Modified ABEAR Algorithm for Efficient Routing in MANETs

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Abstract— It is a challenging problem to design the self-adaption, self-organization and self-configuration routing protocols for Mobile Ad Hoc Network (MANET). Ant colony routing (ACR) is a family of distributed bionic routing protocols based on swarm intelligence. In the mobile Ad Hoc network, due to the node's signal uncertainty, limited energy and mobility, the conventional routing is no longer applicable. In order to solve this problem, we will use Cross Layer approach for Routing Algorithm Based on ACO, which combines mobile agent and ant colony optimization technology. Our proposed strategy will find the link layer, network layer and application layer information actively to achieve optimization routing in a large scale mobile Ad Hoc network.

Key words: MANETs, Efficient Routing

I. INTRODUCTION

During the last decade, the interest of wireless networks has almost exploded probably because of the fast growing Internet. The growth of personal computers and the handy usage of mobile computers lead to share information between computers. At present, this sharing of information is difficult, as the users need to perform administrative tasks and set up static, bi-directional links between the computers. This motivates the construction of temporary networks with no wires, no communication infrastructure and no administration required. Such interconnections between mobile computers are called an Ad-hoc Wireless Network. Ad-hoc wireless networks are increasing in popularity, due to the spread of laptops, sensor devices, and other mobile electronic devices. These devices will need to communicate with each other. That's why we need routing protocols that can work without any central gateway.

There can be two types of wireless network: infrastructure based and infrastructure-less. Infrastructure-based wireless mobile networks are based on the cellular concept. They rely on a good infrastructure support. Mobile devices communicate with an access point, such as a base station, which in turn is connected to a fixed network infrastructure. MANET is the example of Infrastructure-less networks. [1] Mobile Ad-hoc Networks (MANET) are the networks in which all nodes are free to move in any direction and communicate with each other via wireless connection. MANETs have no fixed infrastructure and no centralized access control. So, all nodes act as routers. The main goal of MANET is to provide secure routing of data packets at anytime and from anywhere.

II. ANT COLONY OPTIMIZATION TECHNIQUE

ACO is the primary optimization algorithm being used in SI. The reason behind choosing ACO is its distributed nature and inherent randomness. The algorithm used for optimization is a purely a distributed algorithm. Since in a MANETs the nodes are constrained by power, storage and processing power limitations, a purely distributed algorithm like ACO prevents per node computation load, reduces state information to be stored per node.The ant based routing protocol solves the routing problem based on an artificial intelligence concept called swarm intelligence. We have seen that the problem of routing and especially the problem of finding a path between source and destination is very difficult in mobile ad-hoc networks due to the mobility of nodes. Out of all the techniques inspired by the behavior of social insects, ant colony optimization (ACO) algorithms have evolved as a promising solution for efficient routing in MANETs. ACO is a novel evolutionary stochastic algorithm with characteristics such as positive feedback, distributive computing and the use of a constructive heuristic, etc, to match the demands of network optimization. ACO is based on the behaviors of ants. Ants indirectly communicate by dropping a chemical substance called pheromone. Ants moving back and forth between nest and food deposit pheromone, and preferentially move towards areas of higher pheromone intensity. The probability that the ant chooses a certain trail is proportional to the amount of pheromone on that trail. If it follows the trail, the ant's own pheromone reinforces the existing trail thus increasing the probability of the subsequent ants selecting the path. Shorter paths can be completed quickly and more frequently by the ants, and are therefore marked with more pheromone. This directly influences the selection probability for the next ant leaving the nest, which in turn increases the pheromone level on shorter path. Thus longer paths are less reinforced and ultimately abandoned. This distributed reinforcement learning process eventually allows the majority of the ants to converge onto the shortest. Pheromone evaporates over time, and if that path is not used for long time, pheromone will eventually vanish.

III. RELATED WORK

Author has introduced a new protocol QAMR based on ant colony optimization algorithm which provides plausible path out of multiple paths for data transmission. This algorithm is scalable, adaptive and efficient. AODV protocol is implemented for PDR, Packet loss ratio and delay parameters. ACO algorithm increases reliability of protocol along with adaptive nature. It makes protocol smart to build verdict during link failures. [5]

Author used weakly connected dominating sets (WCDS) which clusters network by node's maximum degree or minimum ID to propose an improved ant-based on-demand clustering routing (AOCR) protocol. AOCR uses ant-like agents inspired by the behavior of ant colonies to explore networks and discover a route which fulfills several QoS requirements including minimal traffic overhead or energy-efficiency for MANET. Compared with other ant-based routing protocols, the proposed ant-based algorithm in this paper needs much less storages and less network transmission resources for performing the intelligent route search. When the route is established, the route with a better performance is selected according to the pseudo-random proportional- selection policy. Therefore, the energy consumption among nodes can be balanced by the routing protocol which considers the energy status on each node. Moreover, the number of ant packets can be decreased since the WCDS structure can facilitate to issue such probe packets efficiently for finding a routing path. In addition, only the destination node can generate Backward_Ants so that the routing loops can be avoided. [6]

One hybrid scheme is introduced. One approach is proactive protocol and another is reactive protocol. Ant colony optimization (ACO) depicts a proactive behavior, is a metaheuristic for solving hard combinatorial optimization problems inspired by the indirect communication of real ants. Multi Agent System (MAS) depicts a reactive behavior, is used to solve problems that are difficult or impossible for an individual agent or a monolithic system to solve. In this paper, a hybrid routing scheme that combines the best properties of ACO and MAS is proposed. The proposed hybrid protocol reduces the end-to end delay, minimizes the packet loss and results in maximum packet delivery ratio. The MAAS algorithm contains 5 phases: Route discovery, Route updating, Data Routing, Route Maintenance & Route failure handling. Results show that the data packets are routed to the destination with minimum loss, minimum delay and maximum packet delivery ratio. [7]

Author proposed an energy efficient routing algorithm for MANETs based on ACO for minimizing energy consumption of the nodes and prolong the life of the overall communication system. The proposed ABIRP algorithm improves the Energy efficiency, robustness and reliability. The efficiency of proposed routing protocol ABIRP is shown to better than other demand routing protocols AODV .The proposed ABIRP routing protocol uses a optimal path routing and fast route discovery. The Established paths provide reliable, Shorter and faster communication. The first phase is Span Design. This elects “coordinates” from all nodes in network. Span coordinators stay awake constantly and perform multi-hop packet routing within the ad hoc network. For Designing a Span involves following three operations as

1) Coordinator Election
2) Coordinator Announcements
3) Coordinator Withdraw

It uses energy conserving routing algorithm. For that Sleep/Awake approach is used. In this Sleep/awake power save mode approach focuses on inactive time of communication. [8]

Another paper introduces a novel Ant-based routing scheme (called MAntNet) and its enhanced energy-aware version for MANETs (called E-MAntNet) as well as energy aware version of AODV (called E-AODV). Here, routing operation is based on nodes with high residual energy. Evaluation function depends on the node’s residual energy to calculate the most possible energy-efficient path to route the data packets. In MAntNet, Forward ants generated and they chooses next node on the basis of probability. At destination, forward ant killed and backward ants generated and follows the same path trailed by forward ants. For E-MAntNet, Author had imposed one condition to set cut-off of residual energy. If node’s residual energy matches the condition then this intermediate node will drop the forward ant without further processing so as to retain its available energy level. E-AODV will also use energy aware condition and node will drop RREQ packet and will be prevented from participating to routing operation until its available energy is good. At last they have concluded that the residual energy generated by E-MAntNet is highr then MAntNet and E-AODV, & also generates lesser numbers of dead nodes then MAntNet. [9]

A new routing algorithm is proposed, AntHocNet-LS (equipped with Location Service) inspired from AntHocNet which rely on simple mobile agents and their collective intelligence for the task of routing. The proposed algorithm considers a dense network, where the network load for storing the route information could take lot of time and at the same time this information would be heavy on the nodes. We have to maintain the complete routing tables and determine the shortest path at each step and forward the packet. We propose to improve this by making use of the concept called as location server. The location server is one of the main nodes which will have the complete information of the topology and the routing path. Any node can request the Location Server node for the information of the other node in network and servers reply with the required information. Author has integrated basic AntHocNet with Location Service for that purpose we used Density-Aware Hop-Count Localization technique (DHL). Location servers at lowest level maintain location information of the nodes in its region for location of a node outside their region they contact location servers at higher levels. Thus, the task of keeping location information is distributed and makes the algorithm simple still powerful. According to the simulation results, it has proven that the proposed algorithm can effectively control the overhead generated by the ants, while achieving improved packet delivery ratio. [10]

IV. PROPOSED WORK

The ABEAR algorithm considers the global and local information of every node. Main goal of the proposed work is to maximize the network lifetime of ad-hoc network. The proposed work is divided into 3 phases: Route Setup, Data Routing & Link Maintenance.

Route setup phase: Each node maintains a pheromone table. This table stores all the routing information. The node starts the route setup procedure by broadcasting a forward ant with TTL. At the intermediate node, if pheromone information is available, then ant chooses neighbor node i as next hop with highest probability. Each forward ant keeps track of sequence of nodes it has visited. When this ant reaches at destination node, destination node generates backward ant, transfers the list of sequence from forward ant and kills forward ant.

Data routing phase: After setting up the route, as backward ant reaches to source node, source node will start communication with destination node. If a node has multiple next hops then it randomly selects next hop with probabilistic equation.

$$P_{id}^{DATA} = \frac{(\tau_{id}^{k})^{\alpha}(E_i\overline{FTE_i^k}ER_i^k)^{\beta}}{\sum_{j\in N_d^k}(\tau_{jd}^{k})^{\alpha}(E_j\overline{FTE_j^k}ER_j^k)^{\beta}}$$

Where, (τ_{id}^{k}) = pheromone value of next node i from k

E_i = Energy level of node i

$\overline{FTE_i^k}$ = Link Quality between node k and its neighbor i

ER_i^k = Error rate between node k and its neighbor i

N_d^k = Set of neighbors of node kα & β = Parameters to control relative weight of pheromone value.

The node energy level can be computed by taking ratio of remaining energy and initial energy as follow:

$$E_i = E_i^{Remaining} / E_i^{initial}$$

The value of Frame transmission Efficiency (FTE) can be measured by counting retransmission required to transmit one data frame. For FTE of link between k & i, k uses $RetransmitRTSCount_{ik}$ and $RetransmitDataCount_{ik}$ to represent respectively the number of RTS/CTS and Data retransmission between node i and itself.

Error Rate (ER) is the total number of packets failed for transmission on that node. It gives a node with good success ratio. It can be fetched by monitoring buffer for retransmitted packet. ER will help to select next node which can increase PDR and decrease End-to-End Delay & Packet Lost.

Route Maintenance Phase: This phase contains two approaches: Pheromone Evaporation & Link Management.

We are considering Energy level of the node, after sometime energy of the node frequently used will be low. So, we have to evaporate pheromone value of that route. Due to evaporation pheromone of that route will be zero and the alternate route will be selected. For evaporation we have to set timestamp and minimum pheromone value. If after particular time the pheromone of that node is less than minimum pheromone value, it will be updated to 0. And alternate route will be selected.

In existing method, pheromone evaporation is modeled by exponential decay. Where, current time, last evaporated time considered. Instead of that, we are using only timestamp and minimum pheromone value in our proposed system.

Link failure may be occurs in different cases:

If node fails to unicast a packet to neighbor, then neighbor will be removed with all associated entries from the list

If a node fails to send data Packet to destination node and no alternate path is available then node will start local route repair by broadcasting RouteRepairAnt (RRAnt). Here node waits for time T, if no backward ants are received within specified time and also no alternate path is available then node will broadcast Link Failure message.

If a node fails to send forward ant to destination and no alternate path is available then node will start broadcasting Link Failure Message.

V. Result Analysis

Implementation of the proposed system is done using probabilistic equations including pheromone values, energy level, link quality, and error rate. And outputs are shown using graphs. Comparison of base system and proposed system is shown in the graphs below.

Parameters	Values	Parameters	Values
A	3	TTL	5
B	0.7	Nodes	7
$Ph_{initial}$	1	$E_{initial}$	100 J
Ph_{min}	0.1		

Table 1: Simulation Parameters

Implementation of the proposed system is done using probabilistic equations including pheromone values, energy level, link quality, and error rate. And outputs are shown using graphs. Comparison of base system and proposed system is shown in the graphs below.

Comparison is shown with the packet delivery ratio and average end-to-end delay of both the algorithms. We can see that performance of the proposed algorithm is better than the existing system.

VI. Conclusion

An Ant Colony Optimization based routing approach gives best performance compared to other routing algorithms. So, we have used this approach in our system. In the proposed

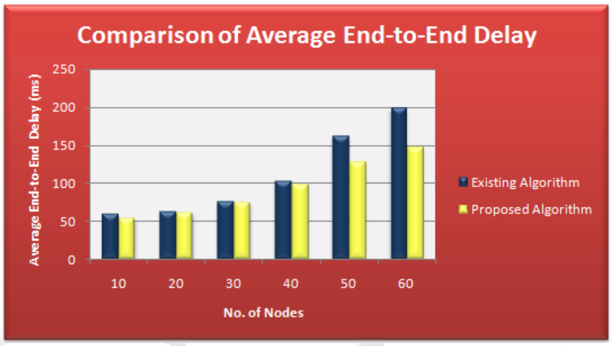

Fig. 1: Comparison of Average End-to-End Delay

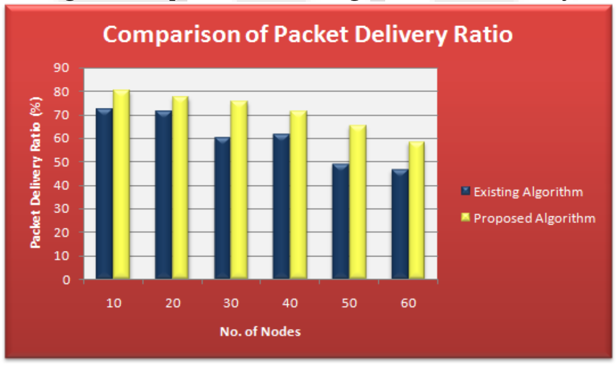

Fig. 2: Comparison of Packet Delivery Ratio

System, we tried to include more parameters to generate strong probabilistic function which can improve the network lifetime through packet delivery ratio and decrease average end-to-end delay. The comparison has done with the existing algorithm and the proposed algorithm. Overall observation is that, our optimized algorithm outperforms the conventional algorithm. Results shows that proposed algorithm have increment in packet Delivery ratio and decrement in End-to-End Delay.

As we are considering energy level of the nodes, this work can be extended to save energy of the nodes i.e. we can apply power saving mechanism in future.

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