

Development of a Smart Car Incorporating Alcohol Detection and Accident Prevention Systems

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Abstract— The proposed Smart Car is an innovative autonomous vehicle designed to enhance road safety through intelligent obstacle detection and alcohol sensing mechanisms. The system integrates ultrasonic sensors for obstacle avoidance and an alcohol sensor for detecting driver intoxication. When alcohol is detected, the car automatically stops, preventing potential accidents. The vehicle operates autonomously using an Arduino Uno microcontroller that processes real-time sensor data to make navigation and safety decisions. Ultrasonic sensors continuously scan for obstacles and measure distance to enable safe maneuvering, while an alcohol sensor monitors the driver's breath. The system also includes a temperature sensor for battery thermal monitoring; if overheating occurs, an automatic cooling mechanism activates to prevent thermal runaway. Additional modules such as a motor driver, LCD display, and buzzer ensure reliable control, feedback, and alerts. By combining driver condition monitoring and collision prevention in a single, low-cost system, this project offers a practical approach to improving vehicular safety, especially in autonomous and semi-autonomous environments.

Keywords— Smart Car, Alcohol Detection, Obstacle Avoidance, Autonomous Vehicle, Arduino Uno etc.

I. INTRODUCTION

In recent years, the rapid advancement of technology and automation has significantly influenced the automotive industry. The development of intelligent and autonomous vehicles has opened new possibilities for enhancing road safety, reducing human error, and improving transportation efficiency. However, despite the progress in automation, one of the most persistent causes of road accidents remains human negligence, particularly drunk driving. According to global road safety reports, alcohol-impaired driving accounts for a large percentage of fatal road accidents each year. This alarming statistic highlights the urgent need for vehicles equipped with advanced safety mechanisms capable of detecting intoxicated drivers and preventing accidents. The integration of alcohol detection systems with autonomous navigation technologies represents a practical and forward-thinking solution to this problem.

The proposed project, titled “Development of a Smart Car Incorporating Alcohol Detection and Accident Prevention Systems,” focuses on designing a compact and intelligent vehicle capable of detecting alcohol levels, avoiding obstacles, and ensuring safe driving conditions. The system aims to

combine two critical safety mechanisms — alcohol detection and obstacle avoidance — within a single autonomous framework controlled by an Arduino Uno microcontroller. This dual-functionality approach not only enhances safety but also contributes to the broader goal of developing smart mobility solutions suitable for real-world implementation.

The Smart Car is designed to operate autonomously by using ultrasonic sensors for obstacle detection. These sensors emit ultrasonic waves and measure the reflected signals to calculate the distance between the vehicle and nearby obstacles. When an obstacle is detected within a certain range, the system automatically adjusts the car's direction to prevent collisions. This capability ensures that the car can navigate safely in complex environments without human intervention. Alongside this, an alcohol sensor continuously monitors the driver's breath for traces of alcohol. If the sensor detects alcohol above a certain threshold, the system immediately stops the vehicle, preventing the driver from operating the car while intoxicated. This function is critical in reducing road accidents caused by impaired driving.

Furthermore, the vehicle is equipped with a temperature sensor to monitor the battery's temperature and prevent overheating. In the event of high battery temperature, the system automatically activates a cooling mechanism, preventing thermal runaway and enhancing system reliability. The combination of safety, automation, and energy management makes this smart car a comprehensive model for next-generation automotive systems.

The control unit of the system — the Arduino Uno — processes the data from various sensors and makes real-time decisions regarding navigation, safety alerts, and system control. Supporting components such as DC motors, motor drivers (L293D), LCD display, and buzzer provide motion control, visual feedback, and alert notifications. The LCD displays real-time parameters such as obstacle distance and alcohol detection status, while the buzzer provides immediate audible alerts in hazardous situations.

This project aims to provide a low-cost, reliable, and scalable solution to improve vehicular safety and automation. By integrating obstacle detection, alcohol detection, and temperature monitoring, the system not only addresses external risks but also ensures internal safety and system integrity.

Ultimately, this Smart Car serves as a model for safer, smarter, and more sustainable transportation in the future.

II. PROBLEM IDENTIFICATION

- Increasing number of road accidents due to drunk and reckless driving, resulting in severe injuries and fatalities.
- Lack of integrated safety mechanisms in compact autonomous vehicles combining both alcohol detection and obstacle avoidance.
- Most existing systems focus only on either collision prevention or driver monitoring, not both simultaneously.
- Absence of real-time decision-making algorithms for smooth navigation and immediate response to safety hazards.
- Limited affordability and scalability of advanced autonomous safety systems for use in developing regions.
- Reliability issues with ultrasonic sensors under different environmental conditions like rain, fog, and dust.
- Insufficient feedback mechanisms for alerting drivers or system administrators during critical safety events.
- Overheating and thermal runaway risks in vehicle batteries without proper temperature monitoring.
- Need for an energy-efficient, low-cost, and autonomous model that ensures both external and internal vehicle safety.
- Lack of awareness and implementation of intelligent safety technologies in small-scale and educational applications.

III. LITERATURE REVIEWS

A) Literature Survey:

Kumar, M. (2025). Sensor systems for autonomous vehicles: functionality and challenges. *Transportation Sensor Reviews* — This review surveys the evolving role of perception sensors (camera, LiDAR, radar, ultrasonic) and their embedded interfaces in achieving safe autonomy. The authors map sensor capabilities to operational design domains and stress the importance of calibration, redundancy, and software-hardware co-design to meet real-time constraints. It highlights challenges such as sensor degradation, cost-constrained sensor suites for lower tiers, cybersecurity risks, and the need for harmonized standards. The paper argues that sensor selection must be use-case driven and that robust fusion and health-monitoring layers are essential to close the gap between prototype research and deployable systems.

Katona, K. (2024). Obstacle Avoidance and Path Planning Methods for Mobile Robots. *Sensors (MDPI)* — This comprehensive review classifies classical and modern obstacle-avoidance and path-planning methods, from reactive techniques (Bug algorithms, potential fields) to global planners (A*, Dijkstra) and learning-based approaches (RL, deep planning). The authors evaluate tradeoffs: computational cost, adaptability to dynamic obstacles, and robustness in cluttered environments. They note that hybrid schemes blending fast reactive layers with slower global planners best satisfy real-time safety requirements. The review emphasizes sensor constraints (range, update rate) and suggests that lightweight learning models and model-predictive components are promising for small, low-cost robots where compute and power are limited.

Hwang, F. S. (2024). Review of Battery Thermal Management Systems in Electric Vehicles. *Renewable & Sustainable Energy Reviews* — This paper synthesizes recent advances in battery thermal management (air cooling, liquid cooling, phase-change materials, heat pipes, and hybrid

strategies). The review quantifies how different BTMS approaches affect temperature uniformity, capacity fade, and safety margins under high C-rate charging/discharging. It emphasizes that active liquid systems offer the best thermal control for high-power applications but at cost and complexity; PCM and passive techniques help with peak mitigation. The authors also discuss the role of sensors and control algorithms to trigger cooling and the need for integrated cell-level temperature monitoring to prevent thermal runaway in compact systems.

Sonko, S., et al. (2024). A Comprehensive Review of Embedded Systems in Autonomous Vehicles: Trends, Challenges, and Future Directions. *Embedded Systems Review (conference/journal preprint)* — This review inspects the embedded stack (MCUs, real-time OS, middleware, CAN/FlexRay/automotive Ethernet) and highlights how constraints on latency, determinism, and power shape design choices. It catalogs typical sensor interfaces used in small autonomous platforms (ultrasonic, IMU, wheel encoders) and discusses software patterns for modularity, safety (ISO 26262 concerns), and over-the-air updates. The paper identifies gaps: low-cost fault-tolerant architectures and explainable decision layers for safety certification in constrained educational or market-entry platforms. Recommendations include modular hardware abstraction and certify-oriented testing toolchains.

Ayas, S., et al. (2023). Drowsiness Mitigation Through Driver State Monitoring Systems: A Review. *IEEE Access / PMC* — Focusing on driver state monitoring (DMS), this review examines physiological (EEG, ECG), behavioral (eye closure, gaze), and context sensors (steering patterns). It compares algorithms for detecting drowsiness and attention loss, noting that vision-based DMS are non-intrusive but sensitive to lighting and occlusion. The authors discuss how DMS can be combined with vehicle control interventions and human-machine interfaces to mitigate risk. They stress privacy and false-positive management, recommending multimodal fusion and personalized baselines to improve robustness — useful lessons when integrating alcohol sensing and behavior monitoring in small vehicles.

Akshay Kumar & K. Stephen (2023). A Systematic Review on Sensor Fusion Technology in Autonomous Vehicles. *ICESC Proceedings* — This systematic review catalogs fusion architectures (low-, mid-, high-level fusion), fusion algorithms (Kalman variants, particle filters, deep fusion networks), and performance metrics across bench tests. It finds that mid-level fusion (feature fusion) often offers the best compromise between latency and robustness for embedded platforms. The review highlights the importance of time synchronization, cross-modal calibration, and failure-mode detection. For low-cost autonomous platforms, the authors recommend lightweight probabilistic fusion with sanity checks rather than heavy neural fusion to ensure predictable failure behavior.

NHTSA (2024). Advanced Impaired Driving Prevention Technology: Report to Congress (Dec 2024). National Highway Traffic Safety Administration — This government report reviews readiness of in-vehicle alcohol detection technologies, legal/regulatory landscapes, and operational challenges. It summarizes technical options (cabin sensors, passive/active breath sensors, touch-based) and pilot deployments, noting key barriers: false positives from

environmental alcohol, user acceptance, privacy, and integration with vehicle controls. The report recommends standardized performance metrics, human-factors testing, and phased deployment strategies beginning with high-risk fleets. Its policy focus and comprehensive technical assessment inform how vehicle-stop logic and user alerts should be designed for safety and acceptability.

Dong, M. (2024). A Systematic Review of the Impacts of Alcohol Consumption on Driving Performance and Automated Driving Takeovers. *Journal of Safety Science* — This systematic review aggregates experimental and simulator studies assessing how various BAC levels impair vehicle control, reaction times, and takeover performance in partially automated driving. Findings underscore that even low BACs measurably degrade takeover response and increase collision risk; distraction and reduced situational awareness compound the effect. The review argues for proactive in-vehicle alcohol detection or stricter handoff policies for conditional automation and highlights research needs: real-world field trials and detection systems that minimize false alarms while ensuring safety.

Kurse, T. K. (2024). Prospects for Implementation of Autonomous Vehicles in Developing Countries. *Infrastructures (MDPI)* — This review examines socio-technical barriers to AV adoption in lower- and middle-income contexts: infrastructure readiness, cost, public acceptance, and vehicle localization. It discusses how low-cost sensor suites (ultrasonic, camera, basic radar) and robust, conservative control strategies can enable useful semi-autonomous functions (parking assist, low-speed delivery) even without full autonomy. The paper recommends research into affordable fail-safe designs, human-centric alerts, and regulatory frameworks that support pilot deployments — directly relevant to designing low-cost smart cars that combine alcohol detection with obstacle avoidance.

B) Literature Summary

- Recent studies focus on autonomous vehicle safety using ultrasonic, infrared, and camera-based obstacle detection systems.
- Research emphasizes real-time collision avoidance and path planning algorithms to ensure smooth navigation.
- Various alcohol detection systems using MQ-3 sensors, breath analyzers, and biosensors have been developed to reduce drunk driving accidents.
- Arduino and microcontroller-based designs provide a cost-effective and compact solution for automation and monitoring.
- Integration of sensor fusion and decision-making algorithms improves accuracy and response time.
- Studies highlight the need for driver condition monitoring to prevent human-related accidents.
- Research also focuses on battery thermal management and embedded safety systems in electric vehicles.
- However, combined integration of obstacle avoidance, alcohol detection, and thermal protection remains limited.

C) Research Gap

- Most existing works focus individually on obstacle detection or alcohol detection, not on a unified system combining both.
- Limited research on real-time decision-making for autonomous safety intervention under varying environmental conditions.

- Few studies address the inclusion of a temperature monitoring mechanism to prevent thermal hazards.
- Lack of low-cost and scalable prototypes suitable for small or educational autonomous platforms.
- Minimal work on sensor reliability testing in dusty, humid, or low-light environments.
- Inadequate integration of control, feedback, and data visualization in a single system.
- No comprehensive framework for autonomous navigation with driver behavior detection.
- Need for a multi-sensor, intelligent, and self-protective vehicle capable of addressing both external and internal safety parameters simultaneously.

IV. RESEARCH METHODOLOGY

A. Proposed System

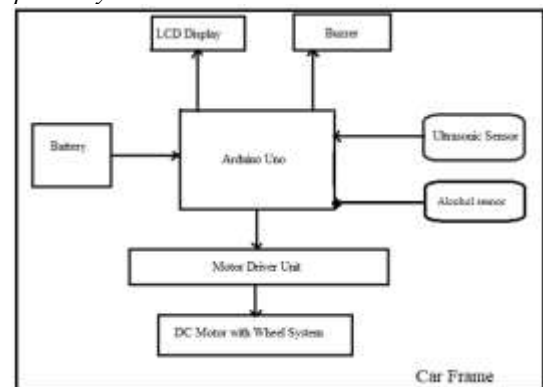


Fig. 1. Block Diagram

Working:

The project is designed to build an obstacle avoidance Smart Car vehicle using ultrasonic sensors for its movement. An Arduino uno is used to achieve the desired operation. A Smart Car is a machine that can perform task automatically. Robotics is generally a combination of computational intelligence and physical machines (motors). Computational intelligence involves the programmed instructions. The project proposes Smart Car vehicle that has an intelligence built in it such that it guides itself whenever an obstacle comes ahead of it. This Smart Car vehicle is built, using an Arduino uno. An ultrasonic sensor is used to detect any obstacle ahead of it and sends a command to the Arduino. In today's world robotics is a fast growing and interesting field. Smart Car has sufficient intelligence to cover the maximum area of provided space. Autonomous Intelligent Smart Cars are robots that can perform desired tasks in unstructured environments without continuous human guidance. The obstacle detection is primary requirement of this autonomous Smart Car. The Smart Car gets the information from surrounding area through mounted sensors on the Smart Car.

B) Calculation

1. Selection of electric motor

A) 30 RPM DC motor SPEED = 30

B) RPM VOLTAGE = 12 VOLT

C) WATTS = 18 WATT

2. Torque of the motor

A) Torque = $(P \times 60) / (2 \times 3.14 \times N)$

B) Torque = $(18 \times 60) / (2 \times 3.14 \times 30)$

C) Torque = 5.72 Nm Torque = 5.72×10^3 N-m

- D) The shaft is made of MS and its allowable shear stress = 42 MPa
E) Torque = $3.14 \times f_s \times d^3 / 16$ $5.72 \times 10^3 = 3.14 \times 42 \times d^3 / 16$ $D = 8.85$ mm
F) The nearest standard size is $d = 9$ mm.

3. Electrical (electric) power equation

- A) Power $P = I \times V$ Where $V = 12$ $W = 18$
 $I = 18/12 = 1.5$
B) A.H.P = .02414

4. Battery calculation

- A) BAH /CI = 8 ah/420ma = 19 hrs
B) To find the Current Watt = 18 w
C) Volt = 12v Current =?
 $P = V \times I$ $18 = 12 \times I$ $I = 18/12 = 1.5$
D) AMPS battery usage with 1.5 AMPS
BAH /I 8/1.5 = 5.3 hrs.



Fig.2. CAD model

V. APPLICATIONS

This device has application in surveying different landscapes and mapping them. It can also be used in commercial devices like,

- Automated lawn mover
- Smart room cleaner etc
- Obstacle avoiding Smart Cars can be used in almost all mobile Smart Car navigation systems.
- They can also be used in dangerous environments, where human penetration could be fatal.
- Unmanned vehicle driving
- Mining Vehicle that uses Obstacle Detection

VI. ADVANTAGES

- Collision control.
- It provides Safe Navigation.
- This is the basic of all Smart Car and has a wide scope of extensions.
- Drink and driving and thus avoiding accidents
- Protect the human life.

VII. LIMITATIONS

- The performance of this Smart Car mainly depends on the sensors and number of sensors.
- The ultrasonic sensor used here is of commercial application so it may easily undergo interference.

VIII. RESULT

The above Arduino controller and ultrasonic sensor were studied and the HCSR-04 ultrasonic sensor was selected, as the controlling result are satisfying for its use in the automobile prototype system being developed. It was used to sense the obstacle and avoid them. On successful implementation of obstacle avoidance algorithm was successfully carried out too with minimal errors, by coding the algorithm in python. Obstacle avoidance is a very good application to be used in vehicle preventing many accidents and loss of life.

This project developed an obstacle avoiding Smart Car to detect and avoid obstacles in its path. The Smart Car is built on the Arduino platform for data processing and its software counterpart helped to communicate with the Smart Car to send parameters for guiding movement. For obstacle detection three ultrasonic distance sensors were used that provided a wider field of detection. The Smart Car is fully autonomous and after the initial loading of the code, it requires no user intervention during its operation. When placed in unknown environment with obstacles, it moved while avoiding all obstacles with considerable accuracy. In order to optimize the movement of the Smart Car, we have many considerations for improvement. However, most of these ideas will cost more money and time as well. In future cameras can be used to detect the obstacle however, it is better to get CCD or industrial use ones to get clear and fast pictures. Even the ones we mentioned in the camera holder part will be better because of the special software.

In this project we have developed a real time model that can automatically shut off the engine automatically. Tests found that this system is highly effective and it's efficient in testing the alcohol percentage of the Human beings and if it crossed the threshold value the dc motor will stop working. By fitting this alcohol sensor into the car. We can save the life of the driver and also the remaining passenger.

The result is obtained for obstacle avoidance Smart Car using Arduino, if the Smart Car moves forward if any obstacle detect it check for other directions and moves where there is no obstacles it moves in forward direction, to sense the obstacle ultrasonic sensor is used. We used servo motor to rotate the ultrasonic sensor.

Case 1: Without Alcohol Consumption

If person did not found Alcoholic, Alcohol sensor send the signal to the microcontroller and microcontroller results its output to LCD display : Alcohol is not detected , Car is ON. Also Buzzer is silent and relay board is active the DC motor.

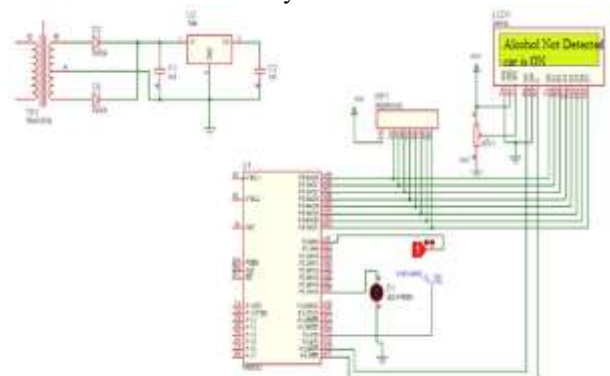


Fig.3. Without Alcohol Consumption

Case 2: With Alcohol Consumption

If person is alcoholic alcohol sensor detect the alcohol, it gives signal to the microcontroller. Lcd display shows the output : Alcohol detected , Car is Off.

Buzzer start siren and relay board is active and stops DC motor rotation

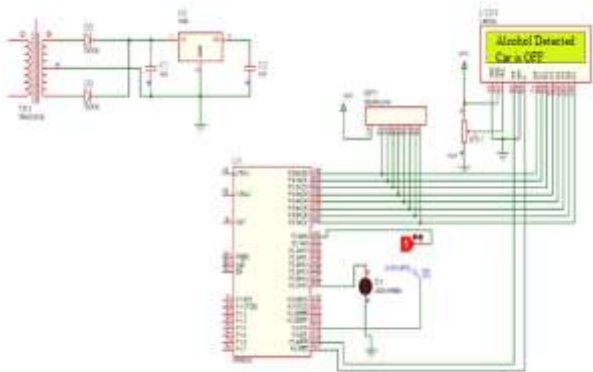


Fig.4. With Alcohol Consumption

The result is obtained for obstacle avoidance robot using Arduino, if the robot moves forward if any obstacle detect it check for other directions and moves where there is no obstacles it moves in forward direction, to sense the obstacle ultrasonic sensor is used. We used servo motor to rotate the ultrasonic sensor.

IX. CONCLUSION

Today we are in the world of robotics. Knowingly or unknowingly, we have been using different types of Smart Cars in our daily life. The project is “obstacle detection and the avoidance Smart Car” is practically proved by using the Ultrasonic sensor for sensing the Smart Car, Motor Shield Driver for the driving the dc motors, dc motor is used for the movement of the Smart Car with the help of the Arduino Microcontroller. A lot of factors determined the accuracy of the Smart Car we designed. These factors were the environmental phenomenon in which the Smart Car was tested, the number of obstacles present making the test space crowded or relatively less crowded the type and shape of the obstacle (the Smart Car is designed for a uniform shaped obstacle). These factors majorly affected the sensors. The accuracy of the Smart Car is dependent on the sensors used. Thus, the nature of the sensor and its accuracy defined the accuracy of my Smart Car.

X. FUTURE WORKS

To enable Smart Cars to be able to adapt to its environment is an important domain of robotics research.

- Whether this environment be underwater, on land, underground, in the air or in space.
- A fully autonomous Smart Car has the ability to Work for an extended period of time without intervention from human or a need for power supply.
- Avoid situations that are harmful.

The most effective method to increase the accuracy of my Smart Car is the inclusion of better sensors, although the project cost might increase but the accuracy will definitely increase as well as the problem space where the Smart Car can be used. Better actuators will result in a faster and more efficient Smart Car.

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