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A Prototype Car Display Control System with Motion and Seat Belt Sensing

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A Prototype Car Display Control System with Motion and Seat Belt Sensing

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Abstract. The article presents a prototype for a car screen lock system that promotes seat belt use while also regulating screen access. The system incorporates motion detection, seat belt monitoring, sound alarms, and screen lock function, and serves as a conceptual model for potential integration into real-world automotive systems. The prototype simulates automotive using motion detection and continuously examines seat belt fastening status, promoting the use of seat belts as an important safety measure. Built-in auditory alerts give the driver with aurel reminders, stressing safety compliance. When the car is moving and the seat belt is fastened, the screen is unobstructed, otherwise is locked with an advisory message. The significance of this approach rests in reducing the significant risks associated with noncompliance. Failure to wear a seat belt not only raises the chance of serious injury in a crash but also encourages distractions such as mobile phone use, missing navigation directions, and ignoring vital notifications, jeopardizing driver focus and overall road safety. The research as a future path includes seamless integration with genuine automobile sensors and displays while following safety rules to provide a practical and safe in-vehicle display control system.

Keywords: Screen lock system, automotive, seat belt security, display control, sensors, microcontroller, driver safety.

1. Introduction

Prioritizing road safety has never been more important in today's changing automotive scene. The potential for distraction within the vehicle has expanded rapidly as technology progresses, creating a compelling need for creative solutions that not only promote safe driving practices but also limit risks associated with noncompliance. This article focuses on creating a cutting-edge car display control system called "Drive Rules" which uses motion detection and seat belt sensing to encourage responsible driving behavior.

"Drive Rules" is primarily intended to address two of the most serious safety concerns in modern vehicles: seat belt usage and screen distractions. Seat belts are the first line of defense against injuries in the case of an accident, and their effective use is an unavoidable safety precaution. However, there are times when drivers and passengers fail to secure their seat belts, putting themselves and others on the road at risk.

The use of in-car displays is the second main source of vary. While these displays provide useful information and pleasure, they can also be sources of distraction, diverting a driver's focus away from the road. Critical Navigation directions, important notifications, and even phone calls and messages frequently compete for drivers' attention, posing serious safety risks.

"Drive Rules" addresses these difficulties by combining motion detection and seat belt sensor technology. It monitors the vehicle's movements, ensuring that the display is only visible when the vehicle is moving. Simultaneously, the device monitors seat belt usage and prompts individuals to buckle their seat belts.

2. Literature review

The use of modern technologies to obtain information in real time is beneficial for drivers and passengers. These offer several advantages, but the biggest disadvantage is that drivers and passengers may lose focus if they are reminded of this information at the same time they neglect the rules of wearing seat belts [1]. Perhaps the designs of the screens and where they are placed will help, for example, positioning them with your head up promotes a level of concentration even when driving [2].

Allowing navigation systems and the growth of information acquisition has its benefits, but this information may also take steps in the sense of safety, such as speed adjustment, and so on [3]. Perhaps the major need of drivers and passengers is to allow the quality of services while driving, with 1045 drivers polled indicating that the quality of services is paramount [4].

The presented paper does not deal with the study of seat belt placement detection because there are several detection techniques and methodologies, mostly using modern technology such as image processing and the application of various sensors. While traveling primarily on highways, drivers are primarily concerned with speed and reaction time is reduced; this scenario leads us to believe that there must be methods of detecting the deployment of the safety belt like in the study's examples [5].

Many scientific studies have shown that not wearing or properly wearing a seat belt increases the number of fatalities. As in the case [6], the results reveal that the increase in the number of fatalities is likewise due to not wearing a seat belt.

Furthermore, regulations on the installation and use of seat belts should be devised and detailed, and it should be made unique for the first time in the continent and the entire world because people are moving much more nowadays [7], the framework must be developed to push drivers and passengers to make decisions, particularly in public transportation. Based on study findings [8], it can be shown that people's confidence in the usage and non-use of seat belts is not very great.

Based on experience, science, and the development of legislation governing the use of seat belts, it is apparent that their use by drivers and passengers reduces the likelihood of fatal accidents. It has been confirmed via a review of the literature that regardless of the complaint, such as the syndrome of not wearing a belt, its use must be mandated both legally and due to technological restrictions.

Referring [9] to the authors who searched the seat belt-related literature on all the publishing platforms, including PubMed, Scopus, Web of Science, etc. From this, we can observe that there are numerous works, but this does not imply that the field is fully explored; in fact, we may still strengthen it with the use of current technologies. In the article [10], infrared cameras were used, as well as monitoring with the Driving Monitoring System and Occupant Monitoring System -OPS, which constantly follow the wearing of the seat belt as well as others related to the condition of the driver, especially eye fatigue. his eye, as monitoring in a cabinet camera[11].

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3. Problem definition

The research attempts to address the safety factors that provide additional risks to drivers and passengers due to the high safety of distraction control.

Research question: What is the effectiveness of in-car display systems in reducing vehicle crashes and encouraging the use of seatbelts?

Hypothesis: Our theory is that the installation of a car screen lock system will encourage the use of seat belts and decrease instances of distracted drivers.

The system will work as a conceptual model for the integration of the actual vehicle and detect potential movement, seat belt monitoring, voice alarms, and screen locks. The screen remains clear when the car is moving and the seat belt is buckled; if not, a warning will appear and the screen will lock. The reduction of an issue about inconsistency highlights the significance of this section. In addition to increasing the risk of injury in an accident, not wearing a seat belt increases the risk of distracted driving, lost navigation, and disregard for traffic

4. Methodology

A systematic method was used in the creation of “DriveRules” car display control system to assure the successful integration of motion detection, seat belt sensing, voice alerts, and display control functions. The techniques are divided into major stages, each of which is critical to the overall operation and safety of the system.

The first phase entailed a thorough examination of the requirements. Gathered information from surveys, current literature, and talks with vehicle safety specialists. This process enabled to identification of the unique issues associated with control display, seat belt monitoring, and distraction prevention while driving.

Following a requirements analysis, carefully choose the essential hardware component, which includes Raspberry Pi Pico, camera module, and piezo buzzer. These components served as the system foundation. Furthermore, because of its versatility and interoperability with the Raspberry Pi environment, python is for major programming language.

Motion detection was accomplished by carefully placing motion sensors within the vehicle to properly evaluate its movement. Seat belt detection methods were built using a combination of camera modules and pressure sensors, allowing real-time monitoring of seat belt usage. To ensure accurate measurements, these components were calibrated and configured.

Voice alarms are added to increase safety, this included the development of voice recognition and synthesis capabilities, which allowed the system to provide audio reminders to the driver in the event of seat belt noncompliance or when the car was not in motion. The display control logic was painstakingly constructed, with algorithms dictating screen accessibility based on motion and seat belt status.

A critical of the system design was user interaction. It designed a user-friendly interface with buttons, indicators, and display messages that allowed drivers to accept audio alarms and renter displays when safety conditions were met. To assure the system's reliability, accuracy, and safety compliance, rigorous testing and validation procedures were carried out utilizing predetermined test scenarios and environments.

In the future “Driverules”, offer the potential for scalability and integration with real-world vehicle systems. These future paths entail more hardware advancement as well as conformity with industry standards. Throughout the project development, ethical concerns about privacy, data collection, and user consent were paramount.

The “Drive rules” car display system was developed using this methodology, setting the groundwork for a comprehensive and safety-conscious solution to seat belt compliance and in-car display distraction, improving road safety.

5. Results

The results are given as predicted system behavior and user interaction in the absence of a fully built system. The following intended outcomes can be expressed using the code and methodology:

Car Status, when you hit the Start Car button, the system replicates the transition of the car from stationary to a driving condition. The car status label is updated as a result of “Fig 1” and “Fig 2”.

The fasten seat belt button simulates attaching the seat belt, the seat belt status label indicates whether or not is secured. When the seat belts have been tightened and the Fasten Seat Belt button is hit, "Fig. 3" immediately sends you a "Have a nice trip" message.

If the seat belt is not tightened or the car is not moving the “Voice Alarm” button activates a simulated voice alarm message to encourage the users to fasten the seat belt and keep the car moving so that the display can be accessed.

The “Control Display” button illustrates display access control. The display becomes available when the car is not in motion and the seat belt is secured. Otherwise, the display stays blocked, and the apps reflect this.

The user experience is expected to correlate with the “Drive Rules” system’s stated safety objectives. Users will be able to engage with the app’s graphical interface to mimic automobile movements, fasten seat belts, receive voice alarms as reminders, and see how seat belt compliance affects display access.

It is critical to recognize the code described here is a simplified prototype that does not communicate with real automotive sensors or hardware. The integration of these components would determine the actual behavior and consequences. Interfacing with authentic automotive systems, adding voice recognition and synthetic ca[abilitites, and resolving safety rules and ethical considerations for a fully functional “Drive Rules” system are all possible in future approaches.

In summary, while the given results are based on a conceptual prototype, they provide insight into how the “Drive Rules” system is planned to operate and interact with users in order to promote seat belt compliance and display control for improved road safety.

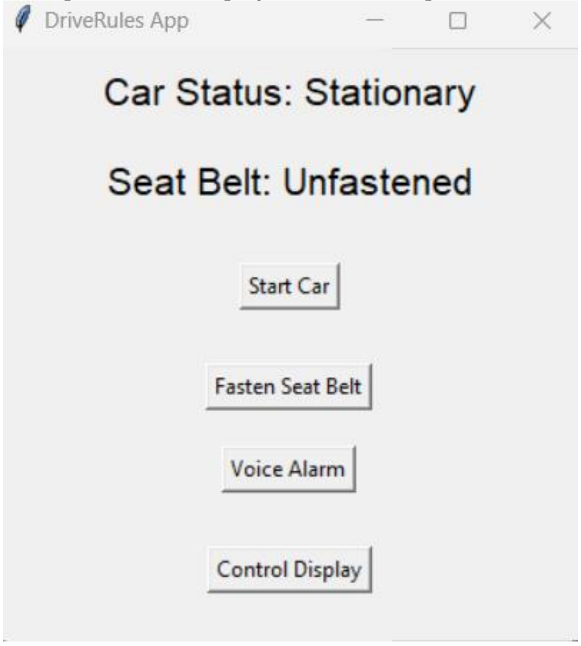

Figure 1. Drive Rules App

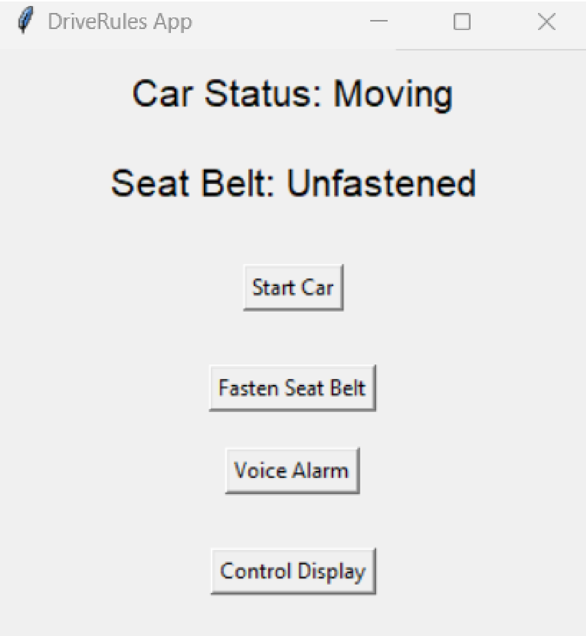

Figure 2. After hitting "Start Car"

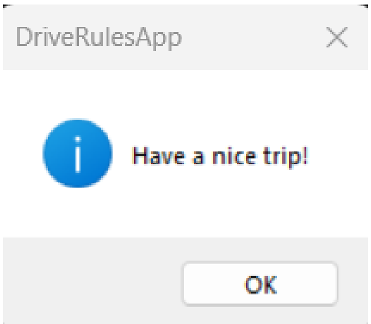

Figure 3. After hitting Fasten Seat Belt button

6. Discussion

In the research paper's discussion, we can highlight the significance of the results obtained from the predicted system behavior and user interaction. The code and methodology allowed us to achieve several intended outcomes. Firstly, the "Car Status" feature accurately simulates the transition of the car from stationary to a driving condition when the "Start Car" button is pressed. The car status label dynamically updates based on the simulated actions represented in "Fig 1" and "Fig 2”. Secondly, the "Fasten Seat Belt" button replicates the process of attaching the seat belt, and the seat belt status label indicates whether it is secured or not. When the seat belts are tightened and the "Fasten Seat Belt" button is pressed, "Fig. 3" promptly displays a "Have a nice trip" message. Moreover, if the seat belt is not fastened or the car is not in motion, the "Voice Alarm" button activates a simulated voice alarm message to remind users to fasten their seat belts and keep the car moving in order to access the display. The "Control Display" button demonstrates access control to the display. The display becomes available only when the car is stationary and the seat belt is secured. Otherwise, the display remains blocked, and the apps reflect this restriction. The user experience aligns with the safety objectives of the "Drive Rules" system. Users can interact with the graphical interface to mimic real automobile movements, fasten seat belts, receive voice alarms as reminders, and observe how seat belt compliance impacts display access. However, it is crucial to acknowledge that the described code represents a simplified prototype that does not integrate with actual automotive sensors or hardware. The inclusion of these components would determine the system's actual behavior and consequences. Future approaches could involve interfacing with authentic automotive systems, incorporating voice recognition and synthetic capabilities, and addressing safety rules and ethical considerations to develop a fully functional "Drive Rules" system. In conclusion, while the obtained results are based on a simulated environment, they provide valuable insights into the potential functionality and user experience of the "Drive Rules" system. Future developments can explore further enhancements and address real-world integration challenges.

7. Future work

The seamless integration of “Drive Rules” system with actual vehicle hardware and sensors is a vital avenue for future study. This would allow the system to interact with real-world vehicle data, such as speed sensors and seat belt sensors, improving accuracy and effectiveness. Integration of the technology with the vehicle's existing display infrastructure would also create more authentic user experience.

Future work can concentrate on implementing improved voice-recognized and synthetic technologies. These improvements would allow the system to interpret the driver’s spoken commands and offer clear and context-aware voice alarms. Improved voice interaction capabilities would make the system more accessible and user-friendly.

Future development should emphasize rigorous testing and validation to assure widespread adoption and compliance with safety requirements. It is critical to test the system's safety features, such as ensuring that voice alarms do not generate distractions. Compliance with industry-specific safety standards and regulatory laws is also critical for the system’s deployment in real-world cars.

The “Drive Rules: systems data can provide significant insights into driver behavior and safety compliance. Implementing data analytics tools to monitor user interactions, assess compliance patterns, and provide individualized safety advice could be part of future development.

Appendix

```
import tkinter as tk
from tkinter import messagebox

class DriveRulesApp:
    def __init__(self, root):
        self.root = root
        self.root.title("DriveRules App")

        self.car_moving = False
        self.seat_belt_fastened = False
        self.display_blocked = True

        self.create_widgets()

    def create_widgets(self):
        self.car_status_label = tk.Label(self.root, text="Car 
Status: Stationary", font=("Helvetica", 16))
        self.car_status_label.pack(pady=10)

        self.seat_belt_label = tk.Label(self.root, text="Seat 
Belt: Unfastened", font=("Helvetica", 16))
        self.seat_belt_label.pack(pady=10)

        self.start_car_button = tk.Button(self.root, text="Start 
Car", command=self.start_car)
        self.start_car_button.pack(pady=20)

        self.fasten_seat_belt_button = tk.Button(self.root, 
text="Fasten Seat Belt", command=self.fasten_seat_belt)
        self.fasten_seat_belt_button.pack(pady=10)

        self.voice_alarm_button = tk.Button(self.root, 
text="Voice Alarm", command=self.trigger_voice_alarm)
        self.voice_alarm_button.pack(pady=10)

        self.display_control_button = tk.Button(self.root, 
text="Control Display", command=self.toggle_display)
        self.display_control_button.pack(pady=20)

    def start_car(self):
        self.car_moving = True
        self.car_status_label.config(text="Car Status: Moving")

    def fasten_seat_belt(self):
        self.seat_belt_fastened = True
        self.seat_belt_label.config(text="Seat Belt: Fastened")

        # Check if the car is moving
        if self.car_moving:
            self.root.destroy()  # Close the window
            messagebox.showinfo("DriveRulesApp", "Have a nice 
trip!")

    def trigger_voice_alarm(self):
```

```
        if not self.seat_belt_fastened or not self.car_moving:
            print("Voice Alarm: Please fasten your seat belt and
ensure the car is moving to use the display.")

    def toggle_display(self):
        if self.car_moving and self.seat_belt_fastened:
            self.display_blocked = not self.display_blocked
                  self.root.title("DriveSafe App - Display
      Accessible" if not self.display_blocked
               else "DriveSafe App - Display Blocked")

if __name__ == "__main__":
    root = tk.Tk()
    app = DriveRulesApp(root)
    root.mainloop()
```

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