Performance Analysis of Enhanced Ant Routing Algorithm for Mobile Ad Hoc Networks

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Abstract - A Mobile Ad-hoc Network (MANET) is a collection of mobile nodes which communicate over ratio. These networks have an important advantage, they do not require any existing infrastructure or central administration. Mobile ad-hoc networks are suitable for temporary communication links. One of the major issues in MANET is routing due to the mobility of the nodes. Routing means the act of moving information across an internet work from a source to a destination. The Enhanced Ant Routing Algorithm (EARA) is based on ant algorithms. This algorithm is inspired from the ant colonies life. Forward packets are used to collect information about the network and backward packets are used to update the routing information in the nodes. EARA has two phases route discovery and route maintenance and also utilities the concept of backtracking when the packets are reaches destination node. Simulation results achieve better packet delivery ratio and reduce the average end-to-end delay as compare to its counterpart.

Keywords: EARA, Packet Delivery Ratio.

I. Introduction

Networking is the practice of linking multiple computing devices together in order to share resources. These resources can be printers, CDs, files, or even electronic communications such as e-mails and instant messages. These networks can be created using several different methods, such as cables, telephone lines, satellites, radio waves, and infrared beams. Without the ability to network, businesses, government agencies, and schools would be unable to operate as efficiently as they do today. The ability for an office or school to connect dozens of computers to a single printer is a seemingly simple, yet extremely useful capability. Perhaps even more valuable is the ability to access the same data files from various computers throughout a building. This is incredibly useful for companies that may have files that require access by multiple employees daily. By utilizing networking, those same files could be made available to several employees on separate computers simultaneously, improving efficiency.

A Mobile ad hoc network is a collection of mobile nodes sharing a wireless channel without any centralized control or established communication backbone. MANET has dynamic topology and each mobile node has limited resources such as battery, processing power and on-board memory. A MANET have a huge number of possible applications like planned networks, emergency services, commercial and resident environments, home and venture networking, education, activity, sensor networks, framework aware servicing and coverage extension. MANET nodes are typically distinguished by their limited power, processing and memory resources as well as high degree o mobility. In such networks, the wireless nodes may dynamically enter the network as well as leave the network. Due to the limited transmission range of wireless network nodes, multiple hopes are usually needed for a node to exchange information with any other node in the network.

Routing in Mobile Ad-Hoc Networks

Routing is the process of selecting paths in a network along which is to send data packets. An ad hoc routing protocol is a convention, or standard, that controls how nodes decide which way to route packets between computing devices in a mobile ad-hoc network.

Routing Types

There are mainly two types of Routing namely Static Routing and Dynamic Routing.

Static Routing

A static route is a manually designed route on your router. Static routes are usually employed in minor networks. For networks that have thousands of routes, static routes are not applicable, since you would have to configure each route independently. A static routing in the sense when we manually add all possible routes in each router's routing table.

Dynamic Routing

This is an intelligent way of routing. In this method administrator configure router with a routing protocol such a way that the protocol discovers about other routers and its routes (Routers exchange routes). Even a new network added or removed router update their routing table each other.

II. Existing Methodology

The existing systems ant colony based routing algorithm is highly adaptive, efficient and scalable. In this design of the algorithm was to reduce the overhead for routing. Compare the performance of ant routing algorithms with other routing protocols.

Dijkstra's Algorithm

Dijkstra's algorithm for finding the shortest path between nodes in a graph. The algorithm exists in many variants dijikstra's original variant found the shortest path between two nodes. A more common variant fixes a single node as the source node and finds shortest paths from the source to all other nodes in the graph, producing a shortest path.

Step 1: *Create a Set sptset (Shortest Path tree Set) that keeps track of vertices included in shortest path tree, i.e., whose minimum distance from source is calculated and finalized. Initially, this set is empty.*

Step 2: *Assign a distance Value to all Vertices in the input graph. Initialize all distance values as INFINITE. Assign distance values as 0 for the source vertex so that it is picked first.*

Step 3: *While sptSet doesn't include all vertices.*

Step 4: *Pick a vertex u which is not there in Sptset and has minimum distance value.*

Step 5: *Include u to sptSet.*

Step 6: *Update distance value of all adjacent vertices of u. To update the distance values, iterate through all adjacent vertices.*

Step 7: *Every adjacent vertex v, if sum of distance value of u (from Source) and weight of edge u-v, is less than the distance value of v, then update the distance value of v.*

Bellman Ford Algorithm

The Bellman–Ford algorithm is an algorithm that computes shortest paths from a single source vertex to all of the other vertices in a weighted digraph. It is slower than Dijkstra's algorithm for the same problem, but more versatile, as it is capable of handling graphs in which some of the edge weights are negative numbers. Bellman-Ford algorithm computes single-source shortest paths in a weighted graph where some of the edge weights may be negative. Bellman Ford runs in VE time, where V and E are the number of vertices and edges. The algorithm is distributed because it involves a number of nodes (routers) within an Autonomous system.

Step 1*:* *Initialization*

$L_0(n) = \infty$, *for all* $n \neq s$

$L_h(s) = 0$, *for all h*

Step 2 *: Update*

For each successive $h \geq 0$

For each $n \neq s$, *compute*

$L_{h+1}(n) = min_J[L_h(J) + w(j, n)]$

Step 3: *Connect n with predecessor node j that achieves minimum*

Step 4: *Eliminate any connection of n with different predecessor node formed during an earlier iteration*

Step 5 : *Path from s to n terminates with link from j to n.*

III. Proposed Methodology

Ant Routing Algorithm is a population-based met heuristic that can be used to find approximate solutions to difficult optimization problems. A set of software agents called artificial ants search for good solutions to a given optimization problem. To apply ARA, the optimization problem is transformed into the problem of finding the best path on a weighted graph.

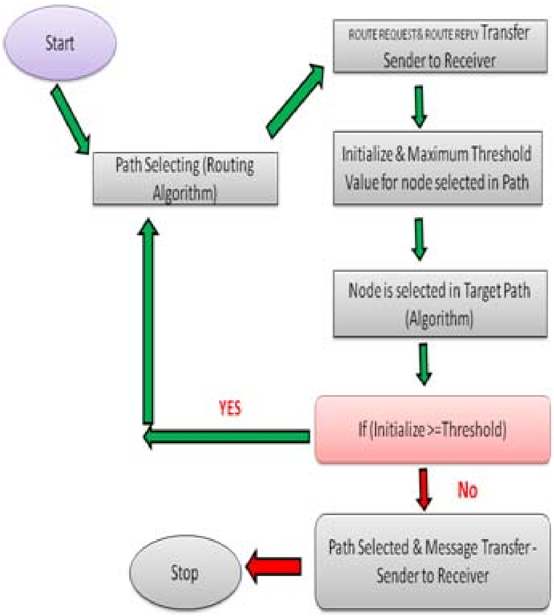

Figure 3.1 Research Methodology

Enhanced Ant Routing Algorithm

The Enhanced Ant colony based Routing Algorithm (EARA) is a probabilistic technique for solving computational problems which can be reduced to finding good paths through graphs.

Step 1: *Initialization*

- *Set initial parameters that are system: variable, states, function, input, output, input trajectory, output trajectory.*
- *Set initial pheromone trails value.*
- *Each ant is individually placed on initial state with empty memory.*

Step 2: *While termination conditions*

- *Construct Ant Solution*

Each ant constructs a path by successively applying the transition function the probability of moving from state to state depend on: as the attractiveness of the move, and the trail level of the move.

- *If there is an improvement, update it.*
- *Update Trails:*

A fixed proportion of the pheromone on each road.

For each ant perform the "ant-cycle" pheromone update.

Reinforce the best tour with a set number of "elitist ants" performing the "ant-cycle".

- *Create a new population by applying the following operation, based on pheromone trails. The operations are applied to individual(s) selected from the population with a probability based on fitness.*

End While

The adaptation of the simple ant algorithm for mobile multi-hop ad-hoc networks and describe the Enhanced Ant colony based Routing Algorithm (EARA). The routing algorithm is similar to many other routing approaches and consists of three phases.

Route Discovery Phase

New routes are created in the route discovery phase. The creation of new routes requires the use of a Forward Ant (FANT) and a Backward Ant (BANT). A FANT is an agent which establishes the pheromone track back to the source node. In analogous, a BANT establishes the pheromone track back to its origin, namely the destination node. The FANT is a small packet with a unique sequence number.

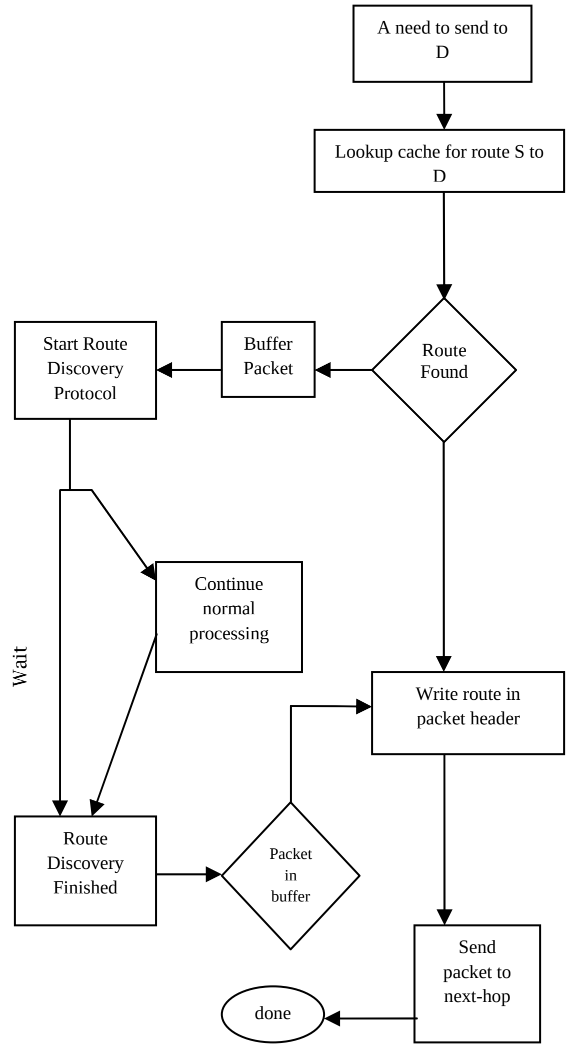

Figure 3.2 Route Discovery Phase

Route Maintenance

The second phase of the routing algorithm is called route maintenance. This phase is responsible for the maintenance of the routes during the communication. ARA does not need any special packets for that purpose. Once the FANT and BANT have established the pheromone tracks for the source and destination nodes regular data packets are used to maintain the path.

Route Failure Handling

The third and last phase of EARA handles routing failures which are especially caused by node mobility and are therefore very common in mobile ad-hoc networks. The current implementation of EARA assumes IEEE 802.15.4 on the MAC layer. This enables ARA to recognize a route failure through a missing acknowledgement on the MAC layer. If a node receives a ROUTE_ERROR message for a certain link, it first deactivates this link by setting the pheromone value to 0.

IV. Experiments and Results

4.1 Simulation Model

The network simulation are implemented using the NS-2.23 simulation tool The Network Simulator NS- 2.23 is a discrete event simulator, which means it simulates such events as sending, receiving forwarding and dropping packets. For simulation Scenario and network topology creation it uses OTCL (Object Tool Command Language). To create new objects, protocols and routing algorithm or to modify them in NS-2.23.

4.2. Performance Metrics

Packet Delivery Ratio

The ratio of the data packets delivered to the destinations to those generated by the sources. It specifies the packet loss rate, which limits the maximum throughput of the network. By considering location information also achieves higher packet delivery ratio.

Packet delivery Radio = No. of received packets / No. Average of sent packets

Table 4.1 Comparison Table of EARA for Packet Delivery Radio

Values	ARA	AODV	ANT	EARA
100	4.3	6.4	8.2	10.2
200	2.5	7	8.4	10.4
300	3.5	5.8	8	12
400	4.5	7.3	12	14

Throughput

Throughput is total packets successfully delivered to individual destination over total time divided by total time. When comparing the routing throughput by each of the protocols, has the high throughput. It measures of effectiveness of a routing protocol.

Throughput = Number of delivered packets *Packet Size Bytes / Total duration of simulation

Table 4.2 Comparison table of EARA for Throughput

Values	AODV	ANT	ARA	EARA
100	2	4	5	5.5
200	3.3	3.8	5.3	5.8
300	2.9	3	4	4.3
400	3	4.2	4.8	5

End to End Delay

This metric represents average end-to-end delay and indicates how long it took for a packet to travel from the source to the application layer of the destination. It includes all possible delay caused by buffering during route discovery latency, transmission delays at the queuing at interface queue, and propagation and transfer time.

End to End Delay = S / N

Where *S* is the sum of the time spent to deliver packets for each destination, and *N* is the number of packets received by the all destination nodes.

Table 4.3 Comparison Table of EARA for End to End delay

Values	AODV	ANT	ARA	EARA
100	4	3.2	2	1
200	4.5	3.5	2.4	0.8
300	4.7	3.9	1.8	1.4
400	5.4	3.7	2.2	1.6
500	5	3.5	2.6	0.7
600	4.8	4.5	2.7	1.9
700	4.9	4.3	3	2

V. CONCLUSION

In this paper, a new hybrid method for path planning of EARA is developed and tested very well. It employs EARA as global path planning algorithm and local planner method. We also exploit pheromone generated by EARA as global information to guide the jump to local minimum. From the simulation results, we can see that by synthesizing EARA algorithm, global optimal and real-time obstacle avoidance can be both satisfied. This proposed routing strategy can be optimized to support multimedia communications in mobile ad hoc networks based on Ant Colony framework. The challenges reside in ad hoc networks is to find a path between the communication end points satisfying user's QoS requirement which need to be maintain consistency. EARA has two phases route discovery and route maintenance and also utilities the concept of backtracking when the packets are reaches destination node.

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