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Novel Emergency Message Dissemination in Vehicular Networks

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ABSTRACT

The number of vehicles has increased proportionally over the last couple of times and this number is rising due to the increase in population extension and the number of vehicles that are manufactured every day. The high business viscosity leads to several problems, from which effectively propagating emergency messages is a major concern. VANETs **(**Vehicular Ad-hoc Networks), it is a vehicle networks of digital communication between cars, trucks, and also roadside units like antennas & buildings.

In VANETs, significant challenges are faced, while disseminating the message across the network. The major challenges are the broadcast storm problem, hidden node problem, and packet collisions. We propose an Effective Emergency Message Dissemination Scheme (EEMDS) for urban VANETs. The scheme is grounded on our mobility metrics to escape communication outflow and to maintain the stability of the cluster structure. Every vehicle takes into account its direction and path loss factor for opting appropriate cluster head. Also, we introduce estimated link stability to choose a suitable dependent vehicle (an intermediary that communicates between multiple clusters) that reduces the number of retransmits and communication traffic in the network. Simulation results covey that NEMDS provides an acceptable end-to-end detention, information coverage, & packet delivery ratio compared to the eminent Emergency Messages dissemination schemes.

INTRODUCTION

Vehicular Ad-Hoc Networks (VANETs) are a type of Mobile Ad-Hoc Network (MANET), designed for vehicular communications. Over the last two decades, many research works have been carried out on VANET due to its numerous applications and benefits. VANETs are helping to reshape Intelligent Transportation Systems (ITS) and are considerably improving the efficiency and performance of transportation systems. ITS offers reliable options for travellers and provide enhanced security.

Characteristics of VANETs:

1. Self - Organized
2. Distributed Network
3. Highly Dynamic Nodes
4. Infrastructure less

5. Critical Latency Requirement

Vehicles confronting a hazard disseminate Emergency Messages to other vehicles within their communication vicinity, this enables nodes to take adequate precautionary measures, such as re-routing, to escape road accidents, travel delays, and traffic congestion. ***Traffic Congestion*** is a condition in transport that is characterized by slower speeds, longer trip times, and increased vehicular queueing.

Existing VANET propagation strategies can be arranged into three kinds-

(i)Push - In push model, data is dispersed proactively by transmitting the messages periodically. This model is favourable when a quick reaction is required for the safety applications.

(ii)Pull - In the pull model, data is dispersed as per the requirement where the protocol conveys data to the nodes that are geographically far. This model is considered for delay-tolerant applications, such as detecting the road congestion or finding a gas station.

(iii)Hybrid- Merges both the dissemination types (Pull and Push Model) to facilitate various types of applications.

The pull-based model often requires fewer overhead, with lesser latency limitations as compared to the push-based model.

Keywords - road safety; vehicular ad-hoc networks; broadcast storms; clusters; communication congestion; flooding

i. **Road Safety** – A VANET based traffic safety management approach has been proposed to reduce road accidents.

ii. **Vehicular Ad-hoc Networks** – It is created by applying the principle of mobile ad- hoc network – the spontaneous creation of wireless network of mobile device to the domain of vehicles.

iii. **Broadcast Storm** – A broadcast storm is the accumulation of broadcast and multicast traffic on a computer network. Extreme amount of broadcast traffic constitutes a broadcast storm.

iv. **Clusters** – It is a virtual group of vehicles, each cluster has at least one cluster head that is the leader of the group. A cluster head is usually followed by several vehicles called cluster members. **Communication Congestion** – The topological dynamic in VANETs cause communication and channel, which is the primary cause of problem such as message drop, delay and degraded quality of service

v. **Flooding** - Source node broadcast Emergency messages to other nodes enclosed by its transmission Range and the receiving nodes broadcasts Ems in their radius until the Emergency messages propagate across the entire network**.**

MOTIVATION

The motivation behind writing this survey paper is to understand how crucial it is to manage the flow of emergency traffic. To ensure the safety of precious lives and to reduces financial loss, we need to make sure emergency traffic reaches its destination successfully and timely. There is still necessity for a more efficient and dependable mechanism for emergency traffic management. Wide distribution the emergency messages is a challenging task, keeping in view the challenges faced in VANETs. It is very important to make sure that the network traffic for emergency services successfully reaches its destination in the least possible time.

The critical nature of this requirement is the motivation behind this work. This work carries out a brief survey of how messages are disseminated using different techniques, what challenges do they face and what are the available models that offer reliable emergency message propagation in vehicular networks.

PROBLEM DEFINITION

On road many problems may come such as re-routing, road accidents, travel delay, traffic congestion. Most frequent and easiest way for EMD is flooding but due to dynamic nature of VANET flooding cause broadcast storm. This effect no longer useful and cause communication congestion, high delay and degenerate the message reliability. Due to this many methods are discovered or use Store - Carry – Forward (SCF) – Cause high end to end delay. Counter based and Distance-based dissemination - Both are appropriate only for well - connected networks. It may threat of unessential retransmission may become greater in amount. It may increase End 2 End delay and packet loss rate, in case of high-density scenario. There problem may be tackled by cluster-based strategy which established a network position by arranging node based on certain previously define or established rules. In this cluster has coordinator unit, cluster head node in a cluster transmits the data to its CH for further dissemination. Clustering in VANET has many open challenges such as non-uniform node distribution, mobility, signal sinking from neighboring nodes, outflow in cluster formation.

To address the previously mentioned challenges we propose EEMDS

1. Consider mobility metrics for CH selection to enlarge cluster stability and to escape communication overhead.
2. Link-state stability metric for depended node selection suppresses retransmission of Emergency Messages across adjoining cluster increase network efficiency.
3. Mobility metric can increase the CH lifetime, decrease communication overhead and reach a high pack delivery ration.

LITERATURE SURVEY

Approaches to tackle communication obstruction and broadcast storm are –

1) Multi Hop Cluster based data dissemination scheme [21] -

CH selection based on relative distance & velocity to form cluster.

Disadvantages – In dense networks it leads to acute propagation detention, increased communication outflow and low PDR.

2) Fog Supported Data Dissemination Scheme [22] -

Every node renovates its status similar to location speed and direction to fog server.

The server illuminates the connected nodes about emergent event and suggests acceptable preventive.

Disadvantages - High maintenance cost & communication detention.

3) Greedy Routing Scheme [24] -

Considers link quality, segment knot and degree of link connectivity among communicating bumps.

The scheme chooses a region called member area within the communication range of a node. It is the most used geographic routing scheme used to establish path between a source node and a destination node (approach utilize distance or direction of the node as parameter for selecting the next node, forwarding node to transmit data from source node to destination node).

Advantages - Improves throughput and PDR (Packet Delivery Ratio).

Disadvantages - Suitable only for well - connected networks.

Location Error Resilient Geographic Routing (LER -GR) [25] -

It uses position prediction and error computation to predict the position of single hop neighbor nodes. To improve the dependability of the named relay knot and reduce communication congestion it uses particle swarm optimization. PSO (Particle Swarm Optimization) is used to select next hop vehicle (NHV). PSO efficiently optimizes various constraints (frequent topological changes, high interference, shadowing effects) involved in NHV selection that is further used to select most reliable NHV for geo casting.

Advantages - Improves the location delicacy of neighbouring nodes.

Disadvantages - Swarm optimisation has the drawbacks of impulsive and slow-speed convergence

Time Barrier based Emergency Message Dissemination [30]–

Every vehicle can communicate with other vehicle either directly or through Ad-hoc networks. The node that is very far within the source node obtain the shortest back up plan that is why every node wait before EMs rebroadcasting. There may be numerous messages at same distance. So, numerous nodes can transmit same EM, that add to communication congestion.

Advantages- It integrates positional information to reduce unnecessary Emergency Messages retransmission.

Disadvantages - Waiting time in time barrier methodology leads to unnecessary delay in EM transmission.

4) **Distributed Vehicular Broadcast [31]** –

DVCAST relies only on local topology information for handling broadcast message in VANETs. It is shown that the performance of the expected DVCAST protocol in terms of reliability, efficiency and scalability is accomplished.

In Store Carry Forward (SCF) each node stores data packets in buffer and whenever the node meets at another node it forward the duplicated data packets.

To reduce rebroadcasting, DVCAST employ inter-node distance to forecast the probability that a good receiver may become relay node that is receive and pass on.

Apart from this, to reduce the delay, a source node with high probability sends Emergency Messages to the farthest nodes.

When distance increases, the probability of sending EMs increase very fast.

As a result, many nodes can retransmit and generate communication congestion.

Advantages - It increases coverage using Store Carry Forward technique.

Disadvantages - Store Carry Forward technique leads to high delay.

Cluster Head [2] –

Only cluster head is behind the retransmission of Emergency Messages in each cluster.

Apart from this, to maximize the coverage it usages relay node and it works good in highway environment.

Table 3. Path loss exponent values.

Environment	path loss exponent, α
Indoor	1.6-1.8
Suburban area	3.0-5.0
Urban area	2.7-3.5
Free space	2.0-4.43

Table 4. Simulation Parameters.

Parameters	Values
Propagation model	Two-ray ground
Mobility model	Krauss
Wireless access	I609/802.11p
Transmission range	300m
Transmission power	20mW
Frequency	5.9GHz
Simulation area	4000 m *4000 m
Simulation time	500 s
Data rate, EM size	6 Mbps,170 Bytes
Node speed	20-100 km/h
Node density	25-150/km
Number of lanes	2
Beacon periodic interval	150ms

SOFTWAREREQUIREMENTS SPECIFICATION

3.1 INTRODUCTION

Software

Feather Linux - It boots from either a CD or a USB flash drive, into a Fluxbox desktop environment. It has a wide range of desktop and rescue software and can load entirely into RAM (if enough RAM is available) or be installed on a hard drive.

NS2 - NS2 is a simulation package that supports several network protocols including TCP, UDP, HTTP, and DHCP and these can be modeled using this package [21]. In addition, several kinds of network traffic types such as constant bit rate (CBR), available bit rate (ABR), and variable bit rate (VBR) can be generated easily using this package. It is a very popular simulation package in academic environments.NS2 has been developed using the C++ programming language and OTcl. OTcl is a relatively new language that uses object-oriented aspects. It was developed at MIT as an object-oriented extension of the Tool command language (Tcl).

Programming Language –

C++ - C++ is a cross-platform language that can be used to create high-performance applications. C++ was developed by Bjarne Stroustrup, as an extension to the C language. C++ gives programmers a high level of control over system resources and memory. The language was updated 4 major times in 2011, 2014, 2017, and 2020 to C++11, C++14, C++17, and C++20.

TCL/ TK - The popular combination of Tcl with the Tk extension is referred to as Tcl/Tk, and enables building a graphical user interface (GUI) natively in Tcl. Tcl/Tk is included in the standard Python installation in the form of a Tkinter.

Hardware

Processor – i3, i5

PROJECT SCOPE

Because since the number of vehicles tends to increase every year in all countries, the number of roads and highways, in contrast, has become more limited as a result of several factors, such as budge, space and etc. These reasons get the number of accidents on roads higher and higher. Besides, the larger number of vehicles also causes serious traffic congestion and transportation delay, especially rush hours. One possible solution to improve road safety can be developed based on wireless communication among vehicles as a part of Intelligent Transportation Systems (ITS) ongoing projects. Due to the recent advance of wireless technology nowadays, Inter -Vehicle Communication (IVC) becomes more concreate and realistic solutions. Examples of road safety applications based on IVC are vehicular emergency warning, cooperative forward collision warning intersection collision avoidance, highway -rail intersection warning, approaching emergency vehicle warning, transit or emergency vehicle signal priority systems, and etc.

ANALYSIS MODELS: SDLC MODEL TO BE APPLIED

1. Neighbour Discovering Phase:

Every node periodically transmits beacon messages to the neighbour nodes to swap information, such as node id, velocity, position, and node state. The accepting node updates its β, which can be passed down in cluster formation phase.

Algoritham 1:*Neighbor discovery.*

Input:N

Output: βi

1 Set βi = ø
2 **foreach** received beacon from ∀ j ∈ N **do**
3 Computed di,j & ϑI,j based on(2)and (4)
4 **if** di,j < R & ϑI,j ≤ π/**4 then**
5 | Add node j to βi
6 **end**
7 **else**
8 Ignor the beacon
9 **end**
10 **end**

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2. Cluster Formation Phase:

When a UN node wants to create or join a cluster, it transmits a beacon to other nodes. The beacon contains the node's state, velocity, and position information. Such as, each Cluster Head also transmits a Cluster Head Advertisement (CHA) message containing its velocity, M, Cluster id, and position. Upon updating β, node i calculates its M value and interchange it with neighbour nodes in βi . When only one CH exists in node i's β, sends a Request to Join Cluster (RJC) message to the CH containing its Node id and becomes a CM. Whenever, node i's β contains more than one CHs, it selects a CH that has the lowest M value and sends an RJC to the selected CH. Unless node i's β does not accommodate /hold a CH, it compares its M with all the neighbour nodes. If the M value of node i is less than that of any other bumps in its β, it declares itself as the CH. Hence, the newly selected CH will announce CHA to nodes in βi , which contains its Mi value and Cluster id.

Algorithm 2: Cluster formation.

Input: β

Output: ʋi

foreach node in β i **do**
    compute M
    if ∃ CHj &Mj < ∀ CHk **then**
        State i←CM
        CMT j←N_id i
        Add i to ʋ j
        CHTi←N_id j
        Invoke Algorithm 3
    end
    else if(Mi < ∀ Mj) **then**
        State i←CH
        C_id←N_id i
        broadcast CHA
    end
    else if i receives RJC form j & Mi < ∀ Mj **then**
        CMT i←N_idj
        Add j to ʋi
        CHT j←N_id i
        Invoke Algorithm 3
    end
    else
        ignore RJC
    end
    Invoke Algoritham 4
End

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3. Gateway Selection Phase:

A CH selects two CMs, which travel on the cluster boundary, to be capable GW. To that end, estimated link stability is taken into account between the CH and the CMs.

A knot with a lower estimated link stability value shows a more stable connection and is determined as GW.

4. Cluster Maintenance Phase:

VANETs are extremely dynamic due to the high-speed mobility of nodes and frequent topological changes. Nodes generally join and leave clusters regularly that causes link detachment between CMs and CH, emerging in a high packet loss ratio. To decline the packet loss ratio due to link disjoining between CMs and a CH, a cluster should be maintained regularly. Hence, in NEMDS, formerly a cluster is created, each CM periodically broadcasts Cluster Member Advertisement (CMA) packets to demonstrate its presence in the network. Also, CH broadcasts CHA packets. In this way, CM and CH identify the presence of each other and maintain the cluster structure. If a CM loses contact with its respective CH. Also, if a CH cannot hear CMA and loses contact with its respective CH.

Algorithm 3: Gateway selection.

Input: ʊi

Output:GW

for ∀ node j, k ∈ ʊ i **do**

Compute d based on (2)

if (d i,j >d i,k) **then**

Select j as a GW

end

else

Select k as a GW

end

if d i,j == d i,k **then**

Compute *L* ST based on (11)

if *L*ST i,k< *L*ST i,k **then**

Select j as GW

end

else

Select k as a GW

end

end

end

Algorithm 4: Cluster maintenance.

Input: ʊ i

Output: maintain ʊ i

foreach CMs in ʊ i **do**

if CHi cannot hear CMA from a CM j **then**

Drop N_id of CMj from CMT i

if no more CMs exist in CMT i **then**

CH i resigns from the CH role

State i ← *U* N

Call Algorithm 2

end

end

else if a CMj cannot hear CHA from CHi **then**

Drop N_id i from CHT j

Statej ← *U* N

Call Algorithm 2

end

else

The CHi continues its role as CH

end

end

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5. Emergency Message Dissemination Phase

NEMDS aims to increase the effectiveness of EMs dispersion in VANETs. In conventional methodology, EMs are broadcasted, which leads to communication congestion and results in a high packet loss ratio and E2E detention . In NEMDS, CH is responsible for propagating EMs to its CMs. When the receiver is a CM, it sends EM to the corresponding CH for further dispersion . To expand the coverage area, NEMDS uses GW to disseminate Emergency Messages to the neighbouring clusters. To intercept multiple nodes from transferring the same Emergency Message, a GW is used to circulate Emergency Messages. As a result, estimated link stability enables NEMDS to tackle broadcast storms and expands the participated area.

5.1 ADVANTAGES

1) Prevention of collision. Emergency alert in case of an accident is vitally necessitated to rescue the victims.

2) Safety - In VANETs, vehicles periodically broadcast periodic basic safety messages to neighboring vehicles which consists of vehicle identity, position, speed and direction.

3) Blind Crossing - VANETs can also be used for the implementation of blind crossing.

4) Dynamic route scheduling - Route scheduling is done based on a prediction model.

5) Real time traffic condition monitoring.

6)Quality of forwarding aware routing.

5.2 LIMITATIONS OF VANETS

i) On-Time Delivery of Safety Messages

Timely delivery of safety messages is the topmost priority in VANET. Due to the contention in the network, these messages face delays in transmission. There can be serious circumstances for the neighboring vehicles if the safety messages are not delivered on time. The probability of transmission delay increases with the increase in network size.

ii) Highly Dynamic Nature

Designing a good routing protocol for a VANET is a challenging task. Due to high mobility, random change of path and frequent change in the topology of the nodes, it is very difficult to design a routing protocol for efficient communication. With high velocity, we face more packet losses, delays and the accurate geographical position of nodes becomes difficult.

iii) Network Scalability

Scalability in VANET is a major concern. If the nodes in the network are increased, the performance of VANET is highly compromised. The addition of new nodes in the network may lead to congestion in the channel and can cause dis-connectivity. Moreover, as the distance between nodes increases, we need to adopt a different wireless communication standard that is required for long-range communication.

iv) Air Pollution Emission Measurement and Reduction

Keeping the environment clean and green is the responsibility of every citizen. The concept of VANET can help us devise a mechanism to tackle the rapidly increasing air pollution. Traffic congestion in a certain area can lead to high emission of carbon dioxide that makes the air pollute. VANET can assist us to develop an

Adaptive Cruise Control concept which helps in the provision of a friendly environment.

v) Privacy and Authentication

To make sure the data and privacy of the user are sustained while using VANET applications multiple types of authentication mechanisms are considered. These mechanisms include various encryption algorithms to secure the user's data. Attackers trying to break into the network and stealing user personal data may compromise the privacy of the users. Ensuring the privacy of users and securing data by authentication is a challenge in VANET.

vi) Network Congestion

The data is disseminated across the network by broadcasting the messages. Due to the hidden node or the broadcast storm problem, at that time the same message is broadcasted several times. So, the repeated transmission of messages makes the network congested. Congestion in VANETs significantly affects the performance of applications that are delay-sensitive.

vii) Volatile

Volatility in VANET can be catastrophic for the network. Due to dynamic behavior of the nodes in the vehicular networks and the short span of communication contact between nodes, VANETs become volatile. This may interrupt the authentication process and can lead to frequent dis-connectivity

APPLICATIONS

i) Event Driven Safety Messaging

Ensuring the emergency messages are disseminated across the network at the right time is a critical requirement. Since safety applications are usually related to real-time based scenarios, efficiency and performance of these applications are critically dependent on time.

ii) Infotainment Applications

Lately, the use of internet and multimedia has increased manifold. Even when people are traveling from one place to another, they are using entertainment applications that require network connectivity. In this situation, providing infotainment services to the public is also one of the applications of VANETs.

iii) Public Safety

The major objective of VANETs is to provide safety to the public including both the drivers and the pedestrians. Not just road accidents, other things such as carbon emission from vehicles is also a hazard for the health of citizens. Smart traffic management using VANET can help us reduce the carbon dioxide emission and keep the air clean where possible.

iv) Traffic Coordination

VANETs provide us with a better traveling experience which can be achieved by the proper coordination of nodes. These nodes share information to make the driver aware of his/her surroundings and to prevent the occurrence of accidents and collisions. Traffic coordination assists the drivers to avoid the congested area and to travel to their destination smoothly.

v) Comfort Application

VANET helps to deliver information to the drivers at the right place at the right time to make their traveling experience enjoyable and comfortable. This information includes gas station location, rest area, nearby restaurants, weather update, route navigation, parking lot, etc. These services make the trip comfortable for the drivers.

vi) Self-Parking

With the help of VANET, we can have the application of self-parking with which the vehicle can properly park itself without the help of the driver. For the vehicle to park itself, it requires precise location, accurate distance, and speed estimation.

vii) Toll Collection Application

With the support of V2I communication, the RSU can collect the toll tax from vehicles automatically. The vehicles do not have to stop at the toll and pay the tax by hand instead the RSU will detect the vehicle using RFID or from the OBU of the vehicle. The RSU also shares the receipt with the drivers about how much tax is paid, the time and the collection point of the toll.

6. CONCLUSION AND FUTURE SCOPE

In this we are putting forward an EM dissemination scheme called EEMDS. For this we are using clustering scheme based on mobility metrics which is suitable for selecting the cluster head and form stable cluster. It is used to overcome unnecessary retransmission and achieve high information coverage PDR and low E2E delay in urban VANETs. We put a link stability metric to select relay nodes to limit the number of nodes for inter cluster communication. Both the link stability metrics and stable cluster structure (means clustering scheme) which is obtain by cluster member advertisement packet to demonstrate link present between the *nodes*.With the help of both link stability metrics and stable cluster structure in EEMDS enables EM dissemination to a large number of nodes with acceptable delay

FUTURE SCOPE-

In the future, we plan to devise an ideal model for emergency message dissemination. We are going to utilize the advantages of current research models and try to tackle the disadvantages faced in the mentioned models. We need to work on a model that is scalable and sufficient to handle the data communication needs. A model that has no restraint to challenges and is capable to be deployed in various scenarios.

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