption of individual nodes. Swarm intelligence, a form of computational intelligence, encompasses the collective actions of autonomous agents that interact locally within a distributed setting to address specific problems, with the objective of achieving a comprehensive solution.

Nancharaiah, B. and Mohan, B.C. [7] present a study focused on ant colony optimization (ACO) and particle swarm optimization (PSO). In the ACO framework, ants function as mobile agents that identify the most optimal paths, which subsequently inform the particle swarm optimization process. Within PSO, the selection of a particle's position and velocity is based on the best previous values, aiming to minimize both cost and delay. The integration of these two methodologies yields superior results compared to ACO alone. PSO effectively determines the optimal solution by evaluating the position and velocity of particles, with the goal of reducing costs and minimizing end-to-end delay. This hybrid algorithm demonstrates enhanced performance when contrasted with the ACO approach.

Al-Ghazal, M.et al.[4] focus on an algorithm that combines genetic algorithm (GA) and cluster head gateway switching protocol (CGSR) to enhance routing in clustering algorithm. The genetic algorithm (GA) maintains current state information about the nearby network and its mechanisms enable systems to self-configure. Genetic algorithms determine the optimal path from source to destination in a network, although it may not always be the shortest route. They also allow a node to swiftly and effectively modify routing information to adapt to a constantly changing local topology, resulting in fewer link breakages and reducing MAC layer overhead.

Alireza, S. et al. in [6], an algorithm utilizing particle swarm optimization (PSO) is introduced for multicast routing within mobile ad hoc networks. This PSO-based approach demonstrates superior performance and speed compared to multicast routing methods based on genetic algorithms (GA). The primary emphasis of the study is on enhancing energy consumption efficiency and minimizing delay during multicast routing. This involves the selection of nodes that exhibit the least energy consumption during route selection, thereby facilitating the construction of a multicast tree that achieves minimal delay. The issue was framed as a PSO problem, leading to the development of an innovative multicast routing algorithm grounded in PSO principles.

Anuj, K. and Harsh, S in [8], 1. This paper primarily addresses the complexities associated with routing, which is recognized as one of the most demanding tasks. Ant Colony Optimization (ACO), a method rooted in swarm intelligence, presents an effective approach for the development of routing algorithms. In this process, ants identify the optimal path by depositing a chemical substance known as pheromone. There are numerous parallels between ants and mobile ad hoc networks (MANETs), particularly in terms of their physical structure, configuration, and routing origins. Researchers have successfully applied this collective intelligence mechanism to enhance ad hoc networks.

Shah, S.K. and Vishwakarma, D.D. in [10], This paper suggests a way to enhance the performance of reactive AODV routing protocol by using an artificial neural network optimization technique. The frequency of Hello interval between events is adjusted to assess network performance. Updating information at fixed intervals may lead to unnecessary traffic, so making the time interval adaptive can help improve network performance in wireless communication.

Zulfiqar Ali and Waseem, S. in [9], This paper explores two methodologies rooted in swarm intelligence: ant colony optimization (ACO) and particle swarm optimization (PSO). Both methodologies facilitate multipath and loop-free routing within ad hoc networks. A variety of routing algorithms have been developed based on swarm intelligence for Mobile Ad Hoc Networks (MANETs), including the Node Neighbour Number Algorithm (NNNA), the GPS/Ant Line Routing Algorithm (GPSAL), and Accelerated Ants Routing (AAR). Each of these methodologies offers optimized routing solutions and is characterized by its meta-heuristic nature. Routing algorithms based on swarm intelligence are particularly advantageous for the unique characteristics of ad hoc and sensor networks, given their inherent mobility and frequent changes in topology. Computational intelligence techniques are effectively employed to address NP-hard problems, yielding promising results.

Harpreet K., Jasmeet S. in [11], specialized in writing content about a bio-inspired optimization algorithm called bacterial foraging optimization algorithm (BFOA).This algorithm mimics the behavior of bacteria and is used in different areas.A new protocol called BFAODV is suggested, which is a result of applying the BFOA technique to the AODV protocol.This protocol helps enhance various network performance metrics and decreases energy usage and the workload of neighbor discovery processes.

E. Hemalatha, J. and Dr. Kannammal in [12], This study presents a novel framework utilizing the Artificial Bee Colony Optimization technique within Mobile Ad Hoc Networks (MANET) to enhance route discovery. This method aims to identify the global optimum value and is based on the collective intelligence exhibited by artificial honey bees. The Artificial Bee Colony Optimization (ABCO) algorithm has proven to be an effective approach for determining multiple stable paths between source and destination nodes.

III. DIFFERENT OPTIMIZATION APPROACHES FOR MANETs

A. Ant Colony Optimization (ACO)

ACO, or Ant Colony Optimization, is a meta-heuristic approach that draws inspiration from the foraging behavior exhibited by ants. This optimization method was introduced by Dorgio and Dicario in 1999. The framework consists of three primary functions:

- Ant Solution Construction: In this phase, artificial ants navigate through neighbouring states of the problem.
- Pheromone Update: After a complete solution is constructed, the pheromone trails are revised.
- Daemon Actions: In this step, additional pheromone is applied to enhance the best solution found.

B. Particle Swarm Optimization (PSO)

Introduced by Kennedy and Eberhart in 1995, Particle Swarm Optimization (PSO) is a stochastic optimization technique that relies on population-based strategies. This approach is inspired by the social behaviors exhibited by flocks of birds and schools of fish. In PSO, each individual is represented as a particle, which possesses both a velocity and a position. The best position for each particle is identified based on the highest fitness value achieved.

The PSO algorithm consists of several essential steps:

- Initialize particles within a designated search space.
- Evaluate the performance metrics of each particle.
- Compare each particle's fitness value with its personal best (pbest). If a particle's value exceeds its pbest, this value is updated as pbest.
- Update the particles' positions and velocities accordingly.

C. Genetic algorithms (GA)

This methodology was introduced by Holland in 1975. The genetic algorithm represents a category of computational models grounded in the principles of natural selection. Among various optimization techniques, it stands out as the most potent. These algorithms draw inspiration from the process of human evolution. Genetic algorithms excel in optimization tasks and are commonly referred to as function optimizers. Within this framework, a population of solutions, termed chromosomes, is initialized for the algorithm. The fitness of each chromosome is assessed using a suitable fitness function. Subsequently, the most fit chromosomes are chosen to undergo crossover and mutation, resulting in improved offspring. Genetic algorithms prove to be beneficial and effective under the following circumstances:

- When the search space is extensive, complex, or poorly understood.
- No mathematical analysis is available.
- When domain knowledge is limited, making it difficult to refine the search space.
- For problems that are complex or vaguely defined, as they operate based on their internal mechanisms.
- When traditional search methods are inadequate.

D. Artificial Bee Colony Optimization (ABC)

Various swarm intelligence algorithms are available, inspired by the behavior of bees in nature.One of these algorithms, proposed by Basturk and Karaboga, is based on the foraging behavior of honeybee swarms.These algorithms are divided into two categories: foraging behavior and mating behavior.
In ABC algorithm there are mainly three groups of bees:

- Onlookers
- Employed
- Scouts

For a food source, bee waiting for making a decision is referred as onlookers. As it goes to the food source, which it visited before is named as employed bee. The bee carries out random search referred to as scouts.

E. Bacterial Foraging Optimization Algorithm (BFOA)

This algorithm represents a global optimization technique that draws inspiration from the foraging behavior of the bacterium Escherichia coli. The Bacterial Foraging Optimization Algorithm (BFOA) is particularly influenced by the chemotactic behavior exhibited by these bacteria, which navigate towards food sources by detecting chemical gradients. The strategy for processing information is executed through a series of distinct processes:

- Chemotaxis: Individual cells traverse the surface sequentially.
- Reproduction: The most effective bacteria are selected to contribute to the subsequent generation.
- Elimination and Dispersal: Ineffective cells are removed, and new samples are introduced.

IV. CONCLUSION

Optimization is the key to finding the best solution from different possibilities. There are many techniques for optimization that can be used to get better results. The main goal is to make the network more reliable and efficient without losing any original data during transmission. It is important to use these optimization methods based on the situation.

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