Grenze International Journal of Engineering and Technology, Special Issue

Real Time Video Streaming in Vehicular Ad hoc Networks

Abhijit H Kulkarni[1], Dhiraj Satish Shet[2], Kirankumar M[3] and Nandhini Vineeth[4]
[1-4]BMS College of Engineering, Bangalore, India
Email: ak7795331121@gmail.com, dhirajshetmanchikeri@gmail.com, itskirankumar98@gmail.com, nandhiniv.cse@bmsce.ac.in

***Abstract*—A Vehicular Ad-Hoc Network (VANET) is a class of a Mobile Ad-Hoc Network (MANET). VANETs help in the implementation of various driving safety applications. Vehicle to Vehicle Communication is wireless transmission of data that provides services for important safety improvements. The adoption of video transmission in VANETs communication has become essential due to the comprehensiveness and applicability of video data for on-road advertisement and infotainment. Video communication in VANETs helps in capturing and monitoring the environment, surveillance, traffic accidents and disaster based smart city applications. In this paper, we propose a real-time system where two vehicles communicate via video streaming. It can be used in an isolated place without the internet. We further propose a system where the first vehicle which detects an accident sends a video stream of the accident scene to the second vehicle so that the second vehicle can take an alternate path to reduce the traffic at the place of accident.**

***Index Terms*— Intelligent Transport Systems (ITS), Vehicular Ad hoc Network (VANET), Video Streaming, Internet of Vehicles (IoV).**

I. INTRODUCTION

The applications of safe driving is one of the most prominent categories in vehicular ad hoc networks (VANETs) because of a very large number of traffic accident incidents. These applications in vehicular ad hoc networks (VANETs) are facilitated to evade traffic accidents by broadcasting emergency messages and information among the vehicles.
Current existing methods of communication using radio such as 2G/3G have various problems such as narrow bandwidth, low quality and high cost, which are the major parameters considered in communication. VANET can be used to transmit live video streams from one vehicle to another. We can use LT-code which shows great performance when compared with the traditional communication protocol to solve the inevitable packet loss encoding of all data.
A traffic control scheme can be applied video communication between two vehicles. From this traffic control application, we want to build a real-time system having two vehicles, in which the first vehicle detects the accident and sends the video stream of the accident scene so that the second vehicle can take an alternate path.

Grenze ID: 01.GIJET.6.2.7

II. LITERATURE SURVEY

As this work includes intelligent transport systems, VANETs, video streaming, real-time systems, an extensive survey has been done on these topics.

A. ITS and VANETs

The vehicle has become an extension of human and its progress is clearly visible over time. Modern technological advancements branched into various fields and its impact leads to the creation of intelligent systems by automation, data analysis, etc. The results of these advancements lead to safer navigation, assistance in navigation, and safety in the transport system, pollution monitoring, analysis and risk assessment and traffic management. The majority of these advancements in recent times is because of IoT. The greatest achievement of this has been the Google Autonomous Car in [1].

Advancements in IoT branched into vehicles and created a subdomain within itself called the IoV aka internet of vehicles with a proper architecture stack, network model, challenges and its own aspects. This led to the evolution of VANETS. There are 5 primary layers in this architecture vehicle to the RoadSideUnit (V2R), vehicle to vehicle (V2V), vehicle to devices, vehicle to infrastructure and vehicle to sensors [2].

Vehicular communication is limited by various factors since the broadcast message range is limited and unidirectional transfer isn't always possible hence the data is relayed across nodes by hopping in various directions in [3]. As with any smart network system, this is also prone to various attacks such as the worm attack along with the electromagnetic attack that can be intentional and mitigations of the said process are described in.

VANET usage might be questionable since techs like ABS (Attribute Based Signature), ESC (Electronic Stability Control) and other innovations take place in the automotive industry, various studies show that 60% of the accidents that arise on roadways could be avoided if the drivers were provided with warning messages just a few seconds earlier to the moment of the accident. The car manufacturing industries and governments have implemented the technology of exchanging active data between vehicles over vehicular ad hoc networks as a base concept of Intelligent Transport System and hence can achieve efficiency and safety in an overcrowded VANET, which is a subclass of MANET wherein the vehicles are the mobile nodes.

The main advantages of Inter Vehicular Communication (IVC) are relatively low latency due to direct wireless communication, broad coverage area, no service fees and little or no power issues [4]. The problem with VANETs is continuous mobile nodes, changing topology, unstable networks and sometimes coverage issues. A better implementation is the combination of LTE and cloud integration for better bandwidth, less interference and noise in [5]. VANET applications include road accident prevention, traffic management, infotainment.

As with any model, there is a Software Defined Network (SDN) for a framework for VANET with network virtualization and a presence of VPV aka virtual private vehicles that enables multi-tenant support in [6]. VANETs work by using an OBU (Onboard Unit) that has GPS, storage capabilities and an electronic map inbuilt. There can be an 802.11 p enabled device mapped to this OBU which enables the connection of a phone to the car in [7]. There are RSU i.e. Roadside Units and infrastructures to handle the entire system's communications. The entire system as a whole is distributed but at the same time collaborative. The idea being the RSU and the centralized servers get all the relevant data off the vehicles GPS off the OBU which helps in early congestion detection and prediction and this data helps in managing congestion much more efficiently in [8].

B. Video Streaming

There are different types of messages sent for different application purposes such as Information Message (IM), Assistance Message (AM) and Warning Messages (WM) [9].

This paper mainly talks about assisting the driver during their journey. Hence video streaming falls under all kinds of message categories. Most of the present research is enthusiastic about the delivery of video streams, from the base network such as TV programs to vehicles. The main feature of these applications is that many vehicles receive video streams from one roadside station. In such a case, radio propagation-induced fading and external noise in the communication channel cause video packets to be lost. Combined techniques of Forwarding Error Correction (FEC) with the Automatic repeat request (ARQ) are used for reducing the prospect of packet losses caused by such components. Additionally, in order to assist the delivery of the data packets to the destination vehicle, the vehicles in between with better link quality are used [10].

The vehicular system based on video includes the following components: video compressing device, IEEE 802.11p/WAVE transceiver and cameras. Using the above-mentioned devices, the following applications can be implemented in order to improve road safety, public security and tra□c control [11]. Multi-view video is growing tremendously and is considered as the next generation of visual communication. Research related to it is based on joint source/channel coding, multi-view representation or encoding, error propagation and frame recovery.

A real time V2V transmission of a video stream is also an issue to be considered for research. Some research has been done for efficient video-streaming in VANETs [12], and model simulations are mainly used to assess the quality of video covering several general features of the IEEE 802.11p communication networks [13-14]. However, it is challenging to obtain bandwidth with less delay present in higher cellular network traffic load. All these say that IEEE 802.11p suits best for video communication in VANETS [15].

C. Real Time Systems

The real time implementation of VANETs is a difficult task as there are rapid changes in topologies, network structure, bandwidth change, high mobility of nodes, etc.

Due to increase in traffic it has led to more pollution and traffic congestion, thus studying traffic management schemes is necessary, in order to achieve green transportation and alleviating kinds of traffic problems [16]. FORT which is an offloading algorithm is developed to minimize the average response time of the traffic management server for messages. Here fog computing is integrated with the decentralized traffic management system [17].

Different unicast routing protocols have been developed such as Software Defined Network Based Vehicular Network Algorithm (CR-SDVN), Adaptive Quality-of-Service based routing for VANET (AQRV), A Hybrid Improved 3-D Scenario Oriented Routing (ITSR), Traffic Light Aware Protocol (TCAR) and A Traffic Light Aware Routing Protocol (TLRC) for multi-hop reliable message communication among VANETs [18].

When designing a protocol several aspects are considered which solve the need for a high-speed wireless protocol by providing predictable behavior for cyber-physical control systems. Geographical forwarding of the packets is used to transfer packets between two consecutive intersections on the path, thereby reducing the sensitivity of the path to individual node movements [19]. As per any of the real-time projects developed, they suffer from the problems of packets losses, bandwidth loss, etc. because of high mobility in vehicles in VANET.

D. Accident Detection

In this work, a pre-trained model for accident detection called Mobilenet SSD is used. Mobilenet SSD is a model developed by Google to detect 90 different classes. It is designed for systems with lesser resources and low computing power like the raspberry pi. We use the above model and retrain it to detect accidents by providing the appropriate dataset. MobileNet can be used to improve the performance even in the devices having lesser resources and less computational power.

III. Proposed System Model

The system contains two vehicles, the one which detects the accident(a) and the one which receives the live video stream(b). Both vehicles have a motor drive which drives the movement of the motors on the specified path. The Arduino Uno present in both the vehicles controls the motor drive. The IR sensors detect the black colored path on which the vehicles move.

The first vehicle ‘a’ has a raspberry pi with an attached camera in which the machine learning model will be running continuously. When it detects the accident, it stops the model and starts streaming the live video stream of the accident site for 30 seconds. The video streaming is done using sockets and port addresses. The server is created by Django which continuously stream the video without saving it. The second vehicle say ‘b’ also has a raspberry pi with an attached display on it. The live video stream will be displayed on this screen using browser which is opened using a python built-in model called selenium and based on whether an accident has been detected, this vehicle makes a decision whether to take an alternate path or continue on the same path.

All the computations such as accident detection, streaming, displaying happens in the raspberry pi. The pi camera captures the video stream and sends it to the raspberry pi. The display on the raspberry pi is used to see the live video stream of the accident site. The Arduino Uno is used to control the dc motors through motor drive. The IR sensors are used for path following. Batteries are used to power the raspberry pi and the motor drives.

IV. SYSTEM ARCHITECTURE

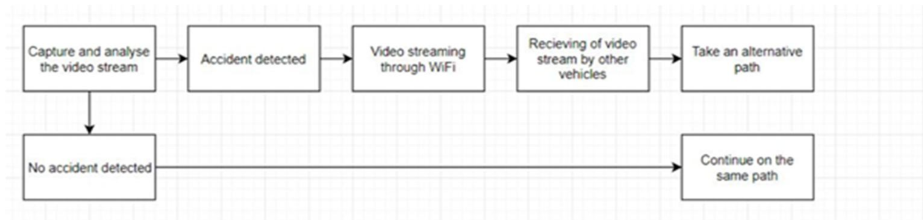

Fig. 1. High level design of the system

Fig. 1. depicts the high-level design of Video Streaming in Vehicular Ad hoc Networks. A machine learning model will be running continuously in the raspberry pi of the first vehicle. When it detects the accident, it starts streaming the live video stream of the accident site to the second vehicle which is following the first vehicle. If there is accident detected by the first vehicle then only the second vehicle takes alternate path if exists. Otherwise, it continues in the same without any change in the path.

V. ACCIDENT DETECTION

We want to develop a system in which one vehicle informs the other vehicles about accidents that happened prior to they reach the place of an accident causing more traffic congestion. The vehicle in the front having a camera captures the scene of an accident, and confirms if an accident has occurred using a machine learning model. Once it detects an accident a live video stream will be sent to the vehicle preceding it which actually cannot see the accident scene. Once the vehicle gets the live video it can take an alternate path if one exists before it reaches the place of accident and hence can avoid the traffic congestion.

VI. CONCLUSION

In this paper, we have proposed a real time video communication system between the two vehicles. Our idea is to use Wi-Fi as a communication medium between vehicles. The vehicle capturing the accident sends live video streams to the following vehicles and hence the following vehicle can take an alternate path to reduce the congestion.

REFERENCES

[1] U. Gerla, M.; Lee, E.K.; Pau, G.; Lee, "*Internet of Vehicles: From Intelligent Grid to Autonomous Cars and Vehicular Clouds*," IEEE Comput. Soc. Washington, DC, USA, pp. 241–246, 2014.

[2] O. Kaiwartya et al., "Internet of Vehicles: Motivation, Layered Architecture, Network Model, Challenges, and Future Aspects," IEEE Access, vol. 4, no. c, pp. 5356– 5373, 2016.

[3] A. Kesting, M. Treiber, and D. Helbing, "Connectivity statistics of store-and-forward inter vehicle communication," IEEE Trans. Intell. Transp. Syst., vol. 11, no. 1, pp. 172–181, 2010.

[4] Q. Zhang and A. Boukerche, "A Novel Infrastructure- Based Worm Spreading Countermeasure for Vehicular Networks," IEEE Trans. Intell. Transp. Syst., vol. 19, no. 7, pp. 2188–2203, 2018.

[5] P. Angskog, P. Nasman, and L.-G. Mattsson, "Resilience to Intentional Electromagnetic Interference Is Required for Connected Autonomous Vehicles," IEEE Trans. Electromagn. Compat., pp. 1–8, 2018.

[6] E. C. Eze, S. Zhang, and E. Liu, "Vehicular ad hoc networks (VANETs): Current state, challenges, potentials and way forward," ICAC 2014 - Proc. 20th Int. Conf. Autom. Comput. Futur. Autom. Comput. Manuf., no. September, pp. 176–181, 2014.

[7] M. Syfullah and J. M. Y. Lim, "Data broadcasting on Cloud-VANET for IEEE 802.11p and LTE hybrid VANET architectures," 3rd IEEE Int. Conf., pp. 1–6, 2017.

[8] A. Bhatia, K. Haribabu, K. Gupta, and A. Sahu, "Realization of flexible and scalable VANETs through SDN and virtualization," Int. Conf. Inf. Netw., vol. 2018– January, pp. 280–282, 2018.

[9] Muhammad Rizwan Ghori ; Kamal Z. Zamli ; Nik Quosthoni ; Muhammad Hisyam ; Mohamed Montaser, "Vehicular ad-hoc network (VANET): Review", 2018 EEE International Conference on Innovative Research and Development (ICIRD) 1-2 May 2018,BangkokThailand.

[10] Zhi Liu ; Mianxiong Dong ; Bo Zhang ; Yusheng Ji ; Yoshiaki Tanaka, "RMV: Real-Time Multi-View Video

Streaming in Highway Vehicle Ad-Hoc Networks (VANETs)", 2016 IEEE Global Communications Conference (GLOBECOM).
[11] Alexey Vinel, Evgeny Belyaev, Boris Bellalta, Honglin Hu, "Live Video Streaming in Vehicular Networks", 156–162, 2014. Springer International Publishing Switzerland 2014.
[12] Fabio Soldo ; Claudio Casetti ; Carla-Fabiana Chiasserini ; Pedro Alonso Chaparro, "Video Streaming Distribution in VANETs", IEEE Transactions on Parallel and Distributed Systems, 14 October 2010.
[13] Alexey Vinel ; Evgeny Belyaev ; Karen Egiazarian ; Yevgeni Koucheryavy, "An Overtaking Assistance System Based on Joint Beaconing and Real-Time Video Transmission," IEEE Transactions on Vehicular Technology.
[14] H. Venkataraman, A. d'Ussel, T. Corre,C.H. Muntean, G. M. Muntean, "Performance Analysis of Real-Time Multimedia Transmission in 802.11p based Multihop Hybrid Vehicular Networks", IWCMC 10, June 28– July 2, 2010, Caen, Franc.
[15] Evgeny Belyaev Tampere; Alexey Vinel ; Magnus Jonsson ; Katrin Sjoberg, "Live video streaming in IEEE 802.11p vehicular networks: demonstration of an automotive surveillance application", 2014 IEEE Conference on Computer Communications Workshops (INFOCOM WORKSHOPS).
[16] Chunsheng Zhu ; Joel J. P. C. Rodrigues ; Victor C. M. Leung ; Lei Shu ; Laurence T. Yang, "Trust-Based Communication for the Industrial Internet of Things", IEEE Communications Magazine.
[17] Xiaojie Wang ; Zhaolong Ning ; Lei Wang , "Offloading in Internet of Vehicles: A Fog-Enabled Real-Time Traffic Management System", IEEE Transactions on Industrial Informatics.
[18] Abd Ullah Khan, "Real time and Efficient Unicast Routing Protocols for Vehicular Ad Hoc Network: A Survey and Recommendations for efficiency enhancement", 2018 15th International Conference on Smart Cities: Improving Quality of Life Using ICT & IoT (HONET-ICT).
[19] Yi-Hung Wei ; Quan Leng ; Song Han ; Aloysius K. Mok ; Wenlong Zhang ; Masayoshi Tomizuka, "RT-WiFi: Real-Time High-Speed Communication Protocol for Wireless Cyber-Physical Control Application", 2013 IEEE 34th Real-Time Systems Symposium.
[20] https://github.com/tensorflow/models/blob/master/research/object_detection/g3doc/detection_model_zoo.md