**Savitribai Phule Pune University, Pune**

**A Mini Project Report**

**On**

**ENHANCING ROAD SAFETY: INTEGRATED VEHICLE SAFETY SYSTEM**

Submitted By

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In partial fulfillment of

**Bachelor Of Engineering  
(Electronics & Telecommunication)**

Department Of Electronics & Telecommunication Engineering

**Sandip Foundation's  
SANDIP INSTITUTE OF ENGINEERING & MANAGEMENT,  
NASHIK  
(2023-2024)**

**Savitribai Phule Pune University, Pune**

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Guided by  
**Prof. Sayali J. Pawar**

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**Sandip Foundation's  
SANDIP INSTITUTE OF ENGINEERING & MANAGEMENT,  
NASHIK  
(2023-2024)**

**SANDIP FOUNDATION SANDIP INSTITUTE OF ENGINEERING & MANAGEMENT, NASHIK(MH) 2023-24**

**CERTIFICATE**

This is to certify that, the project **Enhancing Road Safety: Integrated Vehicle Safety System**

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is a Bonafied work completed under my supervision and guidance in partial fulfillment for award of Bachelor of Engineering (Electronics & Telecommunication) Degree of University of Pune (MS, INDIA).

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**ABSTRACT**

The Integrated Vehicle Security System (IVSS) is a sophisticated technology framework designed to improve road safety and protect vehicle occupants. It integrates advanced hardware and software components, providing real-time monitoring and protection mechanisms for drivers and passengers. The IVSS uses sensors like alcohol detectors, seatbelt sensors, and engine locking mechanisms to detect and respond to potential risks like drunk driving or seatbelt non-compliance. It also enables fingerprint authentication for authorized engine start upon seatbelt fastening, detects and prevents intoxicated driving by gradually stopping the motor upon alcohol detection during vehicle movement, and initiates motor stops and alerts drivers to fasten seatbelts if removed while the vehicle is in motion. For instance, upon seatbelt fastening, the IVSS enables fingerprint authentication for authorized engine start. This process involves capturing a digital image of the fingerprint, converting it into a template suitable for matching, calculating a match score based on similarity with stored templates, and making a pass/fail decision for authentication. Similarly, the IVSS detects and prevents intoxicated driving by gradually stopping the motor upon alcohol detection during vehicle movement. The alcohol sensor provides a binary digital output (0/1) indicating alcohol presence or absence, along with an analog output (variable voltage) that can be converted to an alcohol concentration value for more detailed readings. The IVSS uses sophisticated algorithms and real-time data processing to analyse sensor data, make informed decisions, and trigger appropriate actions to ensure safety and compliance. This holistic approach addresses common risks like unauthorized access and theft, as well as critical safety concerns like impaired driving and seatbelt compliance. The IVSS contributes significantly to creating a safer road environment by protecting occupants and enhancing overall road safety standards.

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SIEM, NASHIK

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**CHAPTER 1.**

**INTRODUCTON**

The Integrated Vehicle Security System (IVSS) represents a significant advancement in road safety by integrating cutting-edge technology to enhance vehicle security and protect occupants. Combining sophisticated hardware and intelligent software components, the IVSS is designed to provide real-time monitoring and protection for drivers and passengers alike. On the hardware side, the system incorporates a range of sensors including alcohol detectors, seatbelt sensors, and engine locking mechanisms. These sensors work in coordination with actuators and controllers to detect potential risks such as drunk driving or seatbelt non-compliance. For instance, when the seatbelt is fastened, the system allows fingerprint authentication for authorized engine start. Conversely, if the alcohol sensor detects alcohol while the vehicle is in motion, the system gradually stops the motor to prevent intoxicated driving. Similarly, if the seatbelt is removed during vehicle movement, the system initiates a gradual motor stop and alerts the driver periodically to fasten the seatbelt. The software aspect of the IVSS is equally crucial, employing sophisticated algorithms and real-time data processing to analyze sensor data and trigger appropriate actions. This comprehensive approach not only addresses common risks like unauthorized access and theft but also tackles critical safety concerns such as impaired driving and seatbelt compliance. Ultimately, the IVSS contributes to a safer road environment for all, protecting occupants and enhancing overall road safety standards.

**1.1 Objectives**

* Driver Authentication: Implement a reliable system for authenticating drivers using a fingerprint sensor to ensure that only authorized individuals can operate the vehicle.
* Alcohol Detection: Integrate an alcohol sensor into the system to detect the presence of alcohol and prevent intoxicated individuals from driving.
* Real-time Monitoring: Provide real-time feedback to the driver regarding the authentication status and alcohol detection status through the Serial Monitor.
* Enhanced Road Safety: Enhance road safety by combining driver authentication and alcohol detection to reduce the risk of accidents caused by unauthorized or intoxicated drivers.
* Scalability: Design the system in a modular and scalable manner to allow for potential integration of additional safety features in the future, such as seatbelt detection, speed limit enforcement, and collision avoidance.

**1.2 Scope:**

* System Initialization: Establish serial communication, set pin modes for buzzer and motor, and connect with the fingerprint sensor during system startup.
* Driver Authentication: Continuously check for a finger on the fingerprint sensor, capture and convert fingerprint images into templates, and authenticate drivers based on matches in the sensor's database.
* Alcohol Detection: Monitor the alcohol sensor's digital and analog outputs to detect the presence of alcohol in the vicinity of the driver.
* Real-time Feedback: Display real-time feedback on the Serial Monitor regarding the status of the fingerprint sensor, driver authentication status, and alcohol detection status.
* Safety Features Integration: Lay the foundation for potential integration of additional safety features like seatbelt detection, speed limit enforcement, and collision avoidance based on future requirements.

**1.3 Significance:**

* Road Safety Enhancement: The project significantly enhances road safety by ensuring that only authenticated drivers who are not under the influence of alcohol can operate the vehicle.
* Accident Prevention: By preventing unauthorized or intoxicated individuals from driving, the system reduces the risk of accidents caused by impaired driving.
* Compliance: The system aims to comply with relevant laws and regulations regarding vehicle safety and privacy, contributing to a safer and more regulated transportation environment.
* Scalability: The modular and scalable design of the system allows for potential expansion and integration of additional safety features, making it adaptable to evolving safety standards and requirements.
* Technological Innovation: The integration of driver authentication and alcohol detection using sensors represents a technological innovation in vehicle safety systems, showcasing advancements in smart and secure transportation solutions.

**CHAPTER 2.**

**LITERATURE SURVEY**

Table 2.1 Literature Survey

|  |  |  |  |
| --- | --- | --- | --- |
| **Title** | **Years** | **Authors** | **Description** |
| Vehicle Safety System Using Fingerprint Scanner and Driving License Data | 2021 | Sudeeksha Agrawal, Shubham Bhardwaj, Raghav Tyagi & Vikas Rastogi | This paper presents a unique method of automobile security where a government-issued authorized driving license is mandatory for a person to drive the vehicle. |
| A Survey of Driver Behavior Detection and Recognition Systems. | 2021 | Hernandez-Mejia, L. A., & Olmos, S. | Reviews driver behavior detection systems, which could complement IVSS for a more comprehensive safety approach. |
| A Review of Intelligent Transportation Systems (ITS) Technologies and Applications. | 2020 | Salam, O. E., Eid, C., Abu-Mahfouz, A. M., & Al-Qadi, I. J. | Discusses Intelligent Transportation Systems (ITS) technologies, which can include some functionalities relevant to IVSS. |
| A Review of Advanced Driver Assistance Systems (ADAS) and Their Impact on Road Safety. | 2020 | Kumari, N., & Verma, U. | Discusses ADAS features and their contribution to road safety, potentially including some related to IVSS functionalities. |
| A Survey of In-Vehicle Driver State Monitoring Techniques. | 2019 | Ji Q., Yan B., Zhang Z., Liu Y., & Li H. | Reviews various driver state monitoring (DSM) techniques applicable to IVSS, including alcohol detection. |
| A Survey of Alcohol Detection Systems for In-Vehicle Applications. | 2018 | Mounir, G., Mussa, M. H., Guettari, N., & Chetto, N. | Reviews alcohol detection systems suitable for in-vehicle use, a core component of IVSS. |
| A Survey of Anti-Theft Systems for Vehicles. | 2018 | Ahire, S. S., & Patil, P. M. | Reviews anti-theft systems for vehicles, potentially including engine locking mechanisms relevant to IVSS. |
| A Survey of Advanced Driver-Assistance Systems (ADAS). | 2018 | Shladover, S. E. | Reviews Advanced Driver-Assistance Systems (ADAS), which can be integrated into IVSS for enhanced safety. |
| A Review of Vehicle Security Systems. | 2018 | Abdullah, N. A. B., Zakaria, Z., & Abd Rahman, M. S. | Reviews vehicle security systems, potentially including engine locking mechanisms relevant to IVSS. |
| A Review of Driver Authentication Techniques for Secure Vehicle Access Control. | 2017 | Wang, Y., Li, X., Cheng, H., & Liu, J. | Explores driver authentication techniques for vehicle access control, potentially applicable to IVSS fingerprint authorization. |
| Driver Alcohol Detection System for Advanced Driver Assistance Systems (ADAS). | 2014 | Ji, Q., Zhang, Z., & Liu, Y. | Discusses alcohol detection systems in the context of ADAS, applicable to IVSS as well. |

**CHAPTER 3.**

**SYSTEM METHODOLOGY**

The Integrated Vehicle Safety System is designed to enhance road safety by integrating driver authentication and alcohol detection. During system initialization, the serial communication is established, and the pin modes for the buzzer and motor are set. The system also connects with the fingerprint sensor and halts if the sensor is not found.

For driver authentication, the system continuously checks for a finger on the sensor. Once detected, the fingerprint image is captured and converted into a template, which is then searched in the sensor’s database. If a match is found, the driver is authenticated, and the motor is turned on. If no match is found, the system triggers the buzzer and continues to loop until a valid fingerprint is detected.

The system also continuously monitors the alcohol sensor’s digital and analog outputs. If alcohol is detected (digital output is 1), the system gradually stops the motor and triggers the buzzer. If no alcohol is detected (digital output is 0), the buzzer is turned off.

The system provides real-time feedback to the driver through the Serial Monitor, displaying the status of the fingerprint sensor, the driver’s authentication status, and the alcohol detection status. The system continuously monitors the fingerprint sensor and the alcohol sensor to ensure safe vehicle operation.

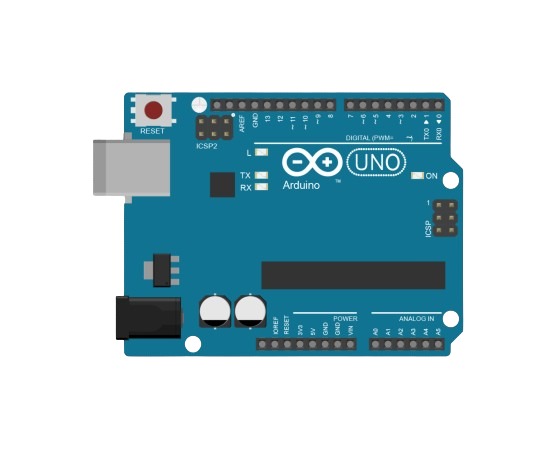
This methodology ensures that only authenticated drivers can operate the vehicle and prevents operation if alcohol is detected, enhancing road safety. This basic system may need to be adapted or extended based on specific requirements or conditions, such as integrating additional safety features like seatbelt detection, speed limit enforcement, or collision avoidance. The system should also comply with all relevant laws and regulations regarding vehicle safety and privacy.

**3.1 Hardware Components**

Table 3.1 Hardware Components

|  |  |
| --- | --- |
| **Component** | **Specifications** |
| Arduino Uno | 5V Microcontroller |
| Fingerprint Module | R307 fingerprint scanner |
| Alcohol Sensor | MQ3 |
| Seatbelt Switch | Limit Switch/Bump Switch |
| Buzzer Module | 5V PCB Mounting Buzzer |
| Motor | 150 RPM L1 Type BO Motor |
| Batteries | 9V |
| Connecting wires | For connection |

* **Arduino UNO Microcontroller**



**Fig 3.1 Arduino UNO (Atmega 328p)**

The Arduino Uno is a popular microcontroller board designed for beginners and hobbyists. Here's a breakdown of its general specifications and features in a non-tabular format:

**Microcontroller:**

• Atmega328P by Atmel (Microchip)

• 16 MHz clock speed

• 32 KB of flash memory for program storage (of which 0.5 KB is used by the bootloader)

• 2.5 KB of SRAM for data storage

• 1 KB of EEPROM for non-volatile data storage

**Input and Output:**

• 14 digital input/output pins (of which 6 provide PWM output)

• 6 analog input pins (with 10-bit resolution)

• A power jack for external power supply (7-12V DC)

• A USB connection for programming and power

• An ICSP header for advanced programming and debugging

**Communication:**

• Built-in hardware serial communication for connecting with computers or other devices (Rx and Tx pins)

• Supports SPI and I2C communication protocols (requires additional library setup)

**Power:**

• Can be powered via the USB connection or an external power supply

• Voltage regulator allows for a range of input voltages (7-12V DC)

• On-board LED connected to digital pin 13 for basic output testing

**Other Features:**

• Reset button for restarting the program

• LED indicator for power and activity

• Compact and breadboard-friendly design

• Built-in Wi-Fi, Bluetooth, or Ethernet connectivity (requires additional shields)

• High processing power for complex applications (better suited for beginner projects)

• Large memory capacity for storing extensive data sets (limitations due to onboard flash memory)

**Application:**

Arduino technology is a key component in the Integrated Vehicle Security System (IVSS), enhancing its functionality and responsiveness. By integrating microcontrollers, the IVSS can process sensor data, execute decision-making algorithms, and control actuators for immediate responses. Arduino boards can manage inputs from alcohol detectors, seatbelt sensors, and engine locking mechanisms, enabling real-time monitoring of driver behaviour and vehicle safety status. The flexibility and programmability of Arduino allow for customized logic implementation, contributing to a more intelligent and proactive approach to road safety.

* **MQ-3 Alcohol Sensor Module**



**Fig 3.2 MQ3 Alcohol Sensor**

**Description:** The MQ3 is a gas sensor that detects alcohol vapor.

**Features:**

* Alcohol detection: Sensitive to alcohol fumes.
* Analog output: Provides an analog signal proportional to alcohol concentration.
* Compact size: Suitable for integration into safety systems.

**Application:**

Drunk Driving Prevention:

* In the vehicle safety system, the MQ3 can detect alcohol presence in the driver’s breath and trigger safety measures (e.g., ignition lock) to prevent drunk driving.
* Configure the Atmega 328p to read analog data from the MQ-3 sensor, which detects alcohol vapor in the environment.
* Implement threshold logic in the microcontroller firmware to determine whether the alcohol concentration exceeds a predefined level.
* If the alcohol concentration is above the threshold, trigger a Buzzer and prevent the engine from starting or disable it if the vehicle is already running.
* **R307 Fingerprint Sensor Module**



Fig 3.3 R307 Fingerprint Module

**Description:** The R307 is an optical fingerprint scanner module from the R30X series produced by Hangzhou Grow Technology Co., Ltd.

**Features:**

High accuracy and reliability: The R307 ensures precise fingerprint recognition.

Fast response time: It quickly identifies fingerprints.

Secure fingerprint template storage: Stores fingerprint templates securely.

Low power consumption: Efficient power usage.

Compatibility with various operating systems: Works well across different platforms.

**Application:**

Biometric Authentication: The R307 can be used for secure access control, attendance systems, and other applications where fingerprint identification is crucial.

* **Seatbelt Limit Switch**

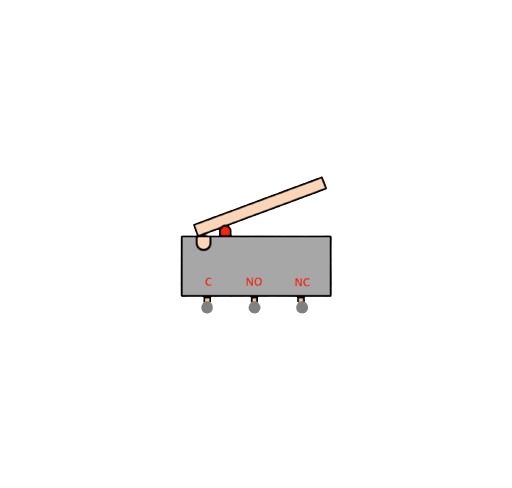


Fig 3.4 Limit Switch

**Description**: The seatbelt limit switch is a mechanical switch installed in the seatbelt buckle.

**Features:**

Normally closed (NC): The switch is closed when the seatbelt is fastened.

Open circuit when unbuckled: When the seatbelt is unfastened, the switch opens.

Simple design: Easy to integrate into seatbelt systems.

**Application:**

Seatbelt Reminder: The switch detects whether the seatbelt is fastened or not. If unbuckled while the vehicle is in motion, it can trigger visual or audible reminders to encourage seatbelt use.

The Limit switch is a crucial seatbelt interlock in the Integrated Vehicle Security System (IVSS), strategically placed near the seatbelt buckle. Its primary function is to detect if the seatbelt is properly fastened. When a passenger fastens the seatbelt, the switch sends a signal to the IVSS control unit, indicating the seatbelt is secured. This information is vital for the system's safety protocols, ensuring passengers comply with seatbelt regulations. If an unfastened seatbelt is detected while the vehicle is in motion, the IVSS triggers immediate action, such as activating seatbelt reminder alerts. The IVSS can also integrate this data into its risk assessment algorithms, adjusting the severity of responses based on safety implications. The Limit switch also contributes to the overall safety ecosystem by providing real-time feedback on passenger occupancy and seating status, enabling targeted safety interventions and optimizing safety systems' responses based on real-time occupancy data.

* **Buzzer**

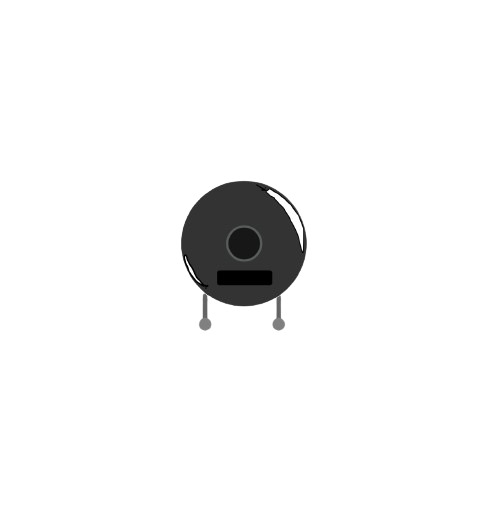


Fig 3.5 Buzzer

**Description:** A buzzer is an electronic component that produces sound when an electrical signal is applied to it.

**Application in Road Safety:**

Warning Signals: Buzzer alarms can be used to alert drivers or pedestrians about potential hazards, such as proximity to obstacles, lane departure, or speeding.

Emergency Situations: In case of accidents or breakdowns, a buzzer can signal for help or draw attention to the situation.

Pedestrian Safety: Buzzer-based crosswalk systems can notify pedestrians when it’s safe to cross.

* **Motor**

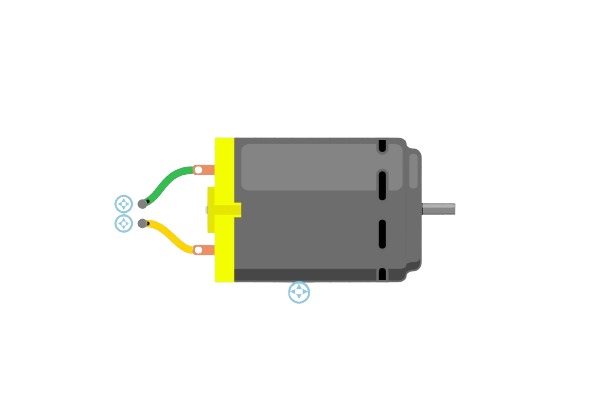
****

Fig 3.6 Motor

**Description:** Motors are devices that convert electrical energy into mechanical motion.

**Application in Road Safety:**

Windshield Wipers: Motors drive windshield wipers, ensuring clear visibility during rain or snow.

Power Windows: Motors control car windows, allowing passengers to open or close them safely.

Seat Adjustments: Motors adjust seat positions for optimal driving comfort and safety.

Electric Power Steering: Motors assist in steering, enhancing vehicle stability.

**3.2 Circuit Diagram**

**Fig 3.7 Circuit Diagram**

**Circuit Documentation**

Summary

This circuit is designed to integrate various components with an Arduino UNO microcontroller to perform a series of functions including alcohol detection, fingerprint scanning, motor control, and visual/audible alerts. The circuit utilizes an MQ-3 alcohol sensor, a fingerprint scanner, a piezo buzzer, a DC motor, a limit switch, and an LED with a resistor for indication purposes. The Arduino UNO is programmed to read inputs from the alcohol sensor and fingerprint scanner, control the motor and buzzer, and light up the LED based on certain conditions.

**Component List:**

* Arduino UNO
* Microcontroller board based on the ATmega328P
* It has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header, and a reset button.
* MQ-3 Alcohol Sensor Breakout
* A breakout board for the MQ-3 alcohol sensor
* It has four pins: VCC, GND, DO (Digital Output), and AO (Analog Output).
  + Piezo Buzzer
  + An electronic device that produces sound when an electrical signal is applied
  + It has two pins for electrical connection.
* Fingerprint Scanner
* A biometric sensor that captures fingerprints for identification purposes
* It has four pins: VCC, TX (Transmit), RX (Receive), and GND.
* DC Motor
* An electric motor that runs on direct current electricity
* It has two pins for power connection.
* Limit Switch
* A switch that is actuated by the motion of a machine part or presence of an object
* It has three pins: C (Common), NO (Normally Open), and NC (Normally Closed).
* LED: Two Pin (red)
* A red light-emitting diode used for indication
* It has two pins: anode and cathode.
* Resistor (200 Ohms)
* A passive two-terminal electrical component that implements electrical resistance as a circuit element
* It has two pins for connection and a resistance value of 200 Ohms.

**Wiring Details**

* Arduino UNO

GND connected to the ground pins of the Piezo Buzzer, MQ-3 Breakout, Fingerprint Scanner, DC Motor, and LED.

3.3V connected to the VCC of the MQ-3 Breakout.

A0 connected to the AO of the MQ-3 Breakout.

D2 connected to the RX of the Fingerprint Scanner.

D3 connected to the TX of the Fingerprint Scanner.

D4 connected to the Piezo Buzzer.

D6 connected to the DC Motor.

D8 connected to the DO of the MQ-3 Breakout and NO of Limit Switch.

5V connected to the Limit Switch.

* MQ-3 Alcohol Sensor Breakout

VCC connected to the 3.3V of the Arduino UNO.

GND connected to the ground net.

AO connected to the A0 of the Arduino UNO.

DO connected to the D8 of the Arduino UNO.

* Piezo Buzzer

Pin 1 connected to the ground net.

Pin 2 connected to the D4 of the Arduino UNO and through a 200 Ohm resistor to the ground net.

* Fingerprint Scanner

VCC connected to the NC of the Limit Switch.

TX connected to the D3 of the Arduino UNO.

RX connected to the D2 of the Arduino UNO.

GND connected to the ground net.

* DC Motor

Pin 1 connected to the D6 of the Arduino UNO.

Pin 2 connected to the ground net.

* Limit Switch

NC connected to the VCC of the Fingerprint Scanner.

NO connected to the D8 of the Fingerprint Scanner.

C connected to the 5V of the Arduino UNO.

* LED: Two Pin (red)

Cathode connected to the ground net.

Anode connected to the pin1 of the Resistor.

**3.3** **Block Diagram**

**Fig 3.8 Block Diagram**

**Explanation:**

* MQ-3 Alcohol Sensor: This is the first block in the diagram. It’s responsible for detecting the alcohol concentration in the vicinity of the vehicle. If the detected alcohol level crosses a predetermined threshold, it sends a signal to the Arduino board.
* Arduino Board: This is the central component of the system. It receives inputs from all the sensors and controls the relay module based on these inputs. If the alcohol sensor detects alcohol above the threshold, the Arduino board activates the relay module.
* R307 Fingerprint Sensor: This block is responsible for driver authentication. The driver needs to place their finger on this sensor before starting the vehicle. If the fingerprint matches an authorized individual, a signal is sent to the Arduino board.
* Seatbelt Sensor/Switch: This block checks if the seatbelt is fastened. If the seatbelt is not secured, it sends a signal to the Arduino board, which then prevents the vehicle from starting by activating the relay module.

In summary, the block diagram represents a safety system where each block performs a specific function, and the Arduino board acts as the central controller, making decisions based on the inputs from each block.

**3.4 Working Principle**

1. **Alcohol Sensing:** The system incorporates an alcohol sensor module, such as the MQ-3 alcohol sensor1. This sensor detects the alcohol concentration in the vehicle's vicinity. When the alcohol level crosses a predetermined threshold, it indicates that the driver is under the influence of alcohol.
2. **Engine Locking:** To prevent the vehicle from being driven while under the influence, the system includes a relay module that can control the engine's ignition or fuel system1. When the alcohol sensor detects alcohol concentration above the threshold, the system activates the relay module, effectively locking the engine and preventing it from starting.
3. **Fingerprint Starter:** In addition to alcohol sensing, the system incorporates a fingerprint sensor module, such as the R307 fingerprint sensor1. Before attempting to start the vehicle, the driver needs to place their finger on the sensor for authentication. Only if the fingerprint matches an authorized individual, the system allows vehicle ignition.
4. **Seatbelt Interlock:** To promote seatbelt usage and ensure the driver's safety, the system integrates a seatbelt sensor or switch1. The seatbelt sensor detects whether the seatbelt is fastened or not. To start the vehicle, the system checks for a valid fingerprint and a secured seatbelt connection. If either of these conditions is not met, the vehicle ignition remains locked.

**3.5 Software Components:**

**Arduino IDE:**

The Arduino Integrated Development Environment (IDE) is a cross platform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards.

The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main () into an executable cyclic executive program with the GNU tool-chain, also included with the IDE distribution. The Arduino IDE employs the program argued to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware. By default, argued is used as the uploading tool to flash the user code onto official Arduino board.

1. **Initializing:** The program starts by initializing the necessary pins, modules (such as ADC for analog readings), and variables.
2. **Alcohol Sensing:** The program constantly reads the analog input from the alcohol sensor module connected to the Atmega 328p. It compares the read value with the predefined alcohol threshold. If the reading exceeds the threshold, it sends a signal to activate the relay module to lock the engine.
3. **Fingerprint Authentication:** Once the alcohol sensing is clear, the program waits for the user to place their finger on the fingerprint sensor module. It reads the fingerprint data and compares it with the authorized fingerprints stored in the microcontroller. If there is a match, the program allows the vehicle ignition to proceed.
4. **Seatbelt Interlock:** As the driver tries to start the vehicle, the program checks the status of the seatbelt sensor or switch. If the seatbelt is not fastened, the program prevents the vehicle ignition and provides a warning through LED indicators or a buzzer.
5. **Additional Safety Features:** You can include other safety features, such as checking vehicle speed, monitoring engine temperature, or detecting abnormal behavior, as required by your project specifications.
6. **Loop:** The program continuously runs in a loop, regularly checking the alcohol level, fingerprint authentication, and seatbelt status. It responds accordingly by locking the engine, allowing ignition, or providing warnings.
7. **User Interface:** The program may include a user interface for display and interaction, such as an LCD screen or LEDs, to show system status, prompts, or error messages.
8. **Testing and Debugging**: It is essential to thoroughly test and debug the software to ensure proper functioning, accuracy, and reliability of the system.

**Program:**

#include <Adafruit\_Fingerprint.h>

#include <SoftwareSerial.h>

SoftwareSerial mySerial(2, 3); // RX, TX

Adafruit\_Fingerprint finger = Adafruit\_Fingerprint(&mySerial);

int buzzer = 4;

int motorPin = 6; // Motor connected to digital pin 6

#define sensorDigital 8

#define sensorAnalog A1

void setup()

{

Serial.begin(9600);

pinMode(buzzer, OUTPUT);

pinMode(motorPin, OUTPUT); // Set the motor pin as output

digitalWrite(motorPin, LOW); // Initially turn off the motor

finger.begin(57600);

if (finger.verifyPassword()) {

Serial.println("Found fingerprint sensor!");

} else {

Serial.println("Did not find fingerprint sensor :(");

while (1);

}

}

void loop()

{

uint8\_t p = FINGERPRINT\_NOFINGER;

while (p != FINGERPRINT\_OK) {

p = finger.getImage();

if (p != FINGERPRINT\_OK)

{

continue;

}

p = finger.image2Tz();

if (p != FINGERPRINT\_OK)

{

continue;

}

p = finger.fingerFastSearch();

if (p != FINGERPRINT\_OK)

{

digitalWrite(buzzer, HIGH);

delay(1000);

continue;

} else

{

// found a match!

Serial.print("Found ID #");

Serial.print(finger.fingerID);

Serial.print(" with confidence of ");

Serial.println(finger.confidence);

digitalWrite(motorPin, HIGH); // Turn on the motor when fingerprint is authorized

}

}

while(1)

{

bool digital = digitalRead(sensorDigital);

int analog = analogRead(sensorAnalog);

Serial.print("Analog value: ");

Serial.print(analog);

Serial.print(" t");

Serial.print(“Digital value: ");

Serial.println(digital);

if (digital == 1) {

// Gradually stop the motor when alcohol is detected

for(int i = 255; i >= 0; i--){

analogWrite(motorPin, i);

delay(20);

}

digitalWrite(buzzer, HIGH); // Turn on the buzzer when alcohol is detected

}

else

{

digitalWrite(buzzer, LOW);

    }

  }

}

**Explanation:**

1. **System Initialization**: In the setup() function, the system initializes the serial communication, sets the buzzer and motor pins as output, and turns off the motor initially. It also starts the fingerprint sensor and checks if it’s connected. If the sensor is not found, the system will halt with an error message.
2. **Driver Authentication**: In the loop() function, the system continuously checks for a finger on the sensor. Once a finger is detected, the system captures the fingerprint image and converts it into a template. This template is then searched in the fingerprint sensor’s database. If a match is found (i.e., the fingerprint is recognized), the system turns on the motor. If no match is found, the system triggers the buzzer and continues to loop until a valid fingerprint is detected.
3. **Alcohol Detection**: The system continuously reads the digital and analog values from the alcohol sensor. The digital value indicates the presence of alcohol (1 if alcohol is detected, 0 otherwise), and the analog value represents the concentration of alcohol.
4. **Safety Actions**: If alcohol is detected (i.e., the digital value is 1), the system gradually stops the motor and triggers the buzzer. This is done using a for loop that gradually decreases the motor’s speed until it stops completely. If no alcohol is detected (i.e., the digital value is 0), the buzzer is turned off.
5. **Feedback**: The system provides real-time feedback by printing the analog and digital values from the alcohol sensor to the serial monitor.

In summary, this system enhances vehicle safety by ensuring that only an authenticated driver can operate the vehicle and by preventing the vehicle from being driven if alcohol is detected. Please note that this is a basic system and may need to be adapted or extended based on specific requirements or conditions. For example, additional safety features such as seatbelt detection, speed limit enforcement, or collision avoidance could be integrated into the system. Also, the system should comply with all relevant laws and regulations regarding vehicle safety and privacy.

**3.6 System Operation:**

* **Power-On Initialization**: When the vehicle's power is turned on, the Atmega 328p microcontroller initializes all necessary pins, modules, and variables. The system is ready to monitor for alcohol concentration, fingerprint authentication, and seatbelt status.
* **Alcohol Sensing**: The alcohol sensor module continuously monitors the vehicle's environment for alcohol concentration. If the sensor detects alcohol above a predetermined threshold, the Atmega 328p sends a signal to the relay module to lock the engine, preventing it from starting.
* **Fingerprint Authentication**: If the alcohol sensing does not detect alcohol levels above the threshold, the system prompts the driver to place their finger on the fingerprint sensor for authentication. The Atmega 328p compares the fingerprint data obtained with the authorized fingerprints stored in its memory. If the fingerprint matches, the system allows the driver to proceed to start the vehicle.
* **Seatbelt Check**: As the driver attempts to start the vehicle, the system checks the status of the seatbelt sensor or switch. If the seatbelt is not fastened, the Atmega 328p disallows vehicle ignition and activates a warning through LED indicators or a buzzer.
* **System Error Handlin**g: Throughout the operation, the system continually checks for errors and inconsistent inputs. It provides appropriate feedback to the driver, such as indicating a failed fingerprint authentication or an unfastened seatbelt.
* **System Reset and Monitoring**: After a driving session, the system resets and prepares to monitor again when the vehicle power is turned off and on.
* **Maintenance and Diagnostics**: The system may include functionality for diagnostic checks to ensure all components are functioning correctly and prompt the driver or service personnel if any issues arise.

**CHAPTER 4**

**PERFORMANCE ANALYSIS**

* 1. **Calculations**

**Blood Alcohol Concentration (BAC) Limit: 0.08%**

- In milligrams per liter (mg/L): 0.08% BAC = 0.08 g/dL = 80 mg/dL

- In parts per million (ppm): 0.08% BAC = 80,000 ppm

**MQ-3 Alcohol sensor Calculations:**

- In milligrams per liter (mg/L): 0.04mg/L to 4mg/L

- In parts per million (ppm):

- 0.04mg/L is equivalent to 40 ppm.

- 4mg/L is equivalent to 4,000 ppm.

**In this project observation:**

* **Initial value**

Analog 32ppm Digital 0

* **Final Value**

Analog 660ppm Digital 1

**Alcohol detected**

* 1. **Results**

Table 4.1 System Analysis

|  |  |  |
| --- | --- | --- |
| **Sensor/Process** | **Expected Calculations/Results** | **Description** |
| Fingerprint Sensor | Fingerprint Image Capture | The sensor captures a digital image of the fingerprint placed on its surface. |
| Fingerprint to Template Conversion | The captured image is converted into a data structure (template) suitable for fingerprint matching. |
| Fingerprint Match Score | The system calculates a score indicating the similarity between the captured fingerprint template and those stored in the sensor's database. |
| Pass/Fail Decision | Based on a predefined threshold, the system determines whether the match score signifies a successful authentication (pass) or failed attempt (fail). |
| Alcohol Sensor | Digital Output (0/1) | The sensor provides a binary output indicating alcohol presence (1) or absence (0) based on a pre-set threshold. |
| Analog Output (Variable Voltage) | The sensor might also provide an analog voltage output that can be converted to an alcohol concentration value for more detailed readings (may require additional calibration). |
| System Monitoring | Fingerprint Sensor Status | The system monitors the fingerprint sensor's health and reports any errors or communication issues. |
| Driver Authentication Attempts | The system tracks the number of fingerprint verification attempts made by the driver. |
| System Uptime | The system may monitor its own operational time to track overall functionality. |

###### **Final View of Project:**

Here is the final review of our project showcasing a fingerprint sensor, alcohol sensor, and seatbelt sensor integrated into a robust security and safety setup. This system includes the IVSS (Integrated Vehicle Safety System), ensuring comprehensive security and safety measures for vehicles.

**Fig 4.1 System Outside View**

**Inside Model mechanism used in system**

**Fig 4.2 System Inside View**

**4.3 Challenges and Future Directions**

**4.3.1 Challenges:**

* **Sensor Accuracy and Reliability:** Alcohol sensors can be susceptible to interference from other substances and require regular calibration.

Fingerprint scanners can be fooled by imperfections or dirt on the reader.

Seatbelt interlock mechanisms might malfunction due to wear and tear.

* **Microcontroller Limitations:** Atmega328 is a capable but relatively basic microcontroller. It might struggle with complex algorithms for sensor data processing and real-time decision making, especially if additional features are added.
* **System Complexity:** Integrating multiple sensors, actuators (engine lock), and user interfaces (fingerprint scanner) requires careful design and robust coding to ensure smooth operation and prevent errors.
* **Tampering and Security:** A determined individual might try to bypass the system by tampering with sensors or the microcontroller itself. Security measures need to be implemented to prevent this.

**4.3.2 FUTURE DIRECTIONS:**

* **Advanced Driver Assistance Systems (ADAS) Integration:** Consider incorporating ADAS features like lane departure warning, blind spot detection, and drowsiness monitoring for a more comprehensive safety approach.
* **Biometric Authentication Expansion:** Integrate additional biometric authentication methods like facial recognition or iris scanning for enhanced security and personalized user experience.
* **Accident Detection and Emergency Response**: Develop a system that can detect accidents and automatically trigger emergency response services, potentially saving lives.
* **Voice Control Integration:** Implement voice control functionalities for features like engine start/stop or adjusting cabin temperature, minimizing driver distraction.
* **Cloud Connectivity and Mobile App Integration:** Explore internet connectivity to enable remote vehicle diagnostics, location tracking, and emergency assistance initiation through a mobile application.

**CHAPTER 5**

**SYSTEM REVIEW**

* 1. **Advantages**
* Enhanced Road Safety: The IVSS significantly enhances road safety by incorporating advanced sensors and intelligent algorithms to detect and prevent potential risks such as drunk driving and seatbelt non-compliance.
* Real-Time Monitoring: The system provides real-time monitoring and protection for both drivers and passengers, allowing for immediate responses to safety breaches like alcohol detection or seatbelt removal during vehicle movement.
* Comprehensive Security: By combining hardware components like alcohol detectors, seatbelt sensors, and engine locking mechanisms with sophisticated software, the IVSS offers a comprehensive security solution that goes beyond traditional vehicle security systems.
* Customizable Features: The IVSS can be customized and expanded to incorporate additional safety features or integrate with other systems, making it adaptable to evolving safety standards and specific vehicle requirements.
* User-Friendly Interface: The system provides user-friendly interfaces such as fingerprint authentication for authorized engine start, ensuring ease of use for drivers while maintaining high levels of security.
  1. **Disadvantages**
* Cost: Implementing the IVSS may involve significant initial costs due to the need for advanced hardware components, sensors, and intelligent software systems.
* Complexity: The integration of multiple sensors, actuators, controllers, and software algorithms can introduce complexity in system setup, calibration, and maintenance, requiring skilled technicians for installation and troubleshooting.
* False Alarms: The system may occasionally trigger false alarms, especially during calibration or in certain environmental conditions, which could lead to driver inconvenience or unnecessary system interventions.
* Dependency on Technology: The IVSS relies heavily on technology components such as sensors, actuators, and software systems, making it susceptible to potential malfunctions or failures that could impact system functionality.
* Regulatory Compliance: Ensuring compliance with relevant laws and regulations regarding vehicle safety, privacy, and data protection may require ongoing monitoring and updates to the IVSS, adding to operational complexities.
  1. **Applications**
* Automotive Safety Enhancement: The IVSS significantly enhances vehicle safety by preventing drunk driving incidents. With its ability to detect alcohol presence and gradually stop the motor if alcohol is sensed while the vehicle is in motion, the system acts as a crucial safety net to prevent accidents caused by impaired driving.
* Personalized Security: The IVSS offers a personalized vehicle access system through fingerprint recognition. By integrating fingerprint authentication with seatbelt fastening for authorized engine start, the system ensures that only authorized drivers can operate the vehicle, enhancing security and preventing unauthorized vehicle access.
* Seatbelt Compliance: One of the key features of the IVSS is its ability to encourage and enforce seatbelt usage for driver safety. The system monitors seatbelt status and initiates motor stops while alerting the driver periodically if the seatbelt is removed during vehicle movement. This not only promotes seatbelt compliance but also contributes to reducing injuries in the event of a collision.
* Impaired Driving Prevention: The IVSS plays a crucial role in preventing impaired driving by detecting alcohol presence and taking proactive measures to stop the motor gradually. This feature is particularly important in mitigating the risks associated with intoxicated driving and reducing the likelihood of accidents on the road.
* Real-time Monitoring and Intervention: With real-time monitoring capabilities, the IVSS provides immediate intervention in situations where safety breaches occur, such as alcohol detection or seatbelt non-compliance during vehicle operation. This proactive approach to safety helps in preventing accidents and protecting vehicle occupants.

**CHAPTER 6**

**CONCLUSION**

In conclusion, the Vehicle Safety System with Alcohol Sensing, Engine Locking, Fingerprint Starter, and Seatbelt Interlock using Atmega 328p is designed to enhance vehicle safety by preventing accidents caused by intoxicated driving and promoting seatbelt usage. The system integrates multiple components and functionalities, working together under the control of the Atmega 328p microcontroller. The alcohol sensing component detects alcohol concentration, and if it exceeds a predefined threshold, the system activates the engine locking feature, preventing the vehicle from starting. The fingerprint starter adds an extra layer of security by requiring driver authentication before allowing vehicle ignition. Additionally, the seatbelt interlock ensures that the driver has fastened their seatbelt before starting the vehicle.

The software component involves programming the Atmega 328p to monitor alcohol levels, perform fingerprint authentication, and check the seatbelt status. The system operates by continuously monitoring these parameters, providing appropriate feedback, and preventing the vehicle from starting if the safety conditions are not met. By combining these features, the system aims to reduce the risks associated with drunk driving and non-compliance with seatbelt usage, contributing to overall road safety. It is crucial to properly test, maintain, and ensure the reliability of all system components to ensure its effective operation. Remember to refer to the documentation and datasheets of the specific components for accurate instructions and guidelines when implementing the system. Safety should always be a priority, and integrated vehicle safety systems like this one can significantly contribute to a safer driving experience.

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**Links**

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* [UNO R3 | Arduino Documentation](https://docs.arduino.cc/hardware/uno-rev3/)
* [Rules against Drunk Driving Cases | Commissionerate of Transport | Government Of Assam, India](https://comtransport.assam.gov.in/frontimpotentdata/rules-against-drunk-driving-cases)
* [Copilot (microsoft.com)](https://copilot.microsoft.com/)
* [Arduino Forum](https://forum.arduino.cc/)

**APPENDIX**

**Program:**

#include <Adafruit\_Fingerprint.h>

#include <SoftwareSerial.h>

SoftwareSerial mySerial(2, 3); // RX, TX

Adafruit\_Fingerprint finger = Adafruit\_Fingerprint(&mySerial);

int buzzer = 4;

int motorPin = 6; // Motor connected to digital pin 6

#define sensorDigital 8

#define sensorAnalog A1

void setup()

{

Serial.begin(9600);

pinMode(buzzer, OUTPUT);

pinMode(motorPin, OUTPUT); // Set the motor pin as output

digitalWrite(motorPin, LOW); // Initially turn off the motor

finger.begin(57600);

if (finger.verifyPassword()) {

Serial.println("Found fingerprint sensor!");

} else {

Serial.println("Did not find fingerprint sensor :(");

while (1);

}

}

void loop()

{

uint8\_t p = FINGERPRINT\_NOFINGER;

while (p != FINGERPRINT\_OK) {

p = finger.getImage();

if (p != FINGERPRINT\_OK)

{

continue;

}

p = finger.image2Tz();

if (p != FINGERPRINT\_OK)

{

continue;

}

p = finger.fingerFastSearch();

if (p != FINGERPRINT\_OK)

{

digitalWrite(buzzer, HIGH);

delay(1000);

continue;

} else

{

// found a match!

Serial.print("Found ID #");

Serial.print(finger.fingerID);

Serial.print(" with confidence of ");

Serial.println(finger.confidence);

digitalWrite(motorPin, HIGH); // Turn on the motor when fingerprint is authorized

}

}

while(1)

{

bool digital = digitalRead(sensorDigital);

int analog = analogRead(sensorAnalog);

Serial.print("Analog value: ");

Serial.print(analog);

Serial.print(" t");

Serial.print(“Digital value: ");

Serial.println(digital);

if (digital == 1) {

// Gradually stop the motor when alcohol is detected

for(int i = 255; i >= 0; i--){

analogWrite(motorPin, i);

delay(20);

}

digitalWrite(buzzer, HIGH); // Turn on the buzzer when alcohol is detected

}

else

{

digitalWrite(buzzer, LOW);

    }

  }

}

**Arduino UNO**

**MQ-3 Alcohol Sensor**

**Limit Switch/Bump Switch**

This is a SPDT Snap Action Micro Switch with a lever for actuating the snap action and the switch to work. It has three pins/legs, namely Common (C), Normally Closed (NC), and Normally Open (NO). This is SPDT Single Pole Double Throw switch and can be used as both NO Normally Opened Switch or NC Normally Closed Switch separately or simultaneously, depending on the application. The lever is used to press a tiny momentary push-button below it which will establish contact between Common (C) and NO terminals. This Product is known as Bump Sensor, Bump Sensor Limit Switch, Limit Switch.

**Specifications: -**

* Voltage Rating: 3.3 ~ 250V
* Switch Type: Limit Switch
* Contact Configuration: SPDT
* Switch Terminals: Solder

**Project Overall Costing**

Table 8.1 Project Building Cost Analysis

|  |  |  |
| --- | --- | --- |
| **Component** | **Specifications** | **Component Cost** |
| Arduino Uno | 5V Microcontroller | 628 /- |
| Fingerprint Module | R307 fingerprint scanner | 1110 /- |
| Alcohol Sensor | MQ3 | 130 /- |
| Seatbelt Switch | Limit Switch/Bump Switch | 100 /- |
| Buzzer Module | 5V PCB Mounting Buzzer | 15 /- |
| Motor | 150 RPM L1 Type BO Motor | 90 /- |
| Batteries | 9V | 40 /- |
| Connecting wires | For connection | 60 /- |
| Adaptor | 12V 1 Amp | 110 /- |
| Board Body | NA | 65 /- |
| Alcohol (Sanitizer) | Sterimil | 100 /- |
| Other Components | LED, Resistors, Insulation tape, screws etc. | 110 /- |
| **Total Amount** |  | **2558** /- |