LCDs:Lane Changing Aid System Based on speed of Vehicles

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***Abstract--* Lane change model is a important issue of microscopic traffic simulation and active safety. Overtaking and lane changing are very dangerous driving maneuvers . In our approach we present the lane changing based system on speed and minimum gap between the vehicles in VANET. This paper aims to propose a solution to ensure the safety of drivers while changing lanes on the highways. Efficient and faster routing protocols could play a crucial role in the applications of VANET, safeguarding both the drivers and the passengers and thus maintaining a safe on-road environment. The paper focuses towards the development of an intelligent transportation system that provides timely, reliable information to the drivers and the concerned authorities. The test bed is created on the techniques used in the proposed system where the analysis takes place in the On Board Embedded System designed for Vehicle Navigation. The designed system was tested on a 4-lane road at Neemrana in India. Successful simulations have been conducted along with real time network parameters to maximize the QoS (quality of service) and performance using SUMO and NS-2 .The system implementation together with our findings is presented in this paper. To illustrate our approach we present some results of the simulation using NS-2.**

Keywords-- GPS, RSU, smart cities, V2V, V2I, VANET,ITS

I. INTRODUCTION

Taking the upcoming model of driverless cars and smart cities into consideration, it is very important to build up mobility models and algorithms for safe and efficient environment. With the introduction of vehicular ad hoc network (VANET) in the field of Intelligent transportation system , a new area for research has evolved out of it. VANET is basically a subset of mobile ad hoc network (MANET) where all the moving nodes behave as vehicles. The Vehicle-to-Infrastructure (V2I) and Vehicle-to-Vehicle communications (V2V) [1] play a very important role in this aspect. In the Vehicle-to-Infrastructure model, the information of the traffic is collected at the Road Side Unit (RSU) and is broadcast to the receiver vehicles and then sent to the central server for monitoring the vehicles. Figure 1 shows the communication model for central monitoring of vehicles.The vehicles on the road communicate with each other and then the information is sent to the RSU. The RSU further exchanges information with the central traffic-monitoring server with the help of the Internet. The communication here is bidirectional.

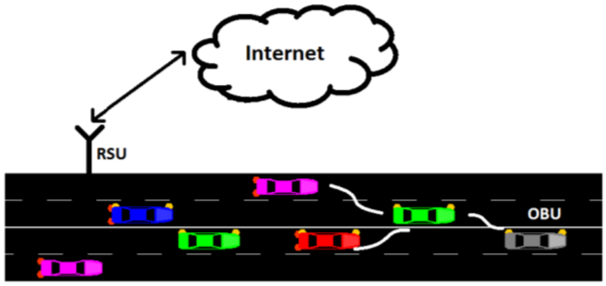

Fig. 1 Communication model (Vehicle-RSU-Central server)

We have assigned the road tracks with particular speed limits for different lanes and the vehicles moving on them will have to follow those particular speed limits. While moving on these lanes, the vehicles can increase or decrease their speed and change the lane accordingly. Changing the lane will be possible only when the minimum gap between the vehicles is as set in the algorithm . But if any particular vehicle is not doing so, the hardware implemented OBU (On Board Unit) in the vehicle will display a warning message to the driver to either change the speed or change the lane. If the defaulter vehicle does not follow the speed rules then the emergency warning message will be broadcast to the vehicles and the RSU's in the communication range of this vehicle so as to maintain a safe environment. The other vehicles will also receive this information that will influence their movement in a particular fashion. As soon as the number of defaulter's messages increase, the RSUs transmit the information to the nearest traffic monitoring system.In this algorithm based model we are using the concept of lane changing with respect to speed, with the help of the information received from the GPS receiver. The latitude and longitude data will be parsed and then we will check the current position of the vehicle with respect to the lane and then check the correct speed of the vehicle with the lane speed limit. If the driver does not drive at the correct speed then the driver will be warned first in terms of alarm and displaying message on the LCD, this process will repeat for some duration. The rest of this paper is organized as follows: In section II we have taken a brief description on the concept of VANETS and the related work done in this field. In section III, the system design and problem formulation has been discussed. In section IV, we have defined our protocol.

In section V we have shown the performance evaluation, taken a look at the applications of GPS and the hardware implementation of the protocol, traffic model generated with the help of SUMO-MOVE followed by the simulation of the VANET network in NS-2. Section VI, concludes this paper and gives a glance of future work to be done in this model. Lastly, we have ended up giving the references .

II. Related Work

VANET (Vehicular ad hoc networks) is a very vast area for research and has opened gates for new possibilities and better technology in the field of transportation both in terms of safety and efficiency. In VANET, cars are defined as mobile nodes in a mobile ad hoc network to create a mobile network [3]. C. -F. Chiasserini, E. Fasolo, [2] the paper discusses about the smart broadcasting of the messages in VANET. This will help in improving the efficiency and also security up to some extent.

In [4] Rajendra Prasad Nayak the thesis proposes a method to calculate the speed of the vehicle based on the position of the vehicle. The vehicles exchange information with RSU and then the RSU sends it to the central monitoring server.

Nehal Kassem, Ahmed E Kosba [5] presented the paper proposes a method of vehicle detection and speed estimation based on RF. The main drawback is that a vehicle can proceed to any speed in case of a miss, which can cause an error in the accurate estimation of speed.

In [6] Ram Shringar Raw, Manish Kumar presented the paper throws light on various technical applications, advantages, challenges and issues in VANET and methods to improve the network system. The paper also discusses about the techniques involved in secure message transmission, which will help us in our future work foe data authentication.

Tanvee Kausar, Priyanka Gupta [7], the authors have proposed an approach for the collision avoidance system in VANETS based on the lane changing using GPS based hardware with trans receivers for data exchange.

Yong Zhou, Rong Xu [8], the paper discusses about the lane changing and safety warning system based on virtual lane boundary. The safety system alerts the driver based on the width of the lane and the time required to cross that point.

In [9, 10], the authors have discussed about the safe lane change assistance system to drivers with the help of cameras and proximity sensors. The basic terminology is to detect the presence of any vehicle in the blind spot region and change the lane based on the speed and the driving style of the driver.

In [11,12], the authors have proposed an approach for lane change tracking and vehicle detection in VANET with the help of cameras mounted on the vehicles. The basic process involved is, the camera takes a recording of the surrounding of the vehicle and then image processing is done. The lane changing and vehicle tracking is done by using Hough transform on the results of the image processing data.

Jamal Saboune, Mehdi Arezoomand [18] presented, the paper discusses about the vehicle detection for safe lane changing. The authors have proposed to use cameras mounted on the vehicles for detecting the vehicles in the blind spot region of the vehicle.

III. System Design And Problem Formulation

Vehicle driving behavior will depend on many factors like situation, speeding, fast lane changing, density of traffic etc.

Therefore, driving recklessly will cause accident and also effect the traffic movement. Now if a driver of a vehicle is at fault and does not follow the proper lane changing protocol and does over speeding then quick actions are required to be taken for stopping that vehicle .

So what can be the solution to check the abrupt over speeding and lane changing mechanism of vehicle and how to minimize it.Also how to send faster warning message to the neighbor vehicle about the situation. Can we minimize the latency and increase the quality of service by using appropriate routing algorithm.

IV. Proposed System (Speed based algorithm)

The protocol was developed to implement the efficient lane changing based on the speed of the vehicle for the sake of safety and an efficient environment in VANET. In this section we have discussed about the SBLS algorithm to study the behavior of the vehicles with its implementation and later on in section VI we have implemented the algorithm in the hardware module and the appropriate routing protocol with the mobility model generation is checked with the help of SUMO-MOVE and the simulation of the algorithm in NS2.

Definition 1 (Road Segment): A road segment is defined by R where $R=\{s(x,y), e(x,y),l,v_l\}$. Here *s* and *e* are the starting and end points of the lane respectively with (x,y) as the location (x=latitude, y=longitude). l is the number of lanes (5 according to our scenario). v_l is the speed of the lane. The length of the road segment and the width of the lanes can be estimated with the help of the location of *s* and *e.*

Definition 2 (Road Network): Road network is a graph $Rn=(j,s)$. Here j is the set of all road segment junctions and s is the set of all road segments.

Parameters:

Assume that there are 3 lanes $L_i=\{L_1, L_2, L_3\}$ with speed limits $(V_i)=\{V_1, V_2, V_3\}$ respectively with a tolerance of 10%.

L_{Bi} is the lane buffer ID which will help us in storing the previous lane ID in which the vehicle was moving.

V_{li} and V_{ui} are the considered as the lower and upper limits of the lane L_i. (Each lane has its own upper and lower limit.)The vehicles at the start point initiate the entire path planning process travelling in various lanes L_1, L_2 and L_3 at different speeds $S_i=\{S_1, S_2, S_3\}$ (speed of the vehicles).

GPS will monitor $\boldsymbol{L_{Bi}}$ and helps to locate the ID of the last lane, the current position and speed to store in a Buffer of the monitor system.

Now suppose that a vehicle is travelling with speed S_{est} in lane L_3 having a upper and lower speed limit lane at a particular point, the GPS based monitor system will check the speed of this vehicle with lane speed limits and give an alert message to the driver to either reduce/ increase the speed or to change the lane, if driving at wrong speed. The system continuously monitors the driving style of the vehicle for a particular time *t*. If the vehicle changes the lane or reduces the speed in the time *t* the monitor system gives an OK status to the driver and to the RSU.

B. Speed based Algorithm

Taking the above assumptions and definitions into consideration, we have the algorithm as follows:

Position Verification:

Obtain the values of *Sest*, V_{li}, V_{ui}, w.r.t L_i

Pos-label

if (*Sest*<V_{ui}) **AND** (*Sest*>V_{li})

then

Alarm OFF;

Display **"ok speed message to driver";**

Display **"*Sest* to driver";**

elsif (S_{est}>V_{ui})

Display **"decelerate or lane change";**

Alarm on;

Timer on ;

Check for **deceleration, lane change subroutines**;

Timer ends ;

Greedy forward of the warning message to **RSU**, neighboring **vehicles;**

goto **P*os-label***

else(*Sest*<V_{li})

Check for engine state

if engine off

then

Display "Vehicle stopped";

else

Display "Vehicle moving **";**

Alarm on ;

Timer on ;

Check for **acceleration, lane change subroutines;**

Timer ends ;

Greedy forward the warning message to **RSU**, neighboring **vehicles;**

goto *pos-label*

Deceleration/Acceleration:

1. **if** (*Sest*<V_{li})

Accelerate

Check for ***Sest***

Check $\boldsymbol{min_{gap}}$

goto *Position Verification*

2. **if** (*Sest*>V_{ui})

Decelerate

Check for ***Sest***

Check $\boldsymbol{min_{gap}}$

goto *Position Verification*

Lane Change:

1. **if** (*Sest*<V_{li}) **OR** (*Sest*>V_{ui})

Check $\boldsymbol{min_{gap}}$

if (min_{gap}) not appropriate

Display **"Lane changing not allowed"**

Else

Display **"Lane changing allowed"**

Update $\boldsymbol{LB_i}$

goto *Position Verification*

V. PERFORMANCE EVALUATION

In this section we have discussed about the working of the on board navigation unit (OBU), the simulation of the algorithm using NS2

A. OBU- GPS enabled monitoring system

It is the hardware that processes the data received by GPS with respect to the moving vehicle. The GPS receiver receives the data packets from the satellites and feeds it to the microcontroller. The microcontroller further parses the required data stores the lane information in Lane ID buffer and checks it with the thresholds set in it. In case of any mismatch, the microcontroller alerts the driver three times. The block diagram and implementation of the OBU described above is as shown in the Fig. 2.

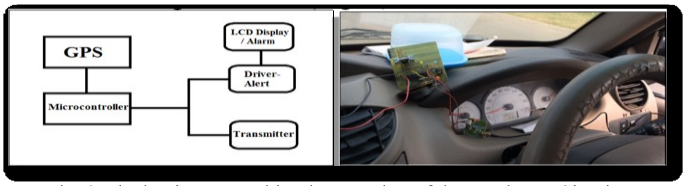

Fig. 2 Block Diagram and implementation of the Hardware Circuit

In hardware of this model comprises of an embedded system comprising a PIC microcontroller interfaced with a GPS receiver with baud rate of 9600 bps, an LCD display, alarm and a radio module for displaying the warning message, alerting the driver and broadcasting the warning messages respectively.

B. SUMO with MOVE and NS2

The mobility model describing our scenario is as shown in the figure below. We have chosen a specific segment of Neemrana, India where we have a 4-lane road and we have implemented the model over there and the simulation results have been recorded. The figure (Fig.3) below shows the roadmap of a segment at Neemrana. The 4-lane road as shown in the picture has different speed limits assigned to each track.

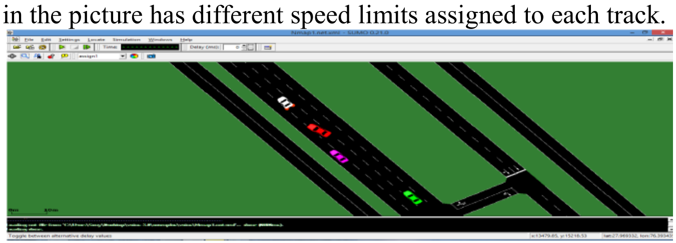

Fig. 3 Scenario

The entire scenario is simulated in NS2 and the algorithm was implemented. The results are described and explained in the next section.

SUMO-MOVE gives us the .tcl and sumo.tr file that are the requirements for simulation to be done in NS-2 . The above scenario was then imported in NS2 and then we have implemented our algorithm in it.

The mobility model which we have generated using SUMO-MOVE will be simulated in NS-2 with the help of the .sumo.tr and .tcl files as mentioned in sub section B. The simulation results of the implemented protocol discussed above can be seen in the figure below (Fig. 4). In NS-2 the nodes -> 1,2,3,4 are the 4 vehicles on 4 different tracks that were generated with the help of SUMO.

In Fig. 4 the vehicle no. 2 shifts it lane based on the speed change. Initially it starts from the first lane and then shifts to the third lane based on the protocol. The min_{gap} estimation is also shown in Fig. 4

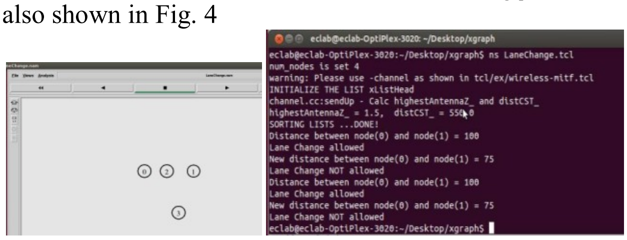

Fig. 4 min_{gap} and speed estimation based lane changing

C. Efficiency Analysis

We have checked our algorithm on the test bed of a flyover in NH-8 Highway of Neemrana, Rajasthan, India and generated the smart flow of vehicles in real time. We have used small range TRX (Transceiver) along with our hardware OBU system in car plying on the four lane highway. Long range TRX has been used as RSU to receive the road segment information and update the congestion status. The lane assistance protocol is checked and sends warning messages about the faulty driving vehicles to other Vehicles using OBU and TRX (short range) and also the effectiveness of the system was verified. The system is also efficient in remote monitoring of traffic. Congestion alert and over speeding can also be checked with given OBU system in the vehicles. We have also checked the scenario on the four-lane flyover and the alert message will be sent by the TRX to the approaching vehicles so that they can avoid congestion and take alternate route. This increases the efficiency and reduces travelling delay. We used the four-lane test bed of a flyover and checked the functionality of OBU implementing speed based algorithm. We have used four cars for driving in different lanes. In the first case we found that all drivers maintained constant lane speed following proper gap among them. The OBU gives the real time speed and Lane OK message to the drivers where there was proper lane-wise driving. We ran this practice three times in a day to test the efficiency of the system. On for the next test without the speed based algorithm we deployed four cars with different drivers. During this test three out of four cars were faulty in terms of maintaining their speed on the basis of their lanes. The third time car number 4 did not follow the lane change rule and broke the speed barrier in various road segments. Hence, previously with the protocol the chances of reckless driving got reduced but the same test without the use of speed based algorithm, reckless driving occurred in almost each case. Given below is the efficiency of the algorithm.

VI. CONCLUSION AND FUTURE WORK

The speed-based lane changing protocol implemented within the On board system will play a very important role in VANET. The use of GPS based system is more reliable as it is more accurate and the data being provided is real time data. Thus this system is more reliable and efficient in terms of safety and accuracy. In this paper, we have explained the protocol and the first level implementation of the algorithm with the help of SUMO-MOVE, NS-2 and some field trials with the hardware prototype. Further, we will use different packet forwarding strategies for different connection states. As we are transmitting information like the location, speed etc. from the hardware, there may be a case where the data can be manipulated. We intend to improve our protocol in such a way that it takes care of these issues.

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