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Accident Prevention System for Public Transport Vehicles

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Abstract: ***Human life loss is biggest loss which cannot be recoverable unlike other property loss. Many people die every year due to road accidents. Plenty of solutions have been applied to prevent these road accidents. Government bodies designed stringent rules and regulations about road traffic and speed. Good road infrastructures have been developed; many road safety initiatives have been executed. Different technologies and methods have been developed to train safe driving but most of them failed to prevent accidents. This paper proposes a real-time on board accident prevention system with major focus on public transport buses. Proposed system monitors some of vehicle parameters like vehicle speed, engine speed, brake pedal status and steering angle. All these parameters are measured by microcontroller based embedded board. Objective of this is to understand driving style of driver based on acceleration and brake pedal operation. If driving pattern falls under pre-defined rash driving criteria, system indicates driver about it and if situation continues, speed limiting is applied to vehicle at the same time text message is send to nearest police control room using GSM module. System also controls speed of vehicle in high density population area like cities and villages on the route. Using GPS module system monitors vehicles current location and if it comes under city area, vehicles speed is limited to safe limit. These above mentioned features makes system self-decision making driving supervisor which helps drivers to improve their driving skills and also prevent accidents and also intentional rash driving.***

Keywords: Global Positioning System (GPS), Pulse Width Modulation (PWM)

1. Introduction

Driving is very sensitive activity which needs to be done very consciously and with high care. One should follow traffic rules and should take all safety precautions while driving on road. Accidents cause both human and economic damage. In a country like India, where people give pay regard for traffic rules, thousands die each year due to road accidents. More than 50% of the people in India travel through public transport running on the roads daily. Past years data shows that majority of percentage of road accidents is of public transport buses.

In many cases, the accidents can happen due to degradation in driver performance, which is caused by fatigue, drowsiness, or inattention. Apart from these reasons long working hours, continues driving, stressful driving due high traffic, unhealthy working environment are reasons for these accident cases.

Several attempts have been made by different authorities to educate and aware drivers to drive vehicles safely and that help in reducing accidents up to some extent. There are systems proposed to control speed of bus like “speed governor” but that increases the travelling time and drivers overload the engines to gain speed which cause reduction in uptime and performance of the vehicle.

Few 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.

This implies that there is need of self-control system which detects driving pattern of the driver and based on situation takes necessary action to prevent the further accident.

This paper proposes an accident prevention safe guard system. It monitor few essential vehicle parameters like vehicle speed, steering movement, brake pedal, vehicles current location in order to detect rash driving and also possibility of accident by controlling speed of vehicle and communicating required message information to police control rooms.

The rest of paper is organized in following way: section II explains about system architecture of the proposed system; section III gives overview of 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.

2. 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.

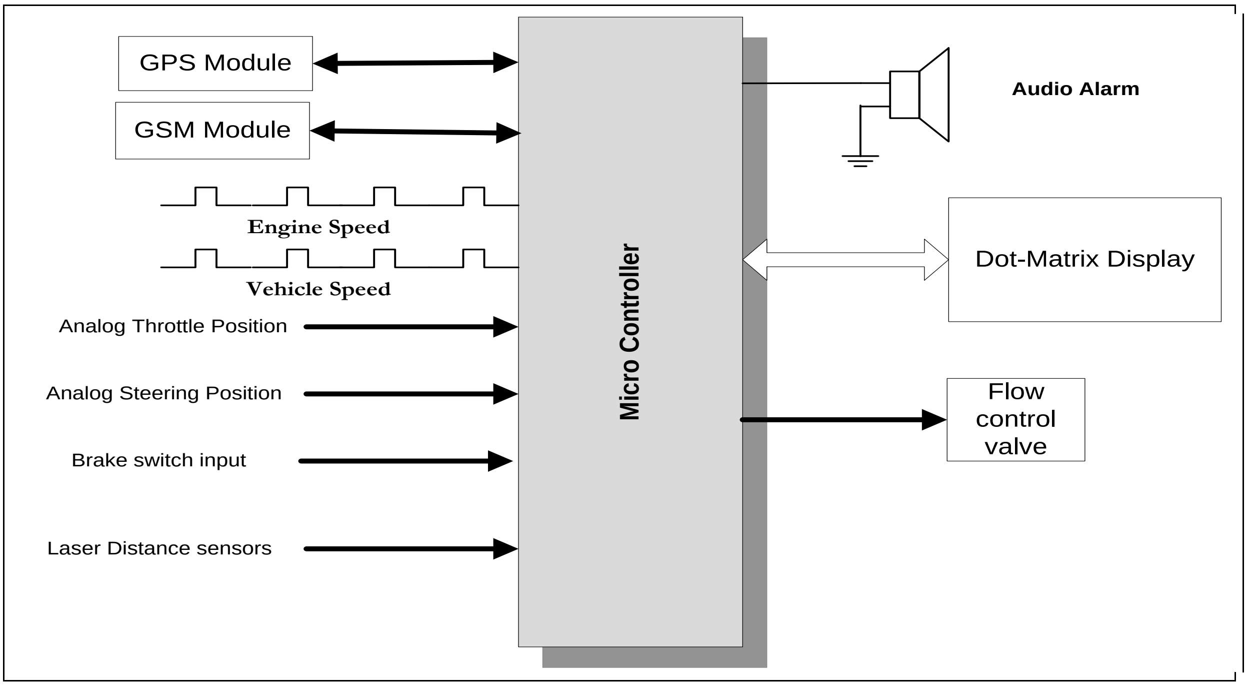

Figure 2: System architecture

- **Analog Inputs (throttle position & steering position):** First analog input is mapped to throttle position. As throttle pedal moves, resistance of analog pot changes. Second input is steering position and it is analog pot, it will give current steering wheel position or angle.
- **Brake switch Input:** It is push button switch that will give logic output of zero or one for brake pedal. Logic zero for brake pedal not pressed and logic one for brake pedal pressed.
- **Frequency Inputs (Engine Speed & Vehicle Speed):** These are magnetic pick up sensors which gives frequency input for engine speed and vehicle speed. These frequency inputs will be further converted into engine RPM and vehicle speed in terms of km/hr.
- **Microcontroller:** XC2224L processor chip is used to design this system. It is 16 bit processor with 12 kB of RAM and 160 kB on chip flash. CPU uses 80 MHz high speed clock & works on 3.3 V ± 10 % power supply.
- **GSM and GPS 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.
- 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.
- **Warning Alarm:** It is used to alert driver about different system warnings. This will be controlled by using low current relay switch by microcontroller.
- **Display:** 16x2 dot matrix display is used to display text warnings for driver. It is also used to display other information.
- **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.

3. System Design

Proposed system consists of two major features,
1) Speed control in high density traffic areas
2) Safe driving control

Designs of these features and detail algorithm is discussed below,
1) Speed control in high density traffic areas
This feature controls the vehicle speed in high traffic areas like cities and villages on the bus route.

- For the route on which bus is used , start and end GPS co-ordinates of all the cities and villages on that route will be stored in the system , which can be re-programmed based on rout selected.
- GPS module continuously fetches the current vehicles location co-ordinates. When the current vehicle co-ordinates fall in prerecorded start of the city co-ordinates, system will limit the speed of vehicle by controlling fuel flow control valve attached to fuel supply line.
- Proportional solenoid valve is used to control the fuel flow. Solenoid valve gets positive supply from constant source and its ground is controlled by microcontroller using low side driver. PWM signal is applied to low side driver where micro-controller varies duty cycle of PWM signals.
- PWM duty cycle controls the current flowing through solenoid hence proportionally controls opening of fuel supply valve.

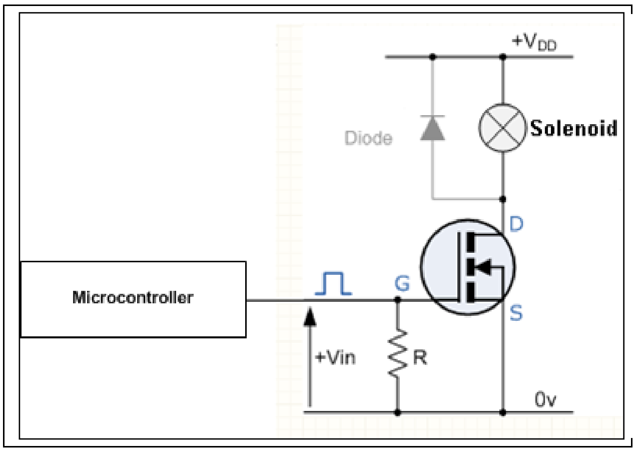

Figure 2: Solenoid Control circuit

- By controlling fuel flow in supply line, system will limit the maximum achieved speed.
- The city co-ordinates are defined in the system. When current GPS location falls under these co-ordinates even if driver exceeds the speed beyond predefined speed, system will not respond for increase in speed.
- When received vehicle GPS co-ordinates go out of speed restricted area, system will resume normal fuel supply and vehicle can go its normal speed range.

Figure 3: Proportional solenoid valve

4. Safe Driving Control

In this feature vehicle driving pattern is monitored closely and based on that necessary action is taken by system.

- System continuously monitors vehicle speed through speed sensor and vehicle braking using brake switch.
- Based on vehicles speed system continuously derives acceleration pattern of bus.
- In controller memory prerecorded rash driving pattern based on vehicle speed and brake switch data are stored.
- With the help of vehicle speed and brake pedal data, if the derived acceleration pattern falls under rash driving pattern, system gives warning to driver and record that instance in memory.
- If the driving doesn't improve after two attempts of warning, system limits vehicle speed using fuel flow control valve and gives text intimation to nearest pre-defined traffic police station about rash driving incidence by sending current vehicle location.
- Figure 3 shows rash driving pattern

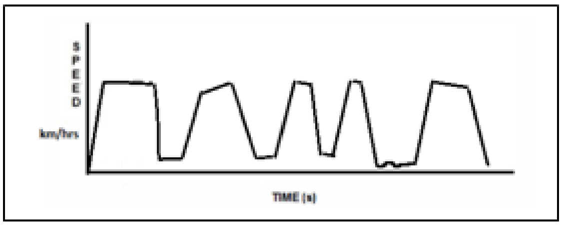

Figure 1: Rash Driving Pattern

5. System Validation

This system is 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. Different test scenarios are created in the virtual simulator. In this test setup embedded board gives throttle information and steering information to test application and simulators provide vehicles speed information back to board where application is running.

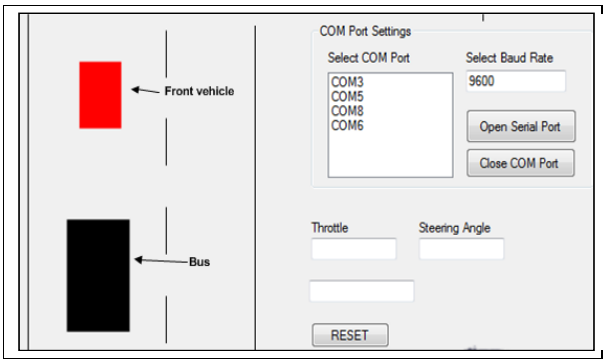

Figure 2: Driving Simulator window

In safe driving control feature different speed pattern are generated and system response is checked. Following two speed patterns are out of different driving patterns for which system indicated as rash driving pattern.

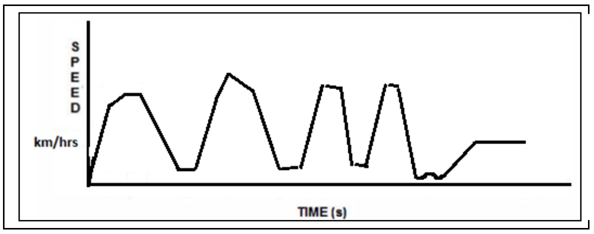

Figure 3: Rash driving pattern 1

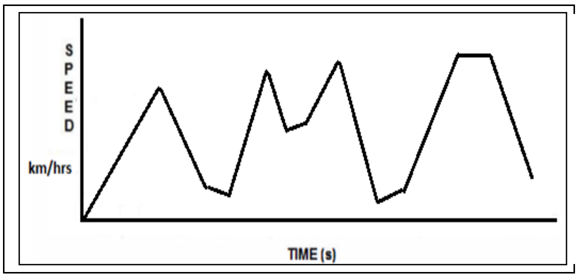

Figure 4: Rash driving pattern 2

For following speed pattern system didn't responded with rash driving pattern

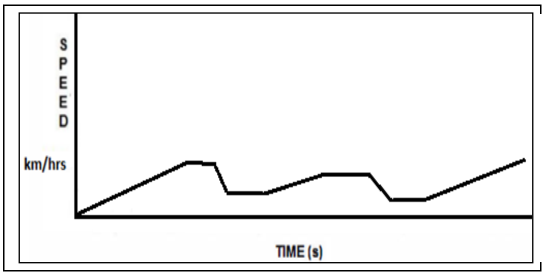

Figure 5: Normal driving pattern

6. Conclusion

In this paper, two major features are proposed which are designed in order to address key factors that cause bus accidents. Based on simulated environment testing after applying defined test conditions, results shows that system is responding well to all the scenarios that are been considered while designing this system.

This system is able to control rash driving and all other unintentional driving habits which can cause accidents and helps in reducing road accidents. This system will definitely help to improve driving skills of bus driver to avoid bus accidents. This will also improve vehicles efficiency. Considering deployment of this feature, it will be very simple to deploy and cost effective solution for country like India.

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