HIGHLY AUTOMATED DRIVING ON HIGHWAYS BASED ON INTELLIGENT VEHICLE TO ENVIRONMENT COMMUNICATION

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Abstract - Being advancement of technologies, Present technologies are much costlier and mostly found implemented in expensive vehicles only. Using Internet of things and electronic embedded system, we proposes three tier system which includes: Obstacle detection and Passenger safety features using sensors, Data exchange through android mobile device and Systematic integration of collected data on server. Number of applications are possible upon citation of basic system service layer and communication exchange. Presenting a system with Vehicle to environment communication, we hope that efficient use of vehicle data will ensure safety, comfort and security of driver and passengers of single vehicle alone.

Index Terms— Automotive Embedded systems, vehicle automation, vehicle to vehicle communication (V2V), vehicle to infrastructure communication (V2I), Internet of things (IoT), vehicle to environment communication, vehicle mobile application, vehicle sensor data, connected cars.

I. INTRODUCTION

Indeed, the auto industry is on the brink of a revolution, and the driving force is the suite of technologies known as the Internet of Things (IoT). With IoT applications—grounded in advances in everything from sensors to artificial intelligence to big-data analysis. The Internet of Things enables transformational change, and there is no question that the automotive sector is changing extremely rapidly. IoT-related technologies will draw the map for the industry to follow, and the connected car will play a major role on the roads and in the economy of the future.

Vehicle automation is proposed as one of the solutions that will make transport safer, more comfortable, and more environmentally. Many of active and passive safety systems has claimed good numbers of reduction in road accidents. If fully automated driving system is provided to human drivers, without necessarily changing equipment on other vehicles or infrastructure i.e. using available resources in present scenario, it will be easy for implementation regarding both cost and safety. The system should facilitate cooperation between the driving system and the host driver during highly automated driving. Hence, the concept is proposed for highly automated driving on highways with subsystems like intelligent intersection collision warning, intersection, obstacle detection using sensors, Data exchange through smart infrastructure, intelligent speed adaptation, and lane-changing functionalities.

Interest in vehicle to infrastructures systems comes from the problems caused by costly automotive systems in market, women security, traffic congestion worldwide and a synergy of new information technologies for simulation, real-time control and communications networks.

True, automakers have yet to turn the “connected car” into a significant revenue generator or a key driver of vehicle sales: Despite two decades of promoting advances in in-vehicle connected services, drivers have resisted paying extra for those features, either not understanding the new technologies or simply seeing little value in the services offered. But this—and a great deal more—is about to change.

II. LITERATURE SURVEY

The increasing use of electronic systems in automobiles instead of mechanical and hydraulic parts brings about advantages by decreasing their weight and cost and providing more safety and comfort. There are many electronic systems in modern automobiles like antilock braking system (ABS), electronic brake force distribution (EBD), electronic stability program (ESP) and adaptive cruise control (ACC). Such systems assist the driver by providing better control, more comfort and safety. In addition, future x-by-wire applications aim to replace existing braking, steering and driving systems. The developments in automotive electronics reveal the need for dependable, efficient, high-speed and low cost in-vehicle communication.

At present, the commercially available traffic detecting equipments include loop detectors, pressure sensors, infrared, radar or ultrasound based sensors
and video cameras. Although loop detectors are cheap to manufacture, their installation and repair are very expensive because they involve digging and re-surfacing of the road, which is labor intensive, time consuming and causes disruption to the traffic. The pressure based traffic sensors have the same problem. Infra-red, radar and ultrasound sensors, on the other hand, are more expensive to make. The use of these active devices in urban areas may have safety and other regulatory implications. In addition, their functionality can be affected by bad weather. Video cameras have long been deployed at key traffic bottlenecks. The effectiveness of this type of sensors can also be affected by bad weather.

Several signal and image processing techniques has contributed important applications to enhance the capability of automotive electronics. There are number of research projects on-going aiming to extract objective traffic condition indicators from the video images. But the huge volume of data involved in video images dictates that such systems requires substantial computation power, and consequently, will not be low cost devices for a considerable period of time. Also these laser beam or radar based systems adds $1500 to $3000 to the costs of a car, and thus are being used in luxury cars only. Finally, GPS based systems have very high operational costs as they need to obtain the precise positions of the vehicles in every few milliseconds.

### III. Aim and Objectives

**A. Aim:**
Systematic collection of integrated, multi-source data to enhance current practices and transform future surface level transportation systems management using proposed vehicle to environment communication

**B. Objectives:**
1) Enable systematic data capture from connected vehicle, mobile device, and infrastructure
2) Develop data environments that enable integration of data from multiple sources for use in transportation management and performance measurement
3) Reduce costs of data management and eliminate technical and institutional barriers to the capture, management, and sharing of data

### IV. Block Diagram and System Description

Proposed system has three tiers: Electronic control unit [ECU], Android mobile device and Data server as shown in below figure.

![Figure 1 Three tier communication system](image)

Tier 1, ECU is compounded of microcontroller circuit with safety sensors and Bluetooth module.

Tier 2, any android smart phone having OS version 4 and above can be used for communication in between Electronic control and data server.

Tier 3, server will store data sent by mobile application via GPRS packet data.

Figure 2 shows proposed block diagram of highly automated driving on highways based on vehicle to environment communication.

![Figure 2 Block diagram of system](image)

The main parts and working methodology is described in detail below.

For real time simulation of vehicle data sensing simulation, sensors such as limit switch for door status monitoring, alcoholic driver detection, push button for seatbelt status monitoring and rear side vehicle distance measurement using ultrasonic sensor and Fuel level sensors has been implemented.

We can avoid accidents by using ultrasonic anti-collision instrument. This instrument is fixed in front side or rear side of vehicle. If any vehicle or obstacle comes nearby this vehicle, immediately this instrument will raise an alarm and it will stop the vehicle.

Ultrasonic can be used to locate objects by means similar to the principle by which radar works. These high-frequency acoustic waves reflect from objects.
The distance to an object can be determined by measuring the delay between the transmission of an ultrasonic pulse and the return of the echo. By doing distance measurement calculation from controller program, the system can find out the distance of opposite vehicle from our vehicle. If the distance is less than predefined set value, the buzzer will give a warning beep. The controller will energize the braking system. Thus vehicle collision is avoided.

Sensor status get monitored every 200msec. Upon receiving query string from mobile application via Bluetooth, Electronic control unit sends required data. Application will ask for data every 10 sec and gets current status of sensors as in reply.

**Figure 3 System architecture**

In case of unavailability of mobile phone network operator or mobile data kept OFF, vehicle data gets stored in mobile memory after every 10 sec. Upon Mobile data connectivity, Application will upload all the data to server.

The main characteristics of a mobile Network includes: energy harvesting, ability to cope with node failures, Heterogeneity of nodes, Scalability to large scale of deployment and ability to withstand harsh environmental conditions. Global positioning system using satellites can provide us important information like speed, latitude, longitude, altitude, etc. We have used inbuilt GPS facility of mobile phone.

Mobile device will now upload vehicle data along with time and GPS data to server. Simultaneously, user can track his location in mobile using GMAP too. Online available all other vehicles with our system installed can be monitored through mobile application as well as web application. This important feature of application incorporates V2V communication facility.

Human interaction can be achieved by display, buzzer and keys. We have used 20x4 LCD to display warnings upon predefined status violation.

Software architecture includes:

1) Microcontroller Software

a. Language- Embedded C language
b. Microcontroller- Microchip PIC18F Family, 18F4550
c. IDE software- MPLAB IDE V8.89
d. Compiler- CCS Compiler V5.008
e. Programmer- PIC Kit3 is used and PGD,PGC are pins used for Programming.

2) Mobile and web Application Software

a. Database platform- JAVA
b. Development Software- Android Studio
c. Mobile application Operability - Google Android V4 Onwards

**Figure 4 Actual photo of Implemented system**

We are aiming at a low cost system that employs use of available distributed mobile network to cooperatively pass their data through the network to server.

V. APPLICATION AND ADVANTAGES

A. Application

Currently for real time simulation of system use, 2 applications are implemented.

1) Fuel level sensing and warning
2) Passenger monitoring system can be implemented where operator can monitor the location of vehicle and status of various sensors

B. Advantages

1) Useful Information IN, Actionable Data OUT
2) Low cost solution for Low end cars
3) Safety Benefits- Dramatically reduced fatalities and injuries through greater situational awareness:
   a. Driver Advisories
   b. Driver Warnings
   c. Vehicle Control
4) Mobility Benefits- Information-rich environment benefits users and operators of all travel modes:
   a. System operators have real-time data to enable better system operations for optimal performance
5) Quality of service can be assured in rent vehicles
6) Collection of data for survey and analysis

VI. RESULT AND DISCUSSION

The main result for this paper is to communication in between vehicle and data server. In clear environment system would be less prone to errors. Efficient algorithms will help for accurate information, communication with server and fast response to actionable input data.

![Figure 5 Warnings displayed on LCD for violation in sensor status](image)

Figure 5 Warnings displayed on LCD for violation in sensor status

<table>
<thead>
<tr>
<th>Sensor Name</th>
<th>Value</th>
<th>Buzzer</th>
<th>Refer to</th>
<th>Value</th>
<th>Buzzer</th>
<th>Refer to</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol sensor</td>
<td>&gt;500</td>
<td>ON</td>
<td>Drunk</td>
<td>&lt;500</td>
<td>OFF</td>
<td>OK</td>
</tr>
<tr>
<td>Ultrasonic sensor</td>
<td>&gt;50 cm</td>
<td>OFF</td>
<td>OK</td>
<td>&lt;50 cm</td>
<td>ON</td>
<td>Warning</td>
</tr>
<tr>
<td>Fuel Level sensor</td>
<td>31%-100%</td>
<td>OFF</td>
<td>OK</td>
<td>30%</td>
<td>ON</td>
<td>Low fuel</td>
</tr>
<tr>
<td>Door Limit switch</td>
<td>1</td>
<td>ON</td>
<td>Door Unlck</td>
<td>0</td>
<td>OFF</td>
<td>OK</td>
</tr>
<tr>
<td>Seatbelt Push button switch</td>
<td>1</td>
<td>ON</td>
<td>Seabt Detac hed</td>
<td>0</td>
<td>OFF</td>
<td>OK</td>
</tr>
</tbody>
</table>

Table 1 Sample Sensor status data indication

It also incorporates safety features like door status monitoring, driver drunk alcohol detection, seatbelt status monitoring and obstacle detection using sensors like nearby vehicles, wall, trees, people, at inevitable distance. Upon violation system will send the message to the display and will give audible warning.

Following points may lead to effective ensured success of system:
1) Facilitate easy, secure access to data environment and enable collaboration in mobility application development
2) Coordination with other Networking Environment program areas and broader ITS programs
3) Active interaction with broader group of stakeholders outside the academic research
4) Development efforts and Rules from Government authorities
5) Not a one-time engagement, will require ongoing collaboration to:
   a. refine program goals
   b. refine data needs
   c. structure relevant and feasible data environment development efforts
   d. prioritize applications development and testing

Highly automated driving on highways based on intelligent communication aims to increase people safety and comfort by using advanced technologies at low cost.

VII. FUTURE SCOPE

Data exchange through server to vehicle may provides-
1) Real time information of roadside shops, hotels, fuel stations, hospitals, location & time updates, traffic rules & regulations in moving area
2) Environmental information and weather report of current region (temp, humidity, weather forecast) and much more.

Extended applications may include but not necessarily limited to:
1) Warn of obstacles which a driver cannot see
2) Ambulance system- To monitor critical situation patient and transmit data to hospital
3) Passenger Transit information for bus
4) Data sharing in tours and travel such as speed, heading, position, brake/acceleration action, vehicle type, vehicle color etc.

VIII. CONCLUSION

In this paper, a basic system has been proposed for efficient use of vehicle data and example applications was developed. This integrates a electronic control unit, mobile device and data server allowing more realistic evaluation of applications.
The deployment of system has enabled the critical innovation of vehicles, drivers and infrastructures. We have proposed a model which ensures safety for vehicle, passengers and driver himself.

Key points concluded-
1) Multiple applications can be developed with leveraging multi-source data
2) Research spurs commercialization
3) Applications will enable transformational change
4) Can make Roads Safer, smarter and Environment Better using intelligent vehicle to environment communication technologies.

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X. REFERENCES


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