An Hybrid Ant Routing Algorithm for Reliable Throughput Using MANET

N. Umapathi, N. Ramaraj, D. Balasubramaniam and R. Adlin mano

Abstract The field of wireless networks is an important and challenging area. In this paper, routing in mobile adhoc networks (MANETs) using ant algorithm has been described. ANTHOCNET algorithm makes use of ant-like mobile agents which sample the nodes between source and destination. In MANET, each and every node has an additional task by which it can forward packets between two or more nodes. The routing protocol in MANET should be capable of adjusting between two or more nodes. The routing protocol should be capable of adjusting between high mobility, low bandwidth to low mobility, and high bandwidth scenario. AODV protocol is being estimated for higher throughput. By varying the time cycle, throughput and packet efficiency can be increased. When throughput is increased, efficiency is also high. This also improves the quality of services.

Keywords Mobile adhoc network · ANT colony optimization · AODV · Throughput tolerance

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1 Introduction

A mobile adhoc network (MANET) is a collection of nodes communicating with each other without any supporting infrastructure. The routing scheme in a MANET can be classified into two major categories—Proactive and Reactive. The combination of this both protocols is called as hybrid. The need for MANETs is growing, and it can be connected to wired or wireless links using one or more different technologies. In this paper, an application of ant routing algorithm for MANETs is being estimated. The shortest path between the nodes from the source node to the destination node is found. It is mainly used for optimum route discovery in wireless networks.

2 Related Work

(a) *Routing in MANETS*

A family of routing algorithms for MANETS is very popular in different applications considering the following factors: reliability, cost, bandwidth, total required power, ease of installation, security, and performance of network. MANET has several salient features: resource constraints, dynamic topology, no infrastructure, and limited physical security. This routing establishes optimum paths to the destination using a number of artificial ants that communicate with each other by the process called stigmergy. Stigmergy is the process of indirect communication between individuals in an adhoc network.

(b) *ACO Routing*

The information is gathered through path sampling using ant agents. An ant going from source S to destination D collects information about the quality of the path and retraces its way from D to S. This information is used to update the routing tables at intermediate nodes. The routing tables are called as pheromone tables. These pheromone variables are continually updated according to the quality of the paths. The ANTS use pheromone tables to find their way to destination.

ANTS are of two types. Mainly here, the concept of negative backward ants and destination trail ants is being included in order to achieve an optimum solution. This technique reduces the time needed for connection setup and insures the delivery of data. There are many various algorithmic techniques that have been inspired by behavior of ants. ANT colony optimization is one of the most successful techniques and best known among them. Scalable routing is being achieved through AODV protocol. As the total number of nodes in the MANET becomes very large, the overheads of the routing algorithms should be low. It is important to study the various performance metrics for understanding and utilization of routing protocols.

3 Literature Review

AODV is adhoc on demand distance vector routing protocol. It is an improvement of the destination-sequenced distance vector (DSDV) routing protocol. It is based on distance vector which uses destination sequence numbers to determine the kind of the routes. The advantage of AODV is that it tries to minimize the number of broadcasts. It creates routes on on demand basis to maintain a complete list of routes for each destination. The usage of AODV protocol for mobile adhoc networking applications provides consistent results for large scale scenarios.

It is also known as Ford-Fulkerson algorithm. It is a kind of distance vector routing protocols such as RIP, BGP, ISO, IPX, NOVELL, and IDRP. This maintains the distance tables which find the shortest path to the sending packets to each node with the help of routers in a network. The information is always updated by exchanging information within the neighboring nodes. The number of data will be equal to the number of nodes in the network. Each data contains the path for sending packets to each destination in a network.

It is a table-driven routing protocol. Each node discovers and maintains topology information in a network. They build the shortest path tree from source to destination. This includes the detection of neighbors and exchanges the topology information among the nodes. When a node receives Hello message from another node, it discovers new neighbor. If a node does not receive any message from the neighbor for a particular period of time, the neighbor is determined which is broken or out of its range.

LAR is location-aided routing protocol. Each node discovers and maintains topology information in a network. They build the shortest path from source to destination. LAR protocol uses GPS to get the location information to reduce the complexity of the protocol. Each host knows its position exactly; the difference between the exact position and calculation position is not being considered.

4 Methodology

Description of Ant Algorithm

ACO algorithms are population-based optimized approach inspired by the behavior of real-life ant colonies. Here, individual ants deposit a substance called pheromone on the path while moving from nest to food sources. Here, individual ants are aided to smell and select the routes. Due to the behavior of ants, the ants would select the shortest path from nest to the food source. The characteristics of artificial ants are as follows:

- Artificial ants are able to memorize their paths.
- Artificial ants are discarded after each time from nest to the food source.
- Artificial ants include heuristic information in this selection.
- Artificial ants live in an environment when time is discrete.

Proposed Ant Algorithm

The proposed ANT algorithm is ANT colony optimization (ACO) algorithm where ANTHOCNET is being used. ANT algorithm requires the following elements:

- Constructions of solutions.
- Pheromone updating table.
- Local search mechanism.
- Heuristic information.
- Termination condition.
- Selection of probability.

Constructions of solutions

Each part of the solution is termed as state. Once a cell is being assigned to a location, the index is taken into a list. The memory is used at the end of the iteration to update the trail levels. Each ant assigns another cell in a location till a complete solution is obtained. This leads each ant to generate a feasible solution.

Pheromone updating table

Real ants deposit a substance called pheromone while moving from one point to another point. The update of each level can be performed either after each move or complete solution.

- Moves with negative trail levels can be avoided. Moves are chosen with equal chances if there is no positive trail level.
- The absolute value is being added to negative trail to become positive. Hence, for negative trail level, there is no chance for selection.

Local search mechanism

ACO heuristic information is used to construct solution. The constructed solution is mainly to update improved solution. Hybrid ant algorithms are included for solving the intercell layout problem.

- Ants are generated randomly based on uniform distribution.
- The distance between the grid points and entries of the flow matrix is created randomly.
- The flow entries must be at most equal to zero and nonzero entries are not uniformly distributed.
- The data problem is generated randomly, and they resemble the distribution of real ants' instances.

Heuristic information

Heuristic information pertaining to the move $v = pi/\beta$ is denoted by gi, and the location is calculated using heuristic approach. From which, heuristic information is calculated. From this, the intercell layout problem is also cleared.

Termination condition

ANT algorithm can be terminated in several manners as the algorithm has maximum number of iterations. The value obtained in each iteration is being compared with the earlier iterations.

4.1 Route Discovery

At a node, when a packet is received by the network layer from the higher layers, the node checks to see if routing information is available for destination over any of its neighbors. If found, it forwards the packet over that node, if not, it broadcasts a forward ant to find a path to the destination. When a forward ant is received by an intermediate node, the node checks whether it has routing information for the destination over its neighbors and if found, it unicasts the ant over that neighbor, else it broadcasts the forward ant. Loops are prevented by a sequence id mechanism and endless flooding is restricted by enforcing maximum number of hops for the ant. Once the ant reaches the destination, it becomes a backward ant and it follows the same path it came from, back to the source.

4.2 Route Maintenance

ANTHOCNET uses a proactive updates to improve route quality. Nodes periodically broadcast information about the best pheromone values to each destination at that node. The neighboring nodes on receiving the information then adjust the value of their existing pheromone values of the routing table entries to every destination over the broadcasting node. This diffusion process is slow and could result in new paths being discovered to the destination. However, these paths are not reliable, are thus not used directly in packet forwarding, and are marked as virtual pheromones to be explored later during another route for the ant. Once the ant reaches the destination, it becomes a backward ant and it follows the same path it came from, back to the source.

4.3 Route Error Correction

A link error may be detected when a Hello message is not received from a neighbor for a timeout period, or if a packet fails to transmit though a link. The algorithm corrects the routing table to reflect the link failure. In the case of packet sending failure, ANTHOCNET checks for alternative routes and if not found initiates a route repair process. It also broadcasts a link failure notification to inform its neighbors about the change in routing information.

4.4 Packet Forwarding

Data packets are forwarded using the probabilities created by FANTs and BANTs, using the colony routing table and local routing table for nodes outside and inside the current node's colony, respectively. The length of the packet queue is considered as an indication of the current level of congestion at the next-hop node, and the next-hop probabilities are adjusted to favor nodes with lower congestion.

5 System Design and Results

For system design of the above system, network load analyses the number of node 25 and varied from 6 to 19 nodes and 400 × 600 sqm, data payload 1,000 byte per packets, and packet rate 250 k. Network simulator (NS2) has been used to construct the network topology graph. Simulator chosen to evaluate the protocols is NS2. It has important advantages when compared to other simulators. Number of nodes can exceed several thousands. It has more efficient routing tables. It is a binded model between C++ and OTCL. Wireless network performance mainly depends upon throughput and average delay. It is cost-effective of network deployment as wiring is not possible.

The topology is described randomly which is being deployed in a grid. The program is written in C++ and OTCL programming languages. Each link is bidirectional. The graph is generated by trace file under NS2. The increasing in time cycles increases the throughput. The software used here is UBUNTU (Fig. 1).

Here, nodes are established, and routing is done between the nodes from node 19 to node 6. The shortest destination to the nearby node is found. The forward and backward ants checks for the pheromone concentration and establishes the path to the node with higher concentration and transfers the data packets. When the backward ant is received, the packet delays to the node are updated. This is to find the shortest route from a source node to the destination node in the wireless adhoc networks (Fig. 2).

Here, nodes are established, and routing is done between the nodes from node 19 to node 6 then from node 10 to node 4; the shortest destination to the nearby node is found. The forward and backward ants checks for the pheromone concentration and establishes the path to the node with higher concentration and transfers the data packets. When the backward ant is received, the packet delays to the node are updated (Fig. 3).

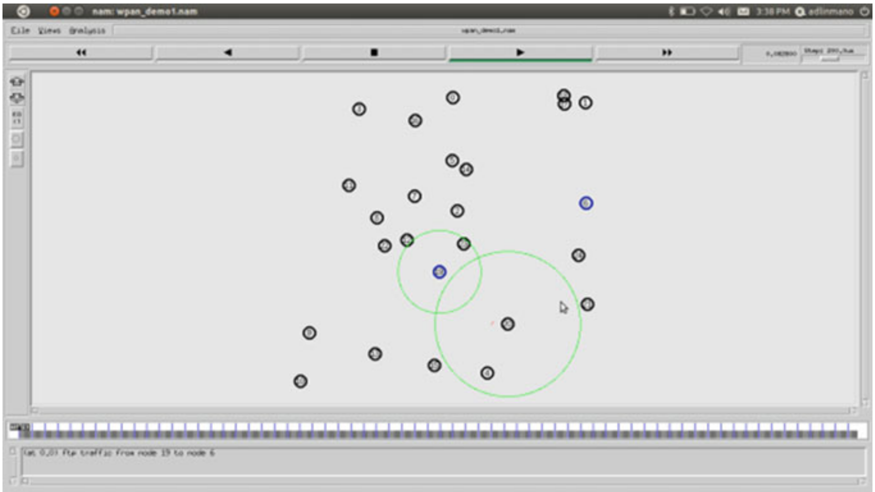

Fig. 1 Network animator from node 19 to node 6

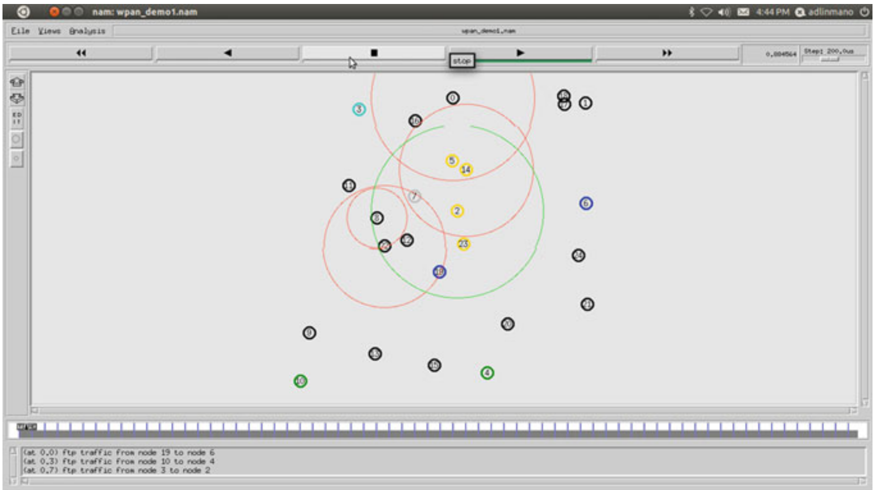

Fig. 2 Network animator from node 10 to node 4

Here, *x* axis denotes the time cycles, and *y* axis denotes the throughput of AODV protocol. When time cycles keep on increasing, the throughput data in AODV also increase, thereby improving the packet efficiency. Figure 4 shows time cycles versus AODV throughput. Throughput is being increased by updating the heuristic information after the local search mechanism. The pheromone concentration is being updated with the termination condition given for each iteration. Here, ant

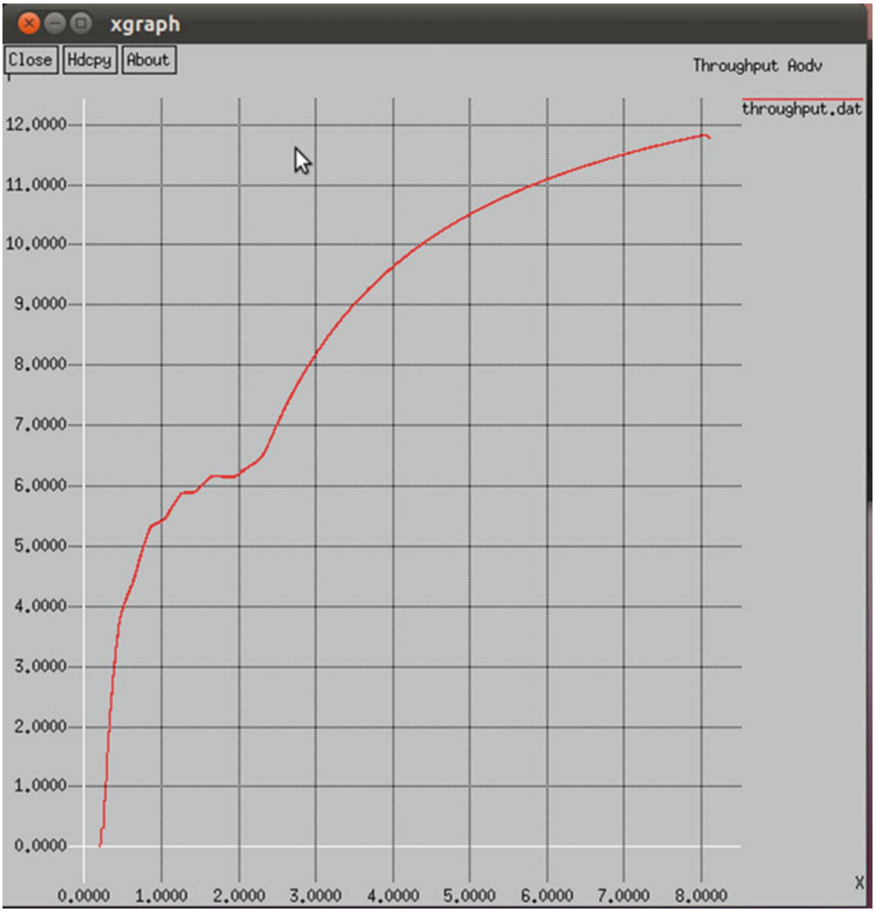

Fig. 3 Time cycles versus AODV throughput

colony termination condition is given for each iteration. Here, ant colony optimization algorithm is being used for delivering high throughput and also for optimization purpose.

Here, *x* axis denotes the time cycles, and *y* axis denotes the packet loss. When time cycles keep on increasing, the packet loss for various cycles decreases by which throughput is being increased. Throughput is being increased by improving the congestion window size and optimizing the packet drop rate, thereby providing high efficiency in MANETs.

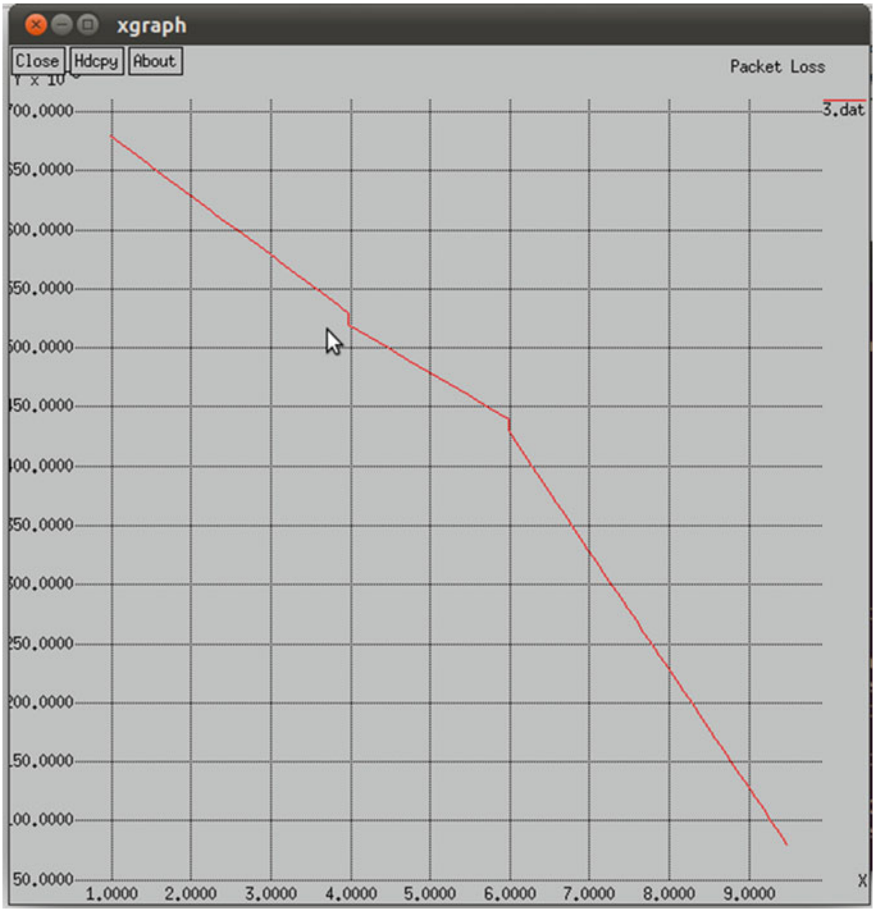

Fig. 4 Time cycles versus packet loss

6 Conclusion

Hence, the optimization problems are solved by the algorithm, and coding is developed for improving throughput. The shortest path from the source node to the destination node is found, and data packets are being updated. The throughput mechanisms are used to select the forwarding node because velocity does not provide information on link quality. The throughput assists the source node to distribute the forward load to available nodes and avoids the routing holes or deadlock problem. Thus, the optimum throughput is being achieved using AODV protocol.

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