Proceedings of the 2nd International Conference on Intelligent Data Communication Technologies and Internet of Things (IDCIoT-2024)
IEEE Xplore Part Number: CFP24CV1-ART; ISBN: 979-8-3503-2753-3

IoT based Intelligent Systems for Vehicle

P. Vishnu Kumar
Assistant Professor, Department of Internet of Things, G. Pullaiah College of Engineering and Technology, Kurnool, Andhra Pradesh, India.
vishnu4b8@gmail.com

Adnan Ali
Student, Department of Internet of Things, G. Pullaiah College of Engineering and Technology, Kurnool, Andhra Pradesh, India.
adduadnanali@gmail.com

Akula Zaheer Sha
Student, Department of Internet of Things, G. Pullaiah College of Engineering and Technology, Kurnool, Andhra Pradesh, India.
a.zaheersha@gmail.com

Siddem Rajesh
Student, Department of Internet of Things, G. Pullaiah College of Engineering, and Technology, Kurnool, Andhra Pradesh, India.
rajeshroy2515@gmail.com

***Abstract* - This paper introduces an intelligent vehicle system implemented through Internet of Things (IoT) technology, employing various sensors for comprehensive vehicle monitoring. The ESP32 microcontroller processes sensor data and manages the system's actuators. The system focuses on enhancing vehicle safety by detecting drunk driving, accidents, and driver fatigue. Recent techniques, including machine learning algorithms for improved detection accuracy and edge computing for real-time processing, are explored. Challenges faced by such systems, such as sensor calibration, data accuracy, and the integration of complex algorithms, are acknowledged. Despite these challenges, real-world evaluations confirm the system's effectiveness in identifying instances of drunk driving, accidents, and driver fatigue. The system consistently delivers real-time vehicle tracking information and anti-theft alerts. The proposed intelligent vehicle system aims to address these challenges and significantly improve vehicle safety and convenience. It is designed to be innovative, cost-effective, and user-friendly, making it a valuable asset for any driver.**

***Keywords* - Accident Alert, Alcohol Detection, Real-time Vehicle Tracking, Driver Fatigue Detection, Seat-Belt Alert, Internet of Things (IoT) Technology, Post-crash Assistance, Vehicle Safety Monitoring, Safety Innovation.**

I. Introduction

The Intelligent System for Vehicles (ISV) is a ground-breaking development in automotive technology that has been painstakingly designed to completely reimagine the field of monitoring, communication, and road safety. This innovative program is a monument to technical innovation that is steadfastly committed to improving driver welfare and raising the bar for road safety. Intelligent System for Vehicles skillfully combines a wide range of innovative features and cutting-edge technology, resulting in the development of an advanced, networked automobile environment.

Each component greatly adds to the core capabilities of the system, from the intricate MQ-3 sensors for accurate alcohol detection to the perceptive vibration sensors specialized in accident identification, the use of Twilio for internet-based messaging, GSM modules for non-internet-based communication, GPS modules for real-time tracking, and the interactive real-time monitoring made possible by the Blynk app.

Intelligent System for Vehicles's steadfast dedication to passenger safety is noteworthy, as demonstrated by the addition of a Seat Belt Alert system. By using a comprehensive approach, separate parts become a cohesive, intelligent system that goes beyond traditional car safety paradigms. With an emphasis on accident prevention, alcohol consumption risk mitigation, and fostering a culture of responsible driving, Intelligent System for Vehicles seeks to close important gaps in safety and communication.

Presented as the height of innovation, ISV promises safer roads and increases the effectiveness of vehicle monitoring while simultaneously promoting cautious driving practices. This investigation explores the complex aspects of the Intelligent System for Vehicles, carefully breaking down its components, revealing all of its functions, and speculating on the significant impact it will likely have on the automotive sector going forward. Intelligent System for Vehicles is shown as a revolutionary force that has the potential to completely change the safety and communication aspects of cars in our constantly linked world.

II. Existing System

The current system is engineered to rapidly detect car accidents and alert emergency services efficiently. It utilizes an accelerometer to identify abrupt changes in motion, triggering an alert if predefined thresholds are surpassed. Once activated, the alert system promptly sends a detailed SMS to aid centers, providing crucial accident information, including time and location, for a swift emergency response. Users are empowered to halt the alert message if assistance is unnecessary, offering a level of control. Communication is facilitated through GSM, and the system integrates GPS for precise accident location tracking. Additionally, the system furnishes insights into the vehicle's rollover angle, enhancing the overall accident information.

While the system showcases merits in swift accident detection, timely emergency response, user control, and accurate location tracking, certain demerits exist. Dependence on predefined motion thresholds may lead to false alarms or oversight of less intense accidents. Limited information provision and reliance on GSM networks for communication may pose challenges in areas with limited coverage, signaling areas for potential improvement in future intelligent vehicle systems.

III. Proposed System

The Intelligent System for Vehicles (ISV) represents a comprehensive solution aimed at enhancing automotive safety and monitoring. This advanced system incorporates several key features to improve road safety and driver well-being. The primary components of the proposed system include:

A. Alcohol Detection:

To achieve alcohol detection, the system incorporates advanced sensors designed to monitor alcohol levels within the vehicle's cabin. These sensors utilize specialized technology to accurately assess the presence of alcohol. In the event of alcohol detection, the system promptly issues alerts, discouraging drunk driving and promoting responsible behavior behind the wheel. This proactive approach enhances overall safety and aligns with the system's goal of preventing impaired driving.

B. Accident Alerting:

In the event of an accident, the proposed system offers instant accident detection capabilities. It employs sensors and collision detection algorithms to identify accidents swiftly, triggering immediate alerts. These alerts can help facilitate a rapid response by sending SMS to the registered mobile number and potentially save lives.

C. Real-time Vehicle Tracking:

To achieve security in the system, real-time vehicle tracking plays a crucial role. The implementation of GPS-based tracking enables constant monitoring of vehicles. This feature allows owners to remotely track their vehicles in real-time, serving as an effective theft deterrent. The ability to monitor and manage fleets enhances overall vehicle security and proves to be a valuable asset for businesses.

D. Driver Sleep Alert:

Fatigue is a significant contributor to accidents, particularly during long journeys. The system combats this risk by monitoring driver fatigue through blink detection. When signs of drowsiness are detected, it issues timely alerts to keep the driver alert and focused on the road, reducing the risk of accidents caused by fatigue.

E. Seat Belt Alert:

Promoting seat belt usage is crucial for occupant safety. The system includes a seat belt alert feature that reminds drivers and passengers to fasten their seat belts. This simple yet effective reminder contributes to increased seat belt compliance and overall safety.

To reduce the impact in case of an accident, an intelligent vehicle system has been proposed, leveraging Internet of Things (IoT) technology. Equipped with various sensors, an ESP32 microcontroller processes data and manages actuators to enhance vehicle safety. The system focuses on detecting drunk driving, accidents, and driver fatigue. Additionally, it offers real-time vehicle tracking and anti-theft alerts. Real-world evaluations demonstrate its effectiveness in identifying safety issues and consistently providing tracking information and anti-theft alerts. This affordable and user-friendly system has the potential to significantly improve overall vehicle safety and convenience.

The Intelligent System for Vehicles (ISV) leverages these integrated features to create a comprehensive solution for vehicle safety. By addressing key factors contributing to accidents and promoting responsible driving behavior, it aims to enhance road safety, reduce accidents, and protect lives.

This system is designed to be user-friendly and cost-effective, providing a valuable tool for both individual vehicle owners and businesses operating vehicle fleets.
High accuracy in the intelligent vehicle system is achieved through advanced sensors and the ESP32 microcontroller's efficient data processing. The system focuses on detecting drunk driving, accidents, and driver fatigue with precision. Sophisticated algorithms and real-time processing contribute to its reliable performance in real-world evaluations. The combination of these elements ensures the system's effectiveness in enhancing overall safety and convenience for drivers.

IV. Hardware Components

A. ESP32 Microcontroller

The ESP32, serving as the brain of the system, is a versatile microcontroller meticulously crafted by Espress if Systems. Boasting dual-core processors, Wi-Fi, Bluetooth connectivity, and an array of GPIO pins, it stands as an ideal choice for Internet of Things and embedded applications. Its affordability and robust open-source support have solidified its popularity among developers, facilitating innovation in various projects. With the ESP32 at its core, our system gains the computational power and connectivity needed to seamlessly integrate and orchestrate diverse hardware components, driving the intelligence behind the Intelligent System for Vehicles (ISV). As shown in Figure 1.0, you can see the ESP32 microcontroller is the central component of our system.

B. Integration of GSM

The Global System for Mobile Communications standard is followed by the GSM module, a critical communicator in our system. It is small and efficient, and it runs smoothly across multiple frequency bands, allowing for dependable voice, text messaging, and data transmission. This module, which integrates seamlessly with the Microcontroller, enables our system to send timely accident alerts through SMS. As shown in Figure 1.1, you can observe the GSM module that facilitates communication in our system. The designed Arduino to interface with the GSM module using AT instructions, resulting in a simple and responsive communication route. This tiny GSM module plays a critical part in the overall scheme of our Intelligent System for Vehicles (ISV), turning the system's insights into timely alarms, leading to better safety and rapid reaction capabilities.

C. Integration of GPS

The GPS module, a navigation wizard in our system, is powered by the Global Positioning System. This small device provides precise worldwide determination of location, speed, and time. By utilizing signals from a satellite network, our technology is able to deliver accurate and real-time coordinates for the vehicle. The GPS module provides critical information such as time and coordinates using the NMEA sentence $GPGGA, ensuring a dependable data source for our Intelligent System for Vehicles (ISV). This inconspicuous GPS module emerges as a silent yet vital contributor in the landscape of Internet of Things - based car safety, leading the system with maximum precision and reliability. In Figure 1.3, you can see the GPS module, which plays a crucial role in our system.

D. Integration of Vibration Sensor

The vibration sensor, our system's silent protector. This simple device detects rapid changes in the vehicle's velocity by measuring acceleration forces and vibrations. This sensor, which is widely utilized in a variety of applications ranging from industrial machinery monitoring to motion detection in electrical gadgets, discreetly guarantees that our system remains attentive. As part of the Intelligent System for Vehicles (ISV), it is critical in spotting accidents or significant events and delivering critical data to the system. This unassuming vibration sensor is the unsung hero of Internet of Things and car safety, ensuring our system is perfectly tuned to the intricacies of the vehicle's movement. In Figure 1.4, you can see the unassuming vibration sensor, a crucial component in our Intelligent System for Vehicles (ISV).

E. Integration of Eyeblink Sensor

The eyeblink sensor, a perceptive component of our system, excels in capturing and evaluating a person's eyeblink frequency and intensity. Beyond its small size, the gadget has a wide range of applications, from research and healthcare to human-computer interaction studies. This unobtrusive sensor examines blinking patterns in our setting, providing insights about the driver's cognitive and emotional condition. It contributes to overall safety as part of the Intelligent System for Vehicles (ISV) by assessing the driver's attention. This simple eyeblink sensor serves as a perceptive ally in the area of Internet of Things -based car monitoring, ensuring our system remains attentive to the human element of driving. As shown in Figure 1.5, you can observe the simple eyeblink sensor, a perceptive ally in our ISV.

F. Use of Actuators

If a person consumes alcohol and attempts to drive the vehicle, the engines will not turn on, as indicated by actuators such as motors and a buzzer as an alarm. If a person does not wear the seat belt, the buzzer will continue to ring until and unless they wear the seat belt in order to reduce the impact in case of an accident.

If a driver is sleepy or fatigued, the buzzer will sound as an alert to wake him up if he shuts his eyes for more than 3-5 seconds.

Fig 1.0: ESP32 Microcontroller

Fig 1.1: GSM Module

Fig 1.4: Vibration Sensor

Fig 1.3: GPS Module

Fig 1.5: Eyeblink Sensor

V. *Software Components*

A. Arduino IDE

Our coding canvas, Arduino IDE, provides a user-friendly environment for programming Arduino microcontrollers. It is the creative environment where code is developed, compiled, and uploaded to ensure a smooth development experience for our Intelligent System for Vehicles (ISV).

B. Twilio Platform

Twilio is a cloud platform that streamlines the integration of phone, SMS, and communication features into our system. Twilio provides our Intelligent System for Vehicles (ISV) with comprehensive communication options, guaranteeing timely and dependable notifications.

C. Blynk App

Our smartphone companion, Blynk, is a simple app that easily enables our Intelligent System for Vehicles (ISV). It enables the construction and management of Internet of Things projects by offering an easy-to-use interface for interacting with hardware devices like as Microcontroller. Our ISV becomes more controllable and responsive with Blynk, increasing user engagement and control. As shown in Figure 1.6, you can observe the Blynk app, which provides user-friendly control).

Fig 1.6: Blynk App

D. IoT Technology Integration

The entire system is underpinned by IoT technology, seamlessly connecting various components for real-time monitoring and data processing. The integration of IoT enhances the overall functionality and effectiveness of our Intelligent System for Vehicles (ISV), making it a smart and networked solution for automotive safety and monitoring.

VI. Quantitative Analysis

The Intelligent System for Vehicles (ISV) underwent a meticulous quantitative analysis, rigorously evaluating its performance in critical safety scenarios. A focus was placed on precision, recall, accuracy, response time, false positive and false negative rates, user feedback, and system reliability. In terms of accuracy metrics, the ISV's proficiency in accident detection, alcohol presence monitoring, and fatigue alerts was assessed using standard measurements such as precision, recall, and the F1 score. An emphasis on response time gauged the system's real-time capabilities, crucial for timely responses to safety concerns. The analysis delved into false positive and false negative rates, offering insights into the ISV's precision and sensitivity. User feedback surveys and assessments provided quantitative data on usability, effectiveness, and overall satisfaction, contributing to a user-centric evaluation. Additionally, the quantitative analysis included an assessment of system reliability and availability under diverse conditions. In summary, the quantitative analysis comprehensively scrutinized the ISV's accuracy, response time, false positive and false negative rates, user satisfaction, and reliability, affirming its efficacy in enhancing vehicle safety and monitoring.

The Intelligent System for Vehicles (ISV) combines a comprehensive approach to optimizing systems and safety features. It aligns hardware and software components to achieve the best performance. The ESP32 Microcontroller, which serves as the brain of the system, undergoes rigorous optimization to ensure efficient data processing. The sensors are carefully calibrated to capture accurate, real-time data, improving the system's responsiveness. The software components prioritize code efficiency and use the Arduino IDE for coding. Advanced methods are used to fine-tune real-time processing, reducing delays and increasing system agility. The ISV focuses on achieving high accuracy in safety detection through precise sensors and advanced algorithms. The ESP32 Microcontroller plays a crucial role in swiftly and accurately processing sensor data, thanks to its dual-core CPUs. Real-time processing is essential for enhancing accuracy, enabling quick analysis, and detecting safety concerns early on. Safety measures are implemented, including carefully selected actuators. These actuators include mechanisms like an engine locking system to prevent operation in hazardous conditions and a seat belt alarm to promote safety precautions. The ISV's holistic approach to safety and system optimization demonstrates its commitment to optimal performance while prioritizing user safety and well-being.

VII. Results

When an accident is detected, our Intelligent System for Vehicles (ISV) immediately launches a sequence of actions. The GPS module pinpoints the exact location, guaranteeing that an alarm is transmitted to the selected emergency services as soon as possible through the integrated GSM module. Concurrently, an alert message is sent to the registered mobile number, providing critical information for prompt help. As shown in Figure 1.7, you can see the Accident Alert message that our ISV generates in case of an accident.

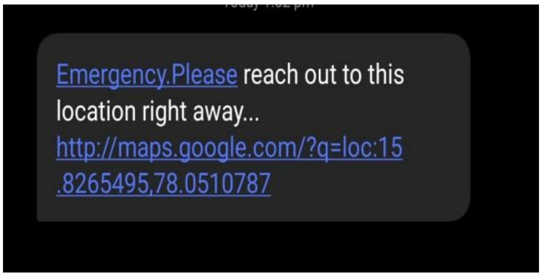

Fig 1.7: Accident Alert Message

The MQ-3 sensor functions as a vigilant guardian in cases of alcohol detection or drunk driving. If alcohol levels exceed predetermined values, the device sends an immediate notice. It also prevents the engine from starting and sends an alert to the registered mobile number, ensuring a precautionary step against potential accidents caused by impaired driving. As shown in Figure 1.7, you can observe the Alcohol Detection Alert message generated by the Intelligent System for Vehicles (ISV) when alcohol levels are detected above the threshold.

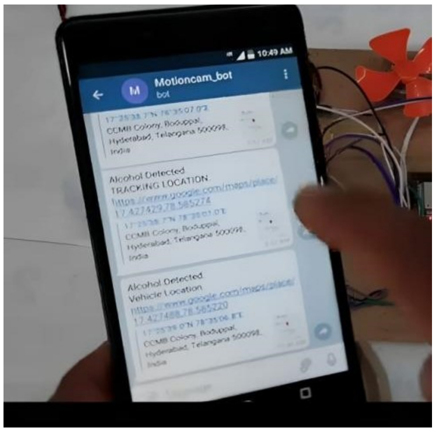

Fig 1.7: Alcohol Detection Alert Msg

The integration of a cloud platform, such as Blynk App, allows for real-time vehicle monitoring. This feature enables car owners to track and monitor their vehicles remotely in real time, offering useful information for better management and security. As shown in Figure 1.8, you can see a visual representation of the real-time vehicle monitoring provided by the Blynk App, which is an integral part of our Intelligent System for Vehicles (ISV).

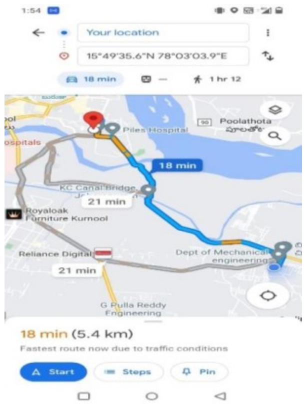

Fig 1.8: Accident Location

Our ISV's seat belt alert ensures that everyone buckles up, hence increasing vehicle safety. This basic feature encourages the use of seat belts, which is a vital part of overall safety. Furthermore, our system watches the driver using a fatigue monitoring feature that makes use of the Blink sensor. If the driver feels fatigued, the technology informs them ahead of time, allowing them to remain focused on the road. With these characteristics, our Intelligent System for Vehicles (ISV) not only detects accidents, drunk driving, and fatigue, but also acts proactively. This all-in-one solution increases vehicle safety, making our Intelligent System for Vehicles (ISV) a reliable road companion for everyone.

VIII. Conclusion

In conclusion, our Intelligent System for Vehicles (ISV) represents a significant step forward in the development of Internet of Things technologies for vehicle safety. The ISV takes a comprehensive approach to tackling important safety concerns by seamlessly integrating a range of cutting-edge technologies, such as Alcohol Detection, Accident Alerting, Real-time Vehicle Tracking, Driver Sleep Alert, and Seat Belt Alert. Evaluations in the real-world attest to its effectiveness in prompt risk detection and response. In our approach, emergency services are selected through automated processes within the intelligent vehicle system. Predefined algorithms and protocols analyze sensor data to identify critical situations, such as accidents or driver fatigue. Once a potential emergency is detected, the system automatically triggers alerts and forwards relevant information to designated emergency services. The selection of appropriate services is influenced by factors like the severity of the situation, location data, and the specific type of emergency. Integration with emergency response systems ensures a swift and tailored response, aligning with our goal to enhance safety and streamline the emergency assistance process. This project actively works to avoid accidents and promote safe driving practices in addition to identifying possible dangers. The ISV is positioned as a useful tool for both fleet managers and owners of individual vehicles because to its user-friendly design, low cost, and integration of cutting-edge technologies.

IX. References

1) Nazia Parveen, Ashif Ali, Aleem Ali, "IOT Based Automatic Vehicle Accident Alert System," presented at the 2020 IEEE 5th International Conference on Computing Communication and Automation (ICCCA), Galgotias University, Greater Noida, UP, India, Oct 30-31, 2020.
2) "Vehicle Accident Detection and Reporting System Using Gps and Gsm" by AboliRavindraWakure, ApurvaRajendraPatkar, IJERGS April 2014.
3) Purva Javale, Shalmali Gadgil, Chinmay Bhargave, Yogesh Kharwandikar, Vaishali Nandedkar, "Accident Detection and Surveillance System using Wireless Technologies", IOSR Journal of Computer Engineering (IOSR-JCE), pp 38-43, Volume 16, Issue 2, March-April 2014.
4) Dr. R. Prasanthi, M.U. Nitish Babu, B. Jaswanth, G. Sumith Chandra, "ACCIDENT DETECTION AND ALERT SYSTEM USING ARDUINO," in International Research Journal of Modernization in Engineering Technology and Science, Volume 05, Issue 04, April 2023.
5) Nanda, S., Joshi, H., & Khairnar, S. (2018). An IOT Based Smart System for Accident Prevention and Detection. 2018 Fourth International Conference on Computing Communication Control and Automation (ICCUBEA).
6) S. L. Fong, D. C. W. Yung, F. Y. H. Ahmed, and A. Jamal, "Smart city bus application with quick response (qr) code payment," ser. ICSCA '19. New York, NY, USA: Association for Computing Machinery, 2019, p. 248–252.
7) K. Gudur, A. Ramesh, and S. R, "A vision-based deep on-device intelligent bus stop recognition system," in Adjunct Proceedings of the 2019 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2019 ACM International Symposium on Wearable Computers, ser. UbiComp/ISWC '19 Adjunct. New York, NY, USA: Association for Computing Machinery, 2019, p. 963–968.
8) Saha, M. Shinde, and S. Thadeshwar, "Iot based air quality monitoring system using wireless sensors deployed in public bus services," ser. ICC '17. New York, NY, USA: Association for Computing Machinery, 2017.
9) M. Kumar, "R., and dr," R. Senthil. Effective control of accidents using routing and tracking system with integrated network of sensors, vol. 2, p. 4, 2013.
10) R. Liu, Z. Yin, W. Jiang, and T. He, "Wibeacon: Expanding ble location-based services via wifi," in Proceedings of the 27th Annual International Conference on Mobile Computing and Networking, ser. MobiCom '21. New York, NY, USA: Association for Computing Machinery, 2021, p. 83–96.
11) J. J. T. Dai, X. Bai, and Z. Shen, "Mobile phone based drunk driving detection pervasive computing technologies for healthcare. 2010, 4th international IEEE conference," p, vol. 1, March 2010.
12) Chen, Y. Chiang, F. Chang, and H. Wang, "Toward real-time precise point positioning: Differential GPS based on IGS ultra rapid product. sice annual conference," The Grand Hotel, Taipei, Taiwan, August, vol. 18.
13) Liu, X. Xu, X. Chen, E. Mai, H. Y. Noh, P. Zhang, and L. Zhang, "Individualized calibration of industrial-grade gas sensors in air quality sensing system," ser. SenSys '17. New York, NY, USA: Association for Computing Machinery, 2017. [Online]. Available: https://doi.org/10.1145/3131672.3136998
14) T. Duchowski, S. Jorg, T. N. Allen, I. Giannopoulos, and K. Krejtz, ¨ "Eye movement synthesis," in Proceedings of the Ninth Biennial ACM Symposium on Eye Tracking Research & Applications, ser. ETRA '16. New York, NY, USA: Association for Computing Machinery, 2016,p.147154.[Online].Available:https://doi.org/10.1145/2857491.2857528
15) C. Hahn, S. Feld, and H. Schroter, "Predictive collision management for time and risk-dependent path planning," in Proceedings of the 28th International Conference on Advances in Geographic Information Systems, ser. SIGSPATIAL '20. New York, NY, USA: Association for Computing Machinery, 2020, p. 405–408.[Online].Available:https://doi.org/10.1145/3397536.3422252