An AHBeeP Swarm Intelligence Optimization Protocol for Wireless Routing in MANET

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ABSTRACT

The world around us is becoming increasingly complex every day and changes dynamically. The problems that we face require adaptive and scalable systems that can offer solutions with ever-rising level of autonomy. Traditional approaches are becoming obsolete because they were designed for a simpler world. Therefore, any advancement in understanding and solving of complex problems can have an impact on the entire set of disciplines in engineering, biology, sociology, etc.

Swarm Intelligence is a problem-solving comportment that occurs as a result of a diversity of interactions between independent components that make up the entire system. The algorithms stimulated by the supportive behavior of nature in colonies of animals and social insects, were initially applied to solve the traditional optimization problems. Swarm intelligence derived from the biological study of social insects and insight about how they manage to solve composite problems in their daily lives. Exploration field as swarm systems are examples of behavior-based systems. In today's scenario the main challenge is to transfer the packets of data from source system to destination system. In the proposed approach the optimization is used for transferring the data packets based on the honey bee's intelligence to communicate each other in the form of dancing language that can be useful for finding the shortest route in the wireless networks and also in optimized way of path finding.

***Keywords:** Swarm Intelligence, staggery, ACO, AHBeeP, Waggle dance.*

1. INTRODUCTION

Swarm Intelligence tactics are more hopeful for MANET's and WSN's due to the following prominent aspects interactions among themselves, availability of numerous paths, scalable performance robustness to failures, easiness of design and tuning.

MANET is nothing but the collection of mobile nodes that inter-communicate each other on the basis of shared wireless channels working in self-configured, infrastructure less networks.

In mobile adhoc networks the nodes are furnished with the connection establishment, flow and error control and connection termination capabilities. The mobile adhoc networks do not depend on any concrete infrastructure and no one having the centralized administration to control the network. In directive to connect every node in the network, each node will work as a router which will accept the data and forwards the packets of data to the other neighboring devices which are in the same range. With this approach the mobile node will also works as router, and with this feature it shows the fast deployment of wireless networks.

The unique characteristics of mobile ad hoc networks, such as shared wireless medium, open peer-to-peer network architecture, strict resource constraints and highly dynamic topology.

The use of Swarm Intelligence (SI) in solving multi model Traveling Salesman Problem (TSP) where a salesman desires to search for the shortest path through a set of towns on his duty. Visiting every node once and without repeating the city. In communication networks where the source needs to send some packets/information to the destination, or the intermediate devices routes the packets towards the specific destination. Although and many more applications are based on this mobile adhoc networks. The main task is to reduce the traffic congestion quite urgently because the amount of money lost due to congestion in traffic networks.

Nature has always encouraged researchers; by simple perceiving the environment by simply noticing the outlines, the set of rules that make seemingly messy processes logical. How do the social insects follow the path to a source of food? How do social insects communicate the messages optimally? These questions are answered by swarm intelligence. Swarm intelligence systems are candidates to meet the requirements of complex path and fault management problems in today's networks.

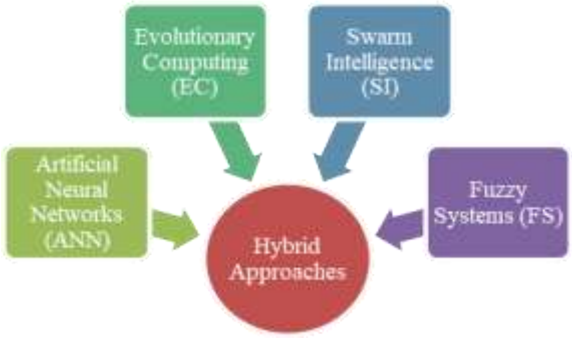

Fig. 1. General Optimization Approaches

Artificial bee colony optimization technique is currently handled in many research areas to crack optimization problems [13]. In real world practical approach, social insect's behavior can be adopted from environment and scheming its behavior in our real world application problem statements.

The overall organization of the paper is as follows, Section 2 describes the challenges in mobile networks and types of networks exist. In section 3 swarm intelligence paradigms are clarified in detail with Ant colony & Honey bee system algorithms. In section 4 simulation environment with performance metrics are elaborated and analyzed the both algorithms.

2. DYNAMIC DIVERSITY ENHANCEMENT SWARM OPTIMIZATION ALGORITHMS

Social insects behavior is always been a fascinating to human being in every aspects. In many areas the capabilities of social insects surpasses the human abilities. After observing the behavior of social insects, animals we have been able to find many interesting solutions which we can co-relate or module into our generic problems.

In this research paper a novel approach proposed as Adaptive Honeybee Protocol (AHBeeP) for mobile adhoc networks take footsteps on *swarm intelligence*. The first approach is ant colony algorithm and the second novel approach is honey bee colony optimization. The ants don't have direct communication instead they communicate by *stigmergy*. The shortest route discovery in ant colony is known as ant colony optimization which takes the help of pheromone. The honey bee colony optimization is a nature inspired discrete search space approach, which can be applied to find the best possible optimum solution.

2.1 Ant System Algorithm

Ant colony optimization is a swarm-based discrete search space approach which models the hunting behavior of ant colonies in nature. The ants through collaboration can solve the composite problems such as survival of fittest along with finding the shortest path to a food source. This feature can be used to solve the engineering problems that require this kind of optimization. When ants move to find the food, we assume that they start their journey from their nest and walks in the direction of food source. At the point where the ant is having two directions for the food source, while moving ants lays pheromone on its path. The path which is having concentration of pheromone indicates the flow of swarm, and observing the pattern of pheromone other ants will follows the same path. As the time passes the attentiveness of pheromone will also decrease this effect is known as dispersion.

The pheromone property is important because it helps to find current issues by integrating dynamic path searching process. While traversing from one location to another, ants leave pheromone trails on the edges connecting the two locations. The activated pheromone trails which is having more concentrated pheromone, attracts other ants that leads to pheromone trail accumulation.

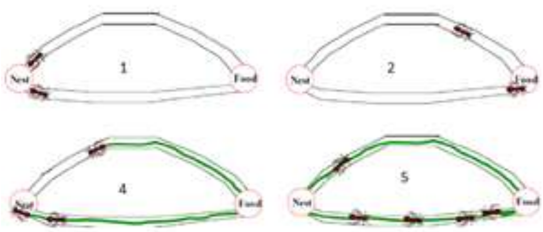

Fig. 2 (a): Ants Bridge Experiment (Cont.)

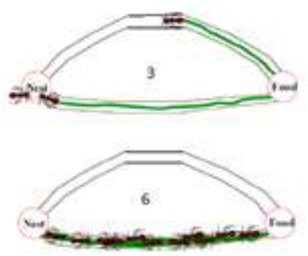

Fig. 2 (b): Ants Bridge Experiment

As the pheromone evaporates, negative feedback is applied through that path and importantly restrains the ants from taking the same path and allows for continuous search for improved solutions.

In this section we will discuss the working of ant colony optimization and adaptive honey bee colony optimization in mobile ad-hoc networks, the ACO works as follows,

2.1.1 Ant Colony Mechanism: In ant colony algorithm, new routes are discovered. The formation of new routes requires the use of backward ant and forward ant. The forward ant establishes path by the pheromone track to the source node. In contrast, a backward ant establishes the pheromone track to the destination node.

A forward ant [1] is advertised by the source and will be transmitted by the neighbors of the source as shown in figure 3.

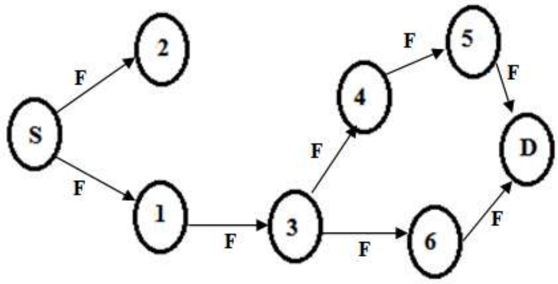

Fig. 3. Route Discovery Phase: FANT

In the process of destination finding, the forward ant arrives at to the destination node; it is processed in a superior way. The destination node extracts the information of the forward ant and destroys it. Afterward, it creates a backward ant and sends it to the source node as shown in figure 4.

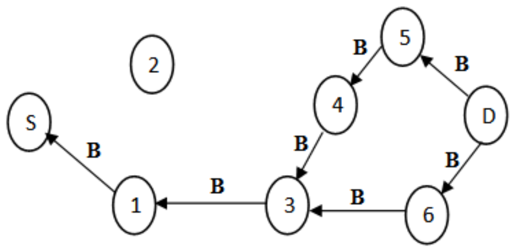

Fig. 4. Route Discovery Phase: BANT

When the source node receives the backward ant from the target node, the path is established and data packets can be sent. In fig. (4), we can see node 3 has two possible ways one is from via node 4 and second via node 6 respectively. Only one pheromone track is created by the forwards ant towards the source node, but the two pheromone tracks are created by backward ant towards the destination node [1]. In this way numerous path routing is also maintained by ant colony.

2.2 Honey Bee Swarm Intelligence

In 1944, a professor of zoology Karl Von Frisch, made a Nobel winner revolutionary discovery that the bee informs other hive mates of the distance and direction of the food source. To communicate other honeybees they use the dancing language known as waggle dance.

Honey bee dancing is one of the most intriguing behaviors in social insects. It is a form of direct communication that worker bees use to recruit other bees in the swarm to follow them to the resource site [16]. When a bee returns to the hive with a load of nectar that is sufficiently nutritious to guarantee return to the source, she performs a dance to share the information about the direction and location of the food source with other bees.

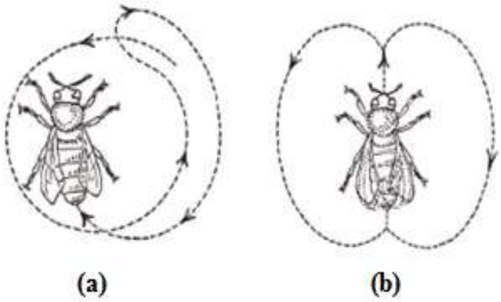

Fig. 5: Honey bee dancing language (a) Round Dance (b) Waggle Dance

Dance patterns may contain two items of information, namely distance and direction of the food source. If a food foundation is located close to the hive which is less than 50 meters the bee performs a round dance. If the food source is at a greater distance more than 150 meters the honey bee performs a "waggle dance" [17].

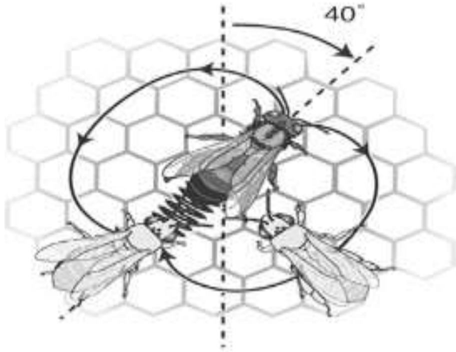

Fig. 6 (a): Waggle Dance

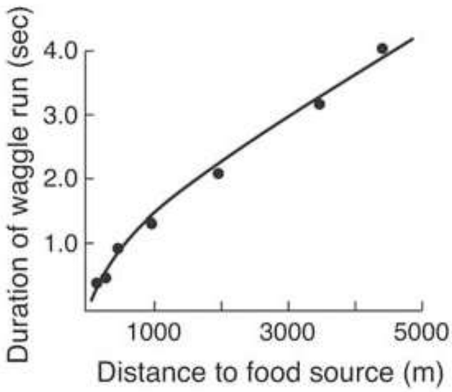

Fig. 6 (b): Bee Distance calculation

The interval of the waggle dance execution is proportional to the length of the outbound flight.

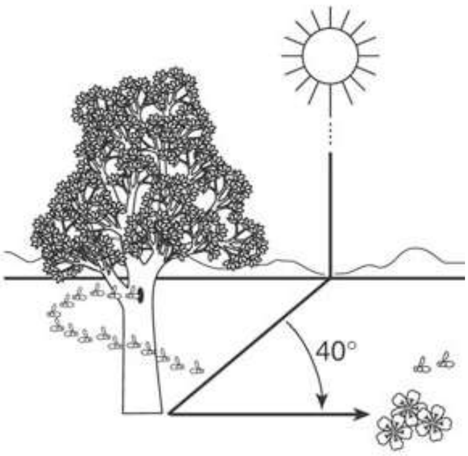

Fig. 6 (c): Bee Direction calculation

The forager bee who is optimistic regarding the information walks upwards while creating a waggle run pattern. The optimistic bee indicates that the nourishing point is in the same direction as with the sun. If the heads of the waggling bee is 50 degree to the right of vertical, her indication is that the nourishing point is 50 degrees to the right of the sun, as shown in fig. 6(c) [17].

2.3 Problem Statement

The main challenges of the wireless networks are the limited battery life and the mobility of nodes in the network. The mobility may arises different issues like connection establishment/ termination. The intention is to mimic the behavior in wireless communications, where different protocols are tested already. The objective is to analyze the two swarm intelligence methodologies and implement these methods in real life technical environment. These two protocols namely Ant colony optimization (ACO) and Adaptive Honey Bee Protocol (AHBeeP) are analyzed in the simulation environment and find the best protocol for the efficient and effective data communication.

3. AHBEEP ALGORITHM:

Initialization parameters:

Generate the initial population size as no,

set the best patch size as bp,
set the elite patch size as ep,
set the number of forager bees recruited to the of elite sites as nep,
set the number of forager bees around the non-elite best patches as nsp,
set the neighborhood size as ngh,
set the maximum iteration number as Maxitr,
set the error limit as Err.

Algorithm:

i=0;
Create initial population,
Evaluate Fitness Value of initial population
Sort the initial population based on the fitness result
while $i \leq Maxitr$ *or*
$FitnessValue_i - FitnessValue_{i-1} \leq Err$

i. $i = i+1$
ii. *Select the elite patches and non-elite best patches for neighborhood search.*
iii. *Recruit the forager bees to the elite patches and non-elite best patches.*
iv. *Evaluate the fitness value of each patch.*
v. *Sort the results based on their fitness.*
vi. *Allocate the rest of the bees for global search to the non-best locations.*
vii. *Evaluate the fitness value of non-best patches.*
viii. *Sort the overall results based on their fitness.*
ix. *Run the algorithm until termination criteria met.*

The Algorithm starts with sending no scout bees randomly to selected sites, The fitness values of each site are evaluated and sorted from the highest to the lowest according to the (bp) best sites are also classified into two sub-groups; elite and non-elite best sites, and for the global sites this process repeats[18]. Finally the overall locations are sorted according to their fitness value and the process runs until the global optimum is found.

4. SIMULATION ENVIRONMENT

The Network Simulator-2 (NS2) is employed to analyze the behavior of two protocols namely ACO and AHBeeP. Network Simulator-2 is a most widely used wired/wireless network simulator. Network simulator-2 targeted the group of people for the networking study and research. It provides substantial support for simulation of traditional as well as discovered protocols over wired and wireless networks. The various simulation parameters required are summarized as follows,

TABLE 1: SIMULATOR PARAMETERS

Simulation Constraints	
Simulator	Network Simulator-2.35
Protocols	ACO, AHBeeP
Simulation	500 Seconds
Simulation Area	600m × 600m
Number of Nodes	50-100
MAC type	Mac/ 802.11
Network Interface	Phy/ Wireless Phy
Link Layer type	LL
Channel Type	Channel/ Wireless

4.1 Performance Metrics

For analyzing ACO and AHBeeP protocols, we focused on three important performance parameters which are Packet Delivery Ratio (PDR), throughput, Routing Overhead.

4.1.1 Packet Delivery Ratio (PDR): The fragment of all the acknowledged data packets successfully delivered at the destinations over the number of data packets sent by the source is known as PDR. The performance of any protocol is measured based on the higher value of PDR, higher the value of PDR, accepted straightforwardly.

$$PDR = \frac{Number\ of\ Packets\ Received}{Number\ of\ Packets\ Send}$$

4.1.2 Throughput*:* Throughput is nothing but the average number of messages delivered successfully per unit time at the receiver i.e. acknowledged average number of bits delivered at the receiver per second.

4.1.3 Routing Overhead*:* Routing overhead is defined as the ratio of the total packet size of control packets including Hello packet, RREQ, RREP, and RERR to the total packet size of data packets delivered to the destinations.

4.2 Results

Following chart graphs shows the simulation results for the packet delivery ratio among ACO and AHBeeP.

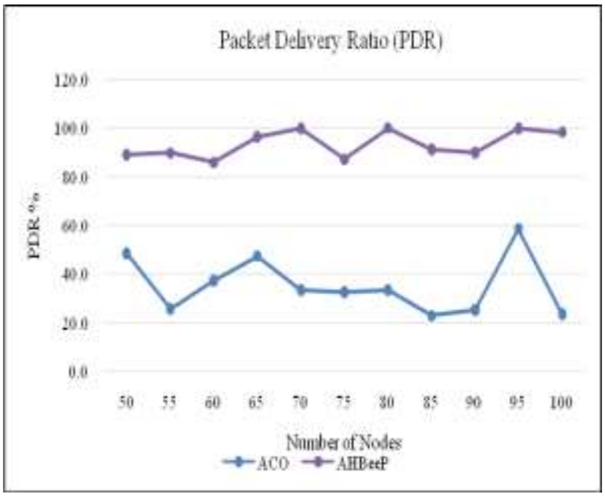

Fig. 7: PDR ratio of ACO & AHBeeP

From the above figure 7 it is obvious that the packet delivery ratio of AHBeeP protocol shows an extraordinary performance as compare to Ant Colony Optimization protocol. The performance of any protocol is considered based on the values of Packet Delivery Ratio (PDR).

Fig. 8: Throughput of ACO & AHBeeP

Figure 8 shows the throughput comparison of ACO and AHBeeP, it shows the performance of AHBeeP demonstrate the high throughput measures with comparing to ACO.

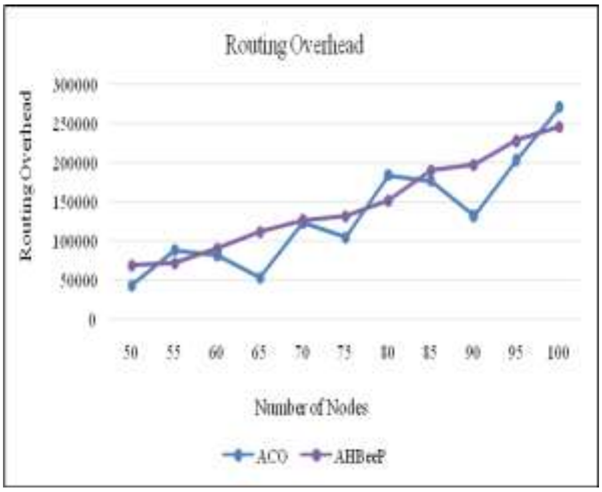

Fig. 9: Routing Overhead of ACO and AHBeeP

Figure 9, shows the routing overhead comparison of ACO and AHBeeP. Initially as the patches selection not cleared out that's why little high overhead appears in AHBeeP protocol. For nodes 75 and 100 proposed protocol works admirably.

5. CONCLUSION & FUTURE WORK

Swarm Intelligence (SI) based ACO and AHBeeP protocols provide exciting clarifications to network routing problems. AHBeeP based routing protocol in MANETs will enhance the efficiency and reliability of packet delivery. The AHBeeP shows out performance for the effective and efficient data communication in terms of packet delivery ratio and throughput in the MANET's. AHBeeP helps in reducing control overhead due to their inherent scalable feature. The proposed AHBeeP approach signifies the transmission of data from source to destination in an effective way as compare to the swarm's Ant colony optimization. In future, the scope will be to impart AHBeeP protocol in robotics or swarm-bots so that they will work as per the optimization proposed in this paper.

6. REFERENCES

[1] Mesut Gunes. Udo Sorges, Imed Bouazizi, "ARA-The Ant Colony Based Routing algorithm for MANET's", Proceedings of the International Conference on Parallel Processing Workshops (ICPPW'02), 1530-2016/02, 2002, IEEE Computer Society.
[2] Alexandros Giagkos, Myra S. Wilson, "BeeIP – A Swarm Intelligence based routing for wireless ad hoc networks", Elsevier Information Sciences 265, pp.23-35, 2014.

[3] Derviskaraboga, “an idea based on honey bee swarm for numerical optimization”, Technical Report-Tr06, october, 2005.
[4] Joshua Kirby, Marco A. Montes de Oca, Steven Senger, Louis F. Rossi, Chien-Chung Shen, “Tracking Time-Dependent Scalar Fields with Swarms of Mobile Sensors”, IEEE 7th International Conference on Self-Adaptive and Self-Organizing Systems, IEEE Computer Society, ISSN: 978-0-7695-5129, June 2013.
[5] Sorin Iliea, Costin Badica, “Multi-agent distributed framework for swarm intelligence”, ELSEVIER Proc., International Conference on Computational Science, ICCS 2013, 18 (2013) pp. 611 – 620, 1877-0509, 2013.
[6] JirapornKiatwuthiamorn, AritThammano, “A Novel Optimization Algorithm Based on the Natural Behavior of the Ant Colonies”, ELSEVIER Proc. 20(2013) pp. 90-95, 1877-0509, 2013.
[7] SifatMomen, “Ant-Inspired Decentralized Task Allocation Strategy in Groups of Mobile Agents”, ELSEVIER Proc. 20(2013) pp.169-176, 1877-0509, 2013.
[8] Omid Mohamad Nezami, Anvar Bahrampour, Paria Jamshidlou, “Dynamic Diversity Enhancement in Particle Swarm Optimization (DDEPSO) algorithm for preventing from premature convergence”, 17th Asia Pacific Symposium on Intelligent and Evolutionary Systems, IES2013, ELSEVIER Proc. 24 (2013) pp.54 – 65, 1877-0509, 2013.
[9] Imane M. A. Fahmy, Laila Nassef, Hesham A. Hefny, “ Predicted Energy-Efficient Bee-inspired Routing (PEEBR) Path Selection Optimization”, (INFOS), 2012, Proc. IEEE on 8th International Conference Informatics and Systems, ISBN: 978-1-4673-0828-1, 14-16 May 2012
[10] Patrick Benavidez, Kranthimanoj Nagothu1, Anjan Kumar Ray, Ted Shaneyfelt, “Multi-Domain Robotic Swarm Communication System”, SoSE '08 Proc. IEEE International Conference on System of Systems Engineering, Singapore, pp. 1 – 6, ISBN:978-1-4244-2172-5, June 2008.
[11] John S. Baras, Harsh Mehta, “A Probabilistic Emergent Routing Algorithm for Mobile Ad Hoc Networks”, *Proc. of WiOpt ’03: Modeling and Optimization in Mobile, AdHoc and Wireless Networks*, Sophia-Antipolis, France, March 3-5, 2003.
[12] Amol V. Zade, R. M. Tugnayat, “Ant Colony Optimization (ACO) in Disaster Information Network”, Published In International Journal Of Innovations In Engineering Research And Technology (IJIERT), ISSN: 2394-3696, Volume 1, Issue 2, and Dec-2014.
[13] Amol V. Zade, R. M. Tugnayat,, “A Honey Bee Swarm Intelligence Algorithm For Communication Networks”, Published in International Journal Of Engineering Sciences & Research Technology (IJESRT), ISSN: 2277-9655, Volume 4, Issue 1, pp. 644-647, January 2015.
[14] Wilensky, U. (1997). NetLogo Ant Lines model. http://ccl.northwestern.edu/netlogo/models/AntLines. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL.
[15] Mr. Amol V. Zade, “A Novel Swarm Intelligence Optimization Algorithm for Enhanced Communication”, Published in International Journal of Engineering and Management Research (IJEMR), ISSN: 2250-0758, Page Number: 412-414, Volume-6, Issue-2, March-April 2016.
[16] Mr. Amol V. Zade, “A Swarm Intelligence Optimization Approach for Smart Hive Finding in Honey Bees”, Published in International Journal Of Engineering Sciences & Research Technology (IJESRT), ISSN: 2277-9655, Volume 6, Issue 1, January 2017.
[17] Frisch, Karl von. 1967. *The Dance Language and Orientation of Bees*. The Belknap Press of Harvard University Press, Cambridge, Massachusetts.
[18] A. V. Zade, R. M. Tugnayat, “A Novel AHBeeP Swarm Intelligence Optimization Approach for Emergent Routing in MANET” Presented in 3rd IEEE Sponsored International Conferenceon Electrical, Electronics, Communication, Computer Technologies and Optimization Techniques at GSSS Institute of Engineering & Technology for Women, Mysore, Karnataka ISBN:978-1-5386-5130-8/18, pp:90, on 14th & 15th December 2018.
[19] Baris Yuce, Michael S. Packianather, Ernesto Mastrocinque, Duc Truong Pham, Alfredo Lambiase, “Honey Bees Inspired Optimization Method: The Bees Algorithm”, Open Access, Insects Journal, ISSN 2075-4450, 4, 2013, pp-646-662.
[20] A. V. Zade, R. M. Tugnayat, “A Novel Optimization AHBeeP Algorithm for Routing in MANET”, Springer Sponsored 7thInternational Conference on Innovations in Computer Science & Engineering (ICICSE-2019), at Guru Nanak Institutions Technical Campus (Autonomous) Hyderabad, on 16th & 17th August 2019.
[21] Friedman, Roy and Anna kaplun Shulman, “A density-driven publish subscribe service for mobile adhoc networks”, Elsevier Journal Ad Hoc Networks, Volume 11, Issue 1, January 2013, Pages 522-540.