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Intelligent Vehicular Driving Assistance System(IVDAS) Using Wireless Computer Networks

Hetal K Mavani
Dept. of Computer Engineering
BVM Engineering college
VV Nagar , India

Prashant Chauhan
Dept. of Computer Engineering
BVM Engineering college
VV Nagar , India

Sunil A. Bakharu
Dept. of Computer Engineering
BVM Engineering college
VV Nagar , India

Abstract— Driving safety is an important issue. There are several factors like human error, mechanical failure of vehicle, inclement weather conditions and roadway limitations that present a real challenge to the safety of the driver by causing road accidents. Most of the accidents take place due to driving stretch, unknown road conditions and lack of understanding of the surrounding traffic conditions. The driver needs to be always attentive towards the movements of other vehicles around him, but he cannot be continuously focused on the road due to factors like stretch, distraction and fatigue etc. With our proposed system, we try to implemented vehicle-to-vehicle collision avoidance facility, which will generate alert message in the vehicle as soon as any other vehicle is found to be too near to it. Also this will minimize the ratio of vehicles skidding from mountain sides and falling from bridges. The vehicle-to-roadside communication using wireless and wired computer networks will give short term traffic at cross roads which will help in accident prevention.

Keywords— Wireless Network, Mesh Network, Computer Network, Wi-Fi, Ad-Hoc network , ITS.

I. INTRODUCTION

A wireless network consists of several components that support communications using radio or light waves propagating through an air medium. A wireless local-area network (LAN) uses radio waves to connect devices such as laptop to laptop, laptops to the Internet and to business networks. [1][2].

A user can be anything like person or a robot that directly utilizes the wireless network. The user initiates and terminates the use of a wireless network, making the term end-user appropriate. Typically, a user operates on a computer device, which often performs a variety of application-specific functions, in addition to offering an interface to the wireless network[1][3].

A wireless LAN is based on a cellular architecture where the system is subdivided into cells, where each cell (called Base Service Station or BSS) is controlled by a Base station (called Access point or AP). The IEEE wireless LAN standards that have been developed and which are currently in use are:

1. 802.11a
2. 802.11b/ g /c
3. 802.11p
4. WPAN / Bluetooth : IEEE 802.15

II. INTELLIGENT TRANSPORTATION SYSTEMS

While driving, the driver not only needs to control his vehicle but also needs to pay attention to the movements of the vehicles around him.

Roads conditions may not always be good. A stretch of a road may be heavily damaged and the driver may not know about it. Also, there may be very poor visibility on the road.

Weather conditions are not totally favorable all the time. There may be medium to heavy rains or snow fall on the road, or it may just be foggy, temporarily.

Accident analysis results indicate that misjudgments made by the driver are among the leading causes of accidents. Many accidents are caused when drivers lack a better understanding of the surrounding traffic conditions. This is compounded with adverse road and weather conditions, fatigue, and some temporary lapse of focus.

With the rise of computer and wireless technologies, new solutions can be developed to assist the driver in hazardous situations and to decrease road accidents.

It can be possible to enhance the vehicles' safety by making use of the wireless sensors or sensor technologies. Advanced safety features such as, collision avoidance, obstacle detection, range detection, reversing sensors, automatic braking, intelligent headlights, etc. can assist them to drive safely. The concept of such driver-aid systems is that, by using the information collected by the sensors on the vehicle, potential unsafe situations could be detected rapidly and automatically; and this captured data can be used to alert the driver or help the driver with appropriate actions.

It should be possible for vehicles in near future, that they are equipped with wireless devices, so that they communicate with central computing elements through the use of nodal elements installed along road sides[4][5][6].

There can be two types of data exchange between the infrastructure and the vehicle:

Data exchange for short term queries requiring very quick response time.

Data exchange for long term queries which can accommodate some amount of time delay.

In this research, our main focus will be on the first type of queries i.e. those which give very quick response.

Intelligent Vehicular Driving Assistance System (IVDAS), using Wireless Computer Networks uses this approach for future intelligent transportation system (ITS). Global Positioning System GPS has many disadvantages [7]:

1. Delay of Troposphere (the lowest portion of Atmosphere) and Ionosphere: Satellites signals become weak when they pass through the atmosphere.
2. Multiple Signals: occurs when GPS signals reflect by the buildings or rocks before reaching to the receiver.
3. Receiver Periodical Errors: Surely receiver's time is not working as proper as GPS satellites: therefore it is prone to high errors about time meters.
4. Orbit Error: Temporary data might not report the exact location of the satellite.
5. Obstacles: Some other satellites, buildings, trains, electronic obstacles, crowded trees can prevent signals.
6. Satellites Geometry: Satellites geometry is pointed to the proportional location of satellites. When the satellites are on the same way or they are in the small groups, some geometry errors happen.
7. Satellite's signal intentional corruption: This was made by Defense Organization to prevent using of robust signals of GPS satellites by unauthorized people

Du to this disadvantages GPS is not a good solution for intelligent transportation system (ITS) and cannot give traffic density at cross roads. Thus we propose Intelligent Vehicular Driving Assistance System using Wireless Computer Networks for highway traffic [7].

In our proposed system, we have done literature survey about Intelligent transportation systems of different country using wireless devices [8] [9].

III. ANAYSIS OF TRAFFIC SENARIO

We know, year by year and day by day, accident ratio increases, and thus traffic safety become a very important issue.

Our proposed system assists the driver at cross roads. Before explaining about our proposed system, we provide analysis of some traffic scenarios at turns, junctions and cross roads.

A. Street corner or Turn

The traffic patterns at street corners are unpredictable and can often lead to dangerous situations.

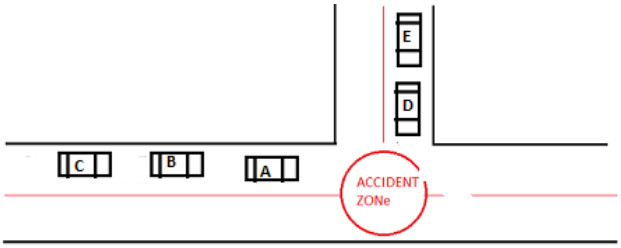


Fig. 1. Street corner traffic senario

In Fig.1, vehicle B wants to overtake vehicle A. Vehicle B cannot see vehicle C. If vehicle B changes the lane to overtake vehicle A, it may collide with the approaching vehicle C. This could be avoided if traffic density of the other road could be displayed on the ON BOARD UNIT of vehicle.

B. Three way or cross roads.

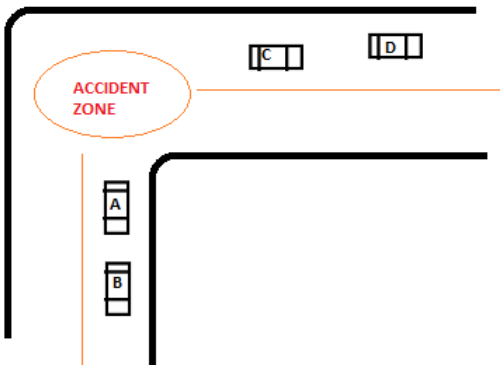


Fig. 2. Three way traffic senario

In Fig.2, we can see that car A goes from left to right side but after some distance they meet at three way road. At that time, car A doesn't know anything about car D coming from the other road, because of some obstacle present between these cars. So the possibility of accident between these two vehicles becomes maximum. We could call this region as an

accident zone. We can avoid this situation using short term traffic at cross roads and three way roads on the on board car unit.

C. Intersection

At four ways cross signal, possibility of breaking the signal and causing an accident is high so this creates a dangerous situation.

Many accidents take place at unmanned crossings due to following factors:

1. Manned level crossing gates are also prone to accidents due to human error by Railway staff as well as forcible opening/crossing by road users.
2. As such, a manned level crossing gate is also not a fool proof arrangement.
3. Accidents at unmanned level crossings primarily occur due to distraction ,stretch and fatigue of users

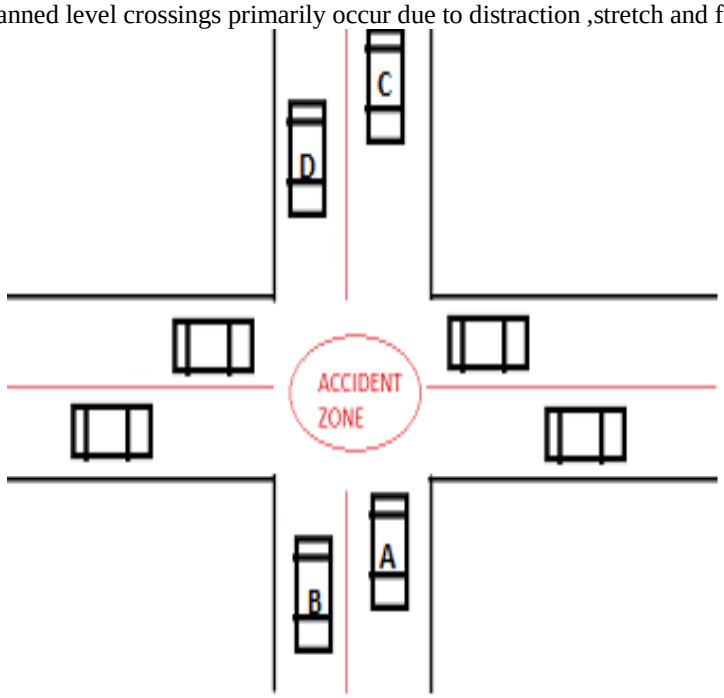


Fig. 3. Intersection

But we could avoid such accidents by giving short term traffic information of other tracks using wireless and wired networks.

D. Vehicle to vehicle collision

We regularly see collisions between vehicles due to several reasons like uncertain turns and lack of any type of signal leading two vehicles coming too near to each other.

IV. SYSTEM ARCHITECTURE

A. System parameter

In our proposed system, wireless device is installed in every vehicles so that each vehicle can communicate with the road side unit. Wireless devices on the vehicle and all road side sensors are connected through wire. Following parameters are used in our proposed system.

V_ ID: This is a unique ID given to each vehicle so as to uniquely identify it.

Location ID: This is the fixed ID given to each of the Unit Servers to uniquely identify them.

Nodal Server ID: This is the fixed ID given to each of the Nodal Servers to uniquely identify them.

Source Nodal Server ID: This is the Nodal Server ID of the Nodal Server acting as the starting location for any specific road segment, so as to be able to identify each road segment.

Unit Server: The wireless server installed at some pre-specified distance along the road sides used for sensing the presence of a vehicle and then perform corresponding communication.

Nodal Server-1: The server supposed to be installed at the end of each road segment, which has quite some good amount of computing power.

Nodal Server-2: The server supposed to be installed at area wised. So driver will be showed area-wise traffic density.

City Server: The server supposed to be installed at every city which maintains whole city's traffic density.

B. *Working of proposed system*

Vehicles continuously send vehicle's identity to corresponding unit server. Whenever a vehicle enters in the sense medium of unit server, it immediately sends vehicle identity (V_ID) to the nearest Unit Server which is installed along road side at some predefined distance.

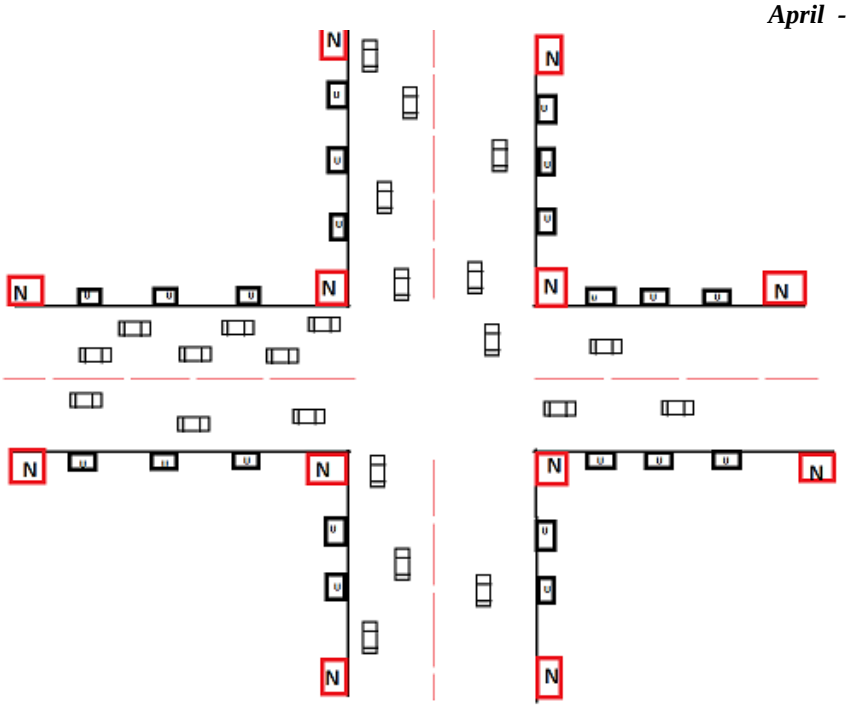


Fig. 4. System architecture

Unit Server always ready to captures V_ID from vehicles and sends V_ID, its own location (LOCATION_ID), TIME and DATE to the nearest Nodal Server.

This DATE and TIME parameter is used to track any particular vehicle.

Nodal Server have quite good amount of computational power so it will be captured all the information of different unit servers and stored in database files.

Nodal Server maintain database file of particular road traffic density i.e. how many vehicles passed from that particular road as well as it also maintains V_ID, LOC_ID, L_SRC, TIME and DATE.

The value of L_SRC is used to identify particular road segments so Each Nodal Server maintains one particular road traffic density. In Similar way, other Nodal Servers also maintain their road traffic density.

Every Nodal Server exchange data to other Nodal Servers and uses this data to get information about other roads or cross road and turns.

At some unit time (t1), Nodal Server sends traffic density file to all the Unit Servers and the Unit Server sends this traffic density file to that vehicle which is within its transmission range. So each Vehicle has traffic density information of all nearby roads so that the driver knows the traffic at cross roads or at railway crossing. At some regular time interval (t2), the Nodal Servers sends traffic density to the City Server.

City Server maintains the traffic density of whole city and this traffic density is sent to the vehicle via Nodal Server and Unit Server so that the driver is able to know about the whole city traffic density on the On Board Unit (OBU) of the vehicle.

Other important functionality provided by our proposed system are, collision avoidance between two vehicles, minimize the ratio of vehicles skidding from mountain sides and falling from bridges.

Using RSSI (received signal strength indicator) to find the distance between any two vehicles, also distance between vehicle and the road side unit. If distance between two vehicle or distance between vehicle to road side unit is less than some predefined distance then an alert message generated and warn vehicle's driver to keep safe distance.

V. HARDWARE AND SOFTWARE

Our system configuration is Intel i3 CORETM inside TM processor and operating system ubuntu-11.10-desktop-i386 and 802.11b/g Wireless device. Using this wireless device to transfer packet between two 802.11b/g devices which are in built in laptops.

VI. PERFORMACE RESULT

Vehicles send V_ID to unit servers, after that unit server convey information to the nodal server.

Cross road nodal servers exchange traffic density between them and send back to unit server and unit server conveys this data to vehicles so that vehicles driver have traffic information at cross road.

The car driver gets the traffic density of any particular road to just enter P_SRC and P_DEST using wireless and wired networks.Vehicles have whole city traffic density on the ON BOARD UNIT of car.

In Fig. 5, we can see that the red circle denotes the Nodal server and the two green lines between the two Nodal Servers denote traffic density from source Nodal Server to the destination Nodal Server which is called forward traffic density between the two Nodal Servers whereas the other line denotes the backward traffic density between the two Nodal servers and thus called backward traffic density.

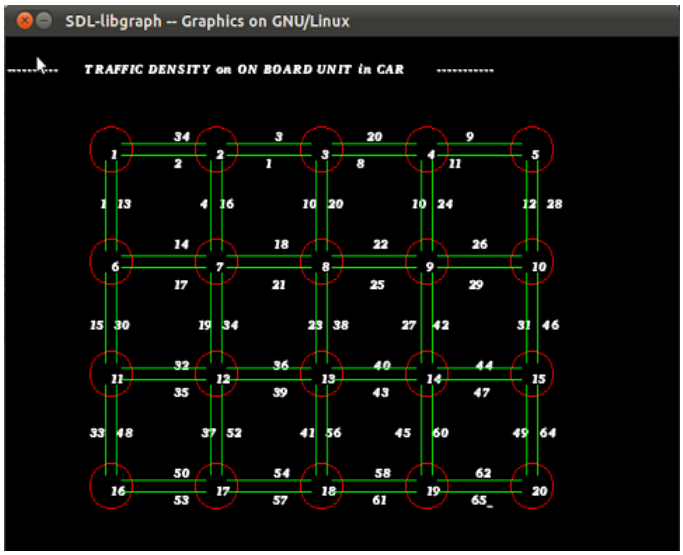
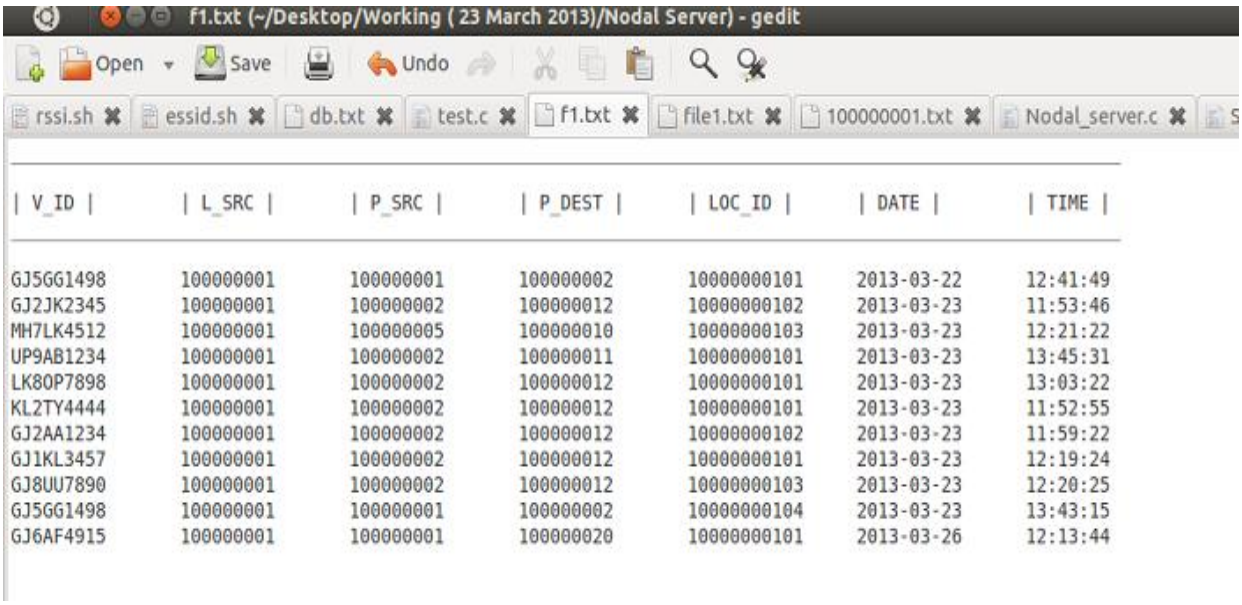


Fig. 5. ON BOARD UNIT in Car

Unit Server receives traffic density file from the Nodal Server and sends this traffic density to specific vehicles which are within the transmission range of the Unit server.

Nodal Server receives V_ID, L_SRC, P_SRC, P_DEST, LOC_ID, DATE AND TIME. It also receives traffic density of that road and passed this information to the City Server at some regular interval time (t2).



V_ID	L_SRC	P_SRC	P_DEST	LOC_ID	DATE	TIME
GJ5GG1498	100000001	100000001	100000002	10000000101	2013-03-22	12:41:49
GJ2JK2345	100000001	100000002	100000012	10000000102	2013-03-23	11:53:46
MH7LK4512	100000001	100000005	100000010	10000000103	2013-03-23	12:21:22
UP9AB1234	100000001	100000002	100000011	10000000101	2013-03-23	13:45:31
LK8OP7898	100000001	100000002	100000012	10000000101	2013-03-23	13:03:22
KL2TY4444	100000001	100000002	100000012	10000000101	2013-03-23	11:52:55
GJ2AA1234	100000001	100000002	100000012	10000000102	2013-03-23	11:59:22
GJ1KL3457	100000001	100000002	100000012	10000000101	2013-03-23	12:19:24
GJ8UU7890	100000001	100000002	100000012	10000000103	2013-03-23	12:20:25
GJ5GG1498	100000001	100000001	100000002	10000000104	2013-03-23	13:43:15
GJ6AF4915	100000001	100000001	100000020	10000000101	2013-03-26	12:13:44

Fig. 6. Database file

Nodal Server has two types of database files in which vehicles details are stored and its structure shown as in Fig.6.

1. Redundant data file.
2. Consolidate data file.

City servers have traffic density of the whole city which is updated at regular time interval (t3).

VII. PERFORMANCE ANALYSIS

In our proposed system, we have implemented end to end communication i.e. the vehicles sends request to the road side unit. After receiving packets from the car by the road side unit, it sends this packet information to the nodal computing element (NCE) and it exchanges this packet information to other NCE's and thus gets traffic density of particular roads or cross road. City server has whole city traffic density. This communication forms forward way communication from vehicle to the City server.

The City server conveys this information in backward way communication i.e. from city server to vehicles

In our system, assumptions are as follows:

1. The distance between two unit servers is 200m.
2. 4-way road.
3. Average length of car is 3m.

If the road traffic is too dense, which means 200 cars within 200m area and we have experimented that end to end communication of 100 packets takes 526 millisecond. Then, within next 1-2 seconds all cars send packets to the road side

unit. If the speed of the vehicle is 120km/h, we calculate that the vehicle can travel 0.033m per millisecond thus 1 packet will be transferred when the vehicle travels 0.1736m.

VIII. CONCLUSION

We have successfully implemented short term traffic density at cross roads and have also calculated whole city traffic density on the car OBU (on board unit).

We had done RSSI value experiment to find safe distance between two computers have inbuilt WI-FI.

This system assists the driver to minimize accidents and save human lives.

We have implemented the whole system on the network so no need of any satellite cost for development of this system.

IX. FUTURE WORK

To avoid collision between two vehicles and provide information at cross road. In future, this information will help to track vehicle and also provide information likes hospital, restaurants, hotels etc. automatically when any vehicle travels on the road.

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