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A Novel Modified Zone Multicasting Routing Protocol for Path Establishment in VANET

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Abstract - Path establishing is a crucial research topic for both MANET and VANET, and incessantly shifting topology in various networks creates many problems in the field of routing. Reactive and Proactive Systems are not that much effective to tenacity the routing issues as both have disadvantages. Zone Multicasting Routing Protocol (ZMRP) is a hybrid protocol use to combine the essential features from both the schemes. Recently a lot of research has been taken into account but multicasting is still a challenge for V2V communication. Establishing a secure and efficient route from the source node to the destination node is very difficult since the mobility of vehicles within VANETs is very high. To establish a route different routing protocols have been developed. Depending upon their properties, the protocols are categorized amongst proactive, reactive as well as hybrid protocols. In order to establish the path from the source node to the destination node, this research work has applied the Modified Zone Multicasting Routing Protocol (MZMRP) technique. For routing the data, the root nodes from the network are chosen within this multicasting technique. A root node is used to select the path from source to destination. The NS2 is used to implement the MZMRP approach and certain parametric values are calculated to provide analytical results

Keywords - *LAR, VANET, ZMRP, MZMRP*

1. Introduction

The safety, comfort, mobility, and quality of huge traffic that is commonly seen within smart cities every day. The Intelligent Transport Systems (ITS) are introduced to provide such facilities within these applications. VANET is extremely significant in the development of ITS for all applications [1]. A network in which vehicular nodes are deployed which keeping changing their locations is known as VANET. There are several researchers attracted to this latest research field from all across the globe. VANETs mainly ensure the safety of vehicles traveling on the road along with providing traffic efficiency and level of comfort to the individuals [2]. In VANET, the information can be shared using Vehicle-to-Vehicle (V2V) communication as depicted by the figure 1. This involves Vehicle-to-Infrastructure (V2I) and Infrastructure-to-Infrastructure (I2I) communication. The roadside infrastructure presented in the diagram shows the various kinds of information sharing possible in these scenarios.

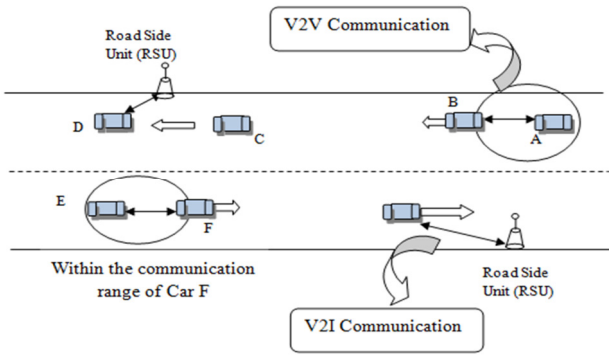

Fig. 1 Vehicular Ad Hoc Networks.

The data is transferred and received from one vehicle or node to another vehicle or node with the use of wireless sensor nodes within 100 to 500 meters and allowed to interact and communicate with one another. When the vehicle falls out of the range of 500 meters then it is dropped out of the network. When the vehicle comes back in the signal range then the network joins together by that vehicle.

The modernized wireless communication appliances are responsible to furnish the vehicles and this furnishing is known as On-Board Units (OBUs). The base station is absent in such types of devices and possibly provides V2V as well as V21 types of interaction along with the network. It is one of the most important types of applications of VANETs and sensor networks [4-6]. In this work, we are going to demonstrate an innovative approach of multicasting which is used for creating a route from source to the desired address. This technique will enhance the response time for all the nodes in the current zone under selection. Whereas in broadcasting the transmission of information is flooded to all the available nodes which make the network slow and the response time for the nodes starts rising [7-8]. The most efficient routing protocols through which the route is established within VANETs are the reactive types of protocols. Depending upon the current network information, a route is established only when required through the reactive routing protocols. The most commonly used protocol amongst them is the Location Aided Routing (LAR) protocol. The broadcasting approach is used here to establish the paths across which the route request packets are flooded to the source node. The route reply packets are sent back to the source by the vehicles that have a direct path towards the destination. The path from source to destination is chosen depending upon two factors which are the least hop count and the sequence number. The novelty of paper constitutes work in different sections like previous studies in section 2, besides the methodology and resources as well as algorithm of MZMRP approach discuss in section 3 which further followed by results and discussion and conclusion section.

2. Related Work

In various studies, to establish the path, different types of protocols have been used which are mainly classified into reactive, proactive and hybrid protocols. Most popular amongst all is the reactive routing protocol which establishes the route due to its effective performance. The concept of broadcasting is used in the reactive routing protocol for route creation. The home node will broadcast the path request packet in the network for communication.
The min-delay routing protocols transmit data towards destination once it's received the data from the source. It will also lower the delay of the transmission. Furthermore, the shortest routing path is the main concern in a VANETs which increases if a multichip forwarding is used. The min-delay routing protocols are Greedy perimeter coordinator, vehicle-assisted data delivery routing protocol, Connectivity-aware routing protocol and, DIR: diagonal-intersection-based routing protocol [9-13]. The nodes which are close to the source node will respond using the route reply packet [11]. The selection of routes is based on hop count and sequence number. The multicast approach for the path establishment as compared to the other approaches is mostly used, as vehicle nodes are used to establish a path for receiving route request packets.

In other studies, the unicast routing protocol is treated as a one-to-one communication system that transmits data from one source to one destination at a single time [14]. The major disadvantage of this type of protocol is it can communicate i.e. either receive or send data packets with only one device at a single time. It increases data traffic when a single message is to be communicated with more than one device. Multicast routing protocol uses a shared tree mechanism to communicate with other devices. It keeps the advantage of communicating with more than one device on a single go. It is a transmission method in which a single device communicates with several devices. It is implemented in the data link layer using one-to-many addressing. In multicast, the information is available or transmitted to a group in a tree-like structure to destinations. The connection is one-to-many [15]. In such kind of communication, the origin from where the information is communicated is a unicast address, and the target address is a cluster of addresses, which terms one or more destinations. The collection of addresses recognizes the associates of the group. Zone Multicasting Routing Protocol (ZMRP) [16] is a source-initiated protocol that combines both the proactive and reactive directing methods. Every single node has a directing zone. In ZMRP whenever a node, which is already a multicast forwarding node for a particular group desiring to link a multicast cluster, changes its status from multicast forwarding node to multicast cluster member. A multicast node participant willing to move apart from the cluster, if the leaving node is the end node in the cluster multicast tree it will trim itself from the tree by broadcasting a multicast trim message to the node next to it. The major limitation of ZMRP is that a node separate from the source routing zone has to ideally wait for a considerable time to join the cluster which leads to more energy consumption in the network. The proposed MZMRP has made significant changes in the existing ZMRP to enhance path establishment in routing and lowering the amount of energy as compared to ZMRP.
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3. Proposed Modeling

3.1 Methodology

To apply the concept of multicasting, the zonal based routing concept will be applied for route creation in a

minimum time span [17]. A novel modified algorithm on Zonal Multicast Routing Protocol (ZMRP) will be used for the multicast approach is implemented in the network, the network routing overhead will be reduced. The zone is well-defined as a gathering of nodes whose least remoteness (in hops) beginning the node in question is no larger than a value that is titled as "zone radius". Outer nodes are those nodes whose least distance from the node in query is equal to the zone radius. As the name shows that it is built on the zones of the nodes present in the network. The zones of all nodes are defined distinctly, and the zones of the nodes present in neighbors can overlap.

The zone of the node is according to the radius defined. All the nodes present in a zone of the specific node must have less or equal distance to its defined radius and thus forms a zone of that specific node. The proposed "Modified Zonal Multicast Routing Protocol" technique which minimizes the consumption of resources of the network. Broadcasting Routing Protocol (BRP) uses the same scheme as it transmits the packet through Broadcasting in which the node sends the packet to the bordering nodes and the nodes present in the interior side (Interior nodes) will be aware of the topology which will be provided by the peripheral nodes [18-19]. Zone radius of the network has very prominent functions for the performance of protocol as if the radius is less (i.e.; 1) in this case then the routing will be purely "Proactive" and it will provide the routing table information. If the radius is greater than the defined, then the routing will be "Reactive". The source node will not send/ receive route request packet to those nodes which cannot establish a route to destination [20][22]. The multicasting approach also reduces the path establishment period as a result increase's the efficiency, NRL, Packet Delivery Ratio (PDR), Route Lifetime and Throughput of the model. The following are the various steps which are followed for the path establishment:

[1] The VANET is made up of various vehicle nodes. This network employs roadside parameters that are employed for the V2V and vehicle to infrastructure interactions.
[2] In the second step, the roadside units send the control message to every node within the network. The vehicles receive that message and check the number of nodes in their direct range (predefined distance).
[3] In the third step, each vehicle node represents a number of nodes in their range (predefined distance) with the other nodes. The vehicle node which has the maximum number of nodes in their range is selected as the zonal head node. The clustering technique also represented in another study where localization is performed using fuzzy logic
[4] The multicasting is the approach which is MZMRP used in this research work for route formation. The multicasting approach will improve the path establishment procedure which is adopted in the broadcasting approach.
[5] There are fixed numbers of vehicle nodes in the multicasting network. The complete network is separated into certain zones based on the two parameters which are speed and distance.
[6] The vehicle nodes which have the least speed and distance are selected as the best node. The best zone is chosen as the zonal head in the network. To establish route, all nodes present in the zone send information to the zonal head.
[7] The multicasting approach will lead to reduction in overhead and it takes less time for the path establishment. Multicasting, in the fields of computer networking, refers to the technique of communication of information, simultaneously to the collection of destination computers from the source. Multicast routing protocols play a crucial role in Vehicle ad-hoc networks, where available bandwidth is limited; since it is always beneficial to use a single multicast rather than multiple unicast [22-25].
[8] By using the Zonal Multicast Routing Protocol, it can also reduce control packets and broadcasting overhead size. The simulation results imply higher performance with respect to NRL, Packet Delivery Ratio (PDR), Route Lifetime and Throughput of the model.

3.2 Pseudo code for MZMRP

Input: Input vehicles nodes
Output: Reliable path from Source to Destination
Initialization Parameters:
-Cluster Size (S)
-Source Node/Vehicle (V_1)
-No of Vehicles in the Cluster (N)
-Roadside Transmission Units (T)
-Cluster Head Selection (CH)
For Each Cluster
Vehicles communicating within the range of (T) belongs to a particular cluster (C)
End
For Each Roadside Transmission Unit (T)
For (V_1=1 to N)
If V_1<T
Continue
Else
Return (V_n) as CH
End //End If
End // End For
For (V_n =1 to N)

R=Request to CH for Route Selection
If R <= Best Route (B_R)
Return R as B_R
End If
End // End For

3.3 Pseudo code for the creation of cluster head(CH)

Input: Vehicles
Output: Cluster Head
Iniziliation Parameter:
-RSU (T)
-Diameter of the Cluster (D)
-Location of Vn Vehicle (Lv)
Distance of the Vehicle from the RSU (Dv)
For Each Roadside Transmission Unit (T)
If (T) Contains Lv with (Dv < D)
Return Vn Belongs to T
End If
For Lv = D/2
Return Vn as CH
End For
End For

The Modified Zonal Multicast Routing Protocol has various phases to forward the route request beginning node S to D at time t1, S estimates the region in which D is localized. However, S has no knowledge about the direction to which the destination node moves. It is not possible to identify almost the nodes that move in the direction that is similar to D. However, the mobility of nodes that go in a direction similar to S is known since the direction to which S moves in t1 time is known. For improving the strength of route across source and destination, a route demand is forwarded to the nodes which move in a direction similar to the source node. On reception of a route request by node, it is important to check the direction of motion as compared to S. When moving in a direction similar to S, the route request is retransmitted. Else, the route request is removed. It is important to add the proposition once the constraints of LAR scheme 1 as shown in Fig. 2, which shows an example for the Bi-Directional Highway Model. Here, since the direction of movement is like S, the route request node I is forwarded to node A to ensure that the route request can be forwarded. If the directions of I and S are not similar, the route request is eliminated. The neighbor to stay the longest time.

This step defines the communication of route request message to the vehicle that requires the highest time in the coverage area for transmitting the vehicle. This step eliminates the process through which the route request is transmitted to all the vehicles moving in a direction like that of the source node. Figure 3 shows the calculation of time for which a vehicle remains in the coverage region so that the vehicle is within the communication range of the side closer to the destination. Based on the vehicle that requires the longest time, the route request message is chosen by the receiver vehicle. The process remains running in an iterative routine until the messages reach the endpoint in the constraints of LAR1 protocol. There are four separate cases presented for calculating the time of each neighbor [26]. Every vehicle assumes to be transmitted to the adjacent vehicles in this scenario. (X_A, Y_A) is the position of vehicle A at t0 time.

The speed of this vehicle is represented as V_A. V_I is the neighboring vehicle's speed. (X_I, Y_I) is the location of this vehicle. At time t1, vehicle I leaves the reporting area of vehicle A. Therefore, to ensure that the vehicle is available in the coverage region, time t0=t1-t0 is considered. For example, the distances that are respectively considered among A and I are h and, On the abscissa, and co-ordinate axis, at time t0 the distances are taken. Further, 'a' is the distance between A and I that is denoted on the abscissa axis at time t1. To denote the distance moved by a vehicle I at time t1, 'x' is represented.

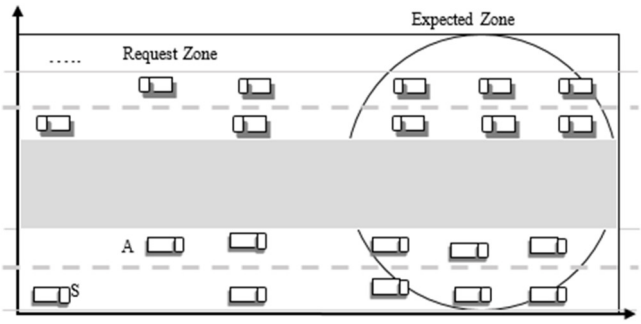

Fig. 2 Bi-directional highway model

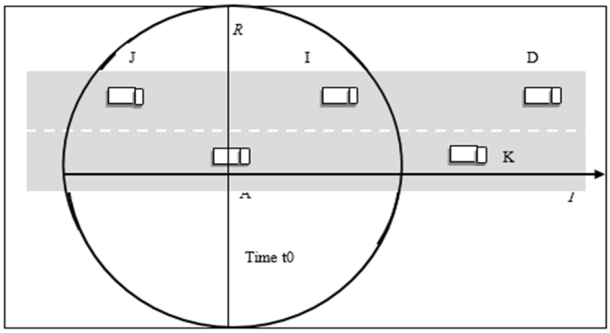

Fig. 3 Half-circle of the communication range in the side closing to the destination

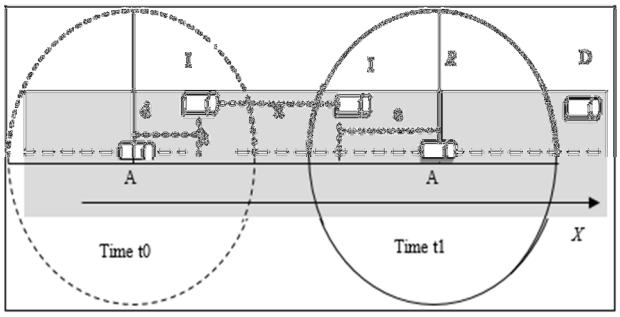

Fig. 4 D is in the dirrection of movement of S and VA>VI

Case First: At time t0, in assessment to I, the swiftness of A is firmly greater and in the route of S, the journey's end point moves. As shown in figure 4, the distances toured by A and I at the time t1 can be premeditated as:

$$d + x + a = t * V_A \quad (1)$$

$$x = t * V_1 \quad (2)$$

From equation (1) we get $t = (d+x+a)/vA$ (3)

From equation (2) we get $t = \frac{x}{V_1}$ (4)

Thus, equating equation 2 and 4 we get equation 5 and further evaluation of equation 5 will results to equation 6

$$\frac{d+x+a}{V_A} = \frac{x}{V_1} \quad (5)$$

$$x = \frac{V_1}{V_A - V_I} * (d + a) \quad (6)$$

$$d = |X_I - X_A| \quad (7)$$

$$a = \sqrt{R^2 - (Y_I - Y_A)^2} \quad (8)$$

$$t = \frac{|X_I - X_A|}{V_A - V_I} + \frac{\sqrt{R^2 - (Y_I - Y_A)^2}}{V_A - V_I} \quad (9)$$

4. Results and Discussion

In a certain region, specified nodes are deployed to perform simulation of the MZMRP model. NS2 simulator is used to device the projected model and certain parameters are used here to in the implementation scenario, which is listed in the table below:

Table 1. Implementation parameters

Description/Parameters	*Value*
Standard	802.11
Number of Nodes	100
Queue Size	50
Queue Type	Priority Queue
Packet Size	1000 Bytes
Antenna Type	Omni-Directional
Initial Energy level of a Node	1 Joule
Transmission Range	250m
Mutation rate	0.03
Data Rate	12 Packets per Second

4.1 NRL Analysis

A network can be difficult to maintain if router performance comes and goes at random intervals. NRL is mainly established on the Optimized Link State Routing (OLSR) protocol.

Figure 5, the NRL value of the ZMRP and MZMRP scenarios are associated for the performance study. It is examined that the NRL value of the MZMRP scenario is less in connection with the ZMRP scheme.

4.2 Route lifetime Analysis

As illustrated in figure 6, the route lifespan of ZMRP system is compared with MZMRP system. The multicasting scheme has a high route lifetime as compared to ZMRP scheme. The route lifespan is increased due to easy path establishment in the network.

4.3 Packet Delivery Ratio(PDR)

The Graph shown in Figure 7 represents the comparison of PDR (Packet Delivery Ratio) values obtained for MZMRP as well as for the ZMRP work shown in the graph. From the simulation results, it is observed that the average values of PDR obtained for the MZMRP approach are comparatively much higher. It is analyzed that the packet delivery ratio of the MZMRP system has a higher Packet Delivery Ratio to ZMRP.

4.4 Throughput

Figure 8 shows the throughput of the ZMRP and MZMRP scheme is compared for the performance study. It is examined that the packet delivery ratio of the MZMRP system has much higher throughput as compared to ZMRP schemes.

4.5 Qualitative Comparison

Figure 8 shows the throughput of the ZMRP and MZMRP scheme is compared for the performance study. It is examined that the packet delivery ratio of the MZMRP system has much higher throughput as compared to ZMRP schemes

Table 2 Qualitative Comparison

Parameter	ZMRP Scheme	MZMRP Scheme
Path Establishment	Broadcasting Manner	Multicasting Manner
Path Establishment Time	High	Low
Route Establishment Packets	High	Low
Network Division	Clustering Method	Zonal Method
Area Coverage	High	Low
AreaHead Selection Parameters	Node Stability	Speed of Node, Number of Single Hop Nodes

4.6 Quantative Comparison

In this segment, the ZMRP and MZMRP algorithms are compared quantitatively. It is examined that the MZMRP algorithm performs well in terms of NRL, PDR and Route Lifetime and Throughput in Table 3

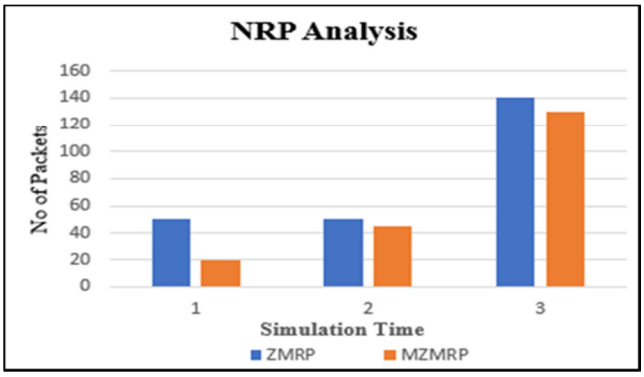

Fig. 5 NRL Analysis

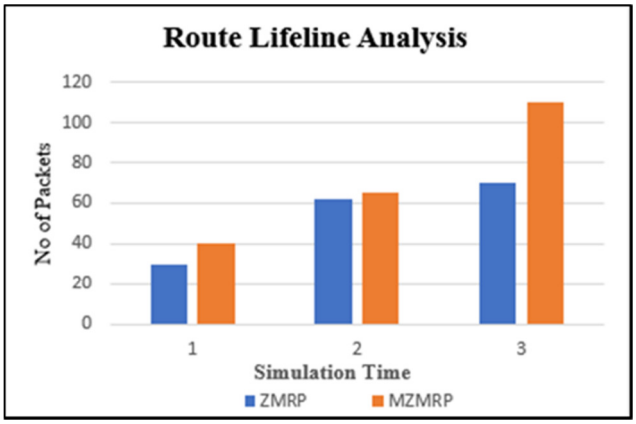

Fig. 6 Route Lifetime Analysis

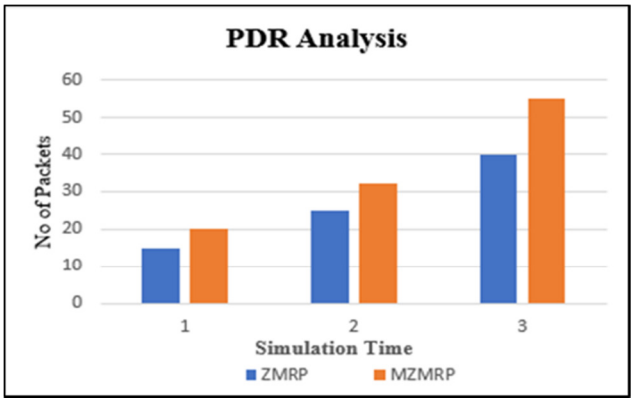

Fig. 7 PDR Analysis

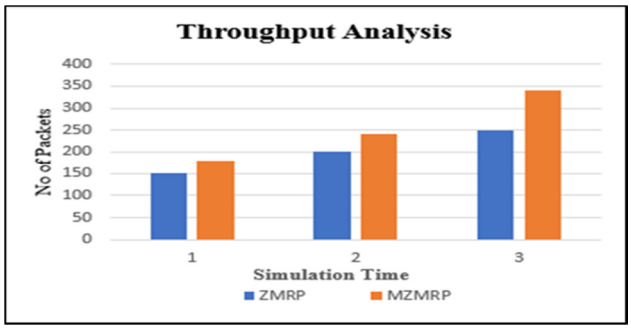

Fig. 8 Throughput Analysis

Table 3 Quantative Comparison

Parameter	ZMRP Scheme	MZMRP Scheme
NRL	35	20
PDR	45	86
Route Lifetime	67	79
Throughput	86	90

5. Conclusions

There are several researchers attracted to this latest research field from all across the globe. VANETs mainly ensure the safety of vehicles traveling on road along with providing traffic efficiency and level of comfort to the individuals. The data is transferred and received from one node or vehicle to another with the help of wireless sensor nodes within 100 to 500 meters and allowed to interact and communicate with one another. When the vehicle falls out of the range of 500 meters then it is considered to be dropped out of the network. When the vehicle comes back in the signal range then the network joins together by that vehicle. One of the most important challenges being faced when designing the VANETs is the development of dynamic routing protocol. Lately, in comparison to other traditional approaches, various changes have been made for routing in VANET because of the topology changes arising in highly dynamic and continuous manner. There are several protocols designed for MANETs previously, which are applied and tested within VANET scenarios as well. In the previous research work, the broadcasting approach is used for the establishing the path. It is concluded that broadcasting approach consumes high bandwidth for the path establishment as establishing such a path that takes least generation time and also consumes minimum bandwidth in the network, hence, this research proposes an MZMRP.

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