

Traffic Congestion Control through Vehicle-to-Vehicle and Vehicle to Infrastructure Communication

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Abstract: Nowadays traffic on the roads is becoming a major problem in developed cities. With the advancement in technology vehicles themselves could be used to compile and analyse traffic data and relay it to the drivers in a format that will allow them to make smart decisions to avoid congested areas, resulting in congestion control. Vehicular Ad-Hoc network (VANET) is one of the best solution which enables vehicle to vehicle communication. Vehicular ad-hoc networks (VANET) are a form of mobile ad-hoc networks (MANET) that provide communications between nearby vehicles and nearby fixed equipment. We present a strategy to control traffic congestion with the help of vehicle-to-vehicle (V2V) and vehicle to infrastructure (V2I) communication. This is achieved by transmission of messages which alerts the drivers about possible traffic breakdown. The message transmitted will guide the driver so as to take the decision needed to control the traffic congestion.

Keywords: VANET, MANET, V2V, V2I, Traffic congestion

1. INTRODUCTION

During the last decades, worldwide road traffic density has been increasing year after year. This case has led to the fact that, currently, motorway traffic congestions are one of the most common phenomena that motorists have to face in their trips. Apart from being a quite-stressful experience for current drivers, they also have a negative impact on the environment and the economy. In addition, the road traffic conditions affect the safety of the population since 1.2 million people worldwide are estimated to be killed each year on the roads.

For this reason, nowadays the automotive industry and governments invest many resources to increase road safety and traffic efficiency, as well as to reduce the impact of transportation on the environment. One of the most promising areas of research is the study of the communications among vehicles and road-side units, or more specifically the Vehicular Ad-hoc Networks (VANETs). This kind of networks are self-configuring networks composed of a collection of vehicles and elements of roadside infrastructure connected with each other without requiring an underlying infrastructure, sending and receiving information and warnings about the current traffic situation. To achieve the efficiency in transportation with the help of vehicular communication, our approach is based on following points.

1. Data packets are generated and broadcasted by affected vehicle itself which contains decision message.
2. Based on decision vehicles adapt the driving behaviour and helps in controlling congestion.
3. Roadside infrastructure monitors the traffic and if traffic is above threshold value it broadcasts the messages.

In proposed technique the data packets will be generated in case of event occurrence only. This further reduces the packet flooding problem of broadcasting as periodically data packets are not transmitted. Data packets are broadcasted to all neighbours in reception range and receiving vehicles will rebroadcast the data packet thus receiving vehicle will be responsible for forwarding the message along to the rest of the vehicles. Roadside units are continuously monitoring the traffic and if the traffic is above predetermined threshold value they will broadcast control messages, ex: Reduce the speed. The previous studies have focused on detection of traffic congestion. Mr. Fernando Terroso have proposed a cooperative approach to traffic congestion detection with complex event processing and VANET (Fernando Terroso-Sáenz, 2012). Our proposed system focuses on traffic congestion control.

2. LITERATURE REVIEW

Various researchers are working on VANET to find the solution for current crucial congestion problem. A paper by Florian Knorr aims to identify 'critical' road segments and to prevent a traffic jam before it actually occurs. Their work focuses on the aspects related to traffic dynamics (Florian Knorr, 2012). Elmar Schoch was proposed five distinct communication patterns that form the basis of almost all VANET applications. These patterns can serve as a base for future development. The classification also reflects that the close coupling between applications and communication in VANETs shifts the focus to a more integrated system architecture which ultimately also includes information aggregation. The patterns can form the basis for security and privacy analysis and thus allow for a bottom-up discussion of security in order to achieve tailored security and privacy solutions (Elmar Schoch, 2008).

Francisco J. Martinez presents a comprehensive study and comparisons of the various publicly available VANET simulation software and their components. The work focuses on an event-driven architecture (EDA) as a novel mechanism to get insight into VANET messages to detect different levels of traffic jams; furthermore, it also takes into account environmental data that come from external data sources, such as weather conditions (Fernando Terroso-Sáenz, 2012). Josiane Nzouonta presents a class of routing protocols called road-based using vehicular traffic (RBVT) routing, which outperforms existing routing protocols in city-based vehicular ad hoc networks (VANETs). RBVT protocols leverage real-time vehicular traffic information to create road-based paths consisting of successions of road intersections that have, with high

probability, network connectivity among them (Josiane Nzouonta 2009).

3. NEED FOR CONGESTION CONTROL

Traffic congestion is a crucial problem of urban areas. The scenario shown below gives an idea about the traffic jam.



Fig 1 Traffic scenario

In the above scene a group of standstill vehicles defines traffic jam. Situations are worse than shown in the diagram. It starts due to several reasons such as driver's mis behaviour, accident on the road, obstacle on the road, weather conditions etc.



Fig 2 Congestion Due to Accident

In the above scene shows congestion occurred due to accident. Result of this is, vehicles are either standstill or moving with very low speed resulting in time lapse and also wasting large amount of fuel. Traffic jam can get resolved within several hours or in critical condition it may take few days to get resolved. Thus congestion affects economy as well as it gives bad impact on the environment. Due to this many Automobile industries are taking initiative to find efficient solution for congestion control. Following table gives an idea of various causes of congestion.

Causes of congestion	Percentage (%)
Bottlenecks	40
Traffic incidents	25
Work zones	10
Bad weather	15
Special events	5
Poor signal timing	5

Table 1: Major Causes of Congestion

4. PROPOSED METHOD

Our proposed method for traffic congestion control is based on VANET. Traffic congestion control is achieved by broadcasting the messages. The proposed communication is vehicle to vehicle communication as well as vehicle to infrastructure communication. The vehicle is assumed to be equipped with communicating device. The communication is initialized by the affected vehicle. The vehicles which are involved in the communication are called as nodes. These nodes are mobile in nature hence while selecting the communication pattern this mobile nature has to be considered. In MANET all the nodes are fixed, hence if we try to apply same protocols for VANET packet loss takes place. To avoid this, an intelligent communication pattern has to be chosen.

4.1 Wireless Access in Vehicular Environment

There are greater challenges in wireless traffic patterns .To know the challenges of IEEE MAC layer operations for vehicular communication scenario, IEEE802.11p Wireless Access in Vehicular Environments (WAVE) was introduced. 802.11p is an IEEE standard that supports Real Time Traffic Transportation Systems (RTTS) ITS)applications in the context of vehicle to vehicle(V2V) and vehicle to infrastructure communications(V2I) that are being developed, namely the DSRC(Dedicated Short Range Communications) operating in 5.9 GHz band. WAVE has become a standard that can be universally adopted across the world. At present DSRC based on the Wi-Fi standard is widely used in VANETs as it connects infrastructure to vehicles and also vehicles to- vehicles using two way short range radio which is of lower costs compared to other wireless standards available. DSRC/WAVE systems fill a niche in the wireless infrastructure by facilitating low latency, geographically local, high data rate, and high mobility communications.

4.2 Communication Pattern

Here for proposed method the proposed communication pattern is Geo broadcasting. The messages are not transmitted periodically; they are transmitted only in case of external event occurrence. Message transmission is unidirectional. The message is transmitted to all the vehicles which are coming in the specified range, hence Omni directional antenna is used for broadcasting and the unidirectional forwarding is achieved by rejection of messages if from behind or from other lane. Communication is single hop communication and message forwarding is done by the next vehicle in range.

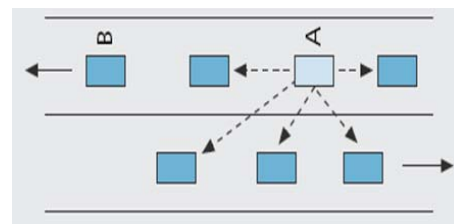


Fig 3: Single Hop Communication

4.3 Field structure of a Message

Field Name	Description
Vehicle Id	Vehicle Identifier
Speed	Speed of vehicle
Lane Id	Lane identifier
Status	Status of Lane
Decision	Decision message broadcasted by affected Vehicle
Decision	Decision message broadcasted by Road side unit

Table 2: Field structure of Message

4.4 Process

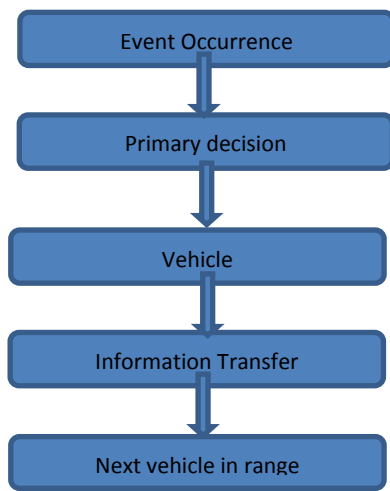


Fig 4 : Decision Making

Algorithm for congestion control:

1. Initialize the system in the vehicle
2. Observe the status of the road
3. Check for the input.
4. If any failure is present check for location of the vehicle
5. Take the decision and Broadcast it on network.

By applying above communication algorithm the congestion control is achieved. Diagram given below indicates the achieved congestion control. For simulation Netbeans is used. The NetBeans IDE is open source and is written in the Java programming language. It provides the services common o creating desktop applications -- such as window and menu management, settings storage and is also the first IDE to fully support JDK 5.0 features. The NetBeans platform and IDE are free for commercial and non-commercial use, and they are supported by Sun Microsystems.

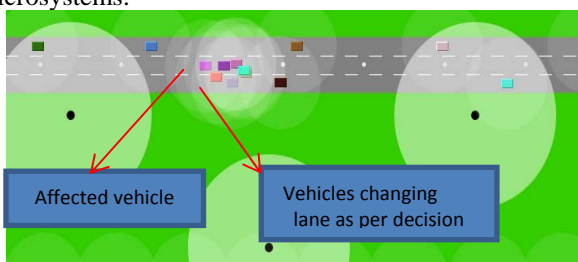


Fig 5: Congestion Control Achieved.

Road is assumed to be divided in three lanes, two outer lanes for heavy and small vehicles traffic and the middle one is for overtaking. By broadcasting the messages, status of the road & event information is given to all the vehicles. This enables the vehicles to take intelligent decision and thus to avoid the congestion. In above diagram the white era indicates the communication range of corresponding vehicles. The communication is possible in this range only and the overlapping of era indicates communication occurrence. In above diagram affected vehicle is shown which is initializing the message transmission hence overlapping white era can be observed. As soon as message received by the neighbouring vehicle, it follows the decision and behaves accordingly. Hence vehicles changing the lane as a result of decision message can be observed in the above diagram.

5. CASE STUDY

Traffic at three different times is observed on a road and the speed v/s count of vehicle is plotted as shown below in diagram.

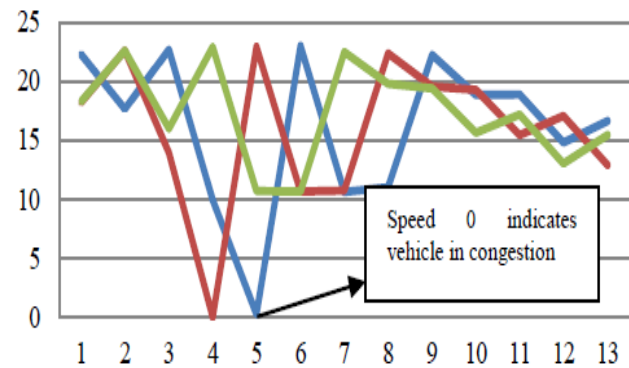


Fig 6: Graph of Speed v/s no of vehicles. Y axis indicates speed and X axis is no of vehicles present on road

Series 1, series 2, series 3 are the different amount of traffic present on particular road at different time. As shown in the graph the speed of vehicles is decreasing up to 0 which indicates congestion creation and after certain amount of time it gets dissolved. This congestion can be controlled by using VANET as shown in the next diagram.

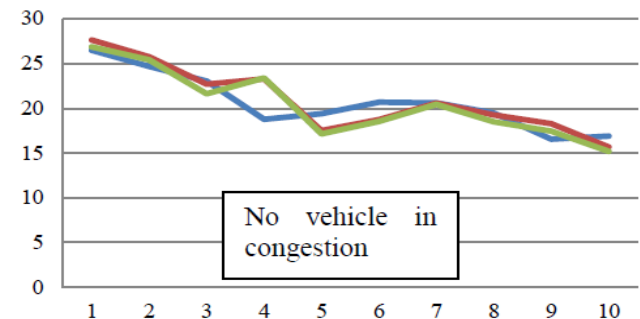


Fig 8: Graph of Speed v/s no of vehicles. Y axis indicates speed and X axis is no of vehicles present on road.

As shown in Fig 8 No vehicle in congestion can be observed which indicates that effective congestion control can be achieved by using VANET.

CONCLUSION

This study addresses the problem of heavy traffic congestion especially in urban areas. This study proposes an effective solution based on VANET. In proposed method the main focus is on traffic congestion control which can be achieved by broadcasting the prior information about the status of road. With updated knowledge now traffic is moving according to the decision of the broadcasted message, thus resulting in congestion control.

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