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RESEARCH ARTICLE

A Review on Artificial Bee Colony in MANET

Richa Kalucha[1], Deepak Goyal[2]

[1]M.Tech Student, Vaish College of Engineering, MDU, Rohtak, Haryana (India)

[2]Associate Professor, Vaish College of Engineering, MDU, Rohtak, Haryana (India)

Abstract- Swarm intelligence models the collective intelligence in swarms of insects or animals. To solve wide range of problems, many algorithms that simulate these models have been The Artificial Bee Colony (ABC) algorithm is one of the swarm intelligence algorithms based on a particular intelligent behavior of honeybee swarms. ABC was introduced to solve numerous optimization problems. ABC maximizes the lifetime of network and provides an effective multi-path data transmission in efficient manner.

Keywords: WSN, ABC, ACO, PSO

I. Introduction

Classical Optimization problems are inefficient in solving large scale combinatorial problems and these cannot adapt solution algorithm to a given problem. Classical optimization techniques have several limitations on solving mathematical programming and operational research models. To overcome these many natures inspired algorithms were developed like genetic algorithms, simulated annealing and tabu search. A Branch of inspired algorithms known as swarm intelligence mimics intelligent behavior of animals living in a community such as birds, fish and insects. Swarm intelligence has advantages such as scalability, fault tolerance, adaptation, speed, modularity, and parallelism Algorithms based on swarm behavior have been developed to solve computational and complex problems in different areas such as Ant Colony Optimization, Particle Swarm Optimization, Bee Colony Optimization etc. Artificial Bee Colony (ABC), a swarm intelligence based algorithms was given by [Karaboga (2005)], which mimics' the foraging behavior of honey bee colonies. Various SI based routing protocols, like ABC, have been implemented for wired networks, satellite networks, MANETs, and, more recently, WSNs. The advantage of such organizations is that it can react quickly to changes in the network.

II. MANET

Mobile Adhoc Network (MANET) is a collection of mobile nodes that can communicate to each other via radio waves. The mobile nodes that are in radio range of each other can directly communicate, whereas others need the aid of intermediate nodes to route their packets. These networks are fully distributed, and can work at any place without the help of any infrastructure. This property makes these networks highly exile and robust [1]

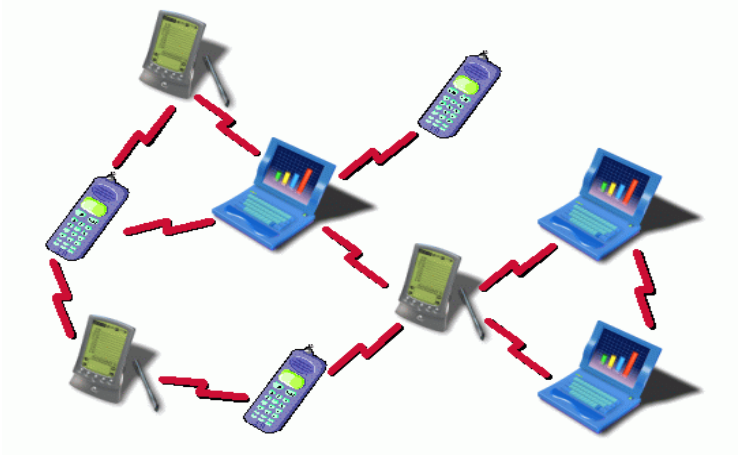

Figure 1: MANET

A. MANETs characteristics

1) Distributed operation: There is no background network for the central control of the network operations, the control of the network is distributed among the nodes. The nodes involved in a MANET should cooperate with each other and communicate among themselves and each node acts as a relay as needed, to implement specific functions such as routing and security.
2) Multi hop routing: When a node tries to send information to other nodes which is out of its communication range, the packet should be forwarded via one or more intermediate nodes.
3) Autonomous terminal: In MANET, each mobile node is an independent node, which could function as both a host and a router.
4) Dynamic topology: Nodes are free to move arbitrarily with different speeds; thus, the network topology may change randomly and at unpredictable time. The nodes in the MANET dynamically establish routing among themselves as they travel around, establishing their own network.
5) Light-weight terminals: In maximum cases, the nodes at MANET are mobile with less CPU capability, low power storage and small memory size.
*6) Shared Physical Medium***:** The wireless communication medium is accessible to any entity with the appropriate equipment and adequate resources. Accordingly, access to the channel cannot be restricted.

B. Advantages of MANETs

The following are the advantages of MANETs:
1. They provide access to information and services regardless of geographic position.
2. These networks can be set up at any place and time.

C. Disadvantages of MANETs

Some of the disadvantages of MANETs are as follows:
1. Limited resources and physical security.
2. Intrinsic mutual trust vulnerable to attacks.
3. Lack of authorization facilities.
4. Volatile network topology makes it hard to detect malicious nodes.
5. Security protocols for wired networks cannot work for ad hoc networks.

D. Attacks on MANET

1. Black Hole- In a black hole attack a malicious node injects false route replies to the route requests, announcing it as having the shortest path to a destination [2]. These fake replies can be fabricated to divert network traffic through the malicious node for simply to attract all traffic towards it in order to perform a denial of service attack by discarding the received packets.

2. Worm Hole:- In a wormhole attack, an attacker receives packets at one point in the network, ―tunnels‖ them to another point in the network, and then replays them into the network from that point. Routing can be disrupted when routing control message are tunneled. This tunnel between two colluding attacks is known as a wormhole. [3]

3. *Denial of Service-* Denial of service attacks aim at the complete disruption of the routing function and therefore the entire operation of the ad hoc network. In a routing table overflow attack the malicious node floods the network with bogus route creation packets in order to consume the resources of the participating nodes and disrupt the establishment of legal routes

4. Flooding:- Malicious nodes may also inject false packets into the network, or create ghost packets which loop around due to false routing information, effectively using up the bandwidth and processing resources along the way. This has especially serious effects on ad hoc networks, since the nodes of these usually possess only limited resources in terms of battery and computational power. Traffic may also be a monetary factor, depending on the services provided, so any flooding which blows up the traffic statistics of the network or a certain node can lead to considerable damage cost.

*5. Sinkhole:-*In a sinkhole attack, a compromised node tries to attract the data to itself from all neighboring nodes. So, practically, the node eavesdrops on all the data that is being communicated between its neighboring nodes. Sinkhole attacks can also be implemented on Adhoc networks such as AODV by using flaws such as maximizing the sequence number or minimizing the hop count, so that the path presented through the malicious node appears to be the best available route for the nodes to communicate.

6. Sybil attack: - The Sybil attack especially aims at distributed system environments. The attacker tries to act as several different identities/nodes rather than one. This allows him to forge the result of a voting used for threshold security methods. Since ad hoc networks depend on the communication between nodes, many systems apply redundant algorithms to ensure that the data gets from source to destination. A consequence of this is that attackers have a harder time to destroy the integrity of information

7. *Eavesdropping-* It is another kind of attack that usually happens in the mobile ad hoc networks. Eavesdropping means to obtain some confidential information that should be kept secret during the communication. The confidential information may include the public key, private key, location and passwords of the nodes. Because such data are very confidential to the nodes, they should be kept secret so that unauthorized nodes can't access this.[4]

III. ACO

ACO is one of the Bio-inspired mechanisms. ACO is a dynamic and reliable protocol. It provides energy aware, data gathering routing structure in wireless sensor network. It can avoid network congestion and fast consumption of energy of individual node. Then it can prolong the life cycle of the whole network. ACO algorithm reduces the energy consumption. It optimizes the routing paths, providing an effective multi-path data transmission to obtain reliable communications in the case of node faults. The main goal is to maintain the maximum lifetime of network, during data transmission in a efficient manner.[5] ACO was inspired by the observation of ant colonies. Ants are social insects. They live in colonies and their behavior is governed by the goal of colony survival . ACO is inspired by the ants foraging behavior, and in particular, how ants can find shortest paths between food sources and their nest.[5,6,7] When searching for food, ants explore the area surrounding their nest randomly. While moving, ants leave a chemical pheromone trail on the ground. Ants can smell pheromone. When choosing their way, they tend to choose path having strong pheromone concentrations. As soon as an ant finds a food source, it evaluates the quantity and the quality of the food and carries some of it back to the nest. During the return trip, the quantity of pheromone that an ant leaves on the ground may depend on the quantity and quality of the food. The pheromone trails guide other ants to the food source .The indirect communication between the ants via pheromone trails—known as stigmergy [8]—enables them to find shortest paths between their nest and food sources.

IV. PSO

Particle swarm optimization (PSO) is a popular multidimensional optimization technique [9]. Ease of implementation high quality of solutions, computational efficiency and speed of convergence are strengths of PSO. PSO has been a popular technique used to solve optimization problems in WSNs due to its simplicity, high quality of solution, fast convergence and insignificant computational burden. However, iterative nature of PSO can prohibit its use for high-speed real-time applications, especially if optimization needs to be carried out frequently. PSO requires large amounts of memory, which may limit its implementation to resource-rich base stations. Literature has abundant successful WSN applications that exploit advantages of PSO. Data-aggregation needs frequent distributed optimization, and fast solutions: Thus PSO moderately suits it. Static deployment, localization and clustering are the problems solved just once on a base station [10].

Particle Swarm Optimization (PSO) simulates swarming behaviors from flocks of birds, schools of fish, or swarms of bees, and even human social behavior. PSO is a population-based optimization technique proposed by Kennedy and Eberhart in 1995 [11].PSO is based on social behavior of bird flocking or fish schooling.[12] PSO algorithm adopts a strategy based on particle swarm and parallel global random search. In PSO, a population of particles starts to move in search space by following the current optimum particle and changing the position in order to find out the optima. This algorithm finds search path according to the velocity and current position of particle. The position refers to a possible solution of the function to be optimized and the evaluating the function by particle's position provides the fitness of that solution PSO algorithm has better performance than early intelligent algorithms on calculation speed and memory occupation, and has few parameter [13].

PSO is based on the study of migration behaviors of bird flock in the process of searching food. In this process, each bird can find food through social collaboration of neighboring birds and the birds who have found food can provide information to other birds around them to fly to the food location. Once these birds also find food, they can guide more birds to find the location that increases the possibility of bird flock finding food [14]. Each swarm always moves to the own local optimum solution and the global optimum solution. PSO can be well adapted to the optimization of non-linear function in multi-dimensional space.

V. Artificial Bee Colony Algorithm

The ABC algorithm is a swarm based algorithm based on the foraging behavior of honey bee colonies. It is a very simple, robust and population based stochastic optimization algorithm. The performance of the ABC algorithm is compared with those of other well-known modern heuristic algorithms such as Genetic Algorithm (GA), Differential Evolution (DE), Particle Swarm Optimization (PSO) on constrained and unconstrained problems [15-17].

The ABC algorithm is composed of three bees: employed bee, onlooker bee and scout. Half of colony consists of employed bees, and the other half consists of onlooker bees. Employed bees exploit the nectar sources explored before and provide information to the onlooker bees waiting in hive about quality of food source [18] Scouts either randomly search the environment in order to find a new food source based on an internal motivation or on possible external clues [18]. One of the employed bees is selected and treated as the scout bee. The selection is controlled by a control parameter called "limit". If a solution representing a food source is not improved by a predetermined number of trials, then that food source is abandoned by its employed bee and the employed bee is converted to a scout. The number of trials for releasing a food source is equal to the value of "limit" which is an important control parameter of ABC. [19]

This emergent intelligent behaviour in foraging bees can be summarized as:-

1. At the initial phase of the foraging process, the bees start to explore the environment randomly in order to find a food source.
2. After finding a food source, the bee becomes an employed forager and starts to exploit the discovered source. The employed bee returns to the hive with the nectar and unloads the nectar. After unloading the nectar, she can go back to her discovered source site directly or she can share information about her source site by performing a dance on the dance area. If her source is exhausted, she becomes a scout and starts to randomly search for a new source.
3. Onlooker bees waiting in the hive watch the dances advertising the profitable sources and choose a source site depending on the frequency of a dance proportional to the quality of the source.

Phases of ABC

ABC contains four main phases:

1. Initialization Phase:

The food sources are randomly generated by scout bees. Each food source is generated as follows:

$$x_{ij}=x_j^{min}+rand(0,1)(x_j^{max}-x_j^{min}) \qquad (1)$$

where i = 1. . .SN, j = 1. . .D. SN is the number of sources and D is the number of optimization parameters.

2. Employed Bee Phase:

Employed bee finds a new food source within the neighborhood of the food source. Employed bees memorize the higher quantity food source. The Employed bee shared the food source information with onlooker bees. A neighbour food source is determined by the following equation:

$v_{ij=}x_{ij+}\Theta_{ij}(x_{ij}\text{-}x_{kj})$ (2)

xi represents the existing position of the food source and vi is a candidate source formed by changing one parameter randomly selected from xi. J is a random integer between [1,D], and k is another random integer between [1,SN] as long as it is different from i value. Φij is a real random number in the range [-1, 1].

3. Selection Phase of Onlooker Bees.

In this phase, Onlooker bees calculates the profitability of food sources by observing the waggle dance in the dance area and then select a higher food source randomly . Each onlooker bee selects one of the food sources depending on the fitness value obtained from the employed bees:

$$p_i = \frac{\text{fitness}_i}{\sum_{i=1}^{SN}\text{fitness}_i} \quad (3)$$

where fit(x i) is the fitness value of solution i. The fitness of food sources is essential in order to find the global optimal.

4. Scout Bee Phase.

In this phase, after all employed and onlooker bees complete their searches, the ABC algorithm checks if there is any exhausted source to be abandoned. The food source is assumed to be abandoned if position cannot be improved further through a predetermined number of cycles. The scouts can accidentally discover more food sources. The value of predetermined number of cycles is called “limit” for abandoning a food source:

$$x_{ij}=x_j^{min}+rand(0,1)(x_j^{max}-x_j^{min}) \quad (4)$$

where i = 1. . .SN, j = 1. . .D. SN is the number of sources and D is the number of optimization parameters.

VI. Previous Work

1. Brajevic et al. (2011) presented an improved ABC algorithm for constrained problems which contain discrete and continuous variables [20].
2. Karaboga (2005) Numerical Proposed a new optimization algorithm (ABC) based on the intelligent behavior of honey bee swarm. [21]
3. Karaboga and Basturk (2007) Proposed a powerful and efficient algorithm for numerical function optimization and compared with other optimization algorithms. [22]
4. Chong et al. presented a bee colony model built on foraging bahaviour and waggle dance, and the model was applied on job shop scheduling [23]
5. Nadezda Stanarevic (2011) performed a work on Modified artificial bee colony algorithm for constrained problems optimization [24]

VII. Advantages

Artificial bee colony (ABC) algorithm uses few control parameters, have fast convergence. Both exploration & exploitation possible with help of ABC algorithm. ABC can be easily hybridized with different meta heuristic algorithms and components makes it robustly viable for continued utilization for more exploration and enhancement possibilities.
Artificial bee colony (ABC) algorithm simulating this behaviour of real honey bees is described for solving multidimensional and multimodal optimization problems

VIII. Conclusion

As compared to other swarm based algorithms, ABC is simple and very robust. ABC algorithm uses simple control parameters, so it can be used for solving multimodal and multidimensional optimization problems. ABC algorithm can also be applied to both combinatorial and functional optimization problems. When the performance of ABC is compared with other swarm based algorithms such as Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO) and also with classical optimization algorithms, most of the studies indicated that performance of ABC is better than other methods.

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