Raspberry-Pi Based Secure Systems in Car

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Abstract: Automotive accidents leads to not only mortality of people but also causes financial cost to both people and society. This special issue is focused on reviewing history and background of automotive system by presenting recent developments. This paper aims at giving an overview of implementing safety and security system in car for today and future development. The key enabling technology for active safety system includes drowsiness detection and Anti pinch window’s effect. Other proposed concepts to be implemented are seat belt detection and alcohol detection. Driver’s drowsiness is monitored using technique called image processing and it is processed through MATLAB but the main constraint in this technique is that processing speed on hardware. The idea proposed in this paper is that Open CV library is used for real time facial images analysis to warn the drowsiness of driver in order to prevent traffic accidents. Anti-pinch window system helps to avoid injuries because of power window. Seat belt alert system gives an audio output to wear seat belts for safety. Finally Alcohol detection detects a drunken driver and it will send a message to the nearby police station along with the details of the vehicle and its position. The proposed system does all the above features with the help of a Raspberry-Pi, camera and few sensors in its hardware part along with coding computations through python which has the advantage of continuous monitoring at minimal cost thereby preventing accidental injuries to a great extent.

Keywords: open CV; Anti-Pinch; Drowsiness Detection; Power window, Raspberry-Pi.

1. Introduction

The main reason for majority of damage to society is because of road accident. As per recent survey, every year 1.34 lakh people die due to road accidents in which 70% of accidents are due to drunken drive. In USA drowsiness causes 20% accidents every year. Tens of thousands more are injured. Families are broken apart. The future of young people is clashed. Road accidents have become the leading cause of death. Drowsiness is also more or less similar to alcohol consumption where in both cases drivers concentration, alertness and attentiveness is reduced. Apart from traffic fatalities, injuries also occur inside the car. Enhancement of comfort features like power windows in car, also leads to hazardousness. Power windows in automobile have killed or injured thousands of children. In past 30 years more than 50 children died because to suffocation due to accidental usage of power windows. Power windows will exert from thirty to eighty pounds of force whereas only 22 pounds of force is enough to suffocate a children. Most drivers and passengers killed in crashes are unrestrained .Seat belts dramatically reduce risk of death and serious injury. It is proven that people who are not wearing their seat belts have high probability of being thrown out from the vehicle during crash. The above work can be implemented using CAN protocol also[10].But to overcome all these problems raspberry pi along with open CV and various sensors is used to reduce the injuries
that cause because of power windows and carelessness of not wearing seatbelt. It also reduces the risk of drowsy and alcohol drunken drivers by monitoring and alerting them.

2. Related Works

A lot of research has been done about security systems in car. Nisi et al [1] have proposed a smart vehicle for prevention of accidents using eye blink sensing technology along with seat belt remainder system. This system takes Arduino Mega 2560 as a main controller and monitors with the help of various sensors and conveys message through GSM module. Roushan Kumar et al [2] aimed to design and developed the hardware for power window control mechanism using AVR ADMEGA16 microcontroller. Wesley Torres et al [3] considered an approach for model based safety functionality for the embedded software of automobile power window system. Dian et al [4] have discussed about the features based on gradient orientation is employed to detect and describe the seat belt by using image pre-processing, the front window location and human face detection. Kiyami et al [5] have discussed the development of a new breath alcohol detector without mouthpiece to prevent alcohol impaired driving. Lea et al [6] proposed to develop a system that captures the iris image of the driver by detecting if the person is drunk and likewise to develop a reliable algorithm for iris recognition.

3. System Overview

The enhanced features helps to suppress the accidents that happen on road. The hardware setup consists of Raspberry pi ARM 11 processor, DC motor drive, LCD display, IR sensor, seat belt sensor, gas sensor and camera. Raspberry pi ARM 11 processor is a credit card sized, single board computer which acts as a heart of the system. The hardware parts like camera, IR sensor, seat belt sensor and gas sensor gives input to the Pi board. Camera is used to detect the drowsiness of the driver and IR sensor is used to find whether obstacle is present in the path of power windows. Gas sensor is used to identify the drunken driver and Banana sensor is used for seat belt monitoring. The system arrangement is shown in figure 1.

![Block Diagram of Safety Systems](image1.png)

The system consists of various steps such as sensing parameters in peak time, comparing with threshold values and activating the corresponding output signal. The driver’s drowsiness is detected by capturing his face and monitoring the eye movement continuously. Initially the threshold value
will be calculated by using horizontal and vertical eye points and then compared with the current real
time value if it exceeds buzzer will alert. Seat belt reminder sensor detects occupants and rear seats.
This information is used along with the banana sensor to trigger an audible output chime. Gas sensor
which has a high sensitivity to alcohol with quick response speed is used to detect the drunken drivers
and sends messages to the nearby police station through cloud.

4. Results and Discussion

4.1 Anti pinch window system

It is a safety system which is employed in power windows of modern cars. If the window finds
any obstacle in its path, it prevents up further movement thus preventing any injuries. This system
consists of motor which is used to operate the window. Usually, children watch out through windows
of the car and they try will lend their hands or necks out through the window. In such a case, it will
cause injuries or asphyxiate to children when someone operates the window accidentally. These
things can also happen in such windows which are programmed without the necessity to press the
switch. To avoid such mishaps, engineers invented the anti-pinch.

The window of the car is equipped with Infrared sensor which is connected to the stepper motor.
If infrared sensor finds any obstacle it will make the motor to stop moving further and also to make it
to rotate in reverse direction. The working of IR sensor is shown in Figure 2. Microcontroller is used
as interface between sensor and stepper motor. Anti-Pinch window effect is shown in figure 3.
infrared signal will get reflected after hitting the obstacle and it is received. The signal received is amplified by amplifier because the signal is very weak. It is a brushless DC motor which divides its full rotation into equal number of steps. Consist of a permanent magnet with rotating shaft, called the rotor.

![Obstacle detected](image1.png)

**Figure 4.** LCD Output For Anti-Pinch Window System

Depending upon the logic signal fed it rotates accordingly in clockwise or in anticlockwise direction, for each step it rotates 90 degree. For each stepper motor it has its own steps. The DC stepper motor along with PI interfacing is shown in Figure 5.

![DC stepper motor interfacing with PI board](image2.png)

**Figure 5.** DC stepper motor interfacing with PI board

4.2. Drowsiness Detection
Face detection is more difficult because of variability and dynamic nature of human face. There are many methods to monitor drowsiness, one of them is camera. It process radio stream in real time to compute the drowsiness of the driver. The calculation are made by monitoring the number of frames when eye is open and number of frames when eye is closed, The camera is placed on the vehicle dashboard for effective face capture. The system takes input image stream of a drivers eyes for analysis purpose. The frames of data stream where the driver’s eyes are detected is used for calculation purpose. The output is sent to the alarm board, when it exceeds the index value, alarm gets activated. Tracking of face and eye depends on the face illumination and right intensity. Image processing is done on each frame to determine the state of driver’s eye in a real time. Flow chart of drowsiness detection is shown in figure 7. The drowsiness index is calculated based on the frame.

![Flow Chart For Drowsiness Detection](image1)

**Figure 7. Flow Chart For Drowsiness Detection**

![Block Diagram of Drowsiness Detection](image2)

**Figure 8. Block Diagram of Drowsiness Detection**

The following technique is used for finding the drowsiness. Those are physiological characteristics, drive operation sensing, vehicle response sensing, and the response of driver. These can be implemented with the hardware support of raspberry pi and support of python and OS platform-Linux. The system block diagram of drowsiness detection is shown in figure 8. Due to secretion of adrenalin and acetylcholine, the area of opening eye changes. Basically, our eye movements are controlled by six muscles namely superior rectus, inferior rectus, lateral rectus, medial rectus, and superior oblique and inferior oblique. And this six muscles activity is controlled by
the nerve. Due to the movements of these muscles, pupil part of eye is dilated or constricted and iris part of eye is also constricted or dilated. In order to monitor the eye movements along with the iris and pupil area, we have to use a camera for capturing the real time images of eye. For further processing on that image; we need to send the image to Raspberry-pi system. Our proposed system consists of open source 5 megapixel digital camera for capturing real time images of car driver. System is loaded with Raspbian OS and Python packages for Open CV (Computer Vision).

4.3. Alcohol Detection

Countless people’s life has been cut short because of driving under alcohol influence. By drinking and driving you put not only your life at risk but also the life of passengers and life of people at road sides. So in this project we developed automatic engine locking system through alcohol detection. This system works on the principle, if a driver has drunk, the sensor will detect the alcohol consumption value in the driver’s breathe and compares it with the reference value. If it goes beyond the reference value it will immediately send the location of the vehicle to the nearby police station. The sensor value is fed to the microcontroller which processes the value and compares with reference value and also operates the GPS module. Before and after detected threshold value is shown in Figure 9 and 10. Generally there are 24 satellites on the earth which gives us latitude longitude and other details of our current location. There are totally six orbits and each orbits consists of four satellites, so totally we use to get location details from four satellites with respect to our location.

4.4. Seat Belt Sensor

As we all know, seat belts are now used by all airlines and in almost all automotive vehicles
with the possibility that they may become mandatory for buses and trains as well. In recent years the Reed Switch sensor has been discovered by safety belt designers as being perhaps the best and most reliable way to detect when a seat belt has been engaged. Our seat belt remainder (SBR) sensor mat detects occupants in passenger and rear seats. This information is the vehicle to trigger a warning light and or an audible chime reminding unbuckled seat occupants to fasten their seat belts. LCD output for Seatbelt Detection is shown in Figure 13.

If you are getting traffic tickets for not wearing seatbelt and when you come to renewal your insurance, rates could skyrocket or even it can be canceled. Read sensor detection with and without wearing seat belt is shown in figure 11 and 12. According to recent survey still seat belts remain the number one vehicle safety device, despite new detection and accident avoiding technologies. Seat belts can also help in keeping pregnant women alive, which is the most important thing a woman can do to protect her unborn child in a car. They are instructed to wear the lap belt low, so that it pulls downward on the pelvic bones.

Figure 11. Reed Sensor Detection without Wearing Seatbelt

Figure 12. Reed Sensor Detection Wearing Seatbelt

Figure 13. LCD Output for Seatbelt Detection
5. Conclusion

The proposed system is a demo version of car safety system using open CV software and other hardware. This detection is based on the high pixel camera therefore it will have more accuracy. Open CV is an open source software therefore the system is cost-effective compared to MATLAB based system. The use of ARM 11 processor also ensures the high speed. Later this system can be employed in most of the cars for enhanced safety. The system can be used for automobile applications by making required changes in the hardware setup according to the number of safety measures should perform simultaneously. The changes may include more no of cameras, high range IR sensor and advanced motors. This system provides detection of drowsiness, alcohol detection, Anti-pinch effect and seat belt monitoring system, all these can be modified according to the future need by reprogramming the requirements which includes interfacing of ignition system for enhanced safety.

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