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An Artificial Bee Colony is Used to Find the Optimal Route in a Mobile Ad-Hoc Network.

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Abstract - The procedures that are used in artificial bee colony simulations can be conceived of as a form of preliminary assessment that is used to find exact or approximate solutions to problems that call for dynamic refinement and search. These procedures are used to find solutions to problems that call for searching and dynamically refining data in real time. These kinds of algorithms are also known as global search heuristics in certain circles and communities. These tactics are an example of dynamic optimization, and they can assist in discovering the quickest path as well as addressing other concerns that are involved with optimization. They model their behavior after that of biological bees in a variety of contexts, including acting as food sources, working as professional foragers, and collecting unemployment benefits, amongst other activities. These solutions give software applications the ability to automatically optimize the configuration settings that they make use of, which is an extremely useful feature. In addition, the findings of the tests demonstrate that employing the ABC method in order to determine the most effective way to direct traffic is better than employing any other technique, and that it enhances performance even when confronted with conditions that are difficult to anticipate. This is demonstrated by the fact that the method is superior to employing any other technique in order to determine the most effective way to direct traffic.

Index Terms—Shortest Path Routing Problem (SPRP), Artificial Bee Colony, Dynamic Optimization Problem (DOP), and Foraging Behavior.

I.INTRODUCTION

A mobile ad hoc network, also known as a MANET, is a self-organizing and self-configuring multi - hop wireless network that is made up of a collection of mobile hosts (MHs) that are able to move freely and relay messages on behalf of one another. This type of network is also known as ad hoc networking. As a result of the introduction of routing capacity into MHs, MANET is able to continue operating in a dependable and cost-effective manner. When used in MANETs, the unicast routing algorithm creates a multihop forward channel between two nodes that are located beyond the range of a direct wireless connection. This allows the nodes to communicate with one another. The nodes are able to maintain their communication with one another as a result of this. Additionally, even in the event that links on these systems are severed as a result of node movement, voltage fluctuation, radio propagation, or wireless interference, the integrity of the attributes is maintained by routing mechanisms. This is the case even though it is possible for these systems to be disrupted. Routing is one of the most critical parts of multihop networks that needs to be taken into consideration because it has such a big influence on the performance of the networks as a whole. Because of this, in order to build routing tables or carry out an indirect search for routes. Every node that takes part in a geographic routing seems to be aware of its own position and therefore is able to make routing information based on the location of the destination as well as the access points that are considered to be its native neighbors. These decisions can be made in response to both the location of the destination and the nodes that are considered to be its native neighbors. It is standard procedure for us to analyze the drawbacks of the shortest route (SP) routing, which is classified as topological routing. This is done in order to improve our practices. Finding the shortest path (SP) from the chosen source of the provided network to the intended destination while simultaneously lowering the overall cost of the trip as much as possible is the objective of the SP routing drawback. This can be accomplished by minimizing the amount of time spent in transit. The SP routing problem is a typical illustration of a combinatorial optimization challenge that can appear in a variety of guises and can be triggered by a variety of different situations [1, 3]. This problem can also manifest itself in a number of different ways. There are many alternative deterministicsearch techniques that may be used to solve the SP problem. Some examples of these algorithms are Dijkstra's approach, the comprehensiveness simulated annealing process, the Bellman–Ford algorithm, and a great deal of other similar algorithms. These algorithms always have a polynomial degree of complexity in terms of the amount of time they take. They operate competently in the wired as well as the wireless infrastructures of a network that uses fastenedinfrastructure. However, they display an unacceptable high process computational complexity for real-time communications, including rapidly changing network topologies [2]. This is due to the fact that they are unable to adapt to rapidly changing network topologies. This is because they are unable to keep up with the constantly shifting topologies of the network, which is the root cause of the problem. As a result, we would like to implement relevant new approaches in order to solve the dynamic SP routing issue (DSPRP) in a network environment that is always evolving. In recent years, the DSPRP has become a topic of attention, and the literature has a number of works that are handled with within the DSPRPs. There are fundamentally two different kinds of routing protocols used in MANETs. These are topological routing and geographic routing. In recent years, the DSPRP has emerged as a topic of discussion and inquiry. Access points make use of the topological information while they are engaging in topological routing so that the routing can be more effective.

A. The Routing Process Within the MANET

In MANETs, the Network layer is often employed as a conduit for the transmission of information between different layers of the system. Finding a path between the source nodes and the destination nodes along which data packets can be sent is the primary purpose of routing in MANETs. This is the core goal of routing in MANETs. An examination of the topology of the network is one method for achieving this goal. A MANET routing algorithm has the ability to not only select the path that would result in the shortest distance between the source and the destination, but it also has the flexibility to be modified so that it may fulfill the prerequisites of the network in question. The vast majority of MANETs do not have their very own built-in connections to other nodes. Because of the dynamic nature of the MANET's environment, the connections are less able to deliver the required level of service quality (QoS). MANETs, on the other hand, have a nature that is multi-hop in nature, which is an additional feature. In order for the data packet to reach its ultimate destination, it will have to go via a number of intermediate nodes first. In order for the MANETs to be able to satisfy these additional requirements, the MANETs' antiquated algorithms will need to be modernized. Every MANET routing algorithm is comprised of three important parts: the route discovery mechanism, the route error correction mechanism, and the route maintenance mechanism. Route errors can occur for a number of reasons.

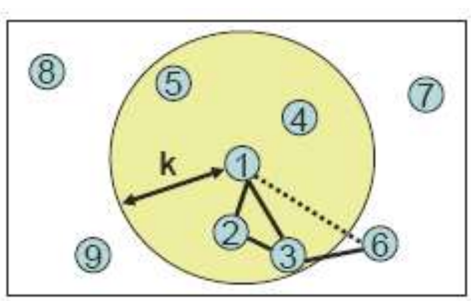

Fig. 2. Sample shortest paths in a MANET.

B. Finding Inspiration in the Natural World

C. A Problem With SP Routing

This investigation centers mostly on the idea of applying Artificial Bee Colony Optimization to the challenge presented by MANETs. Recent developments in computer science have led to the establishment of a variety of methodologies that have been inspired by biology. One of these methodologies is called "Artificial Bee Colony Enhancement," and it is becoming increasingly popular. Just two instances of the strategies that have been sparked as a result of this phenomenon are the particle swarm optimization and the bacterial foraging. The application known as Artificial Bee Colony Optimization recreates the actions of bees as they are foraging for honey in their natural environment. The behavior of flocks of birds as they go from one location to another in search of food served as the impetus for the development of a method of optimization known as "particle swarm." The microorganism hunting algorithms rule is a model that describes the behavior of microorganisms exploring their environment in search of food. This rule has only been around for a relatively short amount of time. These tactics are inextricably linked by the very nature of their design, and when considered from the point of view of optimization, they entail the process of looking for the best possible response within a given search universe. When similar patterns seen in nature are applied to tough technical difficulties, it has been shown that they produce superior solutions [10-14]. [10] It has been proven by a large number of different researchers.

II.SWARM INTELLIGENCE

For the purpose of resolving combinatorial and numeric optimization issues, several contemporary heuristic approaches have been developed. These algorithms will, in fact, be categorized into groups according to the many different criteria that are taken into consideration. The standard will be created, iterative, and population-based all at the same time. The term "swarm intelligence" (SI) refers to the behavior of natural and artificial processes, as well as decentralized, self-organizing systems. The implementation of this idea in computer systems that simulate intelligence. In the context of mobile AI systems, the SI system was primarily made up of a population of simple agents that interacted with one another in their natural environment. In most cases, nature, and more specifically the biological system, is the origin of such ideas and concepts. The agent adhered to extremely basic guidelines, and although there were no structures that were centralized and controlled that defined how each agent should really have behaved, locally, and to some degree randomly, contact amongst agents of the same kind resulted in "intelligent" behaviors that were unknown to the individual agent. An example of SI in a natural ecosystem would be something like an ant colony, a school of fish, a flock of birds, swarming creatures, or growing objects. At the moment, there is no agreed-upon definition of what exactly swarm intelligence is. In the course of a principle, it ought to be multi-agent systems that have the capabilities of self-organization and intelligence. An assembly of animals demonstrating behavior as a group is referred to as a swarm. Examples of swarms include fish stocks, bird flocks, and insect colonies such as ant, termite, and bee colonies. Every single agent that makes up a swarm demonstrates probabilistic behavioral patterns that are indicative of her awareness of the world around her. Swarm intelligence is a collective intelligence that is created when native rules that have no link to the global pattern and interactions between agents that have self-organized themselves lead to the formation of the intelligence. The core ideas behind swarm intelligence are self-organization and synergy, sometimes known as stigmergy.

Self-Organization: Bonabeau et al., in their essay titled "Swarm Intelligence," which was published in 1999, provided the following definition of self-organization: "Self-organization may be a set of dynamic systems procedures where formations appear at the global scale of a system from connections of its lower-level components" [22]. [S]elf-organization may be a set of dynamic systems procedures where formations appear at the global scale of a system from connections of [There is a need for citations] When attempting to quantify a self-organized system, there are three parameters that might be used. Structure, many stable states, and state transaction are all aspects that fall within this category of characteristics.

The development of a pattern from a state that was previously lacking in differentiation; for example, in the case of hunting routes or nests.

In their article titled "Swarm Intelligence," which was published in 1999, Bonabeau et al. introduced the following idea of self-organization in the field of architecture. According to the findings that they came up with, self "may be a set of dynamic systems approaches whereby formations evolve at the global level of a system from linkages of its lower-level components" [22]. [Furthermore, some citations...] The regulation of the quantification of data that is self-organized can be accomplished by using three different parameters. Structure, multi-stability, and the ability to shift between states are three of the most important features.

The production of patterns from settings that did not initially exhibit any differentiation; for example, the formation of hunting pathways or nests from circumstances that did not initially exhibit any differentiation.

III. ARTIFICIAL ALGORITHM OF THE BEE COLONY

Ensure better et al. presented the circuit of what self-organization includes in their work that was initially published in 1999 and was termed "Swarm Intelligence." According to what they discovered, self "may be a set of dynamic systems procedures whereby formations seem at the global level of a system from connections of its lower-level constituents" [22]. [Citation needed] [Furthermore, a few references...] Utilizing these three unique characteristics allows for the management of the quantification of data that has already been self-organized. Organization, multi-stability, and state transaction are only some of the essential features that make up these essential traits.

The development of patterns from settings that initially lacked differentiation; for instance, the establishment of hunting pathways or nests from conditions that were fundamentally undifferentiated.

A. Artificial Bee Colony Optimization, or ABCO, is an Algorithm for the Shortest Path Routing Problem (SPRP)

The subsequent operations are carried out in a loop until a condition that will cause the loop to end is satisfied.

a. Determine the amount of nectar that was collected by sending the worker bees to the various food sources.

a. Once the information that was gathered from the honeybees has been discussed, the observers will choose the food sources, and then they will estimate the amount of sugar that was produced by each food source.

c. Identify which of the bees will take on the role of scouts, and then dispatch them to explore the area in search of potential new food sources.

B.Pseudocode for ABCO algorithm:

a. To initiate the population, a selection of solutions should be chosen at random.

Bees are directed to their various food sources by the constant use of the letter b.

d. guides the bees to the locations of their food sources in accordance with the volume of nectar that is produced by the hive.

a. In order to find fresh sources of food, you should dispatch the scouts to the search zone.

f. Commit to memory the best possible source of nourishment that has been found up to this point in history.

f. Commit to memory the best source of nutrients found up to this stage in the investigation.

The search cycle at ABC is composed of the following three rules: I sending hired bees to a food source and evaluating the quality of the nectar; (ii) observers selecting food sources when obtaining information from employed bees and estimating the quality of the nectar; and (iii) recognizing scout bees and dispatching them to probable food sources. The bees will start the session by determining the positioning of the food sources and evaluating the quality of the nectar that is provided by each source. This will take place at the beginning of the session. The location of the nectar sources is subsequently communicated by worker bees to other bees in the hive that are waiting in the dance space. Once a worker bee has acquired the knowledge necessary to locate the food source, it travels back to the primary source that it frequented during the prior cycle in order to communicate this information. Once it has arrived at its destination, it employs its visual information to select a second food source that is located in the general vicinity of the first source. The last step of the procedure involves the associative in nursing observer selecting a food supply by using the data obtained from the worker bees who are engaged at the music event. The greater the overall quality of the nectar that a food source produces, the greater the possibility that it will be selected as a food source. As a result, the worker bee that has knowledge of a food source that has the most delicious nectar will invite the bystanders to go to that source. The animal then selects a different food source that is similar to the one that is securely kept in its memory, basing its decision on the facts that it has witnessed (i.e. comparison of food source positions). In order to take the place of the food supply that the observing wasps have abandoned, a scout bee will generate a totally new food source using criteria that are either completely random or completely arbitrary. The various operations that comprise the ABC algorithm. Charge the scouts with finding the key food sources and reporting back to you.

REPEAT

It is important to determine how much nectar the plants generate, so the worker bees should be dispatched to the flowering plants. The likelihood value of the sources with which the Onlooker bees have a preference must first be determined, and then the calculation must follow. Putting an end to the practice of exploiting the resources that the bees have left behind should be your first priority. Try dispatching the explorers into the region in a completely haphazard manner so that you can learn more about the region's potential for locating new food sources. Keep in mind the tremendous food supply that has been uncovered up until this point UNTIL (the prerequisites are satisfied) (requirements are met)

These three stages constitute each and every iteration of the search process:

I The process of moving the worker bees to the food sources and calculating how much nectar they have ingested from those sources

ii)after the information of the employed bees and the nectar amounts of the flowers has been communicated, the viewers will choose the food sources that will be used.

iii) Selecting the particular scout bees that will be dispatched and pointing them in the direction of potential food sources.

The bees will select at random a number of potential new food sources at the beginning of the session, and then they will calculate the amount of nectar generated by each of those potential new food sources. Stage 1: After that, these bees will enter the hive and discuss the locations of both the references of nectar with the bees that are currently waiting on the dance space within the hive. Stage 2: After that, these bees will leave the hive and return to the dance space. Stage 3: After that, these bees will leave the dance

The subsequent step, which takes place after the information has been disseminated, consists of all of the worker bees returning to the site of the food source that they had previously investigated during the prior cycle. This is done because the worker bee's memory of the food source is still quite fresh. She uses this information to select a new food source that is situated in close proximity to the one that is now being used.

At the third stage, an onlooker will choose a food source space based on the nectar information that is dispersed by the employed bees based on the tempo of the dance. This decision will be made based on the information that is provided by the dance.

The ABC algorithm is comprised of a number of important elements, constraints, and measurements, some of which are as follows:

In order to successfully implement the ABC method, there are a number of factors and limitations that need to be adhered to; these are summarized below.

a) An opportunity to find a solution to the dilemma, which involves a food source that must be optimized in some way.

b) The standard (fitness) of the solution that is represented by a particular food source relates to the number of nectars that are produced by that food source.

c) The quantity of solutions available within a population can be determined by the number of bees that are actively working or that are merely observing the situation.

d) A procedure that is mostly based on chance is used to pick the observers who will be placed on the food sources. The greater the quantity of nectar that a food source produces, the greater the probability that the food source will be the one that viewers choose as their primary source of nourishment.

g) Every bee colony has scouts, which serve the role of explorers for the colony. While they are searching for food, the explorers do not have any means of steering. The scouts have low search expenses and an occasional average in terms of the quality of the food sources they uncover because their primary responsibility is to discover new food sources.

It is imperative that the scouts study the primary food sources.

REPEAT

To determine how much nectar each flowering plant produces, the worker bees should be dispatched to the plants' flowering areas.

The likelihood value of the sources that the Onlooker bees favor must first be determined, and then the calculation can begin.

Put an end to the practice of using the resources that the bees have abandoned after they have completed their work.

You should make an effort to dispatch the explorers into the region in a haphazard manner so that you may ascertain whether or not new food sources can be uncovered.

Keep in mind the incredible food supply that has been discovered up until this point UNTIL (requirements are met)

Each iteration of the search is comprised of the following three phases:

I The transfer of the worker bees to the food sources and the subsequent measurement of the amount of nectar ingested by the worker bees from those sources.
ii) Once the observers have gained knowledge about the bees that will be used and the amount of nectar that will be produced by the flowers, they will choose the food sources.
iii) Determining which scout bees will be sent out and directing them to possible sources of food.

The bees will first select a number of potential future food source locations at random, and then the amount of nectar generated by each place will be computed. This will kick off the session. After this, the bees will enter the hive where they will discuss the positions of both nectar references while occupying the dance area of the hive.

The second stage consists of all of the worker bees going back to the food source that they went to during the stage before. This is due to the fact that the worker bee's memory of the food source is still quite fresh, which she utilizes to select a new food source that is geographically similar to the one that is now being used.

At the third stage, an observer will select a food supply location based on nectar information supplied by the employed bees based on the rhythm of the dance. This decision will be made based on nectar information supplied by the employed bees.

The ABC algorithm has the following qualities, limitations, and metrics that are considered to be among its most important:

In order to successfully execute the ABC method, it is necessary to adhere to a number of parameters and constraints, all of which are summarized below.
a) The possibility of finding a solution to the problem by utilizing a food supply that calls for optimization.
b) The standard (fitness) of the solution that is represented by a food source is proportional to the quantity of drops of nectar that are produced by that food source.
c) The number of possible solutions for a problem is directly proportional to the number of worker bees and observer bees present in a population.
d) A selection technique that relies primarily on randomness is used to place observers on top of food sources. There is a positive correlation between the amount of nectar that a food source provides and the possibility that it will be the most favored food source among bystanders.

f) Every bee colony has scouts that act in the role of explorers for the colony. The explorers are without direction while they look for a source of nutrition. Due to the fact that they are primarily responsible for identifying food supplies, the scouts have a reputation for having cheap search expenses and occasionally having food sources of middling quality.

IV.EXPRIMENTAL RESULTS

The ns-2 (14) network simulator was utilized during the development of the simulation testing. The sound reproduction, physical layer, and network layer simulations that are included in the ns-2 simulation environment are meant to simulate the development of propagation. The simulations include a thorough modeling of the IEEE 802.11 physical and Mac layers respectively.

The tests consist of nodes that are randomly arranged on an oblong plane region that is 1000 square meters in size. Each node moves in a manner that is consistent with the Random means purpose quality model that was established by Broch et al (1L5). [Citation needed] The way this model works is that each node starts off stagnant for a certain amount of disruptive time. After that, it selects a location somewhere inside the simulation area and starts moving towards it at a constant, distributed speed. This implies that the duration of the pauses, as well as the maximum rate at which random variables can be incorporated into the simulation, are what determine the "mobility" of the simulation. In our simulations, the maximum speed was set at 1 O [m/s], which is equivalent to the utmost speed that is possible for a pedestrian, and the pause time was adjusted between 0 [m/s], 30 [m/s], 60 [m/s], and 120 [m/s]. There is a tendency toward a condition characterized by high mobility for a stop time of 0 seconds; nevertheless, there is a tendency toward a condition characterized by sporadic quality for a halt duration of 120 seconds. The differences and similarities between the recommended algorithms and the current methods are laid out graphically in Figure 1. According to the findings of the study, the performance of ABC is superior to that of other algorithms, including GA, PSO, and ACO, while incurring the least amount of delay.

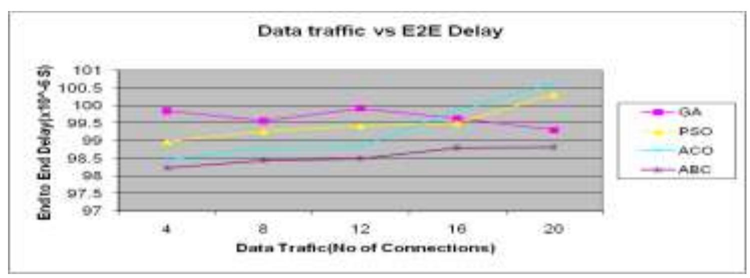

Fig 1 Comparisonof No. Of Connections Vs End to End Delay

Fig 2 Comparison of No. Connections Vs Throughput

V. CONCLUSION AND FUTURE ENHANCEMENT

In this study, the efficacy of the ABCO algorithm is examined in comparison to the GA algorithm, the PSO algorithm, and the PS-EA algorithm, all of which are examples of swarm intelligence and population-based methods to the resolution of complex problems. As a result of the fact that there are possibilities for further study, there are still a great number of issues that need to be resolved. One example of this is the investigation of the implications of controller parameters on the efficiency with which the ABC algorithm merges on solutions as well as the performance of the algorithm as a whole. This is just one example of the many issues that need to be resolved. The Artificial Bee Colony method, in contrast to other heuristic methods, requires a small number of control parameters in ability to successfully explore the path with the shortest distance. This is in contrast to other heuristic algorithms, which require an extremely large number of control parameters. It is possible that, at some time in the future, more research will involve a comparison of the Artificial Bee Colony algorithm to a large number of other possible optimization methodologies. In addition, research will be conducted to determine how the effectiveness of the ABC algorithm for simulcast routing in a dynamic environment is affected by the utilization of various constraint handling strategies.

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