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Vehicle Driving Safety System Using Microcontroller

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ABSTRACT:

Road safety is a major concern globally, and with the increasing number of road accidents, it is imperative to develop systems that help in preventing such incidents. The proposed project, "Vehicle Driving Safety System using Arduino UNO," aims to enhance vehicular safety using a microcontroller-based embedded system. The system integrates multiple sensors and modules including a seat belt switch, alcohol sensor, fuel blocker, bumper switch, GSM, GPS, LCD display, relay, and alarm system. The main objective is to monitor critical driving conditions and respond accordingly by alerting the driver, disabling the ignition, and notifying emergency contacts.

Keywords: Arduino Uno, GSM, GPS, LCD.

I. Introduction:

The ever-increasing number of vehicles on roads has significantly raised concerns about driver and passenger safety. Traditional safety mechanisms in vehicles are either reactive or insufficiently intelligent to prevent accidents before they happen. This necessitates the incorporation of proactive, real-time monitoring and alert systems. The Vehicle Driving Safety System proposed in this project is designed to assist in early detection of unsafe driving behavior, prevent ignition in hazardous scenarios, and facilitate rapid communication with emergency services during incidents.

Road safety statistics indicate that driver negligence, alcohol consumption, and non-compliance with safety protocols like seat belts are leading causes of road accidents. Despite legal frameworks and awareness campaigns, technological intervention is crucial to ensuring compliance and enhancing safety. With the advent of microcontrollers and low-cost sensors, it's now feasible to implement such systems at scale.

This project employs Arduino UNO as the central processing unit due to its simplicity, availability, and support for multiple peripherals. The alcohol sensor (e.g., MQ-3) measures the blood alcohol concentration from the driver's breath. A seat belt switch verifies whether the driver is safely strapped in. The bumper switch identifies impacts that may indicate a collision. In such cases, an alarm is triggered, and GPS data is sent through GSM to emergency responders or guardians.

Objectives:

The primary objective of this project is to design and develop a smart, embedded safety system that enhances vehicle safety through real-time monitoring and preventive measures. Specifically, the system aims to:

1. Prevent drunk driving: Detect alcohol consumption using an alcohol sensor and disable vehicle ignition if alcohol is detected.
2. Ensure driver compliance with safety rules: Monitor seat belt usage using a seat belt switch and restrict vehicle operation if not fastened.
3. Facilitate emergency alerts: Use bumper switch for collision detection and send immediate alerts via GSM with GPS coordinates.
4. Monitor and control ignition: Automatically block fuel supply using a relay-based fuel blocker to prevent vehicle start under unsafe conditions.
5. Provide real-time feedback: Display system status and alerts on an LCD screen and use an audible buzzer for critical warnings.
6. Enable location tracking: Continuously track the vehicle's location using GPS and share it in emergency situations.

This project intends to reduce human error in driving through automation and real-time decision-making. It provides a low-cost, reliable solution that can be integrated into any vehicle without the need for drastic modifications.

Problem Statement:

Despite advancements in automotive technologies, road safety remains a critical issue due to driver negligence and human errors. Key concerns include:

 Drunk driving continues to be a leading cause of road accidents despite strict laws and fines.

 Many drivers ignore basic safety measures such as wearing seat belts, increasing the risk of severe injury.

 In the event of a crash, there is often a delay in contacting emergency services, especially when drivers are unconscious or injured.

 There is no unified low-cost solution that can monitor multiple safety parameters in real-time and take automated actions to prevent the vehicle from starting under unsafe conditions.

The absence of a smart, integrated system to ensure that vehicles are operated under safe conditions is a major contributor to road accidents. Hence, a solution that combines hardware sensors, communication systems, and automated control logic is required.

II. Literature Review:

Several studies and implementations have been conducted to enhance vehicle safety and reduce road accidents through embedded systems:

1. Drunk Driving Prevention Systems: Research has shown that alcohol detection systems using MQ-series sensors are effective in identifying ethanol concentration in a driver's breath. Various implementations using Arduino or Raspberry Pi successfully prevent vehicle ignition when alcohol levels exceed a threshold.

2. Seat Belt Detection Technologies: Traditional vehicles use mechanical seat belt sensors, but recent work includes electronic verification using microcontrollers to ensure compliance before ignition. These systems are often coupled with audio-visual alerts.

3. Accident Detection with GSM and GPS: Numerous projects have used MEMS accelerometers or mechanical switches (like bumper switches) to detect accidents. These are interfaced with GPS and GSM modules to send location and alerts to emergency responders, which significantly reduces emergency response time.

4. Integrated Vehicle Monitoring Systems: Systems have been developed to integrate multiple sensors (alcohol, proximity, temperature, etc.) into a single monitoring unit controlled by Arduino. Such models demonstrate successful real-time monitoring and low-cost deployment.

These studies indicate that a comprehensive vehicle safety system combining seat belt enforcement, alcohol detection, accident alert, and GPS tracking enhances overall safety, especially when implemented on an open-source hardware platform like Arduino.

III. System Architecture and Components

Block diagram:

Fig 1 System Block diagram

Hardware Components:

The system consists of the following key components:

1.Arduino uno: The Arduino Uno is a microcontroller board based on the ATmega328P. It features 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, and a reset button.

Fig.2 Arduino Uno Board

the internal board of Arduino consistsof all the necessary ICs for communication. It is also build compact into a PCB which has connectors for fast and easy prototyping.

2.GSM modem: This is a plug and play GSM Modem with a simple to interface serial interface. Use it to send SMS, make and receive calls, and do other GSM operations by controlling it through simple AT commands from micro controllers and computers. It uses the highly popular SIM900 module for all its operations. It comes with a standard RS232 interface which can be used to easily interface the modem to micro controllers and computers

Fig 3. GSM Module

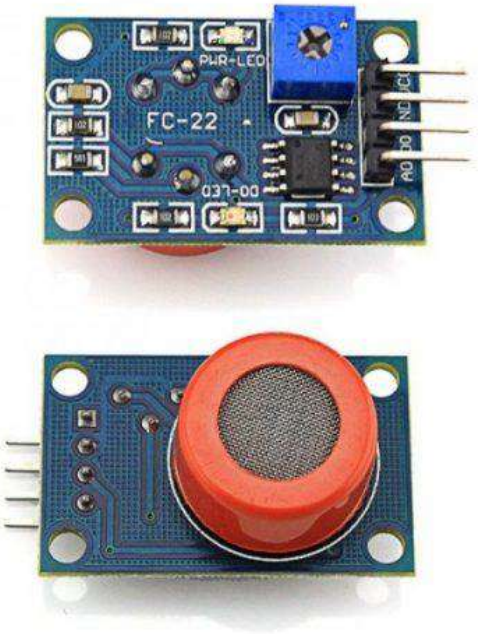

Fig 4. Alcohol Sensor

3.Alcohol sensor MQ-3:

MQ-3 is a semiconductor sensor for Alcohol detection. It has very good sensitivity and fast response to alcohol, suitable for portable alcohol detector. MQ-3 gas sensor has high senility to Alcohol, and has good resistance to disturb of gasoline, smoke and vapor. The sensor could be used to detect alcohol with different concentration; it is with low cost and suitable for different application.

4.GPS receiver module:

The NEO-6MV2 is a GPS (Global Positioning System) module and is used for navigation. The module simply checks its location on earth and provides output data which is longitude and latitude of its position.

These flexible and cost effective receivers offer numerous connectivity options in a miniature (16 x 12.2 x 2.4 mm) package. The compact architecture, power and memory options make NEO-6 modules ideal for battery operated mobile devices with very strict cost and space constraints.

Fig 5. GPS Module

Software and Programming

The system is programmed using:

☞ Arduino IDE: The Arduino integrated development environment (IDE) is a cross-platform application written in Java and is derived from the IDE for the Processing programming language and the Wiring projects.

IV. Working Principle

 Checking seat belt switch, if it is ON then power supply to system otherwise power supply is OFF.

 When driver starting car/vehicle then alcohol sensor starts sensing at condition vehicle speed equal to zero.

 If alcoholic driver detected then immediately ignition system will turn off along with SMS about detection is send to relevant of driver for notification and notification will be displayed on LCD with alarm.

 A flag is set when first condition is passed without detection of alcohol.

 When speed of vehicle is greater than zero. i.e. vehicle started to drive then again along with alcohol sensor, bumper sensor starts to sense collected parameter values are send to microcontroller.

 If alcohol detected in this case, then signal is sent to fuel blocker by microcontroller for blocking fuel supply to ignition system. So, driver feel's that vehicle is going to stop and then place car at appropriate location. At the same time SMS with current location of vehicle, vehicle number and detected information send to relative of driver and police station.

 If bumper switch is ON then it is detected as collision then signal is sent to fuel blocker by microcontroller for blocking fuel supply to ignition system. At the same time SMS with current location of vehicle, vehicle number and detected information

send to relative of driver, ambulance and police station.

V. RESULTS:

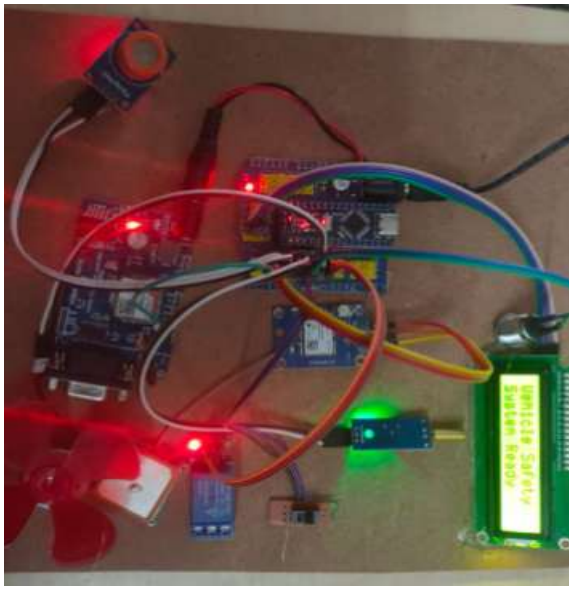

Fig 5. Vehicle safety system ready

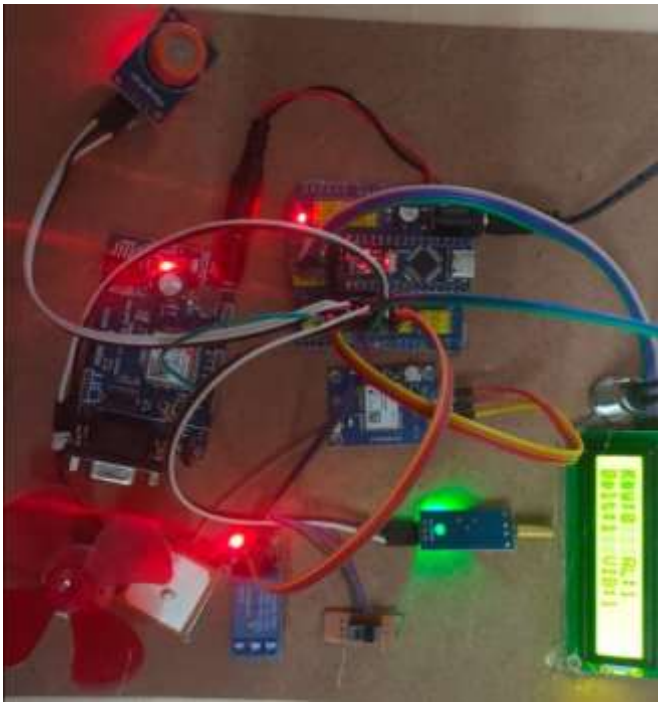

Fig 6. LCD displaying belt

VI.FUTURE ENRICHMENTS:

Future enhancements of vehicle driving safety systems using microcontrollers are poised to play a key role in achieving smarter, safer, and more autonomous transportation.

1.Advanced Driver Assistance Systems (ADAS):Real-time data processing from multiple sensors (radar, LiDAR, ultrasonic, cameras),Decision-making logic (e.g., collision avoidance),Sensor fusion using edge AI on microcontrollers.

2. Driver Monitoring System (DMS):Process input from eye-tracking cameras and sensors ,Detect drowsiness, distraction, or inattention.

3.Vehicle-to-Everything(V2X)Communication:

Handle wireless communication (V2V, V2I, V2P),Relay safety messages like road hazards, traffic light changes.

4. Real-time Environmental Monitoring:

Interface with temperature, fog, rain, gas, or road condition sensors, Road surface condition detection (e.g., ice or potholes),Microcontrollers equipped with AI to predict accident risk zones.

5. Fail-Safe and Redundancy Systems:

Monitor main safety-critical components (brakes, steering, sensors),Self-diagnosing microcontrollers that can reroute control in case of failure.

VII.CONCLUSION:

This paper presents the Vehicle Driving Safety System using Arduino UNO is an innovative solution aimed at enhancing road safety by integrating multiple preventive and monitoring features into a single embedded system. By utilizing affordable and easily available components like seat belt switches, alcohol sensors, GPS, GSM, and bumper switches, this system effectively ensures that vehicles are operated under safe conditions.

Furthermore, the system's modular design allows for future expansion, making it suitable for different types of vehicles including commercial fleets, school buses, and private cars. Its integration of safety technologies makes it a strong candidate for deployment in areas where driver negligence or harsh driving conditions are common contributors to road accidents.

In conclusion, the implementation of this Arduino-based vehicle safety system offers a practical, low-cost, and efficient approach to improving driver behavior and overall road safety. It also supports the development of smart transportation systems, contributing to a more secure and technologically advanced society.

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