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Improved Graph-Based Reliable Routing Scheme for VANETs

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Abstract—VANET are a special form of wireless networks made by vehicles communicating among themselves on roads which pursues the concept of ubiquitous computing for future. VANET has opened door to develop several new applications like, traffic engineering, traffic management, dissemination of emergency information to avoid hazardous situations and other user applications. VANETs are direct offshoot of Mobile Ad hoc Networks having characteristics like movement at high speeds, in-sufficient storage and processing power, unpredictable node density and short link lifetime. As communication links break more frequently in VANETs, the routing reliability of such highly dynamic networks needs to be paid special attention. The recent research based on evolving graph theory, extends Graph theory to be applicable in creating continuously changing routes between source and destination. This existing work has limitation in addressing the high variable velocity, bidirectional traffic and overhead. A new algorithm is proposed to find the most reliable route in the VANET evolving graph from the source to the destination and variable velocity environment which reduce overhead.

Index Terms— VANET, MANET, MRJ, end-to-end delay

1 Introduction

Vehicular Ad Hoc Network (VANET) is a new challenging network environment that pursues the concept of ubiquitous computing for future. They are a special form of mobile ad hoc networks (MANETs) that provide vehicle-to vehicle communications. It can be thought as each vehicle is equipped with a wireless communication facility to provide ad hoc network connectivity. VANETs tend to operate without an infrastructure; each vehicle in the network can send, receive, and relay messages to other vehicles in the network. This way, vehicles can exchange real-time information, and drivers can be informed about road traffic conditions and other travel-related information. VANETs have unique and fascinating features, different from other types of MANETs, such as normally higher computational capability, higher transmission power, and some kind of predictable mobility, with comparison with general MANETs. VANETs bring lots of possibilities for new range of applications which will not only make the travel safer but faster as well. Reaching to a destination or getting help would be much easier. The concept of VANETs is quite simple by incorporating the wireless communication and data sharing capabilities, the vehicles can be turned into a network providing similar services like the ones with which we are used to in our offices or homes. For the wide spread and ubiquitous use of VANETs, a number of technical challenges exist. Besides, VANETs are also similar to MANETs in many ways. For example, both networks are multi-hop mobile networks having dynamic topology. There is no central entity, and nodes route data themselves across the network. Both VANET and MANET are rapidly deployable, without intense of an infrastructure. Although, MANET and VANET, both are mobile networks, however, the mobility pattern of VANET nodes is such that they move on specific paths (roads) and hence not in random direction. This gives VANETs some advantage over MANETs as the mobility pattern of VANET nodes is predictable. MANETs are often characterized by limited storage capacity and low battery and processing power. VANETs, on the other hand, do not have such limitations. Sufficient storage capacity and high processing power can be easily made available in vehicles. Moreover, vehicles also have enough battery power to support long range communication. Another difference is highly dynamic topology of VANETs as vehicles may move at high velocities. This makes the lifetime of communication links that comes into range of the neighbors are usually quite short.

1.1 Motivation

Lot of people die, and many more are injured in traffic accidents around the world. The desire to disseminate road safety information among vehicles to prevent accidents and improve road safety is main motivation behind the development of vehicular ad hoc networks (VANETs).
Over recent years ambitious plans to create a system that would assist in the prevention of a crash were introduced. These systems are known as Active safety systems and differ from previous passive safety systems (seatbelts, air bags, etc.) vehicles are able to detect unusual vehicle behavior e.g. rapid breaking, activating electronic stability systems, breaking red lights, unsafe breaking distance. The current evolving graph theory cannot be directly applied to VANETs. Evolving topological properties of the VANET communication graph are not scheduled in advance.

1.2 Objective

The objective of this dissertation is to propose a novel evolving graph-based reliable routing scheme for VANETs. The novelty of this work lies in its unique design of a reliable routing protocol that considers the topological properties of the VANET communication graph using the extended evolving graph. Considering that vehicles travel at high speeds on highways, the data delivery service could have many disruptions due to frequent link breakages. It is very important to ensure that the most reliable links are chosen when building a route. The major contributions of this dissertation are given here.

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- Improving Neighbor Table Update
- Considering Variable Velocity while building EG

1.3 SCOPE OF PAPER

With reference to the improved graph base reliable adhoc on demand vector enhancement of evolving graph and VoEG (VANET oriented Evolving Graph) mobility model can find mobility link and traffic flow parameter in VANET. Implementation of evolving graph scenario of MANET routing in VANET using I-EG-RAODV (Intelligent Evolving Graph Reliable Adhoc on Demand Vector) results in reduction of overhead.

1.4 OVERVIEW

Section2: This section includes a literature survey on Vehicular Ad Hoc Networks (VANETs), showing their main characteristics and applications. This also makes a background introduction to the different standards that support this kind of network. Additionally, this present the existing solutions to reduce routing overhead, and is contained a review of the previous research work.
Section 3: This section includes overview of proposed methodology and its flow chart and characteristic of proposed work. Algorithm and experimental parameter and also discuss about the minimum hardware specification.
Section 4: This section includes a comprehensive study and comparison of publicly available VANET simulation software and their components. In particular, contrast of their software characteristics, Graphical User Interfaces (GUIs), popularity, ease of use, input requirements, output visualization capability and accuracy of simulation.
Section 5: This section includes the screenshot of existing and proposed methodology and parameter throughput, end to end delay and routing overhead. It includes a summary of the main results of EG-RAODV & I-EGRAODV, along with some concluding remarks.

2. RELATED WORKS

In recent A Study of Improved AODV Routing Protocol in VANET which improved AODV two steps optimization in route discovery and route selection process to improve the route stability and decrease overhead. First step: selecting nodes with more stable links in route discovery phase. Second steps selecting most stable route in route selection process which perform better in link stability and packet delivery ratio. An Improved VANET Intelligent Forward Decision-making Routing Algorithm VANET routing technology based on link quality and velocity vector (LQ-VV-GPSR) which aims at selecting reasonable relay node to convenient forwarding message intelligently. It comprehensively takes into account velocity vector information and underlying link status to determine which next hop data packet will be forwarded. LQ-VV-GPSR has better robustness and scalability, which is suitable for large scale and heavy traffic network scenarios.

Limitations of the Existing System

There are certain limitations as follow

- The existing work does not consider the overhead caused by Bidirectional Traffic when every vehicle is Discovering/Building VoEG.
- Building VoEG for each vehicle need each of them to build neighbor table using HELLO Messages that normally floods the Network.
- Also this work has not addressed the Variable Velocity of Traffic.

3. PROPOSED METHODOLOGY

Fortunately, the pattern of topology dynamics of VANETs can be estimated using the underlying road networks and the available vehicular information. Hence categorize this type of dynamic network as a predicted pattern dynamic network. Consequently, the current evolving graph theory could be extended to deal with VANETs. The current evolving graph theory cannot be directly applied to VANETs. As mentioned before that the evolving topological properties of the VANET communication graph are not scheduled in advance. Moreover, the current evolving graph model cannot consider the reliability of communication links among nodes. The extended version of the evolving graph model, called VoEG, is evolving based on the predicted dynamic patterns of vehicular traffic. These patterns are predicted based on the underlying road network and vehicular information.
Each scenario was designed with a different number of nodes. Figure 3.1 demonstrate the overall overhead caused by HELLO messages with the assumption that all HELLO messages are sent at single HELLO intervals. Based on the I-EG-RAODV proposed theory, if the destination node of the HELLO message is checked among neighbors on a list and is found to have active expiry time, I-EG-RAODV does not send HELLO message to that destination, meaning it filters the broadcasting HELLO message. The difference in HELLO message overhead is illustrated in Figure3.2, where a HELLO message is only sent to a destination that is not in the neighbor list. This difference can provide less routing packets and therefore, better normalized routing load. In fact, I-EG-RAODV can deliver data to its destination by finding a shorter, fresher route entry with fewer routing packets. Figure 3.1, Original AODV HELLO message overhead Figure 3.2, I-EG-RAODV HELLO message overhead
Neighbors are recognized and added to the neighbor list after sending an ACK to the HELLO message sender. The neighbor node's information is used in flooding RREQ and as a starting point for the data delivery route to destination. In I-EG-RAODV, RREQ and RREP headers are checked to compare header information with the routing table. This helps identify newer shorter routes to destination. Thus, I-EG-RAODV can smartly find neighbors while sending and receiving RREQ and RREP. This implementation permits the protocol to discover neighbor nodes quickly and utilize neighbor node information in the route discovery process. The fact that mobile nodes are designed with mobility is an advantage particularly in MANET. However, I-EG-RAODV is much better behaved

in such scenarios involving mobility. Figure 3.1 show an overview of the concept that RREQ and RREP are used for neighbor discovery. I-EG-RAODV is able to recognize a new neighbor before or after Hello Timer(s). This means that I-EG-RAODV checks RREQ and RREP sequence numbers and hop counts while comparing them with route an entry in the routing table, then after checks whether corresponding node is found in the neighbor list, if not then that node is measured a neighbor.
This concept derived from one of the AODV attributes which states that each RREQ and RREP is sent to the next node, so the sender node knows the next hop node's information. By using I-EG-RAODV, there is still a chance of finding neighbors using RREQ and RREP next node's information assuming there is no neighbor discovery functioning in the protocol.

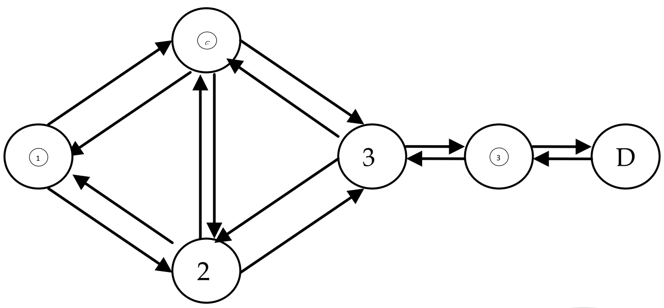

Figure 3.1 Original AODV HELLO message overhead

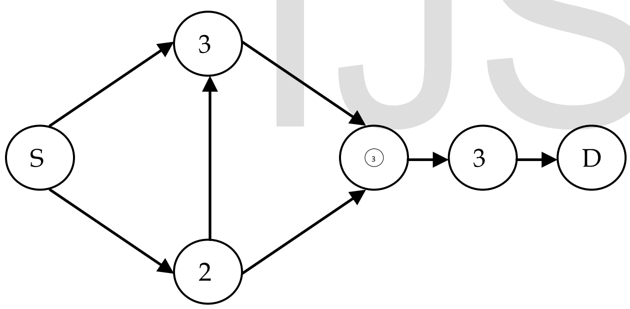

Figure 3.2 I-EG-RAODV HELLO message overhead

ALGORITHM

Input: A VoEG , a source vehicle Sr and a destination vehicle De.
Output: The MRJ from Sr to De.
1. Initialize the reliability route and source array Q
2. For Q ≠ null
a) For each neighbor v obtained from source Sr
b) if Trav (e) is True
Set RG(v)← rt (e)×RG(x);
Insert neighbor v if not visited in Q;
3. For MRJ ≠ null
a) Add x ← first node from MRJ as header to RREQ x.
b) For each open neighbor v of x
do
if time (Ds) is active expiry and exists in neighbor list
Do not send HELLO message
if v does not exist in neighbor list
Send HELLO message
c) Update the neighbor list based on the received RREP message and hop count.
4. Remove x from MRJ
5. Send RREQ x from Sr to De.
6. While an RREP not received wait.
7. Start sending data.

4. SIMULATION RESULTS

EXPERIMENTAL PARAMETER

Sr.No.	Simulation Parameter	Values
1.	Protocol	AODV
2.	Simulation time	180 sec
3.	Mobility model	Random Way Point
4.	Type of traffic	CBR(constant bit rate)
5.	Varying no. of vehicles	20 – 100
6.	Ns2 version	2.35
7.	Mac layer protocol	802_11
8.	Packet size	32-512 bytes
9.	Slot Time	20 µs

TABLE 1 SHOW THE EXPERIMENTAL PARAMETER USED FOR SIMULATION.

1) Packet delivery ratio (PDR): It represents the average ratio of all successfully received data packets at the destination node over all data packets. (ratio) generated by the application layer at the source node.

2) Link failures: It represents the average number of link failures during the routing process. This metric shows the efficiency of the routing protocol in avoiding link failures.

3) Average end-to-end (E2E) delay: It represents the average time between the sending and receiving times for packets received (sec).

4) Throughput: It is the number of bits passed through a network in one second. It is the measurement of how fast data can pass through and entity (such as a point or a network) (bits/sec).

5) Normalized Routing Overhead: The normalized Routing overhead is defined as the ratio of routing packet transmitted to total data packet delivered.

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PARAMETER		DATA TRANSMISSION RATE			
DELIVERY RATIO		20	40	60	80
	EG-RAODV	55	65	68	70
	I-EG-RAODV	58	68	72	75
LINK FAIL-URES		DATA TRANSMISSION RATE			
		32	64	128	256
	EG-RAODV	25	28	30	40
	I-EG-RAODV	20	22	25	33
LINK FAIL-URES		VELOCITY			
		50	60	70	80
	EG-RAODV	20	25	28	30
	I-EG-RAODV	18	20	22	25

TABLE 2 RESULT COMPARISON OF EG-RADOV & I-EG-RAODV

As shown in table comparison of EG-RAODV and I-EG-RAODV is shown for different data transmission and velocity. Table 2 state that link failure in proposed methodology is reduced and also packet delivery ratio improved.

Parameters	Existing System (EG-RAODV)				
	20 Nodes	40 Nodes	60 Nodes	80 Nodes	100 Nodes
Throughput	345.006	460.35	498.62	711.60	839.98
Average End-to-End delay	158.0	233.18	276.05	341.56	368.22
Normalized Routing Overhead ()	18.2	10.2	8.6	6.7	5.3

TABLE 3 RESULT OF THROUGHPUT, AVG END-TO-END DELAY AND NORMALIZED ROUTING OVERHEAD EG-RAODV

Table 3show the simulation parameter for existing system EG-RAODV which evaluate the Throughput, Average End-to-End to delay, Normalized Routing Overhead for 20,40,60,80,100 numbers of nodes. As number of nodes increase the throughput and average end to end delay while normalized routing overhead reduce as shown in table.

Parameters	Proposed System (I-EG-RAODV)				
	20 Nodes	40 Nodes	60 Nodes	80 Nodes	100 Nodes
Throughput	387.420	491.85	552.02	776.02	884.44
Average End-to-End delay	153.40	205.70	251.62	318.06	337.70
Normalized Routing Overhead	13.6	7.6	5.7	4.5	3.6

TABLE 4 RESULT OF THROUGHPUT, AVG END-TO-END DELAY AND NORMALIZED ROUTING OVERHEAD I-EG-RAODV

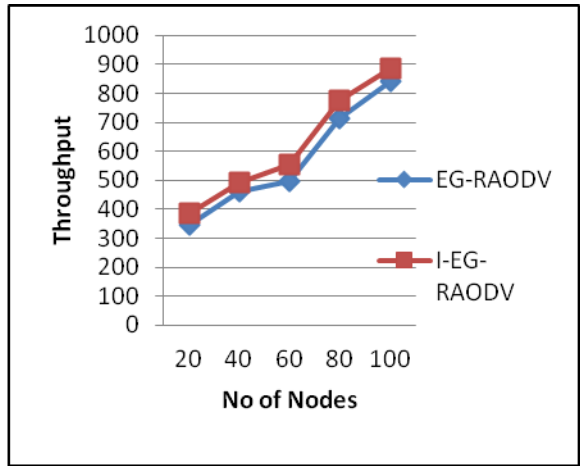

Fig 4.1 Throughput comparison of EG-RAODV & I-EG-RAODV

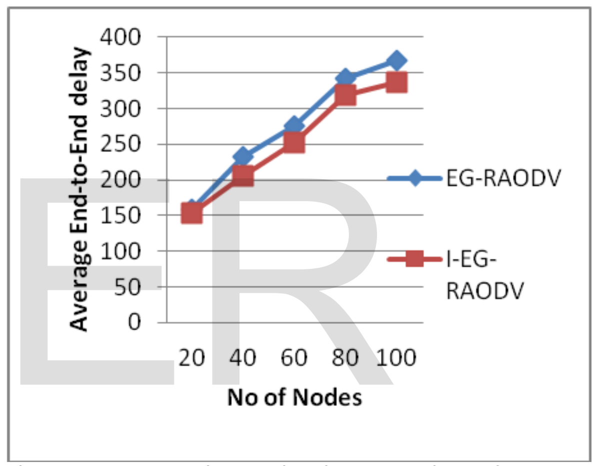

Fig 4.2 Average End to End Delay comparison of EG-RAODV & I-EG-RAODV

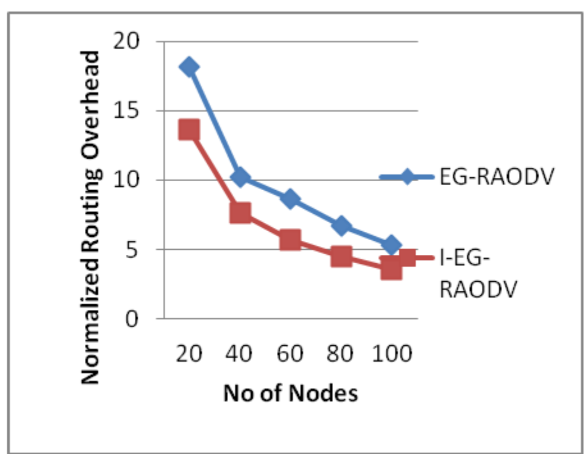

Fig 4.3 Normalized Routing Overhead comparison of EG-RAODV & I-EG-RAODV

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Table 4 show the simulation parameter for existing system I-EG-RAODV which evaluate the Throughput, Average End-to-End to delay, Normalized Routing Overhead for 20,40,60,80,100 numbers of nodes. Comparing outcome of EG-RAODV and I-EG-RAODV it is clear that throughput increase as compare to EG-RAODV and also average end to end delay and normalized routing overhead reduce. Figure 4.1, 4.2, 4.3 shows comparisons of throughput, average end to end delay and normalized routing overhead

5. CONCLUSION

During this research work, discussion of existing VANET routing protocols types, nature and their advantages and dis-advantages. Existing method find the reliable path by finding the reliable value and prediction pattern algorithm. The pro-posal methodology enhance performance of EG-RAODV pro-tocol i.e. I-EG-RAODV based algorithm is presented for better routing in VANET. This proposal fulfills the intelligent rout-ing scheme by updating neighbor node table and reduces the packet load. In addition congestion cause by HELLO message is reduced resulting in reduction in overhead.

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