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Emergency message broadcasting in VANETS

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Abstract- Periodic safety message broadcasting in vehicular networks play a major role. The emergency local message is distributed in VANETs for the safety of users. Safety warning messages are used by safety applications for the purpose of safety applications. A sub layer added in the application layer improves the reliability of safety applications. Random linear coding algorithm allows nodes to broadcasts all the received messages to the nearby nodes. The proposed algorithm is for broadcasting messages using zone based approach. It tackles loss of data and collision problem which results in increased throughput and reduced delay. The proposed algorithm tracks the location of the nodes for better transmission.

Keywords- VANETs, sub layer, random linear coding, zone based approach, localization algorithm.

1. Introduction

Recent years important researches mainly focus on VANETs technology. It uses the concept of setting up and maintaining a communication network among a group of vehicles without using any base station. One of the main applications is broadcasting messages in emergency situation which is very much critical to pass the information from saving human lives. Each and every vehicle controls their network and communicates with its own communication requirements.

VANETs deal with improving the safety of vehicles and roads, and provide comfort to both the drivers and passengers. It mainly uses DSRC, a type of Wi-Fi protocol and other technologies such as cellular, satellite and WiMax. It is a component of Intelligent Transportation Systems (ITS) which uses Vehicle-to-Vehicle (V2V) and Vehicle-to-Road side Unit (V2R) communications for message transmission. In VANETs each and every node is a vehicle, which provides communication between individual vehicles in the network and between vehicles and Road Side Units (RSUs). All nodes can communicate and move freely within the network coverage area.

In Intelligent Transportation Systems (ITSs) [8], each vehicle acts as sender, receiver and router to broadcast messages to vehicle networks, which focuses mainly to ensure safe and free-flow of traffic. The vehicles coming under VANET environment must be equipped with On Board Unit (OBU) which enables short-range wireless adhoc networks for communication between vehicles and RSU's. Vehicles must also be fitted with network such as Global Positioning System (GPS), which permits the position information of vehicles. Another network called backbone network, where fixed RSU's are connected, play a major role to facilitate communication.

The V2V, also termed as inter vehicle communication setup users multihop broadcast to transmit safety information over multihops to group of receivers. The V2R setup uses single hop broadcast in which RSU transmit a broadcast message to all the equipped vehicles in its network coverage area. It maintains high bandwidth link. The safety messages periodically generated are termed as "heart beat" messages [1]. The message contains the vehicles state which consists of various sensor readings such as velocity, acceleration, location, etc. Its main goal is to provide a up-to-date reliable neighbourhood information, which in turn prevents accidents and collisions. It also gives extra information to drivers to choose alternative path. Every message has transmission time for its transmission. The message transmission time is divided into 100 ms. It consists of a Control Channel (CCH) and a Service Channel (SCH). Every 50 ms, the device switches to CCH and the periodic broadcast of Wave Short Messages (WSM) takes place in CCH. SCH is used for delivering IP packets. The Wireless Access in Vehicular Environment (WAVE) is a protocol stack of IEEE 1609 protocol. It supports Dedicated Short Range Communications (DSRC) for its message transmission [2].

The periodic broadcast of messages performs well for less number of vehicles in a network. When the number of vehicles is more, congestion becomes a major problem. Congestion control mechanisms alleviate the congestion problem to some extent. Safety applications also deal with unreliable vehicle-to-vehicle channel loss and some channel errors. Once the message is sent, if acknowledgement is received, then it can be realized that message is being received to the recipient. If not, the message is to transmitted repeatedly until the acknowledgement message is received by the transmitter. For this, repetition based broadcasting schemes [6] have been used. It also maximizes the reliability of the messages broadcasted. In the WAVE architecture, a sub-layer is newly added to the application layer which improves the reliability of the safety messages that is broadcasted in the local neighbourhood map formed. Also it tackles congestion problem and channel loss.

2. Related Works

The sub-layer added in the application layer involves the concepts of local neighbourhood map creation, congestion control, network coding and zone based approach.

Local Neighbourhood Map Formation

The safety message is periodically generated from the vehicles based on the sensor output. These messages are called periodic "heartbeat" messages, which are the building blocks of many such safety applications [11]. The message contains the state of the vehicle, which consists of various sensor readings such as location, velocity, acceleration, etc. Each vehicle has a safety message which consists of its state information such as GPS location, velocity and braking status. It is done at the CCH interval. These are the local information where each vehicle can construct and maintain a local neighbourhood map by grouping such informations, which provide reliable up-to-date neighbourhood information. By using this information, accidents and collisions can be prevented to some extent. At the start of each CCH interval, each node has a safety message consisting of its own vehicle status information.Each user receives the messages of the other users by the end of each CCH interval in order to update its neighbourhood map. The vehicles identify nearest Road Side Unit (RSU) called as Access Point (AP) for their communication. The only wireless technology which extremely meets the short latency requirement for road safety messaging and control is Dedicated Short Range Communication (DSRC).

Congestion Control

The periodic message is broadcasted to each and every node in VANET environment. The vehicle clusters are present in the communication range of each other vehicle to communicate easily. In the network with less number of nodes the message is transmitted to all other nodes within the particular network coverage area. The network with dense number of nodes results in congestion. Collision occurs when two nodes pick the same timeslot in the contention window[5]. Also for high node densities, the collision problem increases. Congestion occurs when many nodes have a newly generated WSM for transmissions and they all switch to CCH at the same time, termed as synchronized collision.

Congestion produce excessive number of collisions and it results in unacceptable reliability measures for safety applications. To reduce congestion, rate control algorithms drop some messages. This algorithm reduces excessive collisions and provides an overall reliability. The message rate is adjusted with the transmission range to alleviate the problem of congestion. Due to this problem, all the nodes cannot transmit.

Active nodes are the nodes that transmit their generated messages and are selected based on congestion control algorithm [4]. Only active nodes transmit their generated messages according to the congestion control algorithm. This algorithm filters the number of active nodes in each CCH interval. If the node is not active, the generated message is dropped. If it is active, it is transmitted at each timeslot. The congestion algorithm can be implemented in both the MAC layer and in the application layer.

Network Coding

The message is disseminated to the vehicles within the network coverage area. It cannot be assured that the message has been received by all the nodes, until the acknowledgement is received. The network coding concept is used to improve the successful message delivery [9]. The sub-layer thus added in the application layer combines all the received messages. The network coding overhead, called as sub-layer header is attached to the received messages and send it to the next layer. The random linear network coding concept with message rebroadcasting is used in reducing delay within vehicles during transmission.

Consider a single cell of active nodes, where the nodes are synchronized. The transmission time is slotted. At the beginning of each subframe (channel) each active node generates a message that is to be received by all the other nodes with the subframe. The generated message is retransmitted several times during a subframe. When a node has transmission opportunity, it transmits a random linear combination of all the already received messages. The random coefficient is attached to the coded message in the random linear coding algorithm. In a congested network, coding overhead may occur. It can be reduced by using the seed of pseudo random number generator[7]. The seed determines the sequence of random coefficients in a coded message. From the received coded messages, new coded messages can be generated. Then the seeds are attached to the newly coded messages. This results in excessive overhead. By using Linear Feedback Shift Registers, all the uncoded messages can be encoded.

Zone based approach

The vehicles transmit their messages to other vehicles within the network coverage area. The vehicles are grouped as zone for effective message transmission. Zones are created based on the availability of channel when the nodes are all active for transmitting messages. The source vehicle broadcast information to its zone and the vehicles which are under the particular network will receive the message. The vehicles location is tracked by using localization algorithm [10]. This algorithm holds good for the vehicles to trace the location by achieving high delivery rate and short delivery time while sending messages to other vehicles. Each sensor node must be equipped with a GPS receiver which provides sensor nodes with their accurate position. Adding GPS to all nodes in the Wireless Sensor Network results in high cost and high power consumption. An alternate solution of GPS is self-localization, where sensor nodes can estimate their position by using different localization discovery protocols. Special nodes called beacon nodes are used to know their own locations by the protocols. These provide position information in the form of beacon messages. Range-based and range-free approaches are used by the localization schemes. Range-based concept is used by considering the range measurement for location estimation.

3. System Model

A group of nodes are considered in the communication range to transmit informations within them. The above mentioned concepts use rate control algorithm, random linear coding algorithm and localization algorithm for effective delivery of messages.

Rate Control Algorithm

The sub-layer added in the application layer initially involves the congestion control process, in which it determines if a node is active in the provided CCH interval. If the node is not active in the particular CCH interval, the generated message will be dropped. If the node is active in its interval, it transmits at each timeslot. This can only be done through the wireless card driver interface and also it ensures instant transmission when the message is sent to the lower layer in the WAVE stack. The congestion control algorithm filters the generated messages to reduce the number of active nodes in each CCH interval. The solution used in solving the congestion problem is message rate control. This rate control algorithms drop some of the messages which reduces congestion. Excessive collision is managed by using this algorithm. Based on the system requirements and the conditions, this algorithm can be implemented in the MAC layer as well as in the application layer. Simple rate control algorithm randomly filters the load. At the beginning of CCH interval, the sub frame picks only the active nodes and allows it to transmit in those sub frames, based on the most up-to-date neighbourhood map.

Random Linear Coding Algorithm

The message is rebroadcasted when there is a channel loss or a packet delivery. So the copy of the message is retransmitted. The random linear network coding with the combination of message rebroadcasting makes the message to be delivered successfully. It achieves multi-cast capacity in a lossy wireless network. Any node can linearly transmit its own coded message and the already received coded messages.

The active node is determined by congestion control mechanism. Initially every node has its own message. When time goes, each node receives other transmissions. Each node enqueues all of the received messages and when it has a chance to transmit, based on its retransmission pattern it broadcasts the random linear combination of all the already received messages in its queue. The original packet is decoded at the end of the subframe. Finally, all the nodes empty their queues and start a new transmission for the next subframe.

Localization Algorithm

The message thus generated is transmitted to zones for quick delivery. The source node transmits the message to the neighbour nodes by the help of Access Point (RSU). Only the nodes coming under the particular RSU can receive the message. The moving vehicles receive the message only when they are active. If not the message is dropped. The destination address is present in the message to identify it easily without confusion. The active nodes are chosen initially before transmitting the information. Each nodes location is traced by using Localization algorithm. In this algorithm, range-based approach is used, where each vehicles location is traced out for successful transmission. This algorithm results in low transmission time.

4. Result

The proposed algorithm increases the throughput which also decreases the delay occurred during transmission of emergency messages. The protocol used is Wi-Fi. The existing system uses Dedicated Short Range Communication (DSRC) protocol where delay is high when related to the proposed system shown in fig 1.

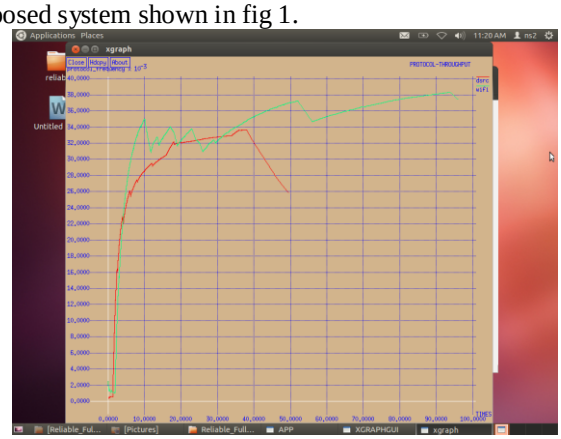

Fig 1. Graphical analysis of throughput

5. Conclusion and Future Enhancement

In this paper, the message is broadcasted to zones, where message is transmitted to the active nodes in the particular zone, which results in reduced transmission time. The backbone network used is the Wi-Fi protocol and the participating nodes come under its coverage area for transmission. The collision is minimized to some extent which in turn reduces packet loss, delay and increases throughput. The future work mainly relies on minimizing the congestion while broadcasting messages.

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