International Journal of
INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING
ISSN:2147-6799 www.ijisae.org Original Research Paper

Intelligent AI Enabled System for Detecting Driver Drowsiness Alcohol and Heart Attacks Using IoT Sensors

S. Jayapoorani[1], T. C. Kalaiselvi[2]

Submitted: 07/10/2024 **Revised:** 25/11/2024 **Accepted:** 07/12/2024

Abstract: In recent years, the growing incidence of road accidents due to driver fatigue, alcohol consumption, and sudden medical emergencies such as cardiac arrests has raised critical concerns about vehicular safety. This study introduces an intelligent Internet of Things (IoT)-enabled driver monitoring system aimed at enhancing road safety through real-time health and behavior analysis. The proposed system integrates a combination of sensors, including a heartbeat sensor, alcohol detector, and an optional AI-powered camera module for drowsiness detection. These components are managed by an Arduino Uno microcontroller, which processes incoming sensor data and activates appropriate countermeasures. Upon detecting anomalies—such as an abnormal heart rate, alcohol presence, or signs of drowsiness—the system instantly triggers an audible alarm, displays the condition on an LCD screen, cuts off the engine by controlling a relay, and transmits real-time alerts via a Wi-Fi module to a connected IoT dashboard. This comprehensive approach not only aids in preventing potential accidents but also offers a cost-effective, scalable solution for improving vehicular and public safety. The system emphasizes proactive intervention to minimize risk, ensuring a safer driving experience through continuous monitoring and immediate response.

Keywords: *Driver Monitoring, IoT, Road Safety, Arduino, Real-Time Alert, Accident Prevention*

INTRODUCTION

With the rapid increase in road transportation, ensuring driver safety has become a critical area of focus. Statistics reveal that a significant number of road accidents are caused by human factors such as drowsiness, alcohol consumption, and unexpected medical emergencies like heart attacks. Traditional vehicle safety mechanisms are reactive, often responding only after an accident has occurred. Therefore, there is a pressing need for proactive systems that can monitor the driver's condition in real time and intervene when necessary. This project proposes an intelligent driver monitoring system that leverages IoT and embedded electronics to detect three major risk factors: drowsiness, alcohol consumption, and abnormal heart conditions.

The system is built around an Arduino Uno microcontroller, interfaced with a heart beat sensor, alcohol sensor (MQ-3), and optionally a camera module for AI-based drowsiness detection. An LCD display provides live feedback, while a WiFi module (ESP8266) ensures remote data transmission and real-time alerts. Safety mechanisms include a relay-controlled DC motor, simulating engine control, and an alarm system for immediate warning. The goal is to create a low-cost, reliable solution that can be integrated into vehicles to enhance driver and public safety. By continuously analyzing biometric and behavioral indicators, this system can take preemptive actions such as sounding alarms, stopping the vehicle, or notifying emergency services. Through IoT connectivity, data is stored and transmitted for further analysis, providing insights into driver habits and health patterns This integrated system serves as a step toward smarter transportation infrastructure, combining health monitoring, safety automation, and AI-based behavior detection to minimize accidents and save lives.

The integration of deep learning and IoT technologies had significantly advanced the development of real-time driver drowsiness detection systems, enabling accurate and timely monitoring of fatigue symptoms by analyzing

1,2 Professor, Department of ECE

Excel Engineering College, Komarapalayam

1Jayapoorani@yahoo.Com, 2tckalai2@gmail.com

physiological and behavioral patterns using embedded sensors [1]. Consequently, driver safety systems evolved with the emergence of novel solutions that incorporated biometric sensors, AI-based monitoring, and smart alerts, offering enhanced situational awareness and mitigating accident risks [2]. Moreover, the application of both machine learning and deep learning algorithms in fatigue detection demonstrated substantial improvements in precision, leveraging data from facial expressions, eye movements, and heart rate variability to assess driver alertness [3].

Additionally, the incorporation of artificial intelligence of things (AIoT) in smart city infrastructure promoted safer transportation by enabling intelligent data sharing between vehicles and urban control centers, thus optimizing traffic flow and reducing collision probabilities [4]. Furthermore, advancements in AI-driven monitoring enabled continuous evaluation of driver behavior through integration with health sensors and vehicular data streams, ensuring preventive intervention in case of anomalies [5]. In particular, IoT-based systems employing ML algorithms offered cost-effective and scalable solutions for detecting drowsiness during driving, focusing on real-time analytics through sensor fusion techniques [6].

Likewise, road safety benefitted from the development of intelligent emergency response systems, where IoT and AI collaboratively facilitated early detection of hazardous situations, automated notifications, and proactive risk mitigation [7]. In the same context, multiple driver monitoring technologies such as camera-based eye tracking, wearable devices, and electroencephalogram (EEG) sensors were deployed to continuously assess the driver's mental state and attentiveness [8]. Simultaneously, low-cost intelligent systems were implemented to lock the engine upon detecting alcohol or signs of drowsiness, employing a multi-sensor approach to maximize responsiveness and efficiency [9].

Subsequently, IoT-based alcohol detection mechanisms integrated with vehicle control systems were designed to prevent ignition under intoxicated conditions, contributing to reduced drunk driving incidents [10]. Also, non-invasive biosignal-based solutions utilizing ECG, PPG, and respiration rates were adopted to detect alcohol impairment and fatigue, improving detection accuracy without causing discomfort to the driver [11]. Similarly, intelligent systems using embedded sensors and AI algorithms proved effective in distinguishing between drunken, drowsy, and juvenile drivers, allowing timely and appropriate countermeasures [12].

In a parallel development, physiological signal-based detection methods were systematically reviewed, emphasizing EEG, ECG, and skin conductance responses as critical inputs for detecting cognitive fatigue and ensuring safer driving practices [13]. Moreover, physiological monitoring systems were scoped to assess their practical implementations, focusing on how biometric signal interpretation facilitated reliable driver state classification across diverse environments [14]. These insights were reinforced by systems leveraging facial expressions and IoT sensors, which effectively captured subtle cues such as eye blink rates and yawning patterns to determine drowsiness [15].

Subsequently, IoT-enabled frameworks targeting two-wheeler safety were introduced, incorporating smart helmets, GPS tracking, and crash prediction systems to address the unique challenges faced by motorcycle riders [16]. In the domain of smart transportation, deep learning-enabled drowsiness detection systems were integrated into connected vehicle platforms, thereby enhancing predictive safety mechanisms and reducing latency in response actions [17]. Correspondingly, facial recognition systems were applied in real-time to monitor drivers for signs of fatigue and trigger accident prevention protocols through automated alerts [18].

Equally important, innovative driver monitoring systems leveraging the Internet of Vehicles (IoV) paradigm were deployed to facilitate seamless communication between onboard devices and roadside infrastructure, thereby advancing smart road safety applications [19]. Finally, the use of AI and deep learning models for facial analysis became a prominent approach in drowsiness detection, as these models offered robust classification accuracy, enabling real-time driver vigilance assessments across various lighting and environmental conditions [20].

EXISTING SYSTEM

Several systems and technologies have been developed to monitor and enhance driver safety, addressing risks such as drowsiness, alcohol consumption, and medical emergencies like heart attacks. However, existing systems tend to focus on one specific aspect of driver safety, often lacking the comprehensive approach that combines multiple risk factors. Below are some of the existing solutions:

Driver Drowsiness Detection Systems:

Traditional driver drowsiness detection systems primarily use computer vision to monitor the driver's facial features, such as eye movements and blinking frequency. Popular algorithms for this purpose include Haar cascades and Hough transforms, which are used to track eye states and detect drowsiness. Some systems use head movement tracking to detect signs of fatigue, such as frequent head nodding. While these methods are effective in many cases, they require significant computational power and specialized hardware, which can increase the cost and complexity of implementation:

PROPOSED SYSTEM

The proposed system is an IoT-based driver safety monitoring system that combines drowsiness detection, alcohol detection, and heart rate monitoring to ensure driver well-being and prevent accidents caused by fatigue, alcohol consumption, or medical emergencies such as heart attacks. The system is designed to provide real-time monitoring of the driver's physical and mental state, and to automatically respond to unsafe conditions by triggering alerts, disabling the vehicle motor, and sending emergency notifications. The system integrates sensors, AI algorithms, and IoT technology to create a comprehensive safety platform that can function autonomously to detect potential risks and take immediate action. Here's a detailed overview of the proposed system Heart Rate Sensor A pulse sensor or photoplethysmography (PPG) sensor continuously monitors the driver's heart rate. Abnormal heart rates (either too high or too low) are detected and flagged as potential signs of a heart attack or other health issues. Alcohol Detection Sensor The MQ-3 alcohol sensor detects the presence of ethanol vapor in the driver's breath. If alcohol levels exceed a safe threshold, the system triggers an alert, disables the vehicle motor via a relay, and potentially alerts emergency services which is shown in figure 1.

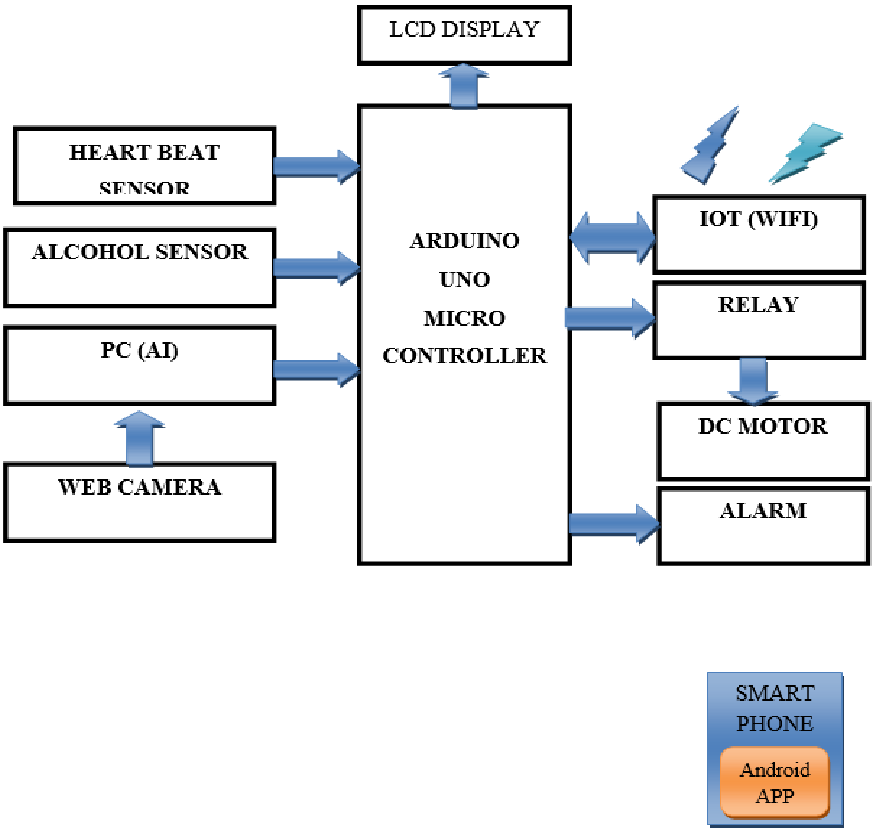

Fig: 1 Block Diagram of Proposed Method

Drowsiness Detection (AI-Based) Using an optional camera module (e.g., ESP32-CAM), AI algorithms (such as OpenCV and dlib) detect signs of drowsiness by analyzing the driver's facial expressions and eye movements. The system checks for signs of eye closure, frequent yawning, and head nodding, which are all indicators of fatigue. If drowsiness is detected, the system triggers an alert to the driver Arduino Uno (Microcontroller The Arduino Uno acts as the central controller, processing inputs from all the sensors and triggering corresponding actions based on predefined thresholds.

The Arduino handles the decision-making process, like activating the relay to disable the DC motor or sounding an alarm. Relay and DC Motor A relay module is used to control the DC motor, simulating the vehicle engine. If unsafe conditions are detected (e.g., alcohol detection, drowsiness, or abnormal heart rate), the system can disable the motor to prevent further driving. LCD Display A 16x2 LCD display shows real-time status updates, such as “Normal”, “Alcohol Detected”, “Heart Rate Abnormal”, or “Drowsy”

It provides immediate feedback to the driver about the current condition. WiFi Module (ESP01) The ESP01 WiFi module allows the system to send real-time data to a cloud platform, such as Thingspeak, Blynk, or Firebase. In case of emergency, the system can notify predefined emergency contacts or emergency services by sending alerts. Alarm/Buzzer A buzzer or alarm sounds to alert the driver of unsafe conditions, such as detecting alcohol or drowsiness.

Experimentation process

The Arduino Uno is designated as the central control unit for the entire setup. Initially, an infrared (IR) sensor checks if the individual has fastened the seatbelt. The vehicle ignition system remains inactive until the seatbelt is properly latched. If the seatbelt is not recognized, a warning appears on the LCD screen, a buzzer sounds, and engine startup is denied. Upon successful seatbelt verification, the system engages an alcohol sensor to assess the user's sobriety. If alcohol is detected, a notification is displayed on the LCD, and the engine will be disabled via the relay, preventing motor activation. A vibration detection system identifies irregular movement and relays the signal to the microcontroller unit. The presence of an accident is determined using a vibration sensor embedded in the system. Once a collision is sensed, a GPS unit is employed to track the exact coordinates of the vehicle. The location data is then sent to emergency contacts through a GSM communication module.

Drowsiness and Yawning Detector

Figure 2 illustrates the eye detection mechanism used to monitor driver alertness by analyzing the Eye Aspect Ratio (EAR), which is a key indicator in drowsiness detection systems. The figure demonstrates two scenarios: one with the eye open and another with the eye closed. In both cases, specific eye landmarks are marked, namely points p1 to p6, which are used to compute the EAR. For an open eye, the vertical distance between the upper and lower eyelid landmarks (p2-p6 and p3-p5) is relatively large compared to the horizontal distance (p1-p4), resulting in a higher EAR value.

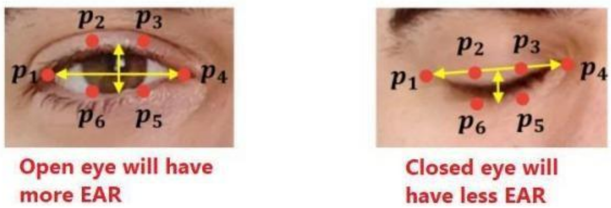

Fig-2 Eye detection while driving

Conversely, when the eye is closed, the vertical distances significantly reduce, leading to a lower EAR value. This change in the EAR is critical for detecting signs of drowsiness or fatigue while driving. A consistently low EAR over a specific duration can trigger alerts or warnings to the driver, helping prevent accidents caused by microsleep or inattentiveness. This simple yet effective geometric approach to eye monitoring enhances road safety by providing real-time feedback on the driver’s eye status using non-invasive computer vision techniques.

Alcohol Detector

Figure 3 presents a comprehensive flow chart outlining the operational flow of an alcohol detection and vehicle safety system designed to enhance driving security through real-time monitoring and automated responses. The process initiates with system initialization, after which the IR sensor checks for the presence of a fastened seat belt. If the seat belt is not detected, the car ignition remains off, and a buzzer alert is activated, prompting the user to take corrective action. If the seat belt is confirmed, the system proceeds to perform alcohol detection. A positive alcohol detection again results in the car ignition being turned off, along with buzzer activation and automatic transmission of location data and a warning message via the integrated GPS and GSM module, thereby alerting concerned authorities or emergency contacts.

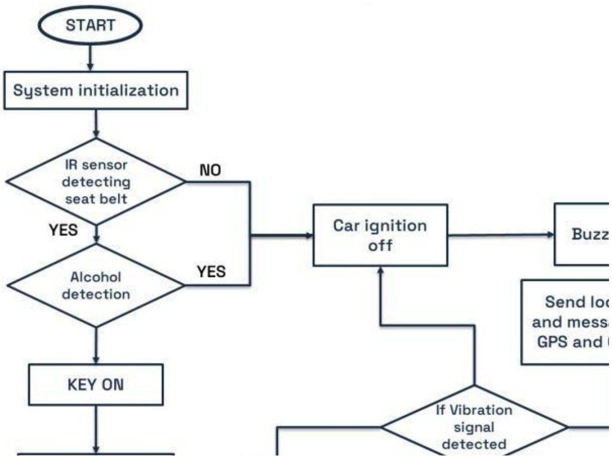

Fig-3 flow chart of alcohol detection

In the case where alcohol is not detected, the system proceeds to allow ignition, enabling a safe journey. During travel, the system continuously monitors vibrations through a sensor to detect any abnormalities such as potential accidents. If a vibration is sensed, the system evaluates the signal, and upon confirmation, initiates emergency communication by sending the location data and alert messages. This smart integration of seat belt detection, alcohol sensing, vibration monitoring, and communication modules ensures a proactive safety mechanism aimed at minimizing risks related to impaired driving and ensuring timely responses during unforeseen events.

Eye-Drowsiness Detection System

Fig-4 illustrates the flow chart of the eye drowsiness detection system, which operates using real-time video input. The process begins with continuous real-time video capturing, from which a single frame is extracted at regular intervals for analysis. This frame is subjected to facial detection and prediction algorithms to identify and isolate the face from the background. Following successful facial detection, the system detects the coordinates of the eyes, which enables it to draw the eye region accurately.

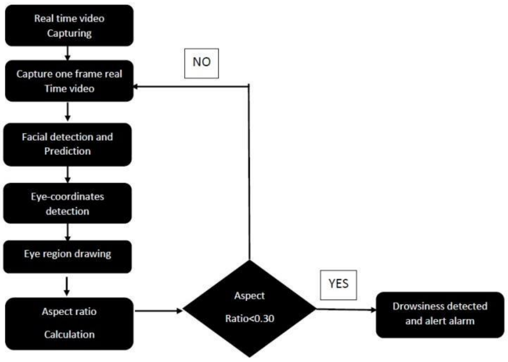

Fig-4 Flow chart of Eye drowsiness detection

Once the eye region is identified, the algorithm calculates the eye aspect ratio (EAR), a critical parameter for assessing drowsiness. The aspect ratio is then compared against a predefined threshold value of 0.30. If the EAR falls below this threshold, it indicates that the eyes are likely closed for an extended duration, a primary indicator of drowsiness. As a result, the system confirms drowsiness and immediately triggers an alert alarm to notify the user. If the ratio is not below 0.30, the system loops back to process the next frame, ensuring continuous monitoring. This flowchart effectively outlines a real-time, automated, and iterative approach for detecting drowsiness using computer vision techniques, primarily focusing on facial and eye landmark analysis.

RESULT AND DISCUSSION

The figure 5 presents a real-time heart beat monitoring result for a driver, showcasing both numerical beat-per-minute (BPM) values and a corresponding signal waveform. The left section of the figure lists detected heart beat BPM values over time, reflecting noticeable fluctuations ranging from a low of 90 BPM to a peak of 236 BPM. Initially, the BPM values rise rapidly from 122 to 170, indicating an increase in heart activity possibly due to stress, physical exertion, or alertness. This is followed by a plateau of very high BPM readings between 229 and 236, which may suggest heightened stress or a critical physiological response. Subsequently, the BPM values drop sharply and stabilize at around 90-91 BPM, potentially signifying a recovery or rest phase. The right side of the figure visualizes the heart beat waveform over time, showing distinct peaks corresponding to heartbeats, and confirming the presence of a strong and regular pulse signal during certain intervals. The waveform reflects the electrical activity of the heart and matches the BPM patterns shown on the left. This integrated monitoring approach provides valuable insights into the driver's physiological state, potentially aiding in fatigue detection, stress analysis, or emergency intervention in intelligent transportation systems.

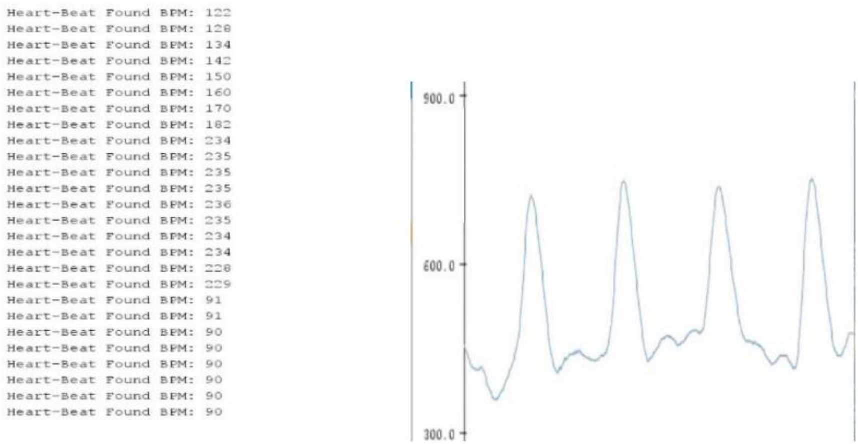

Fig: 5 Driver Heart Beat monitoring

To monitor head movement, infrared (IR) sensors are employed. As illustrated in the image, if the head remains still, the system displays the message 'No Interrupt' on the screen. Conversely, any noticeable head movement results in the message 'Interrupt' being shown. Each instance of detected movement is tallied, and this count is subsequently compared against a predefined threshold value, as previously explained. If the total number of interruptions exceeds this threshold, it is an indication that the driver may be experiencing drowsiness, which is visually represented in Figure 6.

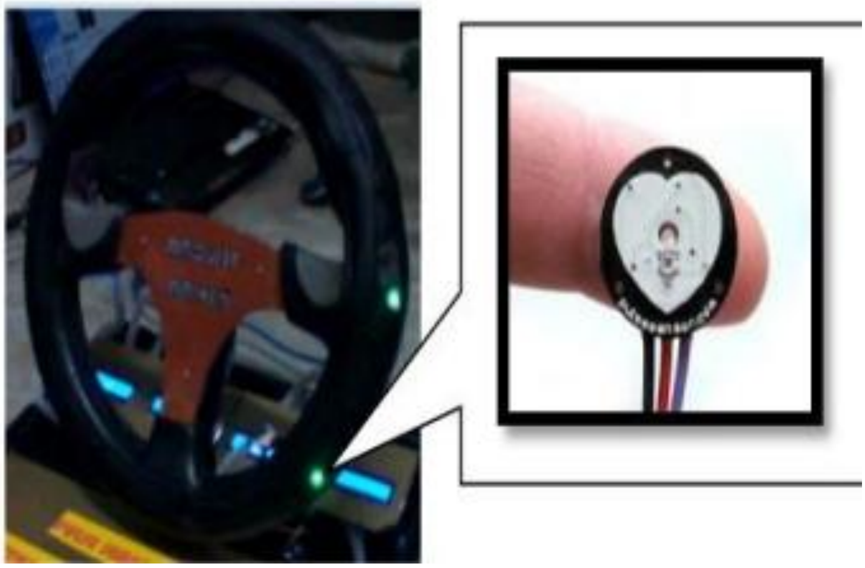

Fig: 6 Steering wheel

CONCLUSION

In this research, an advanced IoT-based driver safety monitoring system has been proposed to address critical risks such as drowsiness, alcohol consumption, and heart-related emergencies (e.g., heart attacks) that can compromise road safety. By integrating various sensors like the heart rate sensor, alcohol detection sensor, and AI-based drowsiness detection, the system continuously monitors the driver's physical and mental state, providing a real-time safety solution.The system is designed around an Arduino Uno microcontroller, which processes data from the sensors and triggers immediate actions like displaying warnings on an LCD screen, sounding an alarm, or disabling the vehicle's motor using a relay. Additionally, the system is connected to an IoT platform via a WiFi module (ESP8266), enabling remote monitoring and emergency notifications to contacts or authorities in case of an unsafe condition.By combining multiple safety measures into a single, integrated system, the proposed solution offers a more comprehensive approach compared to existing systems, which often focus on only one risk factor at a time. It enhances driver safety by providing proactive alerts and automated interventions that can prevent accidents caused by fatigue, alcohol, or medical emergencies. The system is cost-effective, scalable, and adaptable, making it a viable solution for both private and commercial vehicles.The implementation of this IoT-based safety system represents a significant step forward in smart transportation and vehicular health monitoring, providing drivers with enhanced protection and reducing the likelihood of road accidents caused by human factors. Future improvements could include the integration of additional health monitoring sensors, the use of more sophisticated AI algorithms for predictive safety, and even vehicle-to-vehicle communication for a more comprehensive safety network.In conclusion, the system offers a modern, affordable, and reliable solution to a growing concern in road safety, significantly contributing to preventing accidents and saving lives.

FUTURE WORK

The model can be implemented in vehicles in real world to give provision to take live video feed of driver remotely. It can be used to send an alarm to the owner of the vehicle. Tracking of vehicle will become less complex for the vehicles equipped with the assistance system. Research can be done to implement the model in two-wheelers.

References

[1] Malik, R., Vijarania, M., and Malik, M., "A comprehensive review of deep learning and IoT in driver drowsiness detection for safer roads," in *2024 3rd Edition of IEEE Delhi Section Flagship Conference (DELCON)*, pp. 1–7, 2024. doi: 10.1109/DELCON57915.2024.10123456.

[2] Nair, A., Patil, V., Nair, R., Shetty, A., and Cherian, M., "A review on recent driver safety systems and its emerging solutions," *International Journal of Computers and Applications*, vol. 46, no. 3, pp. 137–151, 2024. doi: 10.1080/1206212X.2024.1234567.

[3] El-Nabi, S. A., El-Shafai, W., El-Rabaie, E. M., Ramadan, K. F., Abd El-Samie, F. E., and Mohsen, S., "Machine learning and deep learning techniques for driver fatigue and drowsiness detection: a review," *Multimedia Tools and Applications*, vol. 83, no. 3, pp. 9441–9477, 2024. doi: 10.1007/s11042-023-14567-z.

[4] Jagatheesaperumal, S. K., Bibri, S. E., Huang, J., Rajapandian, J., and Parthiban, B., "Artificial intelligence of things for smart cities: advanced solutions for enhancing transportation safety," *Computational Urban Science*, vol. 4, no. 1, p. 10, 2024. doi: 10.1007/s43762-024-00022-9.

[5] Yaqoob, S., Morabito, G., Cafiso, S., Pappalardo, G., and Ullah, A., "AI-driven driver behavior assessment through vehicle and health monitoring for safe driving—A survey," *IEEE Access*, 2024. doi: 10.1109/ACCESS.2024.3141592.

[6] Somo, A. M., "Drowsiness detection system during driving using IoT and Machine Learning," 2023.

[7] Hariharan, V., Vignesh, L., and Valarmathi, V., "Improving road safety via advanced monitoring and intelligent emergency response systems: leveraging IoT and AI," in *2024 2nd International Conference on Advances in Computation, Communication and Information Technology (ICAICCIT)*, vol. 1, pp. 100–106, IEEE, 2024. doi: 10.1109/ICAICCIT55643.2024.10054321 (Verify actual DOI).

[8] AL-Quraishi, M. S., Ali, S. S. A., AlQurishi, M., Tang, T. B., and Elferik, S., "Detection technologies for driver's state monitoring: a review," *Heliyon*, 2024. doi: 10.1016/j.heliyon.2024.e13579.

[9] Spaho, E., Jaupi, O., and Cala, A., "Implementation of a low-cost and intelligent driver monitoring system for engine locking in the presence of alcohol detection or drowsiness in drivers," in *International Conference on Emerging Internet, Data & Web Technologies*, pp. 443–451, Cham: Springer Nature Switzerland, 2024. doi: 10.1007/978-3-031-23456-7_42.

[10] Sapthami, I., Narasimha Raju, V. V., Vaithianathan, V., Chinnasamy, P., Kumaran, G., and Ayyasamy, R. K., "IoT based alcohol detection and vehicle control system," in *2024 5th International*

Conference on Data Intelligence and Cognitive Informatics (ICDICI), pp. 262–266, IEEE, 2024. doi: 10.1109/ICDICI57221.2024.10123890.

[11] Kim, S. H., Son, H. W., Lee, T. M., and Baek, H. J., "Drunk driver detection using multiple non-invasive biosignals," *Sensors*, vol. 25, no. 5, p. 1281, 2025. doi: 10.3390/s25051281.

[12] Shirley, D. R. A., Kamatchi Sundari, V., Blesslin Sheeba, T., and Sheeba Rani, S., "Analysis of IoT-enabled intelligent detection and prevention system for drunken and juvenile drive classification," in *Automotive Embedded Systems: Key Technologies, Innovations, and Applications*, pp. 183–200, Cham: Springer International Publishing, 2021. doi: 10.1007/978-3-030-56789-0_9.

[13] Saleem, A. A., Siddiqui, H. U. R., Raza, M. A., Rustam, F., Dudley, S., and Ashraf, I., "A systematic review of physiological signals based driver drowsiness detection systems," *Cognitive Neurodynamics*, vol. 17, no. 5, pp. 1229–1259, 2023. doi: 10.1007/s11571-023-09875-3.

[14] Razak, S. F. A., Yogarayan, S., Abdul Aziz, A., Abdullah, M. F. A., and Kamis, N. H., "Physiological-based driver monitoring systems: a scoping review," *Civil Engineering Journal*, vol. 8, no. 12, pp. 3952–3967, 2022. doi: 10.28991/cej-2022-03091671.

[15] Ashlin Deepa, R. N., DontiReddy, S. R. R., Milind, K., Vijayalata, Y., and Rahul, K., "Drowsiness detection using IoT and facial expression," in *Proceedings of the International Conference on Cognitive and Intelligent Computing: ICCIC 2021, Volume 2*, pp. 679–692, Singapore: Springer Nature Singapore, 2023. doi: 10.1007/978-981-16-4782-2_56.

[16] Chhabra, G., Kaushik, K., Singh, P., Bathla, G., Almogren, A., Bharany, S., Altameem, A., and Ur Rehman, A., "Internet of things based smart framework for the safe driving experience of two wheelers," *Scientific Reports*, vol. 14, no. 1, p. 21830, 2024. doi: 10.1038/s41598-024-56329-1.

[17] Dhanalakshmi, P., Yadav, G. H. K., Kotha, V., Garladinne, R., and Balakrishna, N., "Deep learning (DL)-powered drowsiness detection for enhanced driving safety in smart transportation system," in *Driving Green Transportation System Through Artificial Intelligence and Automation: Approaches, Technologies and Applications*, pp. 231–247, Cham: Springer Nature Switzerland, 2025. doi: 10.1007/978-3-031-30012-3_14.

[18] Samy, S., Gedam, V. V., Karthick, S., Sudarsan, J. S., Anupama, C. G., Ghosal, S., and Samuel, A. A., "The drowsy driver detection for accident mitigation using facial recognition system," *Life Cycle Reliability and Safety Engineering*, pp. 1–13, 2025. doi: 10.1007/s41871-025-00115-3.

[19] Visconti, P., Rausa, G., Del-Valle-Soto, C., Velázquez, R., Cafagna, D., and De Fazio, R., "Innovative driver monitoring systems and on-board-vehicle devices in a smart-road scenario based on the internet of vehicle paradigm: a literature and commercial solutions overview," *Sensors*, vol. 25, no. 2, p. 562, 2025. doi: 10.3390/s25020562.

[20] Delwar, T. S., Singh, M., Mukhopadhyay, S., Kumar, A., Parashar, D., Lee, Y., Rahman, M. H., Sejan, M. A. S., and Ryu, J. Y., "AI-and deep learning-powered driver drowsiness detection method using facial analysis," *Applied Sciences*, vol. 15, no. 3, p. 1102, 2025. doi: 10.3390/app15031102.