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A STUDY OF AN ANT COLONY BASED ROUTING ALGORITHMS FOR MANET

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Abstract- Mobile Ad-Hoc network (MANET) is a punch of mobile nodes which collaborate with each other for multi-hop communication in a infrastructure less environment. In MANET routing is challenging task due to various characteristic of a network such as dynamic topology, multipath, link quality, performance metrics, and load balancing parameters between the nodes. Nature –inspired routing algorithms-swarm Intelligence such as Ant Colony Optimization (ACO) have been provided a appropriate technique for developing new routing algorithms for MANET. ACO technique is based on foraging behavior of ant in real life. In recent days many routing algorithms were developed based on Ant Colony Optimization to solve the multiple issues in Quality of service routing in MANET. In this paper, A study is made of various ant based routing algorithms and the methodology what they used was discussed.
Keywords – Ant Colony Optimization, ACO, MANET

1. INTRODUCTION

Mobile Ad-hoc networks have a high-powered dynamic topology because the nodes are highly mobility, inadequate of wireless medium, limited energy of a node, etc. In this dynamic environment updating the routing table of every node during the communication is playing a very important role in terms of providing an optimum path according to the current change of topology[1]. Routing in MANET is challenging task because of no central coordinator as compared to other wireless architecture where base station or fixed routers manage routing decisions[2]. For efficient routing, the MANET routing protocol should provide less packet Loss Ratio, high packet delivery ratio, less routing overhead, less end-to-end delay, Minimum hop, less energy consumption per packet, less Jitter. So it is necessary to balance all these objectives but it is quiet not possible. For the optimization of the stated objectives, the meta-heuristics approach ACO is more reliable than other routing algorithm in MANETs.

2. THE ANT PROTOCOL

Communication or transfer of information among animals is essential for their survival. Many animals have been studied for their unique and remarkable ways of communication. Like way, Ants secrets chemical pheromone, which influences the behavior of other ants. Pheromones concerned with communication between conspecifics and concerned with the maintenance of colony structure. Based on the probability of pheromone ants finds the shortest path to reach the food source[3]. The pheromone concentration raises gradually on the shortest path and that make other ants to follow[4]. This behavior of ants quickly identifies the shortest path. In this paper various ant based routing algorithm is discussed.

3. SURVEY OF AN ANT COLONY BASED ALGORITHMS

Jose Aex Pontes Martines et al., proposed bio-inspired algorithm called Ant Dynamic MANET on-demand (Ant-DYMO) routing protocol[5]. The Ant-DYMO is a hybrid and multi-hop algorithm which has two types of ants for exploring routes for a specific destination. In this algorithm the EANTs carries the information of source node address and all the intermediate nodes passed to reach the source node from the destination node and also it impose pheromone signs along its way. Then EANTs keep updates the path details in the last node pheromone table and broadcast EANT to neighboring nodes. Since Ant-DYMO is a proactive approach the EANTs Keep on updating the routes in a regular interval , so that it has increasing the probabilities of finding an alternative route in case route failure. The ns-2 simulator was used to evaluate the performance of Ant-DYMO with 50 nodes and 20 nodes. Here various configurable parameters were used in Ant-DYMO for the simulation like eants_percentage, eants-history, evaporation factor, eants_route_expiration _time, eants_interval. The basis of DYMO is used in Ant-DYMO implementation. The discussed algorithm was compared with DYMO with respect to different parameters like end-to-end delay, delivery rate, loss rate and routing overhead, and the result says, it comprises the network delay with high probability of quickly finding the optimum route in very less time, high data delivery rate and the data loss rate with less number of node is same as DYMO but with more number of nodes the data loss rate is high because of traffic control over

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head. The routing overhead is more due to transmission and retransmission of information by the (updating routing table)EANTs. It may also gives outmoded paths information, due to the dynamic change in the network topology. A final analysis of Ant-DYMO states that, Ant-DYMO reduces time in data delivery and shows significant improvement in terms of packet loss.

Mamoun Hussein Mamoun proposed a new proactive routing algorithm called NPR with basis of modified Ant Colony optimization (MACO)[6]. In this algorithm single hop HELLO message packet is used to build a neighbor list, Which is used to initialize the routing table node. NPR algorithm uses FANT to reach a specific destination either using unicast or broadcast depending on the availability of a route to the destination. Here the FANT are a light weight packets consist of source IP address, Destination IP address, Packet ID and the keep growing stack which consist of the intermediate Node ID and the Node_Traversal_Time . All these information's are collected by FANTs while going to the destination. The FANT after reaches its destination, it passes all the information regarding the route to the Backward Ant (BANT) created by the destination node and it dies. Then the BANT choose the next hop by popping the stack and updates the traffic model, routing table. The node elapsed trip time and the reinforcement signal of BANT indicates that the good selection of route. The every discovered path by the FANT by the BANT and update the routing table. The data are transmitted through the route that has the leading pheromone concentration, which is going to be a primary path. The ns-2 simulation environment was used to evaluate the result with 100 nodes. The evaluation was compared with reactive protocol AODV with in terms of packet delivery ratio, average end-to-end delay, routing overhead. The final analysis says at high mobility, high packet delivery ratio because the proactive path maintenance of the routing table whereas in AODV reinitiate the path discovery process again. Low end-to-end delay due to maintenance of all the leading paths. Due to heavy traffic of route maintenance it leads to more overhead, which is not handled.

Huva Wang et al., proposed a tree growth based Ant colony algorithm (TGBACA), which is mainly concentrating on QoS in multicast routing[7]. TGBACA aim to trace a tree consists of all the target nodes. In this approach Ant does not select only the target node. The TGBACA has three basic process the first one, Tree Growth - The ant is used to grow a current tree and here the basis principle of Ant Colony Algorithm is used. The multicast tree grows constantly by adding the next node according to the probability and its stop growing when it covers all the multicast members. The second one, Tree Pruning- the grown multicast tree contains some leaf nodes of non multicast member nodes, which will be pruned. Now the final multicast tree is obtained. The final one, Updating Pheromones- the pheromones intensity of the multicast path is keep updates and this will help to increase the process speed. Here the ant number(antnum) enables the cost factor of the algorithm. When the number of ants increases mean while the convergence time also increases. But when the antnum increases certain extent multicast path search will be done randomly. When the network size increases it will lead to slow process, increased process time, average cost value. The parameters were chosen for the experiment via orthogonal experiment like with different ant number, different scales of topology, and different proportions of group members and compared. Here the final analysis says that the TGBACA acquire the better cost of multicast tree but there is more overhead in terms of growing a tree.
Quality of service enabled ant colony-based multipath routing (QAMR) algorithm is proposed by P. Venkata Krishna et al.,[8]. This algorithm has two ant agents (FANT,BANT) to evaluate the different parameters such as next hop availability(NHA), delay and bandwidth to fulfill the QoS constraints. The QAMR algorithm core concept is stability of the link for the route discovery to match the requirement of QoS. The FANTs (reactive) are generated by the source which carries the stack of source address, destination address, address of all the intermediate nodes along the path, bandwidth and hop count, start time to the destination. Here when first time FANT is received by a intermediate node verify about the address of its own incase if the address is not their it adds to FANT and broadcast to all its stable neighbors by its NHA values. The FANT also collects the transmission delay and processing delay of each node. By using all these QoS metrics path preference value will be calculated when the FANT reaches the destination. Only the path which meets the user defined QoS threshold will generate the BANT. By popping the node present in the stack the BANT reaches the destination an unicast manner. For each BANT when it reaches the next hop it will see the probability of preference path by calculating the delay, bandwidth and the hop count. Here the BANT is providing multiple paths to the destination but the higher pheromone value path is chosen for the data transmission. When the higher pheromone path is overloaded it causes more delay, less available bandwidth, reduction of nodes energy. Even due to mobility of the node, the NHA of a node goes below the threshold. The QAMR evaluation is done in ns-2 and compared with AODV and ARMAN. The final analysis says that, Due to the mobility of the node frequent route updating is require which is high routing overhead. In QAMR stability of the link is considered as a main parameters, the packet delivery ratio is high. As well as because of route mobility the the link failure will increase gradually.

D Karthikeyan et al., proposed an Ant based Intelligent Routing Protocol(ABIRP) to minimize energy utilization of the nodes and prolong the entire network lifetime[9]. The ABIRP is mainly focused on maximizing the span of network with minimum overhead. In ABIRP Approach in terms of expanding the span of network there are three operations done wisely coordinator election- The node which has more energy capacity and the more number of neighboring node is elected as coordinator node. Secondly coordinator announcement- The node which cannot reach the coordinator node should become a coordinator node by end of this operation a minimum number of coordinator nodes maintained in the entire network. Since the data are

routed through the coordinator node , this topology duty is to give good capacity. The last operation is coordinator withdrawal- Here if the neighboring node can reach the other coordinator neighboring node either directly or indirectly the corresponding coordinator node should withdraw, regarding this periodic monitoring will take place. So now the non coordinator nodes can sleep most of the time and this way energy can be saved. Periodically the non coordinator node will communicate with the coordinator node. In ABIRP algorithm three different types of packets are used like, the information-data packet, Control packet like FANT and the neighbor control packets –to maintain the collection of available nodes to which the transmission take place. The BANT is used to update the pheromone table. Network simulator ns-2 is used to evaluate the ABIRP performance with 50nodes and compared with unmodified AODV. A final analysis of ABIRP state that high packet delivery ratio and low energy utilization when was compared to AODV protocol.
An Improved Location- Aware Ant colony Optimization based routing for MANETs was proposed by AJIT R. Bandgar et al.,. AntHocNet-LS is a extended version of AntHocNet protocol[10]. The AntHocNet protocol, whenever the changes in network topology rapidly it should restore the link detail and this is lead to the new route discovery process. Here the proposed algorithm introduced the concept of location server, which is consist of updated topology and routing path of a entire network. It will serve the information to the requested node in terms of selecting the optimum nearest to the destination. In the proposed algorithm there are two levels of location server is maintained. That the lowest level of location server maintains the information of the nodes in the region, the higher level of location server maintain the information of the nodes outside the region. Depending on the requirement the location information is received from either lowest or highest level location server and then data is send to the appropriate neighbor. The performance of proposed algorithm was evaluated using ns-2 with 500nodes and compared with basis AntHocNet algorithm. This analysis state that great packet delivery ratio, control overhead and routing overhead remains constant as the number of nodes increases whereas in AntHocNet approach routing overhead keep increases as the number of node increases.

Gurpreet Singh et al., proposed An Innovative ACO based routing algorithm for MANETs(ANTALG). This algorithm mainly concentrating on selection of source and destination, which is done randomly and exchange Ant Agent between them[11]. While the ants moves along its path, The pheromone table and the data structures are created to store the trip time of the node. The ANTALG algorithm creates the community of artificial Ant which is updating the pheromone table. Every ant memory is consist of routing information. The data structure of memory is type of packet used by Ants, Source address and target address Packet length, sequence no, start time of the ant etc.The proposed algorithm consist of, Route setup phase- Here the FANT created in source node and it is send towards the destination, then the source and destination nodes are selected randomly to identify the overall topology. The BANT is created at the destination end and it traverse reverse towards the source in same path of FANT to updates the routing table. Then Route maintenance phase- The FANTs are periodically dispatched by the source node in a proactive manner in order to maintain all the better availability paths. Route discovery phase is the last one – Due to mobility of the node the path can be broken and it broadcast the link failure message and it has to be solved with local repair process in order to find the better path to the destination. The evaluation of the proposed algorithm is done in ns-2. The results are compared with ADSR, HOPNET, AODV with respect to different performance metrics. The results are increased throughput, less packet drop, high packet delivery ratio, more data packet sent, better End-to-End delay, less jitter, large window size.

Gurpreet Singh et al.,[12] proposed an orientation based ant algorithm(OANTALG) with the basis of ANTALG. The ANTALG process is explained in the same section along with this the orientation factor of ants also included. This orientation factor is used to flood the search node in the proper direction. In the proposed algorithm all the nodes are participating in the path finding process (bi-direction). An OANTALG is orientation based distributed learning algorithm. This way the better path can be found fro the destination from source.The evaluation of the proposed algorithm is done in ns-2. The results are compared with ADSR, HOPNET, AODV with respect to different performance metrics. The results are increased throughput, less packet drop, high packet delivery ratio, more data packet sent, better End-to-End delay, less jitter, large window size.

Saptarshi Banerjee et al., proposed a new on-demand power balanced routing algorithm for MANET which is Modified Ant Colony Optimization (ACO) Based Routing protocol . The major task of this protocol is to reduce the overhead for routing[13]. This algorithm uses the remaining battery charge (residual battery charge) of a mobile node as a factor to guide the other nodes, with this can find this algorithm is as power balanced and increasing the process of packet delivery ratio. In the proposed algorithm routing follows the three phases such as Route discovery phase-The sources node creates the FANT which has destination address, next hop, pheromone value is broadcasted to all the neighboring nodes. When the FANT reaches the destination the information's are collected and it dies at the same time BANT is created by the destination ,which come back to the source in the same path of FANT. The BANT when it reaches the source the path is established and it dies. Route maintenance phase- the data packet itself maintain the route. Route failure handling phase- based on the missing acknowledgement the path failure is identified and finds the alternative path. The proposed algorithm was evaluated using OMNET++ 4.5. Here was observed decreased packet delivery ratio due to faster process and quick rescaling factor reduces the time duration of reach ability metric in Modified Ant Colony Optimization algorithm.

Shubhajeet Chatterjee et al., proposed Enhanced Dynamic Source Routing algorithm based on Ant colony Optimization which is called as E-Ant-DSR In this routing algorithm, the path is selected based on the number of nodes present in the path and congestion between the nodes[14]. Here from source to destination the feasible path is chosen with higher pheromone value and less congestion value. The Evaluation of the proposed algorithm is done in Microsoft visual C++ and MATLAB and compared with other ACO algorithms. The final result obtained better results in terms of data delivery ratio, broken route, routing overhead, and energy consumption.

Hajoui Younes et al., proposed a new framework for load balancing based on mobile agent and ant-colony optimization technique [15]. The main focus of this algorithm is constructing a multi-agent system to distribute tasks on a cluster of heterogeneous nodes. In this algorithm a dispatcher agent is committed to distribute the received task to the worker agent in order to select the right path with minimum execution time. The proposed framework system has 3 main layers: user procedure, Task Distribution –Load Balancing, and workers. These layers can be distributed of Procedure agent-allows user to create a task, Dispatcher agent-assigns the received task to the work agents, Tester agent-evaluate the complexity of the task, Controller agent- control and collect the states of the worker agent, Worker agent-execute the assigned task. The pheromone table is updated while each task assigned by the dispatcher. So all the distributed nodes allows, the dispatcher to collect the information's to prepare scheduling decisions. Hence the proposed algorithm maximizes system performance and minimize the overall execution time.

Hyun-Ho Choi et al., proposed a new routing protocol inspired by a pheromone diffusion and rerouting behavior of ants in real life called regional route maintenance algorithm for mobile adhoc networks[16]. The proposed protocol contains two process as follows, local pheromone diffusion – the pheromones (the routing information)are diffused around the shortest path between the source and the destination by overhearing the one hop neighbors and sharing of overheard pheromone information. On the other side the regional route maintenance process- has two types of ants wisely, Exploitation ant- is used to utilize the present shortest path by overheard one hop neighbor and Exploration ant- is used to explore all other alternative paths between the source and destination based on the diffused local pheromones information's. Further the pheromone information's can also be classified into two types like Indirect pheromone- it provides indirect probability to reach the destination by local pheromone information and Direct pheromone- it provides direct regional route to the destination by using exploitation ants pheromone updates. The proposed algorithm consist of series of operation like routing table structure- is consist of basic multipath information for one hop and additionally the relevant routing table updated time, the value of the pheromone and the type of pheromone whether direct or indirect. Local pheromone diffusion and Regional route maintenance–as we discussed earlier. Link failure and rerouting- since the proposed algorithm has maintained all the possible routes, the link failure can be rectified. Here OPNET simulator is used to evaluate the performance of the proposed algorithm and compared with AODV, MDSDV, AntHocNet algorithms. The result states Smaller amount disruption, gradually decreasing end-to-end delay due to availability of alternative paths so high data delivery ratio. According to the performance of network scale the performance decreases as the number of node decreases due to increased collision and propagation time delay of control packets.

The comparative study of above discussed algorithms

Routing protocols	**Packet loss rate**	**End-to-End delay**	**Delivery rate**	**Routing Overhead**	**Packet delivery ratio**
Ant-DYMO	Significant improvement	Low - when compared to DYMO	High	High due to traffic generated by E-Ant	High
NPR	Low	Low -due to the maintenance of the proactive routing table	High	High – due to traffic	High
TGBACA	Low	For the large network its high	For the large network its low	High –in terms of growing tree	Average
QAMR	High – as the mobility node increases	Low –because of periodic updates of route	High- because of node stability parameter	Constant amount remains because of periodic updates	High
ABIRP	Low	Low	High	Low- because of resuming its route discovery process from	High

				where its left	
AntHocNet-LS	Low	Low	High	Remains constant as the number of node increases	High
ANTALG	Low	Less	High	Tolerable level	High
OANTALG	Low	Less	High	Reduced overhead when compared to ANTALG	High
MANET	Low	Low	High	Low	High
E-Ant-DSR	Less	Less	High	High	Average
A NEW FRAMEWORK OF LOAD BALANCING PROTOCOL	Low	Low	High	High- because many agents are used to maintain the routes	Maximized
REGIONAL ROUTE MAINTENANCES PROTOCOL	Low	Gradually decreased	High	High for large network because of collision	Average

4. CONCLUSION

In this paper, Various ant based routing algorithms are reviewed and its feature were discussed in terms of throughput, no of packet send , packets dropped, End to End delay, jitter, window size . Bio inspired approaches algorithms are more promising for Ad-Hoc networks when you compared to the conventional protocols. The Ant Colony based routing algorithms are used to provide QoS for unicast and multicast approach. But still there is various aspects of processing overheads which has to be solved.

5. REFERENCES

[1] Hyun-Ho Choi,Bongsoo Roh,Myounghun Han,Jung-Ryun Lee ,"Regional Route Maintenance Protocol Bsed on Local Pheromone Diffusion for Mobile Ad Hoc Networks" Springer, September 2017.

[2] Dharmendra sutariya, Pariza Kamboj, "A Survey of an Ant Colony Based Routing Algorithms for MANET", European Scientific Journal, Vol. 3, ISSN:1857-7881,2013.

[3] Anjali Jagtap, Ashok Shinde, Smita Kadam, Dipak Raut, Parag Hirulkar,"Implementation of Optimized Ant Based Routing Algorithm for MANET", IRJET ,Vol. 4 Iss. 6 e-ISSN:2395-0056 p-ISSN: 2395-0072.

[4] Amanpreet kaur, V. S. Dhaka, Gurpreet Singh,"Casting Multipath Behaviour into OANTALG to Improve QoS", IEEE-International Conference on Computing for sustainable Global Development (2016)

[5] Jose Alex Pontes Martins, Sergio Luis O. B. Correia, Joaquim Celestino Junior, "Ant-DYMO: A Bio-Inspired Algorithm for MANETs", IEEE-17th Internatonal Conference on Telecommunications(2010) pp. 748-754.

[6] Mamoun Hussein Mamoun," A New Proactive Routing Algorithm for MANET", International Journal of Academic Research, Vol. 2 No 2, March 2010.

[7] Hua Wang, Hong Xu, Shanwen Yi, "A tree-growth based ant colony algorithm for Qos multicast routing problem", ELSEVIR-Expert systems with Applications 38(2011) 11787-11795.

[8] P. Venkata Krishna, V. Saritha, G. Vedha, A.Bhiwal, A.S. Chawla, "A quality of service enabled ant colony-based multipath routing for mobile ad hoc network",IET Communications, 2012,Vol. 6,Iss. 1,pp. 76-83.

[9] D Karthikeyan, M Dharmalingam," Ant based Intelligent Routing Protocol for MANET" , IEEE International Conference proceedings on pattern Recognition,Informatics and Mobile Engineering, Febrarury 2013.

[10] AJIT R. Bandgar and sandeep A. Thorat, "An Improved Location- Aware Ant colony Optimization based routing for MANETs" , IEEE-4th International Conference at Tiruchengode,India,July 2013.

[11] Gurpreet Singh, Neeraj Kumar, Anil Kumar Verma," An Innovative ACO based routing algorithm for MANETs" ELSEVIR-Journal of Network and Computer Applications45(2014) pp.151-167.

[12] Gurpreet Singh, Neeraj Kumar, Anil Kumar Verma,"An Orientation Based Ant Colony Algorithm for Mobile Ad Hoc Network", Springer-Wireless Pers Communication,January 2014.

[13] Saptarshi Banerjee, Arnab Majumdar, Himadri Nath saha, Ratul Dey,"Modified Ant Colony Optimization Based Routing Protocol for MANET", Published in IEEE 978 Iss.1 4799-6908-1 (2015).

[14] Shubhajeet Chatterjee, Swagatam Das," Anty Colony Optimization Based Enhanced Dynamic Source Routing algorithm for mobile Ad-hoc Network", ELSEVIER-Information Science 295(2015), pp 67-90.

[15] Hajoui Younes, Omar Bouattane, Mohamed Youssfi, Elhocein Illoussamen," new load balancing framework based on mobile agent and ant-colony optimization technique" , IEEE-Conference Paper October 2017(978-1-5090-4062).

[16] Hyun-Ho Choi,Bongsoo Roh,Myounghun Han,Jung-Ryun Lee ,"Regional Route Maintenance Protocol Bsed on Local Pheromone Diffusion for Mobile Ad Hoc Networks" Springer, September 2017.