Developing safety system for monitoring seat belt and controlling speed accordingly to avoid fatal injuries

Priyal N Sheth, A.D Badgujar

Department of Mechanical Engineering, Navrachana University, Vadodara, India

Abstract: Major causes of death in road accidents are carelessness in safety while driving. In 2012, more than half of all people who died on Utah's roadways weren't buckled [1]. Hence wearing seat belts might have reduced serious crash-related injuries and saved life. Hence “Driver Assistive Safety System” (DASS) comprises of techniques which inculcate the mandatory safety precautions via alarm, visual indicator, ignition and speed control. This paper describes safety system which ensures that the driver and co-passenger wear safety seat belt while driving a car. The driver assistive safety system works on ‘ignition interlocking” and “speed control” concept.

Index Terms: Driver assistive system, Ignition interlocking, Mandatory seat belt; System to avoid major injuries using seat belt;

I. Introduction

Research in the UK [2] has shown that wearing a seat belt reduces the risk of fatal injury to front seat passenger car occupants by 45%, and risk of moderate-to-critical injury by 50%. However as per Ontario Ministry of transportation [3], seatbelts are not required for the passengers engaged in work that requires them to exit from and re-enter the vehicle at frequent intervals (must travel less than 40kmph). Hence this paper includes city mode option which restricts the car at predefined minimum speed if person is not wearing seat belt.

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Occupant</th>
<th>Protection Device</th>
<th>Effectiveness in Preventing Fatalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car</td>
<td>Driver</td>
<td>Lap/shoulder belt</td>
<td>42 +/- 4%</td>
</tr>
<tr>
<td>Car</td>
<td>Right front passenger</td>
<td>Lap/shoulder belt</td>
<td>39 +/- 4%</td>
</tr>
<tr>
<td>Car</td>
<td>Left rear passenger</td>
<td>Lap belt</td>
<td>19 +/- 10%</td>
</tr>
<tr>
<td>Car</td>
<td>Right rear passenger</td>
<td>Lap belt</td>
<td>17 +/- 9%</td>
</tr>
</tbody>
</table>

Despite of laws on the use of seat belts, a lot of people don’t like wearing them due to various reasons. Following are the common reasons:

- Drivers and passengers think that wearing a seat belt is not that important, especially when driving in short distances or when the traffic is visibly light.
- Tends to forget to wear them, especially when they are on the rush.
- People don’t make it a habit to wear seat belts.

II. METHODOLOGY:

Impact force when car collides is given by:

\[ F_{avg} = \frac{m \cdot v^2}{2 \cdot d} \]

Where, \( F_{avg} \): Impact force, \( m \): Mass of vehicle, \( v \): Velocity of vehicle, \( d \): stopping distance

If seat belt is buckled up than the stopping distance of driver would be extended to amount of stretch of belt. Hence this would reduce the impact force.

At the beginning when passenger or driver enters the car, DASS asks to choose the mode. It would respond as per flow chart prescribed in figure 2.01

Figure 2.01: Flow chart for mode selection and execution
Inputs:
The whole DASS would be working on the DASS circuit shown in figure 2.02. Inputs to Arduino ATmega2560 microcontroller would be from load cell, photoresistor sensor and wheel speed sensor. After processing the inputs as shown in flow charts microcontroller would give different outputs. Microcontroller would be controlling and giving outputs to devices.

As shown in figure 2.04 wheel speed sensor would give speed of vehicle by calculating r.p.m of the wheel. For detecting whether seat belt is installed or not, photoresistor is placed. When person buckle up the seat belt, output is high, otherwise it is low. LEDs are installed in every circuit wherever sensor gives feedback. So it became easy to trace the faults.

Outputs
Electronic actuated motorized valve mounted on inlet manifold would be used to control the flow by quality or quantity governing. The microcontroller would be receiving feedback from different sensors. Other output devices are display screen and audio system.

2.1 HIGHWAY MODE:
System only allows car to get started if driver and co-passenger (if present) buckle up the seat belt in highway mode.

Figure 2.11 displays the flow chart of Highway mode when the engine is off. Initially the ignition circuit would remain open. The connection between starter motor and battery would be connected by relay which would idly keep circuit open. Relay would be operated by microcontroller. Microcontroller would be getting various inputs and would process as per flow chart shown in Figure 2.11. Driver would be only able to start the car if he/she and co-passengers (if present) wears seat belt.
To check the seat belt during running condition, DASS follows the flow chart as shown in figure 2.12. If they unbuckle the seat belt, DASS would alert driver through display screen and audio system. A timer of 60 seconds would be provided in which driver or co-passenger or both have to buckle up their seat belt. Failure to do so would result into limiting car’s speed to specified speed of 20 km/hr [5] if found above it. The speed would be limited by actuating valve mounted on inlet manifold. Microcontroller would be getting feedback from speed sensor. Parking light would alert the surrounding vehicle about slowing down of car. Though driver tries to accelerate the car, motorized valve will automatically adjust the quality and quantity of fuel to keep car within limit.
2.2 CITY MODE

In some cases, people have to travel short distances or frequently enter and exit the car, or travel in traffic areas. In these situations, the car is driven slowly. A study suggests that arm resisted motion reduces injuries of occupants rather than seat belts at low speeds (20 km/hr). Hence, seat belts are not required at low speeds. So Driver Assistive Safety System provides city mode.

City mode system limits the speed of the car to a specified speed of 20 km/hr by controlling the quality and quantity of fuel into the engine. It allows the car to start without buckling seat belts. The driver can shift to the highway mode by buckling up the seat belt at any time.

As shown in figure 2.20, the microcontroller processes the signals. If the passenger wishes to speed up the car, he can put on the seat belt and the highway mode option gets activated on the screen. So he can choose it and would be directed in highway mode.

IV. ADVANTAGES:

- DASS can be installed in any existing car without making major changes.
- DASS consists of two modes which provide flexibility to the driver and also overcome some reasons for not wearing seat belts.
- DASS has a warning system that alerts the driver and provides 60 seconds before taking any action. Hence, it gives time to the driver to take decisions and doesn't abruptly take over the control.
- While decelerating, it switches on the parking lights which indicate that the car will be slowing down, hence alerting surrounding vehicles.
- It has a continuous monitoring system that monitors the seat belt condition, even during driving.
- It has the ability to switch between two modes.
- Apart from visual display, it also interacts through voice messages.
- The system consists of troubleshooting, which displays the instructions and has backup for any failure.
- The system is very simple and economical. It can be incorporated in any car.

V. CONCLUSION:

Seat belt as a safety feature reduces the chances of major injuries or even loss of life in an accident, hence to ensure that people wear seat belts, Driver Assistive Safety System has been proposed. Considering the type of traffic prone to accidents, two modes of Driver Assistive Safety System have been devised.

VI. FUTURE SCOPE

ECU can be directly programmed replacing the microcontroller in newly developed cars, which would further make the system economical by eliminating the requirement of a motorized valve.
REFERENCES:


[5] Yongchul Kim, Chulhue Park, Youngil Youm, Sungchul Choi, Sungjun Han, Hanil Bae “BIOMECHANICAL MODEL OF HUMAN-LIKE ARM FOR A CRASH TEST”


AUTHOR

First Author: Priyal Sheth, U.G Student, Department of Mechanical Engineering, Navrachana University, Vadodara, Gujarat, India. Email id: shethpriyal94@gmail.com

Second Author: Dr. Amarish Badgujar, Asst. Professor, Department of Mechanical Engineering, Navrachana University, Vadodara, Gujarat, India. Email id: amarishb@nuv.ac.in