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INVESTIGATION OF HYBRID VANET SYSTEM FOR IMPROVE THE ROAD SAFETY

[1]BALAJI VENKATESAN, [2]GEJENDHIRAN.S, [3]THANIGAVELMURUGAN.K, [4]GNANARAJ.J
[1234]Department of Mechanical Engineering, Loyola Institute of Technology, Chennai

ABSTRACT

Ad hoc networks are one of the most exciting applications in the areas of automobile sector wireless communication. Ad hoc network technology will be used in the car's onboard communication unit to collect real-time data on traffic and road conditions from a variety of onboard sensors. Application of Ad-hoc networks include services like traffic control, real-time traffic re-routing and safety warning by traffic management intelligent systems. In this work, to improve road safety a hybrid VANET has been developed. In this paper deals with the challenges and special features and that distinguish these systems from other types of ad hoc sensor networks.

Keywords: VANET, H-VANET, Sensor, Road Safety

1 INTRODUCTION

Vehicular Ad hoc Networks (VANets) are to operate wireless communications in the vehicular environments employed by Intelligent Transport Systems (ITSs). VANets are designed to provide reliable and safe environments are provided to users by the VANets in terms of reducing the, traffic jams, road accidents and fuel consumptions and so on. The VANets users will be alerted of hazardous situations by exchanging the information and vehicular communications about surrounding environments(1,6,12). VANets are a simple type of common Mobile Ad hoc Networks (MANets). The vehicles in VANets are similar to the mobile nodes in the MANets. Although VANets inherit many of the characteristics and specifications of MANets, VANets have some special characteristics such as high rate of topology changes, high mobility and high density of the network, and so on(3,5,10). Thus, VANets have some different features in comparison with MANets

The chance of direct exchange of data between vehicles over an ad-hoc network environment called a vehicular ad-hoc network (VANET) has been widely accepeted by academia, governments, car manufacturing industries as a promising technokogy for future realization of intelligent transportation system (ITS) thereby achieving safety and efficiency in our nearly overcrowded motorways(4,8,15). The VANET is a sub-class ofMANET where the mobile nodes are vehicles. The inter-vehicle communication (IVC) compared with Mobile Ad-Hoc Network (MANET) has four major advantages: relatively low latency, broad coverage area, due to direct wireless communication, little or no power issue as well as no service fees(7). In the recent years, the concept of vehicular communications academia, car manufacturing industries and government agencies have putting much joint efforts together to vehicular communications in wide scale Some frameworks are already worked out with the first landmark of standardization processes and the allocation of 75 MHz made by US Federal Communications Communication (FCC) through of dedicated short range communication (DSRC) spectrum(13). It normally to accommodate V2V and V2I communications for safety-related applications.

Vehicular Ad Hoc Networks (VANET) will collect and distribute information regarding safety to reduce the maximum number of accidents by alerting drivers the danger before actually face it. These networks consist of On Board Units (OBU) and sensors they are installed in the car as well as Road Side Units (RSU). The data acquired by the sensors on the vehicles can be conveyed to the driver, pass to the Road Side Units or even send to other vehicles depending on its importance and importance(14,18). The RSU transfers this data, also with data from road sensors, traffic control centres, weather centres, etc to the vehicles and also gives commercial valuable services such as Internet access, gas payment and parking space booking. The network will makes enormous use of the wireless communications to attain its goals but although level of maturity of wireless communications required more to implement such a complex system. A basestation available for synchronization and other services with wireless devices; However using this Vehicular Ad Hoc Networks approach covering all roads with such infrastructure which is impractically too complex expensive.

Developing secure vehicular sensor networks, highly scalable and high-speed presents a tremendous challenge due to a combination of highly dynamic mobility patterns, which leads to highly dynamic network topologies, with the addition of high velocities that would be involved(19) . On the other hand, certain limitations will commonly assume in other ad hoc sensor networks were not present in these Ad hoc systems. With example, sensor vehicular networks will access to power resources and ample computational within the network itself, and they can use high-performance advanced antenna technology and speed wireless communication. Finally, a significant fraction of vehicles will lead to have an accurate and precise knowledge of their own geographical position, by means of GPS.

II. PROPOSED HYBRID VANET SYSTEM

Hybrid Vanet System is designed in the following way. The network is consists of Road Side Units (RSUs), Vehicle nodes, and Sensor nodes. The Wireless communication is established and conducted between these nodes. Every vehicle fixed with a device that can communicate with the other vehicles devices on the road as well as with roadside stations. This device is designed to collect,process, share and deliver precise real-time information about road conditions that could affects the safe driving. Along with a time interval the sensor node collects and stores all the information about any incident that happens in the road. The roadside wireless sensor nodes are sub divided into groups and each of group is managed by a Road Side Units. All sensors in The RSU collect information and transfer the aggregated data to the other RSUs. The local database also maintains the data and transmits it to the vehicle nodes when a vehicle comes in near its communication range. Once a vehicle receives the data, it transfers the data to the other vehicles by the Geocast Protocol in a geographical location. The message is conveyed to the drivers using some simple Driver Assistance System (DAS).

The device of in the on board in the vehicle will have two different interfaces: a IEEE 802.15.4 (ZigBee) interface for communication with the RSUs and Embedded WiFi card (IEEE 802.11) that is used for communication with the other vehicles and The sensor nodes communicate with each other and with the vehicle nodes using the IEEE 802.15.4 (ZigBee) communication interface. Similarly the RSUs also have two different communication interfaces. Sensor nodes and RSUs and are deployed on both the sides of the road in a two way highway. There are fewer RSUs that are deployed at fixed distances. The sensor nodes are deployed in between two adjacent RSUs. The sensor nodes can sense, collect and relay messages to the RSU whereas the RSUs have the ability to also communicate with the vehicles. IEEE 802.15.4 is more energy efficient, costs less, and communicates over a confined small geographical area. On the other hand, IEEE 802.11 used in the vehicle node is quiet more expensive but it can transfer more data over medium distances via multi hop communication.

III. EXPERIMENTAL RESULTS

3.1. FIELD TESTS

A set of experiments were conducted in the large parking area to test how efficiently the message is being transferred to all the nodes. The system and network that was implemented had 3 main components-the normal sensor nodes, Road Side Unit (RSU), and vehicular nodes. The vehicles nodes are developed by attach a laptop in the vehicle with an attached telosb mote. The access points and The regular sensors are implemented with mounted sensors as Telosb motes. Long range WiEye Passive Infrared (PIR) sensors that are here. It has a detection range of 20-30 feet for human presence a wide detection cone of 90-100° and the 50-150 feet detection range for vehicles depending on the size.

The WiEye has an acoustic sensor and visual light sensor that increases the detecting ability of the PIR sensor. The WiEye sensor is directly plugged and enabled in to the TelosB motes. For this experiment, along one side of the road 24 TelosB motes were deployed. The distance between the motes was allocated as 48 m. Every12th mote of the network was set as a Road Side Unit. The test prolonged for 30 min. Vehicles was driven by different volunteers at different velocities from one end to another end.

The detailed network system specifications are listed in the Table 3.1.1

Table 3.1.1 Network system specifications

	VEHICLE NODE	SENSOR NODE
PROCESSOR	64 bits MIPS,266 MHz	16 bits MCU,8 MHz
MEMORY	512 MB	10 KB RAM
EXTERNAL MEMORY	16 MB Flash	48 KB flash
POWER SUPPLY	5.4-22VDC@400Ma	3VDC@25 Ma
TRANSCEIVER	250 Kbits /s 2.4GHz IEEE 802.15.4 chipcon wireless transceiver	-
NETWORK INTERFACE	IEEE 802.11p	IEEE 802.15.4
CONNECTORS	UART,USB,MOST,VICS	UART,SPI,12 C
ANTENNA	External, omni-directional	Directional or omni-directional
OPERATING SYSTEM	Lunix 2.6	Tiny OS

Whenever and wherever a vehicle spots an obstacle it will immediately pass the information to nearby Road Side Units and the vehicles reaches in its range. For the every roadside sensor, an object that reaches its transmission range will be recorded as an event. This may be includes a vehicle itself. In order to avoid these confusions, the following assumptions were made. Minimum speed of a normal vehicle on the road is about 18 km/h. In this scenario the vehicles to pass the transmission range of the Road Side Units it will take about 7 seconds. So the sensors will be detects an obstacle after 7 seconds. If the obstacle still reaches in the communication range after 7 seconds, an alert message is passed to the neighboring Road side units.

The test was conducted in a large parking area and the maximum speed of the test vehicles node was set as 30 km/hr for safety considerations. First a set of 6 volunteers were involved to drive through the parking area. An incident was created at a random time by throwing a dummy doll in the parking area. The time taken for the sensors to indentify, analyze and detect the incident and communicate it with the vehicles in the study area was recorded.

The results obtained shown the message got delivered to all the vehicles within very few seconds, thus encourages the drivers to take decisions accordingly. The times taken in different scenarios for the message to be communicated were noted. The values are tabulated in the Table 3.1.2. The average message delivery time increased with the number of volunteers (or vehicles). This may be leads to increase the higher number of message delivery destinations. More number of retransmissions and higher interference makes the more packet loss.

Table 3.1.2. Times taken in different scenarios

NUMBEROF VEHICLES	VELOCITY {KM/H}	AVERAGE MESSAGE DELIVERY TIME{ms}
5	18 30	660 720
10	18 30	850 910
15	18 30	960 1030
20	18 30	1120 1250

3.2. SIMULATION RESULTS

The GrooveNet simulator was used to simulate the proposed VANET system. In the simulation model, the vehicles were planned to moving in a three lane highway. The average flows of vehicles were 450 v/h/l under low density traffic conditions and 1250 v/h/l under heavy density traffic conditions. In this simulation the 3200 vehicles per hour incoming in a traffic flow. The transmission communication range of the road side nodes were usually between 30-110 m. For experimental purpose, it was allocate as 85 m. The other simulation parameters that are shown in Table 3.2.1.

Table 3.2.1. Simulation parameters

HIGHWAY LENGTH	18900 X 20M
Number of sensor nodes	200
Distance between two sensors	110 m
Transmission range of sensor node	85 m
Transmission range of vehicle node	250 m
Average packet loss ratio	15%
Average vehicle speed	95 km/hr
Synchronization interval	600 ms
Time between two events	5-7 min
Stimulation time	60 min

The message transmission between the vehicular nodes and the sensor nodes is the most important things have to be analyzed. It is very crucial in all the applications related to Hybrid VANET. Suppose the average running vehicle speed as 95 km/h. In this situation, the vehicles will be in the communication range of the Road Side Units for less than a second. A simulation environment was generated in which one car transmits a packet. Compared with the number of packets transmitted successfully with the theoretical upper bound of the number of packets that can be received and analyzed when the nodes were in the communication range. The results are shown in Figure 3.2.1. The more number of cars are present on the road affect the transmission was ignored for the experiments.

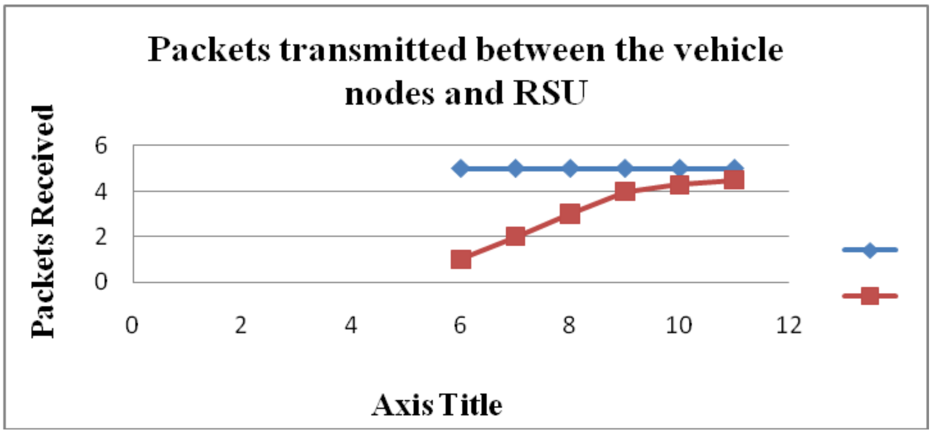

Figure 3.2.1 Packets transmitted between the vehicle nodes and RSU

The normal VANET was compared with a H-VANET. The network systems were compared and considering some random low traffic scenarios. Because in VANETs, low traffic scenarios cause some frequent network disconnections. Some of the typical and abnormal situations when few vehicles on the road include hilly roads, tunnels, remote highways and night time. The message transferred between the vehicles will be meaningful and meaningful only if the message is reached as early as possible enough for the driver to take a correct and necessary decision. The “Acceptable time window” referred as the time interval between the earliest and the last time that a message could be delivered such that the driver is able to receive and react to the message. The acceptable time window for conventional VANET and H-VANET was analyzed under different traffic conditions with the number of messages delivered. It can be note that the conventional VANET with Road Based Station struggles to transfer the message when the minimum number of vehicles on the road. The H-VANET is more reliable and consistent as seen in Figure 3.2.2.

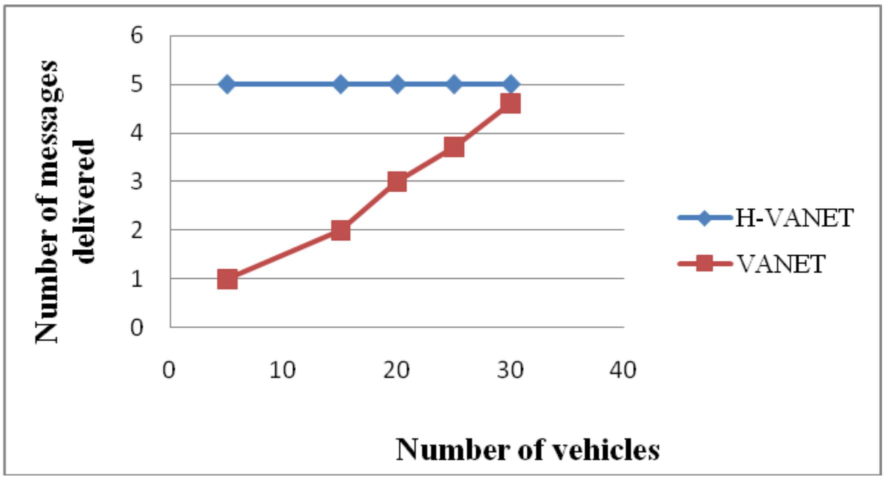

Figure 3.2.2. Number of messages delivered

CONCLUSION

In this work, a prime idea to form the proposed concept of VANETs more reliable and consistent was discussed. Due to the fast changing topology and unpredictable number of nodes of VANETs, impossible to detect and communicate the information on time. The new H-VANET architecture was developed and proposed and that integrates vehicular nodes and sensor nodes with the form a hybrid network. The sensor networking technology is well developed and efficient in detecting and analysing real time incidents in the roads and also very cost effective. Integration of WSN with the VANET will leverage the overall system. The H-VANET's static sensors that are installed in the roadside, will assure that none of the incidents and events on the roads never goes undetected. It also assures that constant connectivity of the network irrespective of the number of vehicles running on the road.

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