Fast Emergency Message Dissemination Routing Protocol in VANET (FEMDRP)

G.Santhana Devi,
Research Scholar, Research & Development Center, Bharathiar University, Coimbatore, Tamilnadu, India.

M.Germanus Alex
Prof and Head, Kamarajar Government Arts College, Surandai, Tirunelveli, Tamilnadu, India.

Abstract – The Vehicular ad hoc network (VANET) is an emerging research area. The research efforts taken over it has been attracted and appreciated both researchers and industries. The natural or man-made disaster demands an efficient communication along with a rescue team to save lives and other resources. In VANETs, the dissemination delay and reliability are the important criteria's for emergency message dissemination. The main focus of this paper lies in reducing emergency message broadcast delay with less overhead which is an important factor for emergency safety message dissemination. We propose FEMDR protocol that combines the features of both direction and time based routing protocols, which make certain the fast emergency message dissemination with less delay and higher throughput. FEMDR Protocol provide efficient and reliable route between source to destination with optimal forwarders and less overheads. FEMDR Protocol takes minimum message reachable time by selecting an optimal forwarder which reduces the network overhead and increase the throughput. We use ns-2 simulations to evaluate our mathematical model and compare FEMDRP with EMD protocols. The simulation results show that FEMDRP achieves less dissemination delay, lower overhead higher reliability and higher throughput than existing protocol.

Index Terms – VANET, Emergency Message Dissemination, Routing Protocol.

1. INTRODUCTION

Now a day the numbers of vehicles are increasing profoundly. Hence it requires many safety applications to solve the road traffic and road accident problems there by saving people's lives and other recourse. VANET is a sub class of Mobile ad hoc Networks with the aim to provide safety and other application to the driver and the passengers. The VANET environment provides a lot of road safety related services and location based services to the users. There are two main types of VANET applications: safety and non-safety applications. Main purpose of the safety applications is to increase the safety of both the passengers and the vehicles simultaneously. This can be achieved by sending emergency messages (EMs) to the vehicles located in the emergency area [1][2][3].

In VANET three type of communication are available Figure 1, shows vehicle to vehicle communication (V2V), vehicle to infrastructure or road side unit (RSU) communication (V2 I) and infrastructure to infrastructure communication (I2I) [4][5][6]. In VANET the node is divided into two categories RSU and OBU. Road Side Units (RSU) located along the road which is connected to the internet. The wireless communication device OBU is equipped with Vehicle.

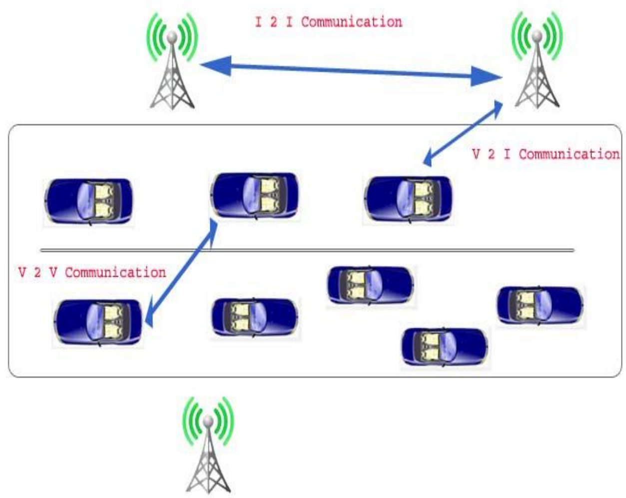

Figure 1: VANET Architecture

Every vehicle is equipped with an OBU and GPS that updates the vehicle's location and its speed. When road traffic accident or danger is detected the emergency message will be generated by the vehicles which are located around the dangerous spots, and then propagated by the nearby vehicles immediately [7]. However in VANET the existing protocol suffers from selecting the greatest next hop vehicle to forward the message. The proposed protocol FEMDRP is based on the direction and the message reachable time and its objective is to reduce the emergency message broadcast delay and overhead thereby to increase the throughput in a fast way.

The fast emergency message dissemination routing scheme operates in four phases: start beaconing, moving direction based Acceptance, Message reachable time based confirmation and path establishment. The highlights of FEMDRP are listed as follows:

- The source node sends a call request to the forwarding node's participants limited to communication range listed in [N (**V**$_i$)] neighbor list.
- The routing approach is enhanced with the moving direction estimation based Acceptance (MDEA) or Rejection (MDER) by calculating the moving direction of every individual node. In this way the unnecessary propagation is reduced thereby decreasing the message overhead problems.
- Chooses the optimal forwarder based on minimum message reachable time and alongside the acceptance node is proposed to reduce the problem of message overhead and delay.
- The best path is established with optimal forwarder.

The remainder of this paper enumerates the following, section 2 the related works. Section 3 the details of proposed scheme FEMDRP. Section 4 presents the performance analysis. Section 5 presents conclusion. Section 6 presents the reference.

2. RELATED WORK

In this section some protocols available for dissemination of emergency message in vehicular network are presented.

When the vehicle starts the broadcast procedure in any disaster event it broadcasts message to the neighbors. After receiving the message each of these receivers rebroadcast the message that causes high rate packet collision and network overhead problem; such situation is known as broadcast storm problem. To avoid broadcast storm problem many authors have proposed protocols to select a forwarder in each hop. The authors in [8][9] propose a network backbone as a minimum connected dominating set, that can be used to forward safety message ; the main problem with this scheme is that it requires high frequency for beacon message that may cause considerable overhead and packet collisions.

The author in [10] proposed protocol operates similar to the distance defer transmission. The farthest vehicle is selected as the broadcasting vehicle. The aim of the forwarding vehicle is to cover the maximum geographical area that was not covered by the source vehicle. The only difference between DDT and optimal multi-hop broadcast is that the later it modifies the formula used to calculate the waiting time value

Lakshmi et al., [11] have proposed a Prioritized Directional Broadcast Technique for Message Dissemination in VANET. Initially, message priority assignment technique is used in which three levels of message priorities, that is, very urgent, urgent and general messages are considered. Binary partition phase is then performed for finding the candidate relay node inside the coverage area of the source. In the proposed extension, we propose a Directional Broadcast and message priority assignment in a cluster based reliable forwarding mechanism for Data dissemination in vehicular networks. The main advantage of this method is that there is no chance of accident even if the driver is not responding. This method provides high reliability during emergency message dissemination.

Jagruti Sahoo et al., [12] have proposed an IEEE- 802.11-based multichip broadcast protocol to address the issue of the emergency message dissemination in VANETs. The protocol adopts a binary partition-based approach to repetitively divide the area inside the transmission range to obtain the farthest possible segment. The forwarding duty is delegated to a vehicle chosen in that segment. Aside from accomplishing directional broadcast for highway scenario, the protocol exhibits good adaptation to complex road structures. The broadcast delay must be reduced for time critical safety applications. The contention delay remains almost constant, irrespective of vehicle density. Mathematical analysis is performed to assess the effectiveness of the protocol

Samara et al., [13] have proposed protocol Particle Swarm Optimization Contention Based Broadcast (PCBB) for fast and effective dissemination of emergency messages within a geographical area to distribute the emergency message and achieve the safety system. This research will help the VANET system to achieve its safety goals in intelligent and efficient way. It is helped to make more accurate analysis and performance, and increased the percentage of the emergency message reception without affecting the channel collision.

Shibu.J1 et al., [14] have proposed to design a cross-layer broadcast protocol (CLBP) for an efficient and reliable broadcast for emergency message dissemination in Inter-Vehicle Communication (IVC) systems. The CLBP is not only used to minimize the broadcast message redundancy and link delay but it is also used for quick and reliable delivery of emergency message in IVC and for improving the transmission reliability. At first a proper relaying node to forward the emergency messages is selected. Then based on the derived metric, a cross-layer approach is made to efficiently broadcast emergency message in the desired propagation direction.

M.A. Berlin et al., [15] have proposed a approach to categorize the messages and to give priority for the E/ W messages using a scheduling algorithm. The neighboring vehicles broadcast the RN messages from the risk zone using inter- zone clusters and intra- zone clusters communication to the rear vehicle by applying the proposed scheduling algorithm. Our simulation results show that this approach performs well and produce less network overhead, congestion control and high packet delivery ratio. We compared our approach with the existing protocol. Here we used clusters for reducing E/ W message count. It is enough to send only one E/ W message to the far away cluster. The node which receives the emergency message will intimate to all the other members of its cluster. By doing this the rear cluster can change its current path before reaching the risk zone. Due to this, the network congestion and traffic congestion will be highly reduced.

Ravindra J et al., [16] have proposed EMD Algorithm that in emergency situations, there is small amount of time to make a handshake with other networks nodes, as the safety/emergency message is disseminating reliably and fast. This scheme selects the forwarder node farthest from the sender .Sending information is usually very costly and without Particular techniques result in serious data redundancy and collisions. This work focuses on effective approach that deals with broadcast storm problem for emergency message dissemination. This work reduces Broadcast storm problem as much possible. But there is a disadvantage that if the source node selects forwarder only based farthest distance so the high message transmission delays occur.

Srinivetha.R1 et.al.,[17] have proposed Adaptive techniques for VANETs to consider features related to the vehicles in the scenario, such as their density, speed, and position, to adapt the performance of the dissemination process. These approaches are not useful when trying to warn the large number of vehicles about dangerous situations in realistic vehicular environments. The Profile-driven Adaptive Warning Dissemination Scheme (PAWDS) has been designed to improve the warning message dissemination process. PAWDS system dynamically modifies some of the key parameters of the propagation process and it cannot detect the vehicles which are in the dangerous position. This paper proposed a new adaptive approach that allows increasing the efficiency of warning message dissemination processes using the information about the urban environment where the vehicles are moving. It can identify the vehicles which are in the dangerous position and immediately send warning message to the vehicles that are in dangerous position. This approach makes use of all the available information efficiently.

Javed MA et.al.,[18] have proposed an efficient time-slotted multi-hop broadcast protocol that significantly reduces the number of required transmissions, while ensuring a timely and successful delivery of the warning messages. To alleviate the broadcast storm problem, we select only a subset of vehicles on the road to serve as the potential relay nodes. Each of these ‘segment leaders’ is responsible for forwarding the warning messages arrived to their own road segment. To avoid interfering with the safety messages transmitted periodically, we propose to allocate separate time slots for the warning messages. We also devise a signaling mechanism that ensures the reliable delivery of these multi-hop messages. At the same time, the proposed solution maintains a high reception rate and low end-to-end delay for the single-hop safety messages.

In [19] authors have proposed the Contention Based Broadcasting (CBB) protocol for increasing the emergency message reception and performance. The emergency message will be broadcasted in multi - hop fashion, and the multi - hop forwarders will be selected before the original message is sent. CBB proven to achieve superiority over the EMDV protocol as it chooses more than one forwarder to rebroadcast the emergency information and gives the message a chance to overcome the preselected forwarder failure. The criteria of choosing the forwarders depend on the progress and on the segment localization where all the vehicles located in the final; none-empty segment are the potential forwarders. The emergency message is rebroadcasted by network segments.

In [20] author have proposed Road Accident Prevention (RAP) scheme for instant EWM dissemination to the vehicles is proposed in order to prevent them from highway road traffic accidents. Thereby the death and injury rates can be reduced in Indian four lane highways. In RAP scheme, once the RSU predicts the possibility of occurrence of an accident or emergency situation, instantly it generates EWM, forms a VBN structure and disseminates EWM to the vehicles which have high reception priority. The number of RSUs required is reduced depending on the usage of VBN structure in VANET. But, the network processing overhead of RAP scheme with VBN structure is found to be higher.

3. PROPOSED METHODOLOGY

The proposed routing protocol forwards a message during the emergency situation from the source to the destination. During the routing process the optimal forwarder is chose based on the moving direction of node and message reachable time. The proposed work is explained in the following steps i) Environment ii) FEMDRP Overview.

3.1. Environment

In VANET environment all vehicles are equipped with Global Positioning System (GPS), hence vehicles can obtaining current location and time. Vehicles are consigned with multiple sensors. These sensors determine vehicle’s critical information. Hence, the vehicle receives and produces critical information in emergency time. Emergency events like natural disasters earthquakes, floods, environmental conditions, man-made disasters accidents and road conditions etc,

We assume that On Board Unit (OBU) equipped in all the vehicles and Road Side Unit (RSU) placed along road side. RSUs have bigger storage space and calculation power than OBUs. Also, RSUs are connected to each other through wired or wireless networks. Hence, our protocol utilizes RSUs when the emergency messages are received from the vehicles and then the emergency messages are sent to Emergency Center [EC] for rescue functions.

3.2. FEMD Protocol Overview

This routing protocol works in critical situation time. FEMDRP sends speedy and direction based transmit emergency messages to the destination, thereby reduces the message transmission delay and reduce message overhead in network. FEMDRP functions work in four phases: Start Beaconing, Moving Direction based Acceptance, Message transmission time based confirmation and Path Establishment. Thus the developed protocol is helpful in speedy distribution messages to the destination.

3.2.1. Architecture of FEMDRP

All the vehicles are registering their identity information in identity management authority which could be under vehicle registration office or social security office that manages the vehicles identity information. Vehicles assumed to be in emergency event time broadcast beacon message to neighbors that include emergency message id, sender position, vehicle acceleration, direction and timestamp. In this paper, we use vehicle direction, distance and speed to discover the next-hop vehicle for forward the emergency message to destination. This protocol uses vehicle to vehicle communications, vehicle to infrastructures communication and infrastructure to infrastructures communications. The architecture of proposed FEMDRP is given in Figure 2.

3.2.2. Start Beaconing

During the start beaconing, the source node broadcast the emergency beacon message surrounding the source nodes that be positioned within the communication range. The Neighbor node List [N(V_i))] contains the neighbor nodes positioned within the communication range of node V. whenever the source node start beacon broadcast it can select a node within its neighbor list [N(V_i))]. Table (1)

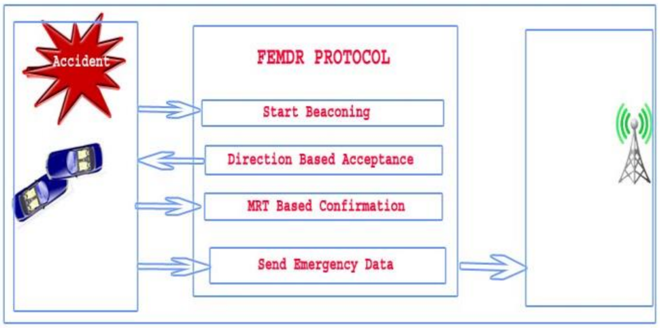

Figure 2: FEMDRP Architecture

Table (1) Terminology

Terms	**Definitions**
N	Neighboring node within the transmission range
V	Set of Nodes {V1, V2, V3,......, Vn}
CR	Call Request

The start beaconing module is as follows: the source node broadcasts Call Request (CR) to the nodes at communication range listed in [N (**V**$_i$)] .Start beaconing is call on standard intervals to update the nodes about their available neighbors.

Algorithm 1 : Start beaconing phase
1. Procedure(start beaconing)
2. Let 'i' be the source
3. Let N (i) E V→Neighbor nodes surround the communication range of node i
4. For each j E N (i)
5. Node i Broadcast CR to node j
6. End for

3.2.3. Moving Direction Estimation`

The moving direction estimation helps the vehicle node to identify itself whether the vehicle moving toward the destination or not. This result also makes it easier to decide on the optimal forwarder. Assumed the vehicle node denoted by V= {v1,v2,…..vn) is consistent and every node has the capability to discover whether the node moves towards the destination or not based on the information about the distance between the current node and the source node.

At the beacon period time the receiver node discovers the distance among the source node is Dist (t_b). At current time the node discovers the distance among the source node is Dist (t). If the condition in Eq.,(1) is satisfied it issues true indication otherwise it issues false indication. If the condition is true, the node is moves towards the destination otherwise node moves in opposite direction.

$$MDE = \begin{cases} T, & IF\ Dist(tb) > Dist(t) \\ F, & otherwise. \end{cases} \quad \text{--- (1)}$$

Moving Direction Estimation based Call Request Acceptance

In this phase the node takes a decision to involve the data transfer as a favorable forwarder to make an acceptance. The decision may be confirmed by the node (MDE) Moving Direction Estimation. The MDEA functions by providing either T or F reply based on the individual node MDE. If the MDE value is 'T', the node is moving towards the destination, otherwise the node is moving in the opposite direction. If the MDE value is true the node moving towards the destination, receives CR and reply CRA to the source node. Otherwise replies CRR to the source node. The entire node in the network maintains a table called Acceptance List (AL) that contains the CRA's provided and CRC reply to particular node that are maintained in the list called Confirmations List (CL) .

Table 2 Terminology

Terms	**Definitions**
CR	Call Request
CRA	Call Request Accept
CRR	Call Request Reject
$Dist_B(t_b)$	Distance from node B to source in beacon period time
$Dist_B(t)$	Distance from node B to source in current time
$(AL)_B$	List for nodes which are accepted the Call Request
$(CL)_B$	List for nodes which are confirmed

The direction measurement becomes essential since the message has to travel toward the destination node that is located in on reverse or obverse of the source node. Whenever source node starts to forward an emergency data message to the destination node, it can select some most favorable forwarder node within the Accept List (AL). The Accept List (AL) is generated during moving direction estimation based call request acceptance. It avoids the source node from unnecessarily forwarding the emergency data message to all the neighbor nodes.

Algorithm 2 Call request Acceptance and Confirmation

```
Procedure Message management
Switch case ('msg ')
Case('msg' ) is CR ('B' receiving CR from 'A')
    Begin
        If  DistB(tb) > DistB (t)
            send reply message 'msg' as CRA
            Insert node A to (ALB)
        Else
            send reply message 'msg' as CRR
        End if
    End
Case ('msg' ) is CRA ('A' receiving CRA from 'B')
    Begin
        if  B posses the Min MRT
            send message as CRC
            Insert B as the optimal forwarder for A
        End if
    End
Case ('msg' ) is CRC('B' receiving CRC from 'A')
    Begin
        delete from (ALB) and insert to(CL A)
    End
End Case
End Procedure
```

3.2.4. Message Reachable Time Estimation

The message reachable time estimation gives somebody the use of a vehicle node to find out itself the message reachable time. This result also makes it easy to decide on the optimal forwarder. The time the node takes to reach the destination is also discovered in advance. Every node has the capability to discover the favorable forwarder based on its Message Reachable Time. Hence all the nodes in the network estimate their message reachable time as shown in Eq.(2)

$$MRT\ (v) = Dist\ (v) / Speed\ (v) \qquad -- (2)$$

Message Reachable Time Estimation based confirmation (MRTEC)

In this section the message reachable time estimation based confirmation of node in the network is discussed. MRTEC discovers whether the received CRA can be confirmed or not. In this phase the source node gets an opportunity to confirm, one of the best forwarder based on message reachable time (MRT). After receiving CRA reply it confirms the best favorable forwarder node farthest from the source node to forward towards the destination. If the source node receives more than one CRA reply it gets a chance to confirm one of the best nodes farthest from the source node they can forward towards the destination with minimum message reachable time (MMRT) .In Eq. (3).

$$MMRT=Min\ (MRT_m) \qquad m=1, 2, ...,.n.$$

Where (MRT_m) is node m message reachable time.

One of the forwarder nodes is confirmed by replying CRC based on the condition Eq. (3) its entry in the acceptance column is removed from AL (Acceptance List), subsequent to insertion corresponding confirmation in the CL (Confirmation List). This insertion is done from time to time. Hence confirmation reply received by the node is to communicate the connection between them which is necessary for path establishment.

Path Establishment Phase

Once the path is established between CRC nodes, they are ready for emergency data transfer. Similarly the path is established from source to destination by connecting CRC nodes at sequence. During the starting stage the node 'A' reply CRC to node 'B' at the optimal forward node. Now the emergency node 'A' which has started the route is added to the path. Further the confirmed nodes in the forward route are added to the path till 'B' equals destination. The FEMDRP develop opportunistic routing by discovering broadcast nature of emergency situation by CRC nodes. This increases the message forwarding reliability with minimum delay, overhead and higher throughput. (Table 3)

Table 3 Terminology

Terms	**Definitions**
$(CL)_A$	List for node A who are confirmed

Algorithm 3 Path Establishment
Input Confirmation List (CL) for nodes which are confirmed Output: Path Establishment source to destination 1. Procedure (Path Establishment) 2. Let A be the source node 3. While (A is not equal to Destination) 4. Add A to the path 5. $A=CL_A$ 6. End while

4. PERFORMANCE ANALYSIS

In this section, the performance of the proposed scheme FEMDRP is evaluated in terms of the message transmission delay, the transmission overhead and the throughput. In the evaluation, FEMDRP is compared with existing protocol EMD Algorithm [16]. The main difference between them, however, is the potential forwarder selection, where EMD Algorithm depends on choosing the best forwarder as the farthest vehicle in sender transmission range, whereas FEMDRP depends on selecting the best forwarder as the farthest vehicle, moving toward destination with minimum message reachable time. The result of the experiment is shown in Figures 3, 4 and 5.

4.1. Simulation Settings

The performance of the proposed work is simulated by using NS2. The simulation parameters are listed in Table (4). The experiments are repeated for five trials with different sets of (i.e. 20, 50, 80, 110, 150) nodes for random topology. The nodes are assumed to be moving randomly. The destination is deployed at the road side. The source node initiates start beaconing from the emergency area.

Table (4) Simulation Parameters

Parameters	**Value**
No of Nodes	20, 50, 80, 110, 150
Area Size	3000 (meters)
Vehicle Speed	Random
Topology	Random
Compared Routing Protocol	EMD
Transmission Range	250 m

4.2. Performance Metrics

The following metrics are used to evaluate the performance of the proposed FEMDRP.

- Message transmission delay
- Transmission overhead
- Throughput

Message transmission delay:

Message transmission delay is the time taken by the message to travel from the source node to the destination node.

Transmission overhead:

Transmission overhead is the ratio of the total no of beacon packets broadcasted to the total no of data packets sent.

Throughput:

The throughput is defined as the number of packets delivered to the destination per second.

4.3 Results and Discussion

4.3.1 Message Transmission delay

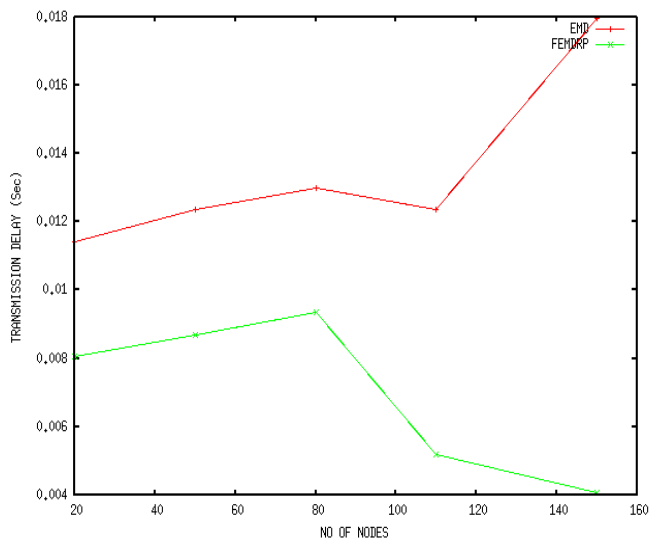

Figure 3: Message Transmission delay VS No of Nodes

Figure 3 shows the message delay in FEMDRP compared with the message transmission delay in EMD. The simulation computes the delay for broadcasting and rebroadcasting of the emergency that of message, showing that EMD during the no of node increase that has a higher time delay than the proposed FEMDRP. The proposed FEMDRP uses technique that has quick performance and response. In the emergency systems with high mobile network like VANET, a few microseconds are crucial in saving life or avoiding hazard.

4.3.2. Transmission Overhead

The message transmission overhead of FEMDRP in random topology is compared with that of EMD as shown in Fig (4). The emergency message transmission overhead of FEMDRP is shorter than EMD protocol.EMD selects an optimal forwarder at the farthest distance from sender .As a result the message transmission overhead increases. FEMDRP also selects forwarders more carefully than EMD. While the former selects forwarders at the farthest distance. The later selects the forwarder at the farthest distance evaluating the direction and speed of the vehicle. Hence the proposed protocol avoids the source node from unnecessarily forwarding the emergency data message in the opposite direction of the moving vehicle nodes. The emergency message is also forwarded to destination with minimum overhead which is less than the existing EMD protocol. Hence the proposed protocol considerably decreases the message transmission overhead.

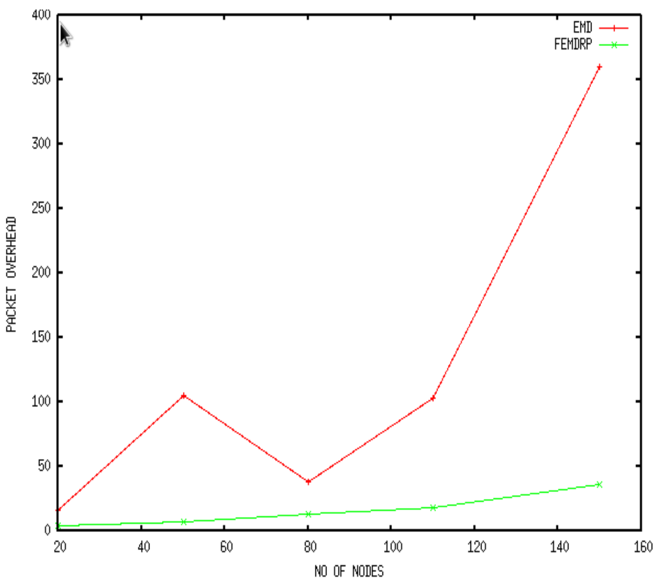

Figure 4: Message Transmission overhead VS No of Nodes

4.3.2. Throughout

In Figure 5 shows the simulation results of the proposed FEMDRP message throughput compared with that of the existing EMD Algorithm. The result shows that the proposed protocol can increase the performance of the message throughput. More noteworthy is the fact that FEMDRP can achieve better performance when the no of nodes in 80 or more there by the throughput value is increased. Hence the emergency message is forwarded to the destination with minimum time. It is less than that of the existing EMD protocol. Hence in the proposed protocol the message transmission throughput is considerably increased.

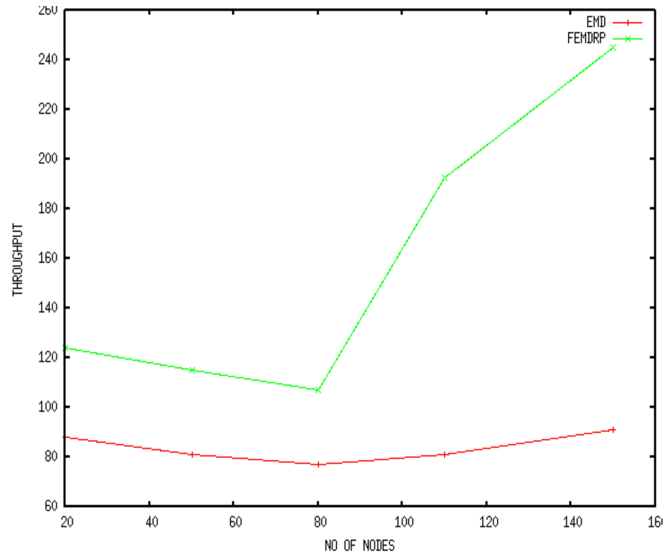

Figure 5: Throughput VS No of Nodes

5. CONCLUSION

In this paper the proposed protocol FEMDRP which belong to the emergency message transfer routing category selects the optimal forwarders to forward the emergency data to destination. The source node neighbor are get a call request and send a reply CRA based on the node moving direction estimation to act as optimal forwarders. Finally the optimal forwarder confirmed by CRC reply based on MRTE. With the set of optimal forwarders, confirmed nodes, possible path is constructed from source to destination during the path establishment phase for emergency message data transfer. Thus the result through simulation confirm that the proposed protocol improve the emergency message transmission throughput with minimum delay and low overhead. When simulation results of FEMDRP are compared with that of EMD protocol, the proposed method has shown improved performance in terms of message transmission delay, transmission overhead and throughput. It is proposed to extend the protocol with location privacy and message security for the future works.

REFERENCES

[1] Ni SY, Tseng YC, Chen YS, Sheu JP. The broadcast storm problem in a mobile ad hocvnetwork. Proceedings of the 5th annual ACM/IEEE international conference on mobile computing and networking. 1999, pp: 151–162.

[2] Rubin I, Yang CY. Lane based backbone synthesis protocols for vehicular ad hoc networks. 13th annual mediterranean ad hoc networking workshop (MED-HOC-NET), 2014, pp.95 – 102.

[3] Busson A, Lambert A, Gruyer D, Gingras D. Analysis of intervehicle communication to reduce road crashes. IEEE Transactions on Vehicular Technology.2011: 60(9): 4487–4496.

[4] Javed MA, Ngo DT, Khan JY. A multi-hop broadcast protocol design for emergency warning notification in highway vanets. Eurasip journal on wireless communications and networking. 2014, Article 179.

[5] Shraddha SM, Golait SS and Ghodichor NA. Inter-infrastructure and vehicle communication for traffic information sharing in vanet. IOSR journal of computer science. 2014:ICAET 2014:5 12.

[6] Ganan C, Loo J, Ghosh A, Esparza O, Rene S, Jose L. Analysis of inter-rsu beaconing interference in vanets. Proceedings of 5th international workshop-macom 2012. 2012november, pp: 49–59.

[7] Chunxiao Li, Jun Sun, Jing Yang, Dawei He, Jun Wu, Mei Sun, A Fuzzy logic based Next hop Selection Scheme for Emergency Message Propagation in VANETs, WSEAS TRANSACTIONS on COMMUNICATIONS, Volume 15, 2016, pp:72-81

[8] Z.Shi,F.Liu,S.Xu, Novel relay scheme based on traffic type in vehicular networks in:Proc of the ICICTA 2008

[9] P.Laai,X.Wang, N.Lu F, Liu, A reliable broadcast routing scheme based on mobility prediction for VANET, in Proc of the IEEE Intelligent Vehicles Symbosium, 2009

[10] Benaidja, S. Moussaoui, F. Naït-Abdesselam (2013). An optimal broadcast of warning messages in vehicular ad hoc networks. International Journal of Computer and Information Technology (IJCIT), vol. 2, no. 5., pp. 986-992.

[11] s.Lakshmi dr.R.s.d.wahida banu Prioritized directionalbroadcast technique for message dissemination in vanets Journal of Theoretical and Applied Information Technology Vol. 68 No.1, October 2014.

[12] Jagruti Sahoo, Eric Hsiao-Kuang Wu, Pratap Kumar Sahu, and Mario Gerla, Binary- Partition Assisted MAC-Layer Broadcast for Emergency Message Dissemination in VANETs, IEEE Transactions on Intelligent Transportation Systems, Vol. 12, No. 3, September 2011

[13] Samara, Tareq Alhmiedat Intelligent Emergency Message Broadcasting in VANET using PSO of Computer Science and Information Technology Journal (WCSIT) Vol. 4, No. 7, , 2014

[14] Shibu.J1, Ramkumar.R2, D.Gowthami3, S.G.Siddharth An Efficient Approach for Emergency Message Dissemination in VANET International Journal of Innovative Research in Computer and Communication Engineering, Vol.2, Special Issue 1, March 2014

[15] M. A. Berlin, S. Muthu Sundari Cluster Based Message Dissemination for Broadcasting the Emergency/Warning Messages using a Novel Scheduling in VANETS International Journal on Computer Science and Engineering (IJCSE), Vol. 3 No. 1 Jan 2011

[16] Ravindra J. Makwana An Algorithm - EMD for Emergency in VANET International Journal of Computer Science & Engineering Technology (IJCSET), Vol. 6 No. 06 Jun 2015

[17] Srinivetha. R1, Gopi. RInter Alert Message Dissemination Protocol for VANET to Improve Road Safety International Journal of Emerging Technology and Advanced Engineering Volume 4, Issue 1, January 2014

[18] Javed MA, Ngo DT, Khan JY. ,A multi-hop broadcast protocol design for emergency warning notification in highway vanets. Eurasip journal on wireless communications and networking. 2014, Article 179.

[19] Ghassan Samara, Wafaa Alsalihy, Sureswaran Ramadass, Increasing Network Visibility Using Coded Repitition Beacon Piggybacking, World Applied Sciences Journal (WASJ), Volume 13, Number 1, pp. 100 - 108, 2011.

[20] Gokulakrishnan P1*, Ganeshkumar P , Road Accident Prevention with Instant Emergency Warning Message Dissemination in Vehicular Ad-Hoc Network , PLOS ONE | DOI:10.1371/journal.pone.0143383 December 4, 2015 1 / 36