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Performance Analysis of Collision Avoidance Frame Works in Vanets

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Abstract

Background/Objectives: To analyse the performance in VANET and to suggest a framework for collision avoidance in VANET. **Methods/Statistical Analysis:** A Vehicular Ad hoc Network (VANET) has emerged to be one of the novel and powerful technologies providing safety for the persons driving the vehicles and also provides reliable communication between the vehicles. In this VANET technology, each vehicles act as a mobile node that communicates with each other using the Road Side Units (RSU). There are numerous protocols employed in the VANET. The different routing technique such as geographic, hybrid, topology and clustered routing helps in the reliable delivery of the packets from the origin to the target nodes by determining their geographical location. **Findings:** To facilitate efficient transfer of data we need to improve the QOS parameters such as jitter, delay, congestion, energy efficiency and latency. In order to eradicate the frequent occurrence of accident, the implementation of VANET technology is being used in various modes of transportation. Here, we had made an accumulative study of various routing protocols and collision avoidance techniques that are used in the field of navigation, human robot and biological collision avoidance. **Applications/Improvements:** The result observed from this work will motivate to develop a collision avoidance framework in VANET.

Keywords: Collision Avoidance, Forwarding, Routing, VANET

1. Introduction

Vehicular Ad hoc Networks (VANETs) are specialized type of mobile ad hoc networks, in which vehicles are assumed to be mobile nodes. It consists of two different types of entities such as access points and vehicles. The access points are firm and usually connected to the internet and they could perform as a distribution point for vehicles. VANET includes the wireless communication from one vehicle to another (V2V) and from vehicle to infrastructure access point (V2I). Vehicle to vehicle communication is of two types: one hop communication which involves direct vehicle to vehicle communication and multi hop communication which includes vehicle that relies on other vehicles to retransmit. VANET also has unique characteristics that distinguish it from other mobile ad hoc networks. The most important characteristics includes maximum mobility, self-organization, geographically distributed communication, restricted road pattern, and network size without any restrictions, thus all these characteristics made vehicular ad hoc network environment as a challenge to develop routing protocols in an efficient way.

The vehicles provide a great opportunity for the development of new driver assistance systems by exchanging information among them. The systems of

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this type will be able to publish and to gather information about the other vehicles along with the road traffic and environmental conditions in real time. These data will be handled and evaluated to ease the driving by contributing useful information to the user.

The applications of VANETs are mainly categorized into two types: safety and efficiency applications. The VANETs based systems finds many difficulties in terms of system design and implementation. Such difficulties include security, routing, connectivity, quality of services and privacy.

2. Motivation

The hiked mobility of people caused a higher cost for societies as impact of the increasing number of traffic problems like fatalities, congestions and injuries. Vehicular Ad-Hoc Networks determines supporting services for Intelligent Transportation Systems such as monitoring of traffic, vehicle navigation, collision avoidance, control of traffic signals, and congestion management by signalling to drivers. VANETs comprise vehicles and roadside equipment owning wireless interfaces able to communicate among them by wireless and multi-hop communication.

A Vehicular ad hoc network is an exclusive kind of ad hoc networks and it affords basic communication between computers installed vehicle. One of the major goals of VANET is the safety. Therefore, collision avoidance among vehicles is very interesting. For clarification, the term "collisions" here refers to collisions between cars or between cars and pedestrians, not for packet transmission in MAC.VANETs are subjected to interference and propagation issues, as well as different types of attacks and disturbances which may harm intelligent transportation system services. The high mobility nodes in networks are characterized by, wireless links subject to interference, fading due to multipath propagation and high changes in the network topologies. There was an increase in complexity of security management operations, particularly, access control, node authentication and cryptographic key distribution, allowing the participation of malicious nodes in the network and posing nontrivial challenges to security design due to the absence of central entities. The wireless communication in further is subjected to eavesdropping, jamming and interferences making easy to damage information and service security.

3. Contributions

Here, a survey is done based on various routing protocols that have been used in the VANET'S, the different collision avoidance techniques that have been used to avoid collision. Subsequently, for each collision avoidance technique there are some drawbacks. Our preferences were drawn to the techniques that have been published by major journals and conferences. We did opt for the techniques and protocols that provided that provided major changes and not minor ones. We explained the following i) the general content about VANET's ii) the survey about the different collision avoidance techniques, their issues and their drawbacks if any iii) the different transmission strategies. Some of the vulnerabilities have also been stated and the reason for their occurrence is also stated. Finally a short description of the experimental techniques is stated. Thus the analysis and technical details of some algorithms have not been included and it refers to the reader of the publications to obtain the information about the design and analysis of algorithms.

4. Organisation

The flow of work as stated in Section 3 states the mobility in the VANET's. Section 4 provides a literature survey where the different collision techniques are mentioned along with their pros and cons. Section 7 provides the routing techniques and the protocols that are used for routing. Section 8 deals with the detailed description about the quality of service. Section 9 and 10 provides the different threats that occur during the information transfer and the experimental techniques. Section 11 concludes the paper.

5. Literature Survey of Papers

Vivek Pant et al.[1] proposed a detailed simulation analysis of two collision avoidance models: spatio-temporal integration model and Rind model is made with and without visual tracking showing how tracking improves the performance of the model and illustrates their shortcomings. It is inclusive of the following features such as The STI model with tracking is able to distinguish all the collision scenarios from the non-collision Ones. Collision avoidance model is based on a matched filter for optical flow which has been argued to be a good mechanism to

determine the motion of rigid objects. Some of the flaws are found in representing three-dimensional Motion in the real world on a 2D sensor array failed. The low frame rate of the camera sometimes blurred the motion which made edge detection difficult. A highly textured and/or high contrast background would clearly interfere more with collision detection performance.

Yuhong Liu et al.[2] implemented the case base reasoning techniques to collision avoidance systems and they are using automated case learning methods for maritime. The cases are generated using the historic maritime affair records. The significant feature of this technique is that it automatically generates cases from the records of history that it has stored so that it is precautionary. The cases are developed at the initial stage. Certain drawbacks are not advantageous to implement these cases during execution of run time as it is costly and it deals with a safety issue. Since the cases are assumed from the prehistoric issues, some cases may not be considered.

Jocelyn Buisson et al.[3] evolved an advance model for collision avoidance that serves for pedestrians and bicyclists. This is used for simulation of large crowds in real time. The prominent implementation is a unique kind of force referred as the sliding force is used for collision avoidance and it reduces the complexity of the model. This model is oscillation free. But it has the following limitations like it is not oscillation free for the concave obstacles. The force is not scaled according to the distance. When individuals are facing each other they block each other.

M. Valdes-Vela et al.[4] proposed methods to avoid the car collisions by the appropriate vehicle movement detection by the longitudinal communication with the extracted fuzzy rules from the maritime data. This scheme does not need any additional sensors and so it is cost effective. They are provided with the relevant vehicle movement detection which is accurate and specific depending on the functioning of the controllers. There's no need of buffered information hence saves the memory space and helps in large storage operations. The system complete dependency on fuzzy logic leads to the sudden change of actions which is not readily accommodated by the driver and leads to further confusion.

Vicente Milanes et al.[5] defined methods to evade the posterior collision between vehicles using collision warning and collision avoidance methods which provide a relative velocity between the two vehicles. Using these methods helps in alerting the driver to prevent or mitigate from the collision. They also help in providing a trigger and use the avoidance controller to prevent the collision. These two techniques aim at optimizing the time-to – collision. The paper lags in that the sudden change of action by the function of the controllers is unpredictable and the collection of data using the vehicle to infrastructure (V2I) which involves all the information of the surrounding and is not specific and accurate.

Xilin Yang et al.[6] has presented ways to avoid the spatial collision in unmanned Ariel vehicle using the switching controllers which helps in the detection of the occurrence of collision and help to avoid the collision. This paper aims to achieve the desired relative bearing in the horizontal plane and relative elevation in the vertical plane so that the host aircraft is able to avoid collision with the intruder aircraft in 3D. The paper aids the host aircraft to follow the desired trajectory and resume the pre- arranged trajectory after collision is avoided which helps in providing the stability of motion. The prearranged controller and collision avoidance controller are used to avoid collision in a standard method. Some of the difficulties faced in the proposed method are it requires a continuous data link which at times is not possible to be provided. The technique is at its best when applied only for the vehicle in the same velocity.

Lihui Wang et al.[7] proposed a novel idea to avoid active collision by using robot control in a virtual environment and it states a unique approach for the safety of humans which includes detection of collision between pictures and three dimensional models. An essential feature of this paper is the communication between the robots and humans which increases the efficiency of complex process mainly when a robot acts as an intelligent agent. This paper has few drawbacks such as, In Robot, the built-in sensors, limits the motion capture to only the wearer, whereas the surrounding of the Wearer is omitted. This leads to serious security issues when a moving object hits an ideal object.

Ata M. Khan et al.[8] defined that the main theme of paper is to design a self-calibration adaptive model that prevents rear and side collisions. In order to identify the pre-crash conditions, the cognitive vehicle must contain the information about location and distance between the vehicles on-line using Bayesian-Monte Carlo Model. This paper includes various advantages like the longitudinal Control of a cognitive vehicle in order to enhance

safety, reduce abrupt deceleration and acceleration for improving driving comfort and efficiency and minimizing environmental effects. Some drawback of this paper are only the human control cases such as drivers' distraction, self-calibration capability and some related features are covered in this proposal.

K.Y. Chee et al.[9] proposed a new collision avoidance technique to implement and develop an unmanned aerial vehicle. The main purpose for avoiding collision involves ultrasonic and infrared sensors. The advantages include the capability to achieve more stability than a manned system and certain algorithms to improve the vehicle performance. Major issue is that it provides some limited services for collision avoidance as it only uses internal sensors such as infrared and ultrasonic sensors.

Rafael Toledo-Moreo et al.[10] proposed an innovative method to exclude vehicle collision by the cooperation of vehicles included in a scenario. Changes in the lane are foreseen with the response time so that it can be used for the support of collision avoidance. The deceleration and acceleration can be checked with latency time. Here the drawback is the digital mapping system along with the road shapes.

6. Routing and Forwarding

Routing refers to exchange of name-prefix announcements among routers; forwarding refers to Interest and Data processing, done hop-by-hop according to the Strategy Layer in each node. VANET's has certain number of new features for mobile ad hoc network, which creates the necessity for new routing techniques. Based on features of VANET and other requirements for applications the network selection relays on the communication and the performance of the network. To reduce the effects caused due to the delay it is necessary to select an effective network with dynamic scenarios. The charging control nodes are helpful in signalling and transferring the information in a communication network that can collect and process, record and rate packet data. The nodes might use any of the routing protocols for routing and forwarding.

In this routing technique, the cluster formation plays a major role. The efficient transfer of information between the nodes can be done by using the clusters. If a collision takes place then the information is transferred to the different road side units that are located nearby by using wireless network technology. From the road side units, the information is transferred to the main nodes that are allocated. From the main node the information is transferred to the vehicles in that particular cluster. In order to achieve the intelligent cluster communication, some of the methods used in broadcast strategy are adopted.

In Forwarding, flooding is the easiest way to forward Interest packets on the wireless networks which is simple and faces situations in which end-to-end path set up and maintenance are difficult and costly as in dynamic ad hoc environments. Flooding facilitates content sharing in the network that is a node can access other node in a network without an explicit request thus reducing the number of transmissions and saves the node's energy.

A new awareness mechanism have been included in the forwarding plane to help in selecting the outgoing interface, the content provider and the hop nodes, by dispensing the new entries in the tables. They distribute the information stored in the forwarding table to select the outgoing interfaces at each node.

7. Open Challenges

From the literature overview it clearly emerges that there are several works related to the routing of information between vehicular nodes have been proposed to its inherent potentialities. Regardless of the modifications and enhancements proposed in the VANET's to exceed challenges and constraints of vehicular ad hoc networks, research in the field can be developed with some hints for future deployment can be provided as follows.

Many issues related to the security methods are completely open. Most of the vehicular nodes are resource constrained devices and signature and authentication operations can be expensive in terms of time and energy resources consumption. This complicates the management of the security framework in the transfer of the information. Therefore the use of the general cryptographic methods may help in providing the security necessary for the secure transfer of the information through the network in the encrypted format to the destined nodes where the information can be retrieved with the help of the keys. Thus a secured communication between the nodes in the vehicular network can be provided.

The other major challenge is the congestion and collision control in the VANET. Usually in crammed networks, more number of vehicles transmits information

at multiple points and the channel gets congested easily. Such situations will decrease the throughput and the delay will increase. Such issues can be dealt with the event driven detection technique which checks the safety message and starts the congestion control algorithm each time when the safety message is generated or detected. The low priority messages will be paused as soon as the congestion control is launched and allows the high priority messages to the transferred quickly without any further delay. The measurement-based detection is also used which monitor the packets queue when congestion is sensed then it discards the low priority messages and allows the quick transfer of the prioritized messages. Thus the congestion in the communication network can be managed.

Other such challenge is the bandwidth and packet rate problems. The issue with wireless networks in the transfer of information is there is only a limited amount of bandwidth available in the transfer channels. Such conditions can be managed by the types of safety message in ad hoc networks. Initially, the messages alert other vehicles which are located in that area of vehicle state. Next, in the state of unsafe driving the necessary warnings are generated. When periodic are large because of the high density the warning messages will take a lot of time to be received. In an emergency situation, the flow of periodic messages should be bounded. The possibility that a message will arrive depends on the distance between the sender and the receiver, the rate at which the message will be received is based on the type of message and the models used for simulation. Thus by the use of packet priority the messages can be delivered and the packet transfer rate can be managed.

8. Identified Challenges

In this section, we discuss the challenges and future trends derived from our analysis.

8.1 Trends and Challenges

VANET security is one of the trending topics in the field of network security. The traffic problem is one of the annoying things that any driver would dream to avoiding. There are number of vehicles which might cause problems which should be reported to other vehicles state to avoid traffic. Sometimes, irrelevant or incorrect information is transmitted by the vehicles which make the situation worse. Thus the initiatives are taken by car manufacturers and governments to improve the safety in the transport system.

Recent improvements in the Transportation Systems imply that the vehicles will be provided with wireless components that will help in communication between the vehicles and form a wireless vehicular state. The general purpose is to enable safe and secure transportation of the vehicles in the networks. This can be obtained with the help of the sensors and other routing protocols which are used for the transfer of the messages. The car manufacturers are integrating the on board units like radar sensors, GPS and others effective sensors for obtaining and to transfer the routing information between the vehicles[11,12].

VANETs involve the routing and addressing concepts. The focus is on the combination of geo networking with mobility and IPV6 that supports the routing of vehicles. Some technologies like ambient traffic sensor application can also be used where the vehicles are provided with sensors that encounter road faults, accidents and congestion. On the encounter of the event, the vehicles will try to notify the centre which monitors the traffic, by sending the message to one of the roadside units in the city. Thus the information can be accessed by all mobile nodes and the congestion and traffic can be controlled by efficient routing of the mobile nodes.

Lack of support for these capabilities in the vehicles lead to the insufficient traffic management and also leads to many traffic control and routing issues. Thus we consider that this is an important area for research for the future.

9. Emerging Threats

The security system in VANET's plays a very important role. Attacks in the network can be classified into different types.

VANET's have been prone to several vulnerabilities. Some of the vulnerabilities include the following:

9.1 Authentication

Authentication refers to protecting the network or the system from the external users by not providing access to the external users. It generally does not allow external users with false identity. This includes the following

- *Global Position Spoofing*: In this the GPS satellite maintains a table with the geographic position and the identity of the vehicles. The attacker can use a GPS simulator that generates more signal than the normal GPS satellite that is used to identify the location and the attacker can provide false reading with different locations.
- *Position Faking:* Vehicles are responsible for providing their position. If the communication is unsecure then it paves way for the attackers to change the location or position of the vehicle and it also prevents the vehicle from receiving the safety messages.
- *Sybil Attack:* It is the state where the attackers hack into a network and provide false information to the vehicles in that particular network and force the vehicles to take an alternate route.
- *Masquerading:* The attacker acts to be a part of the network and provides a variety of attacks to the nodes in that particular network. This action can be easily performed in VANET's.
- *Message Tampering:* Any node acting as a part of the network can disrupt the communication. The attacker can modify and transmit the false information and can claim that it was transferred by somebody else.

9.2 Jamming

Jamming is the prevention of communication within the communication range. The attacker partitions the vehicular network in a simple manner. The coverage area can be well defined locally so this is a low effort and easy way to hack into the network and disrupt the communication.

9.3 Availability

Some threats to availability includes the following

- *Spamming:* The spam messages in the network are difficult to control because of the lack of the centralised administration and also the basic infrastructure. The presence of spam messages in the network increases the risk of transmission latency. This leads to some serious problems in the network.
- *Malware:* Malwares are nothing but introduction of viruses or worms into the network. Malware attacks are most commonly caused by the insider of the network rather than the external attacker. These malwares cause a serious threat to the network. The malwares are introduced mainly when the software updates takes place.
- *Black Hole Attack:* This takes place when an existing node drops out or when a node refuses to participate. When a particular node drops off, the routes in which it participated are broken and this leads to the failure of the message propagation.
- *Denial of Service Attack:* It is the case where the authenticated users are not provided with the access to their network due to the jamming or flooding. This attack is usually caused by both the insiders and outsiders of the network. The important objective is to exclude the user from accessing the resources and the services.

9.4 Selfish Driver

A selfish driver wants to make the highest profit out of the network. So in this case he uses the network in an illegal manner. The driver informs the other vehicles that the road is congested and you can take the alternate path and the route will be clear.

9.5 Broadcast Tampering

It is the case where the attacker injects false message into the network. This is implemented to cause damage to the vehicles and is prone to the accidents of vehicles.

10. Experimental Techniques

Experimentation is the way to provide a newly developed design. In the experimentation we use different techniques. Each technique differs from each other in various aspects. The experimental technique can be an emulation technique or a simulation technique. The simulation is done using the wireless networks. The wireless networks involve a stack of protocols. The stack of protocols is arranged based on the OSI model. The application to be tested is implemented on the top of the stack of protocol. A component is used to test if the nodes are connected properly and then evaluate which nodes are affected during the transmission. The result could be either the nodes have received the data correctly or the nodes would have received garbled bits because of the collision that had taken place during the transmission of data. Introducing the concept of mobility into the VANET's it is generally used to move the nodes around. Simulation mainly focuses on how this technique works in the external environment and also the operational properties required. Usually the channels in the wireless

networks are unpredictable and sometimes chaotic. In the VANET's we mostly use the radio propagation techniques. In the past several technologies such as the infrared and the short range radio have been used. Recent days most of the VANET's use 802.11p standards.

The implementation in simulation can be explained in a simple way. The nodes which are in a relevant distance are signalled and they calculate the signal strength that they receive. For the transmission of the data to take place the nodes should have the same signal strength. Based on the bit error rate we can judge if the message has been received correctly or not.

11. Conclusion

VANET consists of several collision techniques which help in the collision avoidance. In the paper, a survey of the various collision avoidance techniques and different controllers that had been newly proposed to improve the performance of existing system is reviewed. The boons and bane of each projected model had been ascertained and listed. Some of the drawback found in these models can be enhanced by improving the response of collision avoidance made dependent on the distance of an obstacle from the observer. This can be done with the help of the navigational sensors attached to the vehicles which provides the combination of the shape of the road and data from the digital maps and displaying it to the vehicles and making this technique available to all the fields of transportation with different the velocity ranges. Real time applications of these techniques can be employed to find out the correct performance to that of the simulated results.

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