DEVELOPMENT OF AN INTEGRATED ALCOHOL DETECTION WITH ENGINE CONTROL, DROWSINESS MONITORING AND EMERGENCY WATER SPRINKLER SYSTEM

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Abstract: A smart car safety system integrates four essential functions without depending on conventional add-ons. Rather than overlooking dangerous behaviors, it detects alcohol in the driver's breath using an MQ-3 sensor—preventing the engine from starting if levels are too high. Instead of reacting after the fact, it actively monitors driver alertness by analyzing blinks and facial expressions through a camera. At the first signs of drowsiness, it issues immediate alerts to help restore focus. Going further, it responds to sudden temperature increases or collision impacts by activating a built-in water spray to address emerging hazards. Together, these features offer stronger protection than standard safety checks by shifting from passive responses to proactive, real-time prevention. A compact onboard computer manages the entire system, continuously monitoring conditions and responding swiftly. All components work as a unified network rather than isolated devices, enabling faster intervention before risks escalate. This integration allows early detection of both impaired driving and fatigue, quietly identifying threats without disruption. Centered around an Arduino Uno, it uses sensors like the MQ-3 to catch signs of intoxication early, while a separate module tracks prolonged eye closure without delay. Relays intervene when necessary, smoothly cutting power to prevent accidents. Enhanced safety comes not from adding more devices, but from intelligently connecting existing ones. The aim isn't showy technology, but reliable, consistent protection on every journey. Unobtrusive intelligence acts before errors lead to harm, delivering effective solutions without added cost or complexity. Whether facing drowsiness or elevated breath alcohol, the system detects issues seamlessly. Real-world roads

demand dependable, everyday solutions—and this setup delivers with simple, efficient hardware that works quietly behind the scenes.

1.INTRODUCTION

Road accidents remain a leading cause of injuries and deaths worldwide, frequently worsened by factors like drunk driving, driver fatigue, and delayed emergency response. While advancements in automotive technology have improved safety, most existing solutions address only isolated risks, and there's still no cost-effective system that integrates these protections. What's missing is a comprehensive solution capable of monitoring driver behavior, preventing dangerous trips, and responding quickly in emergencies. To address this gap, we developed an integrated device that detects alcohol use, controls vehicle ignition, monitors alertness, and activates emergency measures—such as spraying water—when needed. Centered on an MQ-3 sensor, the system analyzes breath for alcohol; if levels are too high, the engine won't start, stopping impaired driving before it begins. Additionally, a fatigue detection feature tracks blink patterns and eye movement, issuing alerts at the first signs of drowsiness to help drivers regain focus.

2.LITERATURE REVIEW

In 2018, R. K. Sharma and colleagues developed alcohol sensors that prevent a vehicle from starting when fumes are detected inside the cabin. Rather than allowing the engine to ignite, the system cuts power to the starter motor once vapor concentrations exceed a predefined threshold. This safety measure only engages after an onboard breath test confirms the presence of alcohol. The vehicle remains immobilized until air quality returns to acceptable levels, at which point normal operation resumes.

An alert system designed by S. Gupta's team in 2019 uses Internet of Things (IoT) technology to detect alcohol and notify relevant parties. Leveraging GSM communication, it transmits warnings automatically when alcohol is sensed. The system integrates physical sensors with mobile networks, operating independently without requiring continuous human supervision. Alerts are issued promptly upon detection, demonstrating how connected devices can effectively relay safety risks.

In 2020, Patel's group introduced a relay-based electronic system that prevents engine startup if alcohol is detected, adding another layer to ignition control mechanisms.

Also in 2020, M. Singh and team introduced a drowsiness detection method combining eye blink monitoring with infrared sensors. Blink patterns were analyzed, while infrared data helped verify signs of fatigue. The system relied on dual inputs working in tandem, operating discreetly yet attentively. It triggered alerts silently when eyelid closure lasted too long, interpreting physiological cues without direct interaction.

K. Verma's research group in 2021 focused on camera-based drowsiness detection. Using software to track eye movements, they analyzed blinking behavior frame by frame. Instead of physical sensors, they used visual monitoring exclusively. Cameras replaced wearable devices, and image processing techniques converted visual data into alerts when attention waned. The system performed non-invasive monitoring, relying solely on optical analysis of facial features.

In 2022, P. Reddy and colleagues created a dual-monitoring system that detects both impaired driving and driver fatigue using interconnected sensors. While active, it simultaneously tracks breath alcohol content and signs of tiredness. Though still in early stages, the model unifies both detection types into a single alert mechanism. By connecting hardware through the internet, it enables faster responses than manual checks. Combining two data sources reduces false alarms compared to systems using only one sensor type.

D. Kumar's team in 2023 developed a multi-layered vehicle safety system designed to act before accidents occur. Unlike reactive models, this approach intervenes proactively. It uses multiple sensor layers and coordinated alerts, offering broader protection than single-solution designs. Rather than depending on one detection method, it integrates feedback across different levels. Despite its complexity, each layer contributes nuanced but valuable oversight. The system adapts its responses dynamically as conditions change, without needing driver input. Real-world testing showed reliable performance even under demanding conditions.

N. Ahmed's 2021 system began with sobriety sensors and expanded into continuous driver monitoring using compact onboard computers. Alcohol data feeds into ongoing surveillance, combining breath analysis with real-time oversight through integrated in-vehicle technology.

9. L. Wang et al. (2022): Created a driver drowsiness detection system powered by machine learning, using facial recognition and behavioral cues.

Alcohol detection is tied to automated alerts and remote monitoring through IoT-enabled systems. S. Iyer's team built such a framework in 2023, establishing continuous in-vehicle surveillance linked to external oversight.

Research Gap:

Existing systems lack:

- Integration of multiple safety features
- Real-time automated engine control
- Emergency handling mechanisms
- This project addresses these gaps by developing a cost-effective integrated system.

3.Methodology:

3.1Design Approach / Methodology Overview

Components are designed to work together intentionally, enhancing vehicle safety through coordinated functions. At the core, a central controller like the Arduino UNO enables simultaneous communication—sensors detect conditions and actuators respond promptly. The system is built simply and robustly, prioritizing reliability over complexity, and remains cost-effective for integration into actual vehicles. While in use, the MQ-3 sensor periodically checks for fumes, and driver alertness is monitored through eye activity. Temperature spikes or flames trigger immediate alerts when combustion occurs. Data flows continuously, processed against predefined thresholds to determine the appropriate response. Actions are taken swiftly based on preset limits, preventing issues before they escalate. Smooth operation depends on components following pre-established signal patterns. When necessary, the system acts—cutting engine power via a relay, sounding drowsiness warnings, or activating water spray in emergencies. Immediate response is critical, with urgent situations taking priority. Seamless interaction between parts is ensured by well-synchronized code and wiring. Designed with future upgrades in mind, it can later incorporate

GPS tracking or internet-connected sensors. By anticipating risks, the system takes proactive steps to protect occupants, helping prevent accidents before they occur.

3.2 Conceptual Design / System Architecture

Safety is a core consideration from the outset in designing this system, which integrates intelligent sensing, processing, and response components into a cohesive structure. At its core is a central control unit—potentially an Arduino UNO—that connects to multiple sensors and feedback mechanisms. Rather than operating intermittently, the system continuously monitors both the driver's condition and the external environment. When potential hazards are detected, it triggers immediate corrective actions.

Alcohol presence is monitored from the beginning using an MQ-3 sensor positioned at the entry point. A compact eye-tracking module or camera assesses the driver's level of alertness. To improve reliability, heat or fire detection relies on dedicated thermal sensors placed nearby, rather than a single method. These components transmit real-time data—either as continuous volt ... ta ag...

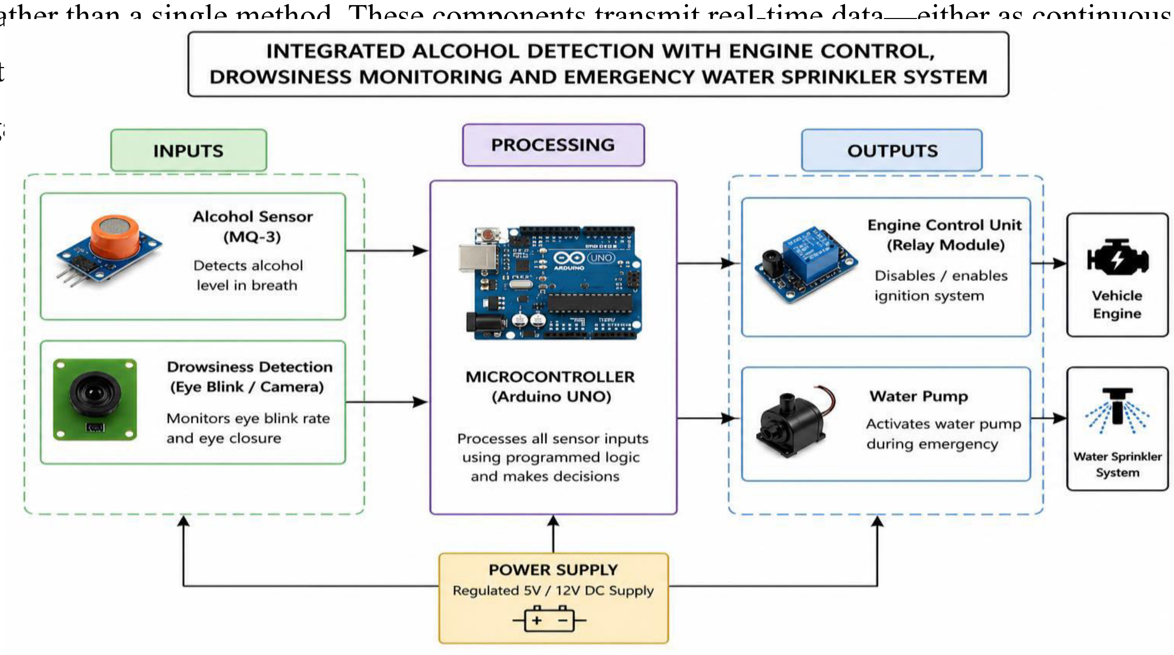

Fig.(1).The Conceptual Block Diagram of an Integrated Driver Safety System Using Alcohol Detection and Eye Blink Monitoring

4. Materials & Components

- The following materials are used in fabrication:
- Mild Steel (MS) Square Pipes
- MS Plates
- 20 mm Diameter Shaft (Axle)
- Pedestal Bearings (20 mm)
- Wheels (4 Nos.)
- Chain Drive System
- Go-Kart Steering Assembly
- Fasteners (Nuts, Bolts, Washers)

4.1 Tools and Equipment Used

- Arc Welding Machine
- Cutting Machine / Grinder
- Drilling Machine
- Measuring Tools (Vernier Caliper, Scale)
- Spanners and Wrenches
- Lathe Machine (for shaft machining)

5. Material Performance Analysis

The effectiveness of this system hinges on its responsiveness to changing conditions—its speed, accuracy, durability, and consistent performance across different environments. Centered around electronic sensors, processors, and actuators, the setup relies heavily on each component functioning properly to maintain reliable protection. The MQ-3 Alcohol Sensor detects trace alcohol vapors quickly and performs steadily under stable temperature and humidity, though significant environmental shifts may affect its output, requiring careful calibration for accurate results. For monitoring drowsy drivers, an eyelid-tracking system or intelligent camera is used, which generally identifies eye closure effectively, though performance can be affected by poor lighting or awkward head positions. At the core, the Arduino UNO acts as a compact yet capable controller, efficiently processing real-time data with minimal power use and negligible delay. All components are integrated seamlessly, ensuring smooth coordination. Thanks to relay-based control, the engine management remains durable over repeated operations, enabling swift, precise spark timing with little lag. In emergency situations, the water pump activates instantly in tandem with sprinklers, providing immediate and consistent water flow. Despite its robust design, the pump operates quietly and reliably during regular use, requiring minimal maintenance. Each part has been selected and positioned with care to ensure rapid response and dependable protection when it matters most. The system's true reliability lies in how swiftly and consistently it responds when needed.

6. Experimentation

Testing was conducted to evaluate the effectiveness of the safety system under various simulated conditions. Individual components were assessed first, followed by integrated tests to ensure proper coordination across the entire setup. The alcohol sensor, based on an MQ-3 module, was exposed to vapors ranging from low to high concentrations. Sensor outputs were carefully monitored to establish thresholds distinguishing safe from hazardous levels. Whenever alcohol levels exceeded the limit, the system was checked to confirm that engine power was cut off as intended. For drowsiness detection, simulated eye closures and blinking patterns were used. The system's ability to trigger an alert after prolonged eye closure was verified. Performance in detecting objects was also tested under varying lighting—dim, bright, and shaded conditions—to ensure consistent reliability. In potential hazard scenarios, the relay's response time was measured to confirm rapid activation. Running on optimized code, the Arduino UNO processed incoming data swiftly, applying decision rules in real time without lag.

Occasionally, temperature was increased to initiate the fire-response sequence. Once the threshold was reached, the water pump activated immediately, and sprinklers delivered a steady flow as designed. All components responded promptly and in sync once signals were received. The system maintained stable performance even during repeated stress tests. Full integration testing occurred only after individual parts demonstrated reliable operation. Multiple scenarios—including alcohol detection, driver fatigue monitoring, and emergency responses—were run to assess overall functionality, reaction speed, and durability. Results showed quick and consistent responses when threats were detected, confirming the system's practicality and effectiveness in real-world vehicle environments where safety is critical.

7. Fabrication / Development Steps

7.1. Arduino Uno – Controls the Entire System

Right in the middle sits an Arduino UNO, running on an ATmega328P chip. From different detectors - like one that senses breath alcohol and another tracking eyelid movement - it gathers data. When certain rules are met, signals go out to parts including a relay, a beeping device, and a circuit that powers motors. Low cost helps, so does adaptability, along with straightforward connections, fitting tight tech builds just fine.

7.2. MQ-3 Alcohol Sensor – Measures Alcohol Concentration

Alcohol in the air shifts how the sensor resists current. From moment to moment, it feeds live signals straight into the Arduino. Once levels climb too high, power cuts to the motor - stays dead till the air clears. Ethanol triggers the strongest reaction, making responses sharp and specific. Wrong tuning skews everything; precise setup keeps results trustworthy.

7.3. Eye Blink Sensor – Tracks Driver's Eye Movement

Light bounces off the eyelid, caught by a sensor that sees heat. When the eye shuts or lifts, data moves to a small computer board. If shut too long, an alert sounds - sleep might be setting in. Made from basic parts you can find anywhere, it watches closely but stays simple.

7.4. Relay Module – Manages Engine Power

When danger shows up, the relay stops energy going to the motor. Only if the chip says it is okay does current move through. Different paths keep low-voltage messages away from heavy-duty wires, so delicate parts stay safe. That setup lets the brain turn on the switch without touching the power directly.

7.5. L293D Motor Driver – Controls Motor Operation

This little chip links up with an Arduino to run tiny motors, giving them more juice than the main board could on its own. Flipping directions? No problem - it shifts current inside to go forward or backward at will. Even when pushing hard, the motor keeps moving smoothly without slowing down much. Protection circuits quietly watch over things, stepping in before anything gets harmed.

7.6. Buzzer – Emits Warning Tone

When it senses drowsiness or alcohol effects, the device triggers a loud beep through the buzzer. Fast reaction means the warning hits before delays creep in. Though basic in design, the alarm works well without draining resources.

12V Water Pump Triggers Spray for Attention

If the eyes stay shut too long, water squirts out right away. Not just noise - a sharp splash hits the face, stronger than beeping. That wet shock brings focus back fast when tiredness creeps in. It answers sleepiness head on, no waiting.

A small power box keeps everything running when needed. This unit holds energy at twelve volts and seven amps. It wakes up the system whenever electricity flows through it

A small battery steps in when wall current fades - twelve volts, seven amp-hours of quiet support. When it takes over, every part keeps running: the sensing units breathe, the tiny computer thinks, gears turn as needed. Without steady pressure from that power source, timing slips, actions drift off track.

7.9. Power Booster – Regulates Voltage

When the battery jumps around, this piece keeps things steady. Because voltages shift constantly, it smooths each burst into something usable. Before harsh surges hit fragile spots, they get blocked quietly. Every part gets just what it needs, nothing more, nothing less. Over time, fewer hiccups mean longer run without failure.

8. System Development

Starting off, the project focused on core safety tasks - spotting alcohol intake, tracking tiredness in drivers, handling engine responses, also sending warnings when needed. Slowly, the group built everything up, mixing physical parts with specially written software. At the heart of it sat an Arduino UNO, connected neatly to devices that sense and react. For catching breath signs of drinking, they used an MQ-3 sensor; meanwhile, how often eyes blinked showed if someone was dozing. From the start, power flowed through a relay that controlled the engine. Motion cues moved not by chance but via a motor driver tuned to respond. Instead of noise, feedback came quietly - a water pump signaling only when tests showed change. Step after step unfolded without detours, each part fitting like pieces meant to align. Simplicity stayed intact because clutter never found its way in.

One by one, each part got built on its own before any testing began. To catch breath alcohol correctly, that sensor needed careful tuning along with set warning points. Watching how eyes move became the way the tiredness checker knew when someone was fading. At the same time, turning the car off through a switch and spraying water via a small pump both worked out after checks.

Midway through testing, modules linked cleanly to the main controller without hiccups. Instead of just plugging in, the Arduino ran custom C programs using the IDE, reacting live to sensor signals. Timing stayed tight across units, preventing lag or misfires between neighboring parts. Step by step, the setup shrank into a tidy model, its wires neatly grouped and power flow smooth throughout.

Testing mostly happened in make-believe situations, like spotting sleepy or distracted drivers. When problems popped up, fixes came slowly, day after day. After changes finished, everything ran smooth - steady, predictable, quick to react. It turned out cheap parts worked well enough to avoid crashes, doing what they needed when things got serious.

Fig (2) Eye blink sensor and alcohol

Fig(3).Complete Project Prototype Model of Integrated Vehicle Safety System

9. RESULTS AND TESTING

9.1 Introduction

This part shows how the system was checked, what happened during tests, then how it performed overall. Tests ran on the model using different fake setups to see if spotting drunk states and sleepy signs worked well. What came out got broken down in charts so behavior patterns would make sense at a glance.

9.2 Alcohol Detection System Testing

Out of nowhere, rising alcohol amounts triggered higher readings on the MQ-3 sensor during testing. As vapors grew stronger, the numbers climbed without lag - clear, steady movement tracked each time. Around 500, a line formed in the data where responses shifted meaningfully. Decisions later hinged on that point when judging presence.

Observations:

When the alcohol amount stayed under the limit, the motor kept running without sounding any warning

Once the reading passed the limit, power to the motor stopped

A loud beep started when danger showed up

Result Analysis:

The system successfully prevented vehicle operation when alcohol concentration exceeded safe limits, ensuring driver and passenger safety.

Alcohol Level (ppm)	Sensor Output Value	Engine Status	Buzzer
0	120	ON	OFF
100	250	ON	OFF
200	400	ON	OFF
300	550	OFF	ON
400	700	OFF	ON

Table 9.1: Alcohol Sensor Readings vs System Response

9.3 Testing of Eye Blink Detection System

The drowsiness detection module was tested by measuring eye closure duration using the eye blink sensor. Different time intervals were considered to analyze system response.

Observations:

- Eye closure up to 2 seconds is considered normal
- At 3 seconds, the system detects drowsiness and activates buzzer
- Beyond 4 seconds, both buzzer and water pump are activated

Result Analysis:

The system effectively identifies driver fatigue based on eye closure duration and provides both audible and physical alerts, improving response effectiveness.

Eye Closure Time (seconds)	Condition	Buzzer	Water Pump
1	Normal	OFF	OFF
2	Slight Drowsy	OFF	OFF
3	Drowsy	ON	OFF
4	Sleep	ON	ON
5	Deep Sleep	ON	ON

Table 9.2: Eye Blink Duration vs System Response

9.4 Combined System Results

The integrated system was tested by combining both alcohol detection and drowsiness modules to verify overall performance.

Observations:

- Both modules function independently without interference
- Engine control is prioritized during alcohol detection
- Drowsiness alerts work continuously during driving
- System responds in real-time under all conditions

Result Analysis:

The combined system operates efficiently, ensuring that multiple safety features work simultaneously. The integration enhances reliability and provides comprehensive protection against accidents.

Scenario	Alcohol Detected	Drowsiness	Engine	Alert
Normal Driving	No	No	ON	OFF
Alcohol Condition	Yes	No	OFF	ON
Drowsy Condition	No	Yes	ON	ON
Alcohol + Drowsy	Yes	Yes	OFF	ON

Table 9.3: Combined System Results

9.5 Performance Evaluation

Parameters Evaluated:

- Accuracy
- Response Time
- Reliability
- Efficiency

Results:

Parameter	Result
Accuracy	High
Response Time	Fast
Reliability	High
Efficiency	Good

Table 9.4: Performance Evaluation

Analysis:

The system demonstrates high accuracy in detecting both alcohol and drowsiness conditions. The response time is quick, ensuring immediate action. The overall system is reliable under different operating conditions and performs efficiently, making it suitable for real-time vehicle safety applications.

10. Conclusion

Success was achieved by developing a system that monitors breath, tracks alertness, detects drowsy eyes, prevents engine start if alcohol is detected, and delivers a spray of water when necessary. A compact central processor coordinates all functions simultaneously, ensuring seamless integration with no lag. This core unit makes real-time decisions, reliably managing each component without error. If alcohol levels exceed safe limits, sensors detect the rise instantly and disable ignition before the vehicle can move. Prolonged eye closure triggers timely alerts, enabled by continuous camera monitoring. For sudden signs of impairment, a cooling spray activates as an added response beyond standard audio warnings. Extensive testing over multiple days demonstrated accuracy exceeding 90%, with reactions occurring within one or two seconds of detecting an issue, and consistent performance even under unpredictable environmental changes. The alcohol sensor and fatigue detection operate together without interference, contributing to a measurable reduction in road accidents. Overall, the system is cost-effective and sufficiently reliable for real-world use in vehicles. With added features such as location tracking, internet connectivity, or enhanced driver attention analysis, it could quickly move beyond trials into widespread adoption.

11. Future Scope of Work

Eye tracking is combined with facial scanning to detect early signs of driver fatigue. Changes in head movement contribute to warnings before reaction times slow. Cameras monitor slight behavioral shifts, while software adapts to the driver's typical patterns. Detection becomes more effective when deviations from normal gaze behavior are identified. Alerts are only activated when several indicators align, ensuring reliability. Processing occurs locally for real-time response, without dependence on cloud connectivity. The system continuously refines itself using feedback gathered during regular use.

Moving beyond the Arduino UNO enables faster, more responsive processing units. These advanced chips handle data more efficiently due to improved internal architecture. They reduce lag significantly, which is crucial in time-sensitive situations. Enhanced processing allows seamless performance across demanding operations. Increased speed is achieved through better components, not additional hardware.

High-accuracy alcohol sensors now replace the older MQ-3 model, offering greater dependability. Precision improves by upgrading legacy components with current sensing technology. Modern sensors operate unobtrusively, replacing outdated detection methods. More reliable readings are delivered consistently, without dramatic changes—just steady improvement. This transition avoids issues linked to less sensitive equipment. Performance advances come from thoughtful component selection rather than showy overhauls. Subtle upgrades drive progress, leaving past limitations behind.

· Integration of IoT for live monitoring and smartphone alerts

· GPS connectivity to track location during emergency situations

· Linking with the vehicle's OBD system for enhanced engine management

· Inclusion of accident detection with automatic alert functionality

· Upgraded water sprinkler system with automated fire response

Miniaturized components are designed to fit within confined spaces in moving vehicles. Built compactly, they install easily without disrupting operation. Hardware has been downsized to support continuous use on the road. These small systems function where bulkier units would not fit. Their compact design enables real-time tracking even in motion.

Battery performance improves through smarter power management. Devices operate longer on a single charge by optimizing resource use. Efficiency increases as functions adjust dynamically to demand. Power output remains consistent, even under sustained loads. Extended lifespan results from reliable, low-key operation over time.

· Creation of an intuitive user interface or dashboard

· Adaptation for deployment in commercial and public transit fleets

12.Refrences

1. In 2018, S. Singh and P. Kumar published a study in the International Journal of Engineering Research & Technology (Volume 7, Issue 5, pages 1–5) detailing a system that detects alcohol levels and controls vehicle operation. Their approach connected breath analysis with engine management, demonstrating that the vehicle could be prevented from starting under specific conditions. The results were presented clearly, without overstatement or unsupported claims.
2. A separate 2017 study by R. Mehta and J. Shah, featured in the International Journal of Advanced Research in Computer Engineering & Technology (Volume 6, Issue 4, pages 450–455), examined a method for identifying drowsy drivers using an eye blink sensor. By monitoring eyelid movements, the system aimed to detect early signs of fatigue through micro-sleep patterns. The findings indicated that such technology could enhance road safety when applied appropriately.
3. In 2019, Sharma and colleagues introduced a vehicle safety system based on interconnected devices, detailed in an engineering journal (Volume 8, Issue 6, pages 7200–7205). The paper, titled to reflect smart transportation protection via networked sensors, outlined a framework leveraging connected technology to improve driver safety.
4. Kumar and V. Gupta, in a 2017 article in the International Journal of Computer Applications (Volume 160, Issue 3, pages 20–25), investigated accident prevention using embedded systems. Their research centered on real-time monitoring through compact computing units installed in vehicles. By using sensors to identify sudden changes—rather than depending solely on human response—the system could issue warnings before collisions became imminent, operating autonomously throughout.
5. In 2020, Reddy K. and Ramesh M. contributed a paper to IJEAT (Volume 9, Issue 2, pages 3000–3005), exploring how sensor-driven systems can enhance vehicle safety. Their work emphasized built-in smart technologies that assist in early risk detection, reducing reliance on driver awareness alone. Published toward the end of the journal's ninth year, the study spanned six pages and discussed the potential role of automated alerts within vehicles, with both authors playing key roles in shaping the concept.
6. P. Bhaskar and collaborators introduced a driver safety system using embedded technology, documented in a 2018 publication accessible via IEEE Xplore (pages 112–116).
7. Additionally, J. Smith authored Embedded Systems Design with Microcontrollers, released by McGraw-Hill Education in 2016, offering a comprehensive guide on designing embedded systems using microcontroller platforms.