A Proposed Routing Protocol for Mobile Ad Hoc Networks

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ABSTRACT
Routing in wireless mobile ad hoc networks (MANETs) is a challenging task. Geographic routing protocols offer promising solutions for routing in MANETs. Their advantages are eliminating the need of topology storage and the associated costs. A disadvantage is that all nodes must be equipped with GPS receivers to be aware of their own positions which consume money and energy. Besides, GPS receivers may not work in areas that are mostly concentrated with computing devices. This work proposes a new routing algorithm that is suitable for network where some nodes may be aware of their position through GPS while others are not. In the proposed algorithm, routing decision is made by the combination of greedy forwarding mechanism and on-demand routing one. Packets are forwarded in greedy mode when position information is available and routed using a reactive on demand procedure when this information is missed. Simulation results show that the proposal achieves better performance compared to GPSR and the DSR protocols concerning end-to-end delay, throughput and packet delivery ratio

Keywords
Mobile ad hoc network (MANET); Routing protocol; topology-based routing; Position-based routing; DSR; GPSR.

1. INTRODUCTION
A wireless ad hoc network is a decentralized type of wireless network consists of a collection of mobile nodes communicating with each other without using any central administration devices such as base stations or access points. In these networks, nodes can communicate directly with other nodes within its transmission range, otherwise, communication is done through intermediate nodes, and hence the node acts as both host and router[5, 28]. The fact that power and bandwidth are scarce resources in such networks of low powered wireless devices, requires more efficient routing protocols [2]. There are a number of routing protocols proposed for Mobile Ad Hoc Networks (MANETs) which can be categorized into two different approaches: topology-based and position-based routing protocols [20,12]. In topology-based routing protocols packet forwarding is performed using link information that exists in networks. These protocols can be further divided into proactive (table driven), reactive (on demand) and hybrid approaches [25,22,15].

In proactive routing protocol, each node in a network maintains routing tables which are regularly updated by broadcasting messages to the entire network. Nodes use these pre-established table-based routes to forward packet to their destinations. The advantage of these protocols is that there is no need of route-discovery procedures. However, maintaining routes between all node pairs all the time causes significant routing overhead [17]. Distance Vector (DV) protocol and Destination Sequenced Distance Vector (DSDV) protocol are the examples of Proactive protocol [27]. In contrast, reactive on-demand routing protocols build and maintain routes when a route is needed only. Reactive routing needs less memory and storage capacity than proactive protocols. It also eliminates the periodic table-update messages used in proactive protocols. Ad Hoc On-Demand Distance Vector (AODV), Dynamic Source Routing (DSR), and Temporally Ordered Routing Algorithm (TORA) are examples of on-demand routing protocols [21]. Topology based routing protocols suffer from the disadvantages of consuming significant amount of network resources (in terms of memory and communications) whether from routing tables updates or route requests. Unlike topology-based routing, Position-based or geographic routing protocols do not need to have a global view of the network topology or maintain routing tables. Nodes need only to store information about their one-hop neighbors that are directly accessible via radio. Forwarding decisions are based on knowledge of the neighbors' positions and the destination's position inserted in the packet header by the source. Greedy Perimeter Stateless Routing (GPSR) is the most commonly used position-based routing protocol for MANETs [24].

2. RELATED WORK
In this section, protocols that our proposed algorithm relies on are described here.

2.1.DSR Routing Protocol
The main idea in reactive routing (on-demand routing) is to find and maintain routes only `when there is a need and thus minimizes routing overhead. The DSR protocol is composed of two mechanisms: route discovery and route maintenance [8, 18, 19]. Route discovery operation is initiated when a source node wants to send a packet to a destination node and does not have a route. Route maintenance operation is used when there is an error with an active route [6]. In DSR, each node maintains a route cache where it saves source routes that it has learned. When a source node attempts to send a data packet to destination node, it first checks its route cache for a source route to the destination. If a route is found, the sender transmits the packet with it. If more than one path is found, a route selection method is used to select one of them [26]. If no route is found, the source node applies a route discovery process. First, it saves the original packet in a local buffer called the Send Buffer and broadcasts a route request packet (RREQ) to all its neighbors. The source node appends source ID, destination ID and a unique request ID to it. The RREQ packet also contains a route record to list the address of each intermediate node it passes through. When an intermediate node receives a RREQ packet

that is not seen before, it appends its id to the RREQ packet's route-record then it rebroadcasts the RREQ again. A route reply (RREP) is generated when the route request reaches either the destination itself or a node having a route to the destination in its route cache. The RREP is then sent back (through the reverse path which exists in the route record of RREQ) to the source node which appends the route record in RREP to data packet to be sent to destination and update its route cache. While waiting for the route discovery to complete, the initiator node buffer the original packet in order to transmit it once the route is learned from route discovery, and continue normal processing, sending and receiving packets [14, 10]. In DSR the intermediate nodes need not to maintain up to date routing information. When a node detects a link break, it creates a Route Error message "RERR" and sends it to the original source, which in turn initiates a new discovery process [23]. The major drawback with source routing protocols is that Time delay in reactive protocols is greater comparative to proactive types because routes are only established when needed. Routing overhead is considerably involved due to the source-routing mechanism employed in DSR. This routing overhead is proportional to the path length directly [11].

2.2.GPSR Routing Protocol

The principle approach in geographic routing is greedy forwarding in which a node forwards a packet to a next node which is closer to the destination than itself [3]. Geographic routing protocols assume that all packets are marked by its source node with the destination position at the time of sending the packet; each node knows its geographic location through GPS or other localization schemes and a source can obtain the destination position through some kind of location service. Each node also knows the location of its neighbors in the transmission range by periodically broadcasting its updated location information to all of its direct neighbors through update packets known as beacons.

In GPSR, a source node sends the data packet to the destination through greedy forwarding scheme where node forwards packets to its neighbor node that is closest to the destination node [1]. Forwarding in this strategy follows successively closer geographic hops until the destination is reached. A node uses a metric based on its own position, its neighbor's positions and the destination position in order to choose the next hop. This forwarding scheme may fail due to the non-existence of nodes closer to the destination than the forwarding one. In such cases, recovery strategies are needed to resolve such dead end or local minimum situation [16, 13]. GPSR recovers by forwarding in perimeter mode until reaching a node closer to the destination, then resuming in greedy forwarding again [30,29].

Geographic routing protocols reduce the reliance on topology information and thus eliminate the need of expensive topology storage and maintenance. This also makes them more suitable to handle dynamic behavior frequently found in wireless ad-hoc networks [4]. However, in order to make the geographical routing protocols useful, all nodes must know their geographical position all the time. Therefore, each mobile node must be equipped with GPS or other devices to be aware of its own positions. Practically, it is difficult to let all nodes equipped with GPS receiver. Adding a GPS receiver increases the weight, size, and cost of the mobile node. Besides, GPS receivers may not work in areas concentrated with computing devices inside homes, offices, and enclosed publics [7]. Moreover, the recovery strategies required to resolve the local minimum problem, such as the face routing used in GPSR, causes more processing cost and end-to end delay [9].

3. THE PROPOSAL

This work proposes a new routing algorithm that is suitable for heterogonous networks where only some nodes are equipped with GPS receivers. The algorithm makes use of geographic position information of nodes to forward packets in greedy fashion while using on demand routing procedure to continue the packet delivery process. The algorithm assumes that:

- Each node maintains a route cache to store routes that have been discovered for possible future use.
- Each node maintains a table that includes all its immediate neighbors, each entry contains neighbor ID, IP-address, and x-y position if known.
- Each data packet header determines packet type (request, reply, error, and data).
- The source node of a data packet appends the destination position in the packet header if it is aware of it.

In the proposed algorithm; when anode receives a packet, it first checks whether the packet header has a valid source route or not. If a valid route exists, the packet type is then checked and handled according to its type. In case of absence of a valid route, the receiving node initiates a route-record in the packet header, inserts its ID then checks its direct neighbor list for the destination or check its cache for a route. Otherwise, it forwards the packet in greedy fashion if the required position information is available. Else, the data packet is saved in its send buffer and a route request is broadcasted to wait for route reply. The algorithm is demonstrated in the flow chart shown in figure 1. The Route request packet contains addresses of the request packet initiator, the destination and the unique request identifier.

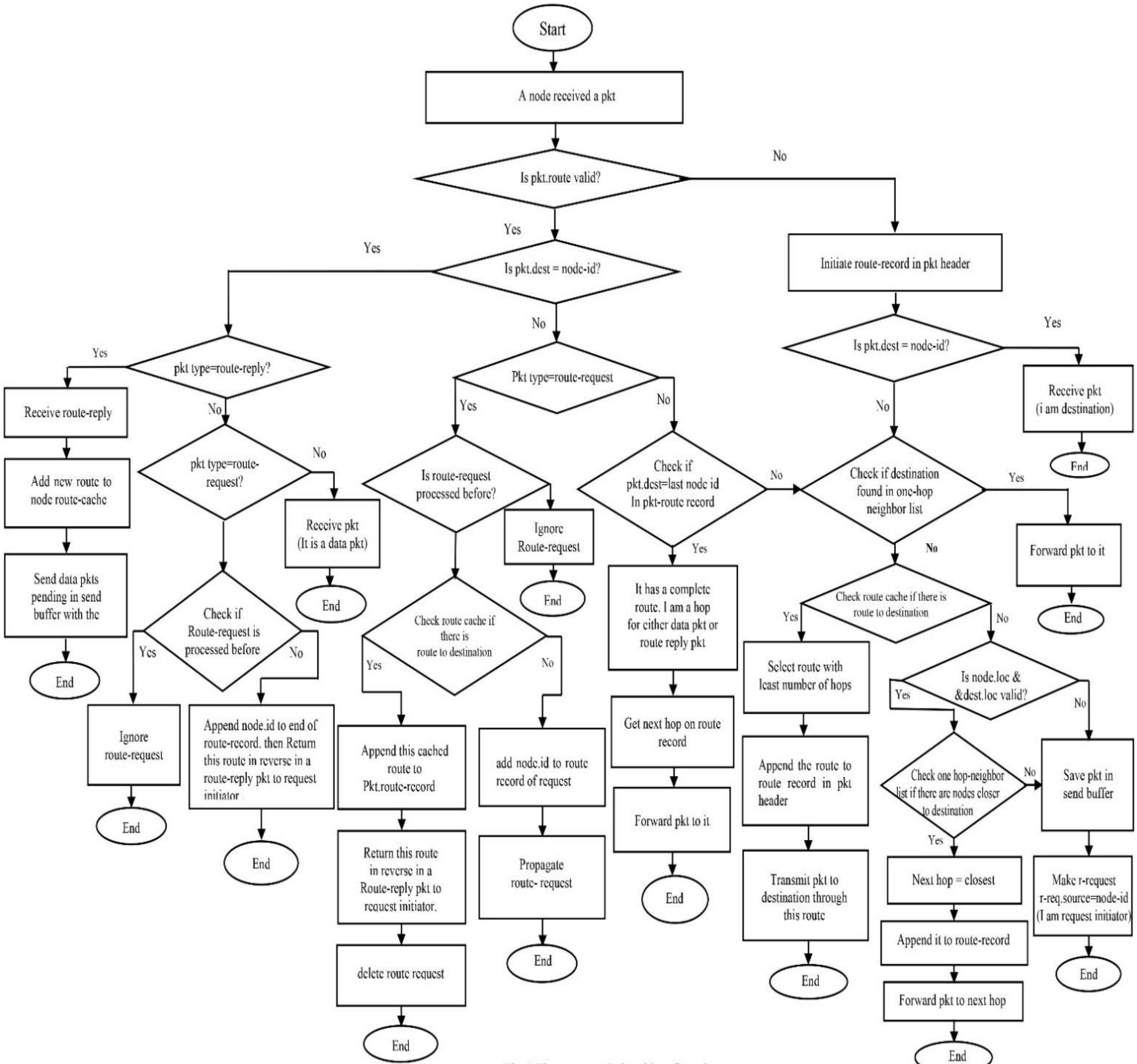

Fig 1.The proposed algorithm flowchart.

4. SIMULATION ENVIRONMENT

To show the effectiveness of the proposed algorithm, the performance of the proposed one is compared to the performance of both DSR and GPSR routing protocols. The simulation tool used is the discrete-event Network Simulator (NS-2). Three performance metrics are used to evaluate the performance; Average End-To-End Delay, Throughput, and Packet Delivery Ratio. A tcl script is created to describe the simulation models concerning the network topology composed of nodes, routers, links and shared media. 20% of nodes are assumed to be aware of their own position. The simulation parameters are listed in table 1.

Table 1. Simulation Parameters

Simulation parameter	Value
Simulation area	500*400
Simulation time	200
Number of nodes	20,40,60,80,100,120,140,160
Antenna type	Omni-directional antenna
Radio propagation model	Propagation / TwoRayGround
MAC Protocol	IEEE 802.11
Channel type	Channel / wireless channel
Network Interface Type	Phy /wirelessphy

5. PERFORMANCE EVALUATION

The performance of the simulation is evaluated according to the following performance metrics.

5.1.Average End- to-End Delay:

Average End-to-End delay is the average time a data packet takes from the beginning of a packet transmission at a source node until packet reaches the destination. Good performance requires Low average end-to end delay. It is calculated using awk script (delay.awk). As we can see from Figure2, the average end-to-end delay of the proposed algorithm is reduced compared with DSR. That is because the availability of forwarding the data packet directly to the destination if it is a one hop neighbor or forwarding it greedily eliminates delays caused by buffering of data packets during discovery of routes and saves the time of route rediscovery process.

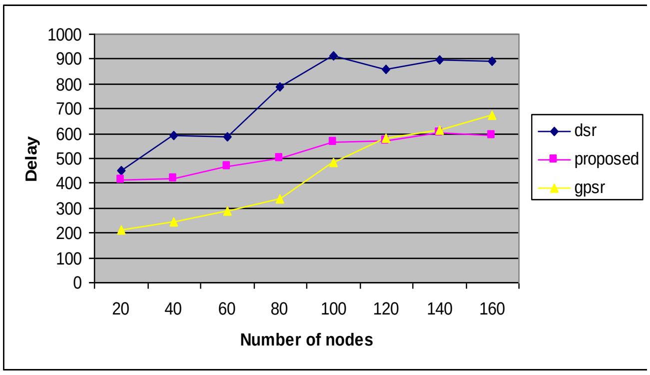

Fig2.End-to-EndDelay comparison of DSR, GPSR and proposed algorithms with different node density.

5.2.Throughput:

The amount of packet transferred over the period of time expressed in kilobits per second (kbps). As it is seen in Fig 3the proposed algorithm performs better than the basic DSR. This effect may be due to the reduced congestion in the path. It is shown also that the proposed algorithm outperforms GPSR due to the greedy forwarding failure.

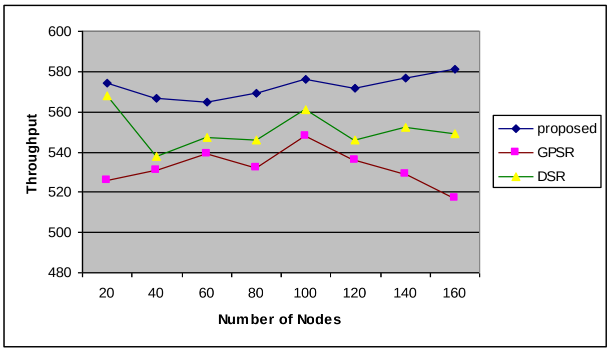

Fig3. Average throughput comparison of DSR, GPSR and proposed algorithms with different node density.

5.3.Packet Delivery Ratio

It is the ratio of the number of data packets received by destination node to the data packets sent by source node. Figure 4 shows that the proposed algorithm has a better PDR value when compared to DSR and GPSR.

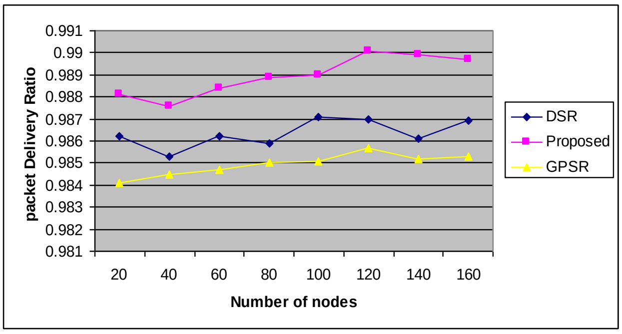

Fig4. Packet Delivery Ratio comparison of DSR, GPSR and proposed algorithms with different node density.

6. CONCLUSION

In this work, we proposed a new routing algorithm for MANETs. The algorithm uses the greedy forwarding strategy to forward packets as long as the required geographical position information of nodes is available. When geographical position information of nodes is missed, it continues routing the packets using the on-demand mechanism. GPSR and other geographic routing algorithms deal with networks where all nodes are aware of their positions. This algorithm provides a suitable routing solution for network where only some nodes are aware of their positions. On the basis of result, it was concluded that the proposed algorithm performs better compared to GPSR and DSR protocols considering end-to-end delay, throughput and packet delivery ratio.

7. REFERENCES

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