

Safe Overtake Monitoring System for Public Transport Vehicles

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Abstract— Every year many people in India die in road accidents and year by year this number is growing. Many agencies and organization have done studies on finding out root causes of these accidents. One of the major reasons came out of those studies is overtaking of vehicles on the road.

This paper proposes a real-time on board safe overtaking monitoring system with major focus on public transport buses. Proposed system monitors vehicle parameters like speed, engine speed, brake pedal status and steering angle. All above parameters are measured by microcontroller based embedded board. Additionally there are four laser sensors attached to vehicle to measure distance from the surrounding vehicles. Systems monitor these parameters and based on algorithm it gives alert to driver if overtaking is not safe. If driver ignores these overtaking algorithms many times then it is informed to nearest police control room and bus agency supervisor. The proposed system is self-decision making driving supervisor which helps drivers to improve their driving skills and also prevent accidents caused due to overtaking.

INTRODUCTION

Driving is very sensitive task which needs to be done very consciously and with high care. Careless driving causes both human and economic damage. More than 70% of the people in India use public transport for travel out of which mostly it is through buses. Past years survey shows that bus accidents contribute more in total accidents happened on road. Some of major reasons for these accidents are inadequate road infrastructure compared to traffic density, rash driving and unsafe overtaking.

Several attempts have been made by public transport system authority and also by road transport department of state government to educate and aware drivers to drive vehicles safely but that did not helped much to prevent the accidents happening every year. There are some systems already available to control speed of bus like “speed governor” but that increases the travelling time and in some cases drivers overload the engines to gain speed which cause reduction in uptime and performance of the vehicle.

Some solutions have been designed which detects rash driving and gives intimation using some or other kind of wireless media but most of them failed due to reliability issues and most of them are just indicative systems and not preventive. There is need of self-control system which detects overtaking intention of driver, guide driver for safe overtaking condition and based on drivers response takes necessary action to prevent the further disaster.

In this paper an onboard safe overtake monitoring system is proposed. Unlike other existing systems this system will act as on board driving supervisor. It monitors few essential vehicle parameters like vehicle speed, steering movement, brake pedal, vehicles current location, and distance measurement sensors to guide driver for overtaking and control speed of vehicle.

If driver doesn't following the instructions then system sends required text message to police control rooms.

The rest of paper is organized in following way: section II explains system architecture of the proposed system; section III elaborates design and algorithms of major features in the proposed system; section IV has system validation results and section V will give some conclusion remarks and future enhancements; section VI references.

SYSTEM ARCHITECTURE

Figure 1 shows overall system architecture of proposed system. All the major components involved in this system are represented in the figure. Brief information about each component is given.

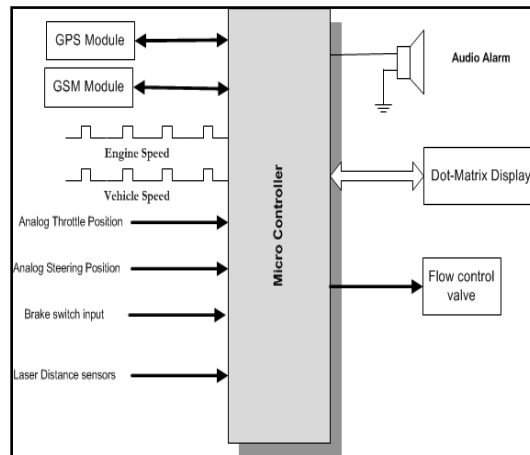


Fig 1. System architecture

[1] Analog Inputs (throttle position & steering position)

There are two analog inputs, throttle position which will be mapped to throttle position. So as throttle pedal moves, resistance of analog pot changes. Second input is steering position analog pot, it will give current steering wheel position or angle.

[2] Frequency Inputs (Engine Speed & Vehicle Speed)

These are magnetic pick up sensors frequency inputs which gives Engine speed frequency and vehicle speed frequency. These frequency inputs will be further converted into engine RPM and vehicle speed in terms of kms/hrs.

[3] Brake switch Input

It is push button switch that will give logic output of zero or one for brake pedal. Zero for brake pedal not pressed and one for brake pedal pressed.

[4] Laser sensors(L1,L2,L3 & L4)

Three laser sensors are used to measure relative speed of machine, for detecting overtaking conditions and measuring distance of vehicles from opposite lane.

[5] Audible Alarm

It is used to alert driver as well as other passenger about different system warnings. This will be control by using low current relay switch by microcontroller.

[6] Display

16x2 dot matrix display is used to display text warnings for driver as well as for other text info.

[7] Fuel flow control valve

Fuel flow control valve limits vehicle speed to predefined maximum value by controlling fuel flow. Microcontroller controls valve opening by controlling current flowing through solenoid valve.

[8] Microcontroller

XC2224L processor chip is used to design this system. Its 16 bit processor with 12 kB of RAM and 160 kB on chip flash considering future application expansion.

CPU uses 80 MHz high speed clock & works on 3.3 V \pm 10 % power supply.

[9] GSM module

GSM module is used for sending emergency text message to pre-defined GSM numbers.

SIM900 is chip used in this system. Its industry standard GSM chip with smaller form factor, GPRS enabled which works for text, voice and data as well.

[10] GPS module

GPS module is used to get local GPS co-ordinate where the vehicle is going on its route.

PA6B GPS chip is used for this design which has higher accuracy and high sensitivity and tracking capabilities.

I. SYSTEM DESIGN

In this system four laser distance sensors are used which are placed at four unique locations. Two sensors (L1 & L2) are placed on front side of the bus next to headlights to measure relative distance of vehicle ahead of bus and relative distance of vehicle in opposite lane when bus shifts to opposite lane for overtaking. These sensors along with steering angle sensor help system to detect overtaking condition.

Rests of two sensors (L3 & L4) are placed on left side of bus one at front and another at rear end as shown in Figure 2. System monitors steering angle sensor continuously and any time system finds steering angle is more than 10 degree continuously for some time, system consider it as intention for lane change.

At the same time feedbacks from the front laser sensors are taken, and distance of the bus from the front vehicle is calculated and using existing vehicle speed system calculates whether measured relative distance and speed is safe enough to continue overtaking. If the distance is not safe system will give audio and visual warning to driver for not overtaking the front vehicle and if still driver goes ahead system will log this event as violation of

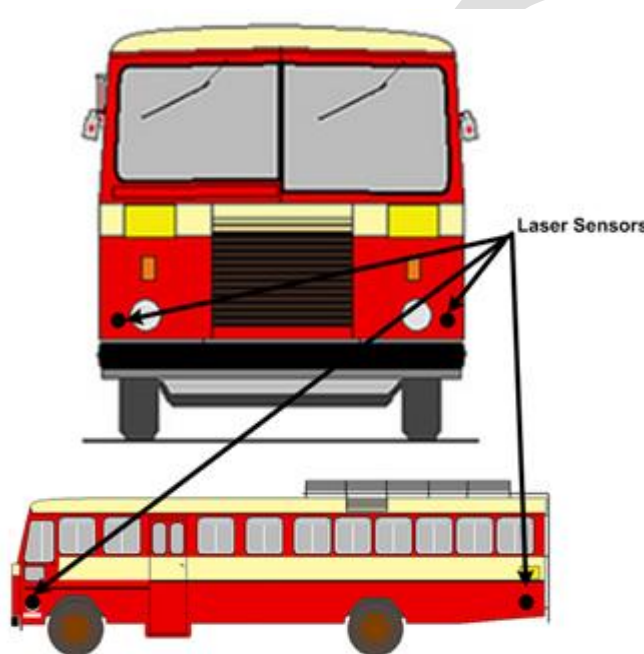


Fig. 1. Distance sensor locations

driving safety. As soon as bus starts entering into opposite lane, right side front laser sensor L2 measures distance of vehicle in opposite lane. Based on the sensor feedback if there is rate of change in distance measured system detects vehicle from opposite lane and measure distance from bus. Based relative bus speed (speed with respect to front vehicle) and distance of vehicle in opposite lane system takes decision if overtaking is possible or not and informed driver accordingly (Figure 3).

Complete lane change is detected with the help of feedback of both laser sensors L1 and L2 and at the same time If it's possible system will not give any indication to driver and keeps monitoring vehicle's speed and left side two laser sensors. While bus overtaking front vehicle system measures left side two sensors L3 and L4 to check side wise distance between two vehicles and also detecting whether bus has crossed vehicle or not. If system detects lane change (back to home lane) started through steering angle sensor before bus has crossed vehicle completely with safe marginal distance system will give audio indication to driver for that and log the event in memory. During this complete overtaking process system keeps accumulating distance travelled by bus starting from lane crossing into opposite lane to coming back to home lane after overtaking and calculated total distance. And if that distance is less than safe overtaking distance that bus has to travelled for overtaking another vehicle, system will do nothing but if it's not system will

give audio indication to driver about it and log this event in the memory. If driver does unsafe overtaking even after system has given warning to him, after third attempt system will send the text message predefined number belonging to either Police department and/or Public bus transport authorized person and also lock vehicle speed by controlling fuel supply through flow control valve activated by relay. Here is the formula how safe overtaking distance is calculated (figure 4),

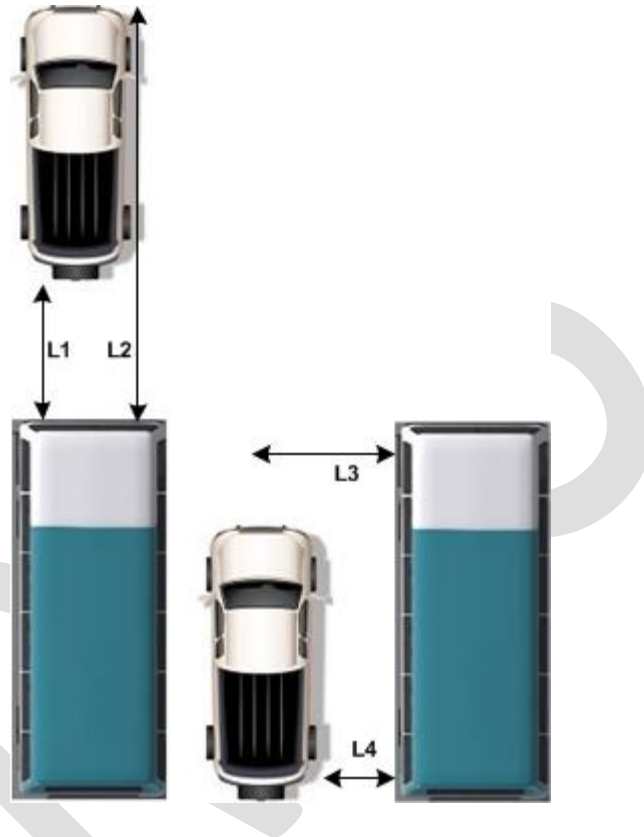


Fig. 2. laser sensors operation during overtaking

$$L_{min} = L + L_{front} + L_{safe}$$

Where,

L: length of bus in meters

L_{front}: length of front vehicle in meters

L_{safe} = (L_{safe1} + L_{safe2}): safe overtaking dist. between two vehicles

L_{min}: Minimum distance travel to overtake vehicle

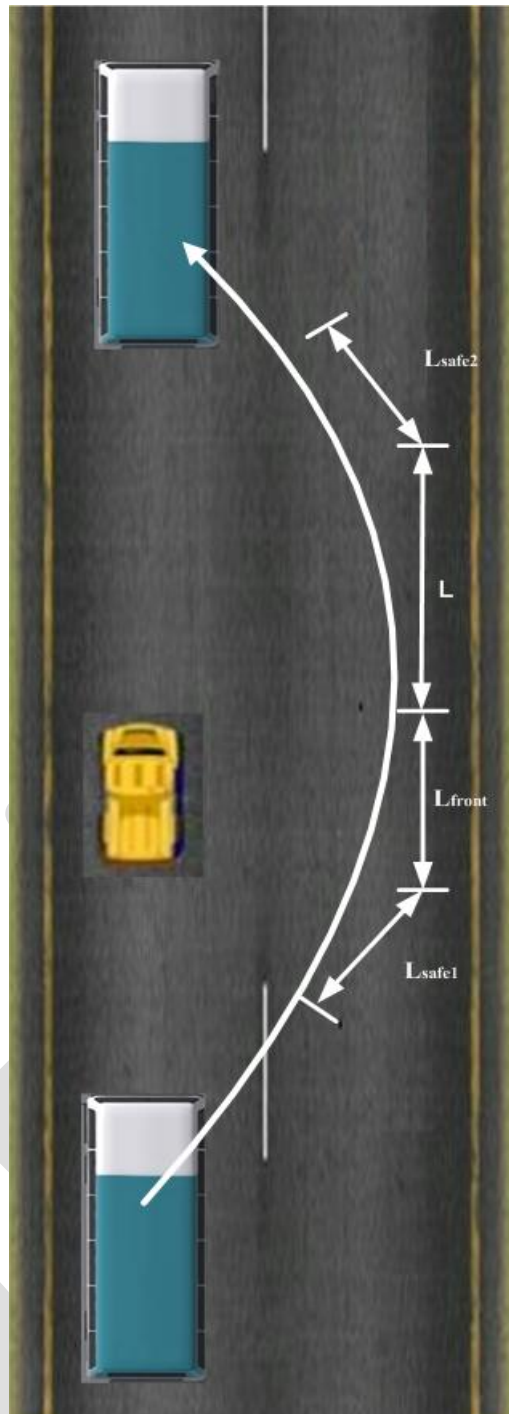


Fig 3.Overtaking scenario

II. SYSTEM VALIDATION

This system tested in simulation environment where system is implemented on embedded board in which throttle sensor, steering sensor are interfaced and rest of the inputs are taken from the virtual test simulator developed in visual basics where test scenarios are created. In this test setup embedded board gives throttle information and steering information to test application and simulators provide laser sensors output to board back, where application is running.

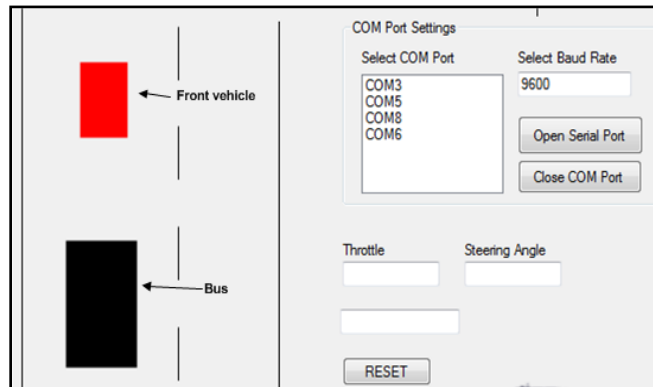


Fig:4 Driving Simulator window

Following are the test scenarios simulated and results captured from those scenarios.

1. Initiating overtaking from unsafe distance from front vehicle:

In this scenario simulator sent front lasers output to application and application then took decision of not overtaking the front vehicle and sent text information through communication port and message was shown on application window.

This test was repeated for multiple distances between two vehicles where in system could be able to give correct indication for driver.

2. Overtaking front vehicle for both safe and unsafe total distance travelled:

For all scenarios where total distance travelled was less than actual total distance travelled system have shown warning for driver for unsafe overtaking.

III. CONCLUSION

In this system is designed in order to address one of the major reasons of bus accidents observed majority of time. Based on simulated testing after applying certain testing conditions, results shows that system is responding good to all the scenarios that are been considered while designing this system. Advantage of this system is it is able to help in improving driving skills which can cause accidents. It helps in reducing road accidents. Considering deployment of this feature, it will be very simple to deploy and cost effective solution for country like India.

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