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# Design and Developing Systems to Enhance Vehicle Safety and Usability

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***Abstract* - Road traffic accidents are a significant global concern, particularly in developing countries such as India, where the number of accidents is increasing due to inadequate safety features on vehicles and poor visibility at night. In response, a study has been conducted to design and develop safety measures to reduce accident severity and minimize casualties. This research paper proposes several safety measures, including a new system that allows the driver to access the vehicle even without the keys and addresses common issues such as sharp turns and seatbelt engagement that can prevent serious injuries in accidents. The study provides a comprehensive overview of safety technologies designed to prevent accidents and reduce fatalities.**

***Keywords:*** Vehicle safety, Arduino UNO, Keyless access, Auto-adjusting Headlamps, Speed limit, Seatbelt.

## 1. Introduction

Vehicle safety has become a top priority for manufacturers, leading to the development of various safety systems that make vehicles safer and more customers friendly. With increasing complexity, manufacturers are integrating safety systems with Arduino based control systems, making them more manageable and user-friendly. This project aims to improve the safety and automation of the vehicle.

The project is motivated by common problems encountered by drivers such as forgetting or losing car keys, inadequate lighting around turns, and safety hazard when seat belt not engagement properly. The project proposes keyless access to vehicles through mobile phones, adaptive headlights for safer night driving, and a seatbelt warning system to reduce the effort required to manage safe driving practices.

These solutions will be linked to Arduino systems, reducing costs and effort for passengers.

The project aims to enhance the safety of vehicles by reducing the likelihood of accidents and injuries to drivers and passengers.

## 2. Literature Review

**Keyless access:**

- Jinita Patel [1] (2018) developed a new RKE system that helps prevents and protects vehicle on-board systems from key fob cloning, relay attack, jamming, etc. This technology uses advanced authentication of key and vehicle onboard systems by preserving the privacy information of communicating entities. This technology helps maintain security as well as improve the efficiency of operation for the users.
- Ji Gao NIU[3] (2018) implemented a system to improve the security and convenience of the remote keyless entry (RKE), based on the MC9S12G128 microcontroller and μC/OS-II real-time operating system. The method adopts advanced radio frequency technology, which can realize the two-way authentication between the key and the vehicle without taking out the key, thus opening the car door. The test results show that the proposed PKE control system has better stable performance, high security, and convenient operation.
- Nishad N. Gupte and Mihir R. Shelar [3] (2013), proposed a system with replaces the physical key with a digital key to access the equipped system. This digital will help maintain access to the user anywhere without ever needing a key to access, the key will be unique and will only be restricted to the correct user. This technology will improve the overall safety of the equipped system and help protect the user from illegal access.

**Auto-adjusting headlamps:**

- Priyanka M Dubal [1] (2018) proposed a system to help drivers in tight corners and low illumination areas using flexible front lights for automobiles to illuminate the road ahead at night. AFS (adaptive front-lighting system) is used to detect information about the corner in advance with the help of a sensor that detects the information and sends it to the motor to adjust headlamps to get the lighting beam that was suitable for the corner.
- Fengqun Guo [2] (2013) analyzed the photometric characteristics of vehicle headlamps when turning the

 

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corner and developed a new kind of AFS (adaptive front-lighting system) based on CCD (charge-coupled device) which was better than traditional AFS. This new AFS used a CCD image sensor to detect information about the corner and then sent the curvature radius to electronic control units in advance.

- Vaishali D. Todkar [3] (2016) researched AFS (Adaptive front light system) for automobiles for assisting drivers in dark or closed corners at night, it uses an LPC 2138 and an ARM7 series microcontroller is used to control the motor. The motor is used to rotate the headlight mounted above it. The system improved the accuracy and reliability of the headlamp which resulted in the overall safety of the vehicle.

**Seatbelt warning:**

- S.D. Rahul Bhardwaj [1] (2014) proposed a seatbelt system integrated with a sensor that is connected to the wheels of the vehicle. In this system, the vehicle will only start when the seatbelt of the driver is engaged, and the door of the vehicle is locked. According to the estimation the implemented system can decrease the fatality rate in accidents by up to 70%-80% in comparison to the old system.
- Akshay Vetal [2] (2017) proposed a system in which Drivers will be unable to start vehicles without wearing a seat belt. The technology connects the driver and the co-passenger seat belts with the Ignition system such that without fastening the seat belts, the engine will not start. The control also disengages the power input to the ignition switch after 30-40 seconds resulting in shutting down the vehicle in half position.
- Priyal N Sheth [1] (2015) proposed a system that not only improves safety but also aids the driver. The system safety system ensures that the driver and co-passenger wear safety seat belts while driving a car. The driver-assistive safety system works on 'ignition interlocking" and "speed control". This system improves vehicle occupant safety and overall improves road safety.

In this paper, we are using Arduino-based solutions to design and develop systems to improve the safety standards of the vehicle. These systems will be implemented using various Arduino UNO applications and will help improve the overall experience for the passenger as well as reduce costs and try to maintain good safety standards.

## 3. Requirements

### 1) Hardware requirements:

*Keyless access:*

- Arduino Uno
- Power source- battery
- Linear Solenoid, 12V DC
- 5V Relay

*Auto-adjusting headlamps:*

- Servo Generic continuous rotation(micro-size)
- Breadboard-half size and side pot (10 k liner taper)
- Arduino UNO with all system requirements
- Capacitor, Resistor, and Lights
- Power supply (12V DC 2A)

*Seatbelt warning:*

- Arduino Uno
- Seatbelt buckle switch
- Speed limiter

### 2) Software Requirements:

- Arduino IDE
- C and C++

## 4. Objectives

The main objective of this project is to improve vehicle safety and ease of driving for the driver and passengers. Other follows:

1) To operate and perform vehicle operations with ease, while maintaining the authenticity between vehicle and user, in the absence of a physical key.
2) Headlight setup which orients itself according to turn angle and speed, being able to illuminate the areas on turns.
3) To improve occupant and road safety of the vehicle by limiting the speed when the seatbelt is not engaged.

## 5. Methodology

**Keyless access:**

- Phones have now become an essential part of life, as they allow people to perform various tasks, which range from business operations, transactions, communication, entertainment, etc. Hence, a person may forget the keys to the vehicle but is highly unlikely to forget their phone.
- This Arduino based door lock has one solenoid lock. A Solenoid lock acts as a latch for electrical locking and unlocking. The Arduino Bluetooth module connects the vehicle to the phone via Bluetooth. Arduino Uno is a main platform where all the components are mounted and programmed. Relay 5 volt is an automatic switch that is commonly used in an automatic control circuit and

 

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to control a high-current using a low-current signal 18650 battery, Battery holder, and jumper cable.

**Auto-adjusting Headlamps:**

- Traditional headlamps are fixed to place and illuminate the path right in front of the vehicle. With adaptive headlamps, we conceptualize the need for self-adjusting headlamps, whose purpose is to orient themselves according to the turn of the vehicle i.e., vehicle path/road, and according to the vehicle speed.
- This setup would require input sensors, a microcontroller, and servo motors for positioning the headlights.
- The headlamps are to orient themselves as per the driving circumstances. The position of the headlights is dependent on the direction of the vehicle so the input to the headlight system is attached to the vehicle's steering shaft. A simple geared mechanism is attached to a low-power type potentiometer that can then feed directly into the microcontroller.

**Seat-belt warning:**

- When the driver and passenger sit on the seats of the vehicle, a spring switch gets activated. The switch acts as the first system to interact with occupants and the control unit on the vehicle which is the speed limiter to keep the vehicle limited to the set safety limit allowed.
- The speed limiter is connected to the Arduino Uno which has been programmed to control and manage the safety of the occupants when the seatbelt is not engaged by setting the vehicle speed to a limit. The speed limit is removed once the seatbelt is engaged, and the vehicle is allowed to speed up to the maximum speed.
- A warning is given to the driver by an indicator on the dashboard of the vehicle through Arduino Uno that the seatbelt is not engaged, and the occupants need to check their seatbelts. This system is integrated into the vehicle seats and control unit for better management.

## 6. Proposed System

**Keyless access:**

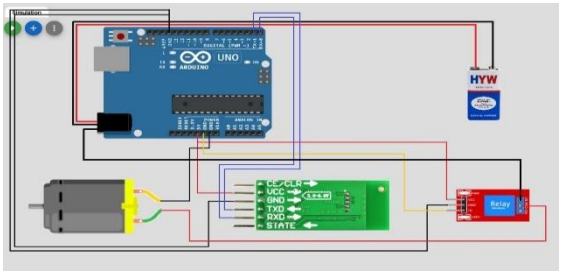


**Figure 1: Keyless Access system configuration**

The proposed system consists of Arduino UNO which is programmed to connect to a mobile device with an active Bluetooth connection. The signal is sent from the phone to the Bluetooth module (indicated in green) via an RF signal. Arduino UNO is coded to perform the locking and unlocking of the solenoid lock, as per the signals received.

**Auto-adjusting headlamps:**

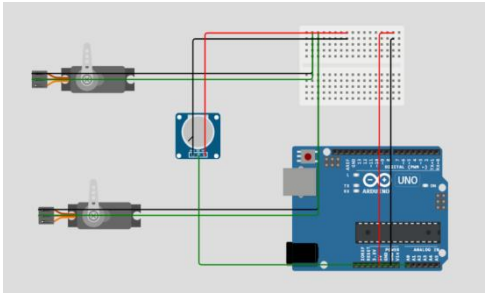


**Figure 2: Auto-adjusting headlamps system configuration**

The proposed system consists of a potentiometer that is linked to the steering column. The rotation given to the steering by the driver, sets the resistance value of the potentiometer. The value is then analyzed by the Arduino UNO, which is programmed to adjust the servo motors according to the driver's input.

**Seatbelt warning:**

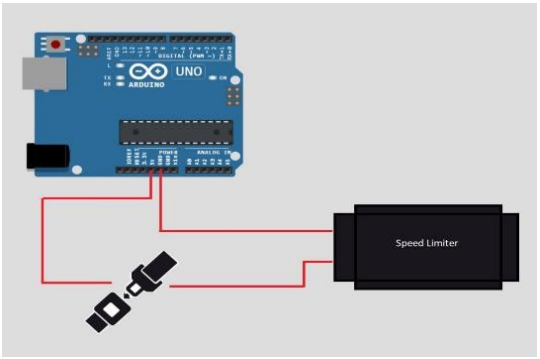


**Figure 3: Seatbelt warning system configuration**

The proposed system consists of a switch mechanism inbuilt into the seat belt buckle. The switch acts as a circuit breaker for the speed limiter. The speed limiter is set to a safety speed limit of 45kmph, in case the occupants don't have their seat belts fastened, and removes the speed limit when the seat belts are fastened. The whole system is based on the programming set in the Arduino UNO.

## 7. Results and Conclusion

- Maintain authenticity between user and vehicle, even in the absence of a physical key.

 

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- Improved headlight illumination technology, i.e., enhancing visibility at turns.
- Improving occupant and road safety by applying seatbelt engagement verification system.

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