Road Traffic and Congestion Management System for Intersections Based on VANET

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***Abstract*—Road safety is regarded as the most severe problem in the world right now. With the increase of road accidents considerable research has been done in recent years regarding road safety. Vehicular Ad Hoc Networks (VANET) is used as the platform with infrastructure for the development of new systems to enhance the safety and comfort. With the new trends like self-driving cars, colour light systems are not effective. Therefore junction traffic control is of paramount importance. In this study, the traditional colour light system is replaced using VANET. VEINS framework has been used to simulate the traffic environment in a 4-way junction. OMNET++ is used to control the traffic in the simulated junction. Simulation results show that Vehicle to Vehicle communication (V2V) reduces road traffics and accidents. Also for a low congested junction, a prioritization algorithm using speed is implemented. This is much better than the previous approach for a low congested junction. Lane detection is also implemented using Machine Learning, to avoid the misbehavior of drivers and the violation of rules. This method results in ensuring safety of the drivers and passengers.**

Keywords— VANET, colour light, Lane detection

I. INTRODUCTION

According to WHO report (2018) Sri Lanka is ranked 96 in the world in road traffic accidents related deaths with 16.37 deaths per 100,000 of population. Also in Sri Lanka most of the accidents occur around intersections. The potential of an intersection assistant which supports the driver in such conditions, would be enormous. The concept of Vehicular Ad-hoc Networks (VANET) which has opened new possibilities to avail the use of road safety applications, recently came into limelight [1].

Vehicular ad-hoc networks are responsible for the communication between moving vehicles and its surrounding. It enables communication among vehicles and roadside infrastructures. It makes transportation systems more intelligent. Since the movement of vehicles is restricted by roads, traffic regulations, we can deploy fixed infrastructure at critical locations to make intelligent decisions based on the vehicle movements.

II. OBJECTIVES

The main objective of this project is to automate the road traffic handling mainly near a junction. This will result in reducing the road accidents and in turn will ensure the safety of the civilians.

III. METHODOLOGY

The software employed in this research are SUMO and OMNET++. Also Veins; a vehicular network simulation framework is used on top of OMNET++ to visualize the simulations. SUMO is used to simulate the junction while Veins is used to simulate the traffic while OMNET++ is used to code using C++

In the proposed system each vehicle is recognized using a unique identification number (ID), which can be the license plate number or a custom made ID. Wireless communication devices onboard enable vehicles to communicate with each other, vehicle to vehicle (V2V), or roadside infrastructures (RSU), vehicle to infrastructure (V2I) by sending and receiving messages, using their unique ID. The system proposed utilizes a predefined queuing area where the vehicle waits for the reply from the RSU which is the centralized controller [2]. All Vehicles are programmed to stop or slow down when they enter the queuing area.

In the proposed system a packet is transmitted by the RSU to the nearby vehicles and a reply packet is transmitted by the vehicle requesting to leave the intersection after entering the queuing area. The RSU design will consist of processing power as well as intelligence to make decisions. Hence, once the reply packet is received at the RSU, it analyzes and compares all the received data from all vehicles near the junction. Next, the vehicles are prioritized using a predefined priority mechanism. The response packets are transmitted to the prioritized vehicle allowing to leave the junction. Once left the junction the vehicle should retransmit an acknowledgement message back to RSU and in response RSU clear all the data related to the vehicle ID which left the junction. [4]

In the proposed system the vehicle prioritization is handled two ways; First In, First Out (FIFO) or category of the vehicle type. In FIFO, the speed based protestation algorithm is adopted. In the Speed Prioritization the estimated time to reach the junction is calculated, using the information received from the vehicle. Then vehicles are ordered according to the expected time to reach the intersection. A permission to pass notification is sent to the vehicle with the fastest arrival, while the others are informed to slow down, with a pre-calculated speed-rate, in such a way that they too

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can leave the junction in an ordered manner without completely stopping the vehicle

$$\text{Expected Time} = \text{mean velocity/distance} \quad (1)$$

In the vehicle priority based method, emergency vehicles such as ambulances, police cars, are given the priority to pass the junctions without slowing down, while informing the other vehicles to slow down with appropriate speed-rates. These speed-rates are calculated at the RSU with the help of the information packets received from the vehicle itself at regular intervals.

Further a lane detection is simulated using python to detect the lane [3] for each vehicle to pass through. The vehicle will use the lane information as well, when applying brakes to slow down or accelerating to speed up near a junction.

IV. RESULTS AND DISCUSSION

Fig.1, shows a simulation instance at SUMO, for the proposed system. In the designed environment a beacon message is generated from the RSU and transmitted to all vehicles at every 2s intervals. In Fig.1. The beacon is shown in white dot and the vehicle is shown in blue dot. Beacon is sent when a vehicle enters the core area or the range of the RSU. After receiving the beacon, the vehicle transmits the REQUEST message to the RSU. The command prompt in Fig1 shows that the RSU received REQUESTs as data. After sending the REQUEST, the vehicle receives a command to go as PERMIT or one of the other commands to wait. Next, the vehicles start to leave the intersection using the lanes they are currently in.If a lane change is necessary the RSU sent a RESPONSE, asking the vehicle to move to another lane. Fig.2 shows the output of the lane detection algorithm.

Fig. 2. Output of Lane Detection

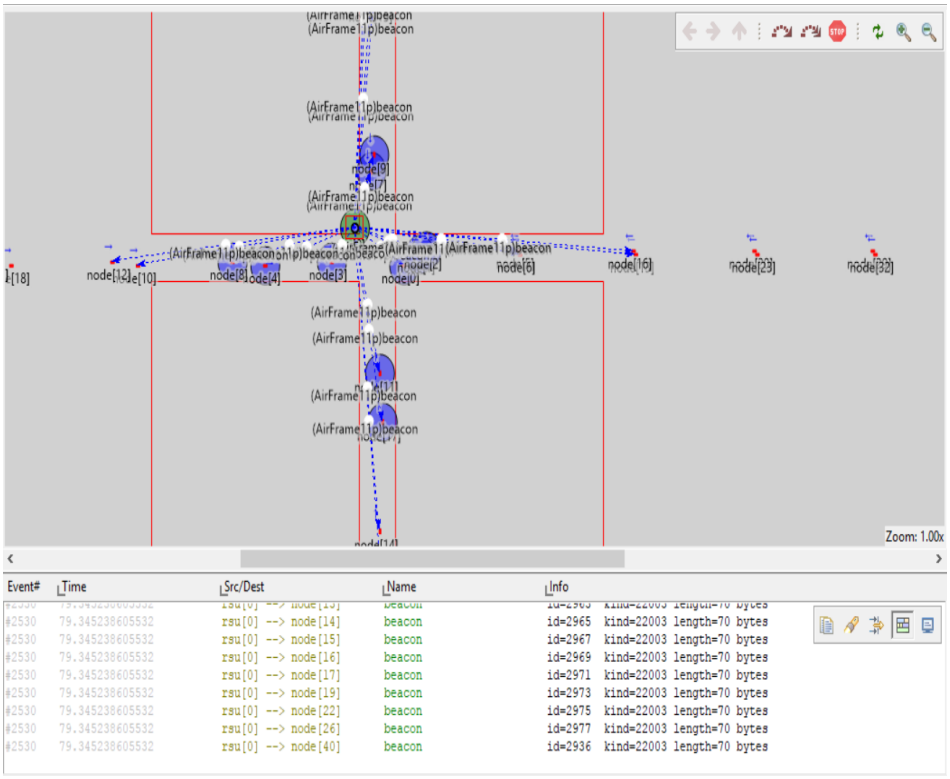

Fig. 1. Simulation of the Process

V. DISCUSSION

The VANET architecture defines the communication mechanism between vehicles and roadside units. It does not specifically present any vehicle traffic handling or decision taking system [6]. Current VANET based transportation systems include automated driving with safety protocols such as breaking, lane changes, speed regulations etc. [6]. Although there exists few complex intersection management architectures [7], the proposed is a simple, low powered traffic control system based on vehicle speed analysis, facilitated through roadside infrastructures.

For a highly congested junction, color light can be simply replaced by a VANET based control system to achieve better performance. Using the proposed system, it is possible to implement a traffic handling mechanism, where a lane with higher congestion is cleared first by the RSU. This can be achieved by creating different lists at RSU called permitted list, pending list, and priority list, and assigning incoming

vehicles into the most suitable list after analyzing the messages received from the vehicles. Also in an ordinary congested junction using the comparison algorithm that we have developed, significant traffic control can be achieved. We are able to achieve this improvement by estimating their distance to travel, and prioritizing the vehicles with lesser estimated time to arrive at the junction. With the introduction of lane detection the vehicle can estimate the traffic ahead in the lane it travels. Also, it can be further used by the vehicle navigation system to detect bad driving such as sudden lane changes or drink driving. The inbuilt communication units can share this information with neighboring vehicles using VANET architecture.

VI. CONCLUSION

VANET is a very useful networking architecture in Road Safety and Traffic Management. It is used in the presented application to communicate between V2V and V2I transmission. Our aim was to manage the traffic within an intersection to reduce the traffic congestion and to reduce the road accidents near an intersection. According to simulations, the proposed algorithm successfully manages the communication between vehicles and RSU to achieve a good traffic management. Using this technology we could make roads safer and faster to travel.

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