

# **A Smart Vehicle Safety System using LoRa and CAN Integration**

**Aishwarya K<sup>1</sup>, Harini M<sup>2</sup>, Gokulrajan R M<sup>3</sup>, Divya Dharshini D<sup>4</sup>, Dr. Blesslin Sheeba T<sup>5</sup>**

<sup>1,2,3,4</sup>UG Students, Department of Electronics and Communication Engineering

<sup>5</sup>Professor, Department of Electronics and Communication Engineering

R.M.K. Engineering College, Tiruvallur, Tamil Nadu, India

**Abstract:** *Studies show that drowsy driving contributes to a significant number of crashes and fatalities each year, making it a serious safety concern that greatly increases the risk of accidents and injuries. According to the NHTSA, sleepy driving contributes to more than 100,000 collisions each year, which cause thousands of injuries and fatalities. To resolve this issue we have a solution which integrates both hardware and software. The drowsiness of the driver is detected using facial recognition system with computer vision algorithms and give alerts to the driver. Our solution incorporates GSM and GPRS module to send live location to the respective person or healthcare center. Also the solution involves LoRa module to alert other drivers around the vehicle with a particular range. To make this more effective approach and reduce accidents CAN protocol is used to communicate between ECU and other systems in the vehicle, to automatically reduce the speed of vehicle. It is a user friendly approach as it does not consists of any wearable sensor which may cause irritation to the drivers or maybe wear off during fatigue. Using this the accidents due to fatigue can be drastically reduced and avoided*

**Keywords:** Drowsiness, LoRa, Alert, Traffic Analysis, CAN Module

## **I. INTRODUCTION**

Road crashes do not only destroy property, but they also take lives. This is a global problem from which we all suffer currently. The primary reason for the increasing number of accidents on roads today is because vehicles and motorcycles have increased in number, as well as the driving behaviour of the drivers, most often due to tiredness, or rather badly under-occupied minds. Sleepy driving is one of the worst causes of accidents, especially among people who drive large trucks over long distances. Fatigue slows a person's response time to stimuli, makes a person unable to act sensibly, and increases their risk of an accident.

Drowsy driving is a leading factor in road crashes throughout the world. The National Highway Traffic Safety Administration (NHTSA) in the United States show that more than 100,000 crashes each year involve a driver who was fatigued, and these crashes correspond to more than 1,550 deaths and 71,000 injuries annually. Research shows that a person who has been awake for 18-20 hours has performance equal to a person who has a blood alcohol concentration (BAC) of 0.05%, and that same person who has been awake for more than 24 hours would show performance equivalent to a BAC of 0.10% (above the legal limit in most countries). Overall, drowsy driving accounts for 20-30% of road crashes worldwide, demonstrating an urgent need for drowsy driving prevention. The statistics provide further context and affirm the need for the implementation of an effective real-time status monitoring and alert system(s) to reduce the number of crashes associated with fatigue.

Well, in consideration of existing problems, these technologies have designed themselves to prevent accidents smartly. They exemplify numerous technologies including that function for sensing sleepiness in a driver, collision avoidance and quick reaction during emergencies. Real-time video interpretation is how systems use to tell if a driver becomes sleepy. Applied computer vision techniques observe the driver's face and eye movements. The system sends out alerts to keep the driver awake when it senses frequent blinking or yawns, which indicates sleepiness.



Once an accident or other emergency occurs, the system conveys information to the emergency response teams for rapid assembly at the nearest emergency unit using the GPS and GSM technology to locate the accident site and rescue injured persons. This is a new technology that will save as many lives as possible and reduce the incidence of dangerous accidents on the highway.

### Limitations in Existing Systems

Presently, there are various constraints with drowsiness detection and collision avoidance systems, particularly with wearable sensor-based equipment (i.e., EEG headbands or heart rate monitors). These wearable devices are intrusive and uncomfortable for long periods of use, potentially distracting drivers. The systems may or may not interface with existing vehicle control systems or communicate with other vehicles. ADAS-based solutions are often costly, proprietary, and not available for mid-range or low-end vehicles. Long-range vehicle-to-vehicle communication of any type is rarely provided during operation to notify surrounding drivers. As for the traffic analysis using LoRa, gateways are used or LoRa module being placed on the roadside infrastructure.

### Scope of the Project

The goal of the new system is to eliminate the deficiencies associated with existing systems by providing a non-intrusive and intelligent method of integrating computer vision to automobile networking. With respect to computer vision, leveraging facial recognition and eye-tracking algorithms provides driver comfort without a physical sensor. The Real-Time Communication node using LoRa module provides alerts to surrounding vehicles regarding the presence of a drowsy driver through V2V (vehicle-to-vehicle) communication within a defined range and real-time traffic analysis with gateways. In addition, GSM/GPRS enhances capability through location-sharing with family members and healthcare centers in case of emergency. The system can also provide direct feedback and connect to the Vehicle ECU through the CAN protocol, allowing the system to take over full control of the vehicle to slow down the speed or activate other safety features. The approach of this system is affordable, effective, and adaptable to current mid-range vehicle types, in addition, it may provide further opportunity to collect data via additional environmental sensors (e.g., fog, rain, and air quality) to support road safety enhancement.

Overall, the project offers a broad scope of opportunities in the intelligent transportation system, road safety, and accident prevention.

## II. LITERATURE REVIEW

Reference [2] shares a new Vehicle Overtaking System (VOS) that leverages low-power, long-range (LoRa) communication technology to help improve safety decisions when overtaking. This system utilizes vehicle-to-vehicle (V2V) communication and indicates real-time communication between vehicles to the cloud (V2C) for information sharing. This information allows drivers to view important details such as the direction and speed of other vehicles and safe distances for overtaking. The VOS uses a hardware architecture consisting of a Raspberry Pi Model B in conjunction with an Arduino Uno allowing for processing the information received from sensors and making decisions. The VOS provides visual and audible notifications to drivers to encourage or assist with overtaking. Notifications are based on the American Association of State Highway and Transportation Officials (AASHTO) safety distance calculation recommendations.

Reference [3] presents a real-time, non-intrusive driver drowsiness detection system, called ViT-DDD, which leverages Vision Transformers (ViT) with the goal of improving vehicular safety. The ViT-DDD model assesses the driver's state as either "drowsy" or "alert" by analyzing the full facial image of the driver, as opposed to conventional CNN-based or specific-feature-based algorithms. The design also had the opportunity to consider the entire facial image and therefore less subtle visual characteristics of driver fatigue. For the hardware implementation, the system was deployed to a Raspberry Pi microcomputer with an integrated infrared (IR) camera, GSM/GPS module, and buzzer, enabling real-time monitoring, alerts, and a communication link to the owner of the vehicle.



In Reference [9], a dual-modal driver drowsiness detection system was proposed that leverages facial recognition analysis and heart rate analysis for road safety enhancement. The heart rate of the user is assessed using rPPG, and a webcam can retrieve the heart rate in a non-invasive manner without the need for the driver to wear a device. Simultaneously, a CNN is used to classify the user's state, "alert" or "drowsy," based on analysis of facial expressions. The models were trained, and evaluated on multiple standard trained datasets, real-time evaluation testing with six people indicated robust heart rate calculation and stable drowsiness detection in real-world applications.

Reference [13] presents a system for detecting driver drowsiness that employs Vis-Net, which combines Vision Transformers with multiple deep neural networks (MobileNet-V2, Inception-V3, ResNet152-V2, NASNetLarge, DenseNet) to detect and classify gradual levels of drowsiness. Rather than producing simple binary classifiers, the system quantifies gradual levels of fatigue, drawing from Katajima's drowsiness scale, so that alerts can be adapted when critical impairment is occurring. The overall pipeline uses YOLOv8 for facial extraction, followed by feature extraction using DNNs, and then leverages Mostafa's emotion detection system to optimize processing by filtering non-relevant frames in the process. The system incorporates enhancements to real-time alerting mechanisms, as well as providing overall cost reduction for compute as compared to typical Vision Transformer methods.

Reference [7] describes a data-driven machine learning collision avoidance system based on vehicular heterogeneity focused on the Internet of Vehicles (IoV). The system incorporates Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) communication to receive real-time and historical data depicting vehicle types, speeds, maneuverability, driver behavior, and road surface conditions. Machine learning algorithms using supervised learning, in particular support vector machine (SVM) algorithms, predict the potential for a collision and recommend the most suitable preventive actions with an ability of 96.5% accuracy. The approach noted reliance on the heterogeneity of vehicles and human behavior in collision avoidance, which allows for improvements on traditional collision avoidance systems that relied only on vehicular and weather parameters.

Reference [14] showed a vehicle communication and traffic analysis system using LoRa that provides management and road safety improvements. LoRa is a low-power, long-range method of communicating between vehicles and road infrastructure. With LoRa, LoRa onboard units (OBUs) located in vehicles exchanged data with other vehicles. LoRa Gateways then collected and aggregated vehicle data, and provided a centralized method of analyzing the data. The system allows real-time monitored traffic data such as vehicle density, speed, and congestion, and predicting information to manipulate traffic signal timing and allow early detection of bottlenecks. The system has dependence on showing coverage across a deployment density of LoRa gateways, which can be difficult in highly urbanized areas due to signal interference. Furthermore, real-time analytics may not happen immediately once the volume of data is greater than normal and pre-cognition may not be as effective with more dynamic traffic volumes.

### III. EXISTING METHOD

In conclusion, several systems have been presented to enhance vehicle safety capability and prevent vehicle accidents associated with driver fatigue, or risky behavior, but each have limitations. The Vehicle Overtaking System [2] employs LoRa-based V2V and V2C communication to supply instantaneous Overtaking assessment information and identify safe, overtaking conditions, but it does not analyse the capability of the driver. There are several common vision transformers based and dual-modal drowsiness assessment systems capable of assessing driver fatigue and drowsiness [3] including assessments using facial recognition coupled with heart rate [9]. However, these systems remain challenging as they are usually only effective under controlled lighting conditions and careful camera placement, and have no integration into the vehicle control system. Vis-Net combined with emotion detection [13] also demonstrated improved drowsiness classification with higher classification accuracy but are computationally intensive and require high-end hardware. Additionally, in the event the driver is wearing glasses or a mask can create occlusion and errors from the system. IoV collision avoidance using data [7], v2v/V2I communication, and machine learning to help prevent the vehicle from colliding can demonstrate prediction of a vehicle accident risk. This too is dependent on sufficient sensor infrastructure in the surrounding environment and requires real-time information. In summary, each



systems previously described has limited automation, deployment for real-world driving systems, and lack integration within the vehicle electronics, thus creating a need for a lightweight, in-vehicle, non-intrusive system to monitor the driver's drowsiness while establishing effective long-range communications.

#### IV. PROPOSED METHOD

The proposed system is a LoRa-enabled Drowsiness Detection and Collision Avoidance System with CAN Integration aims to enhance vehicular safety while addressing some weaknesses of existing drowsiness detection systems. The system utilizes computer vision facial recognition, LoRa to communicate in real time, and the automobile's CAN protocol to automate in-vehicle safety for drivers and passengers.

The drowsiness detection component of the system uses computer vision algorithms to analyse aspects of a driver's face, including eye closure, blink frequency, and head position when a person is fatigued. The drowsiness detection system provides a non-intrusive experience for the driver when compared to athlete, wearable, and physiological sensor systems that can be bothersome over longer periods of time. The system sends monitoring for drowsiness messages and can sound an audible alarm or flash a light for immediate attention.

Recognizing external safety, located outside of the vehicle, is obtained using a LoRa module which receives messages from vehicles within range and sends messages to vehicles within range to warn of a potential drowsy driver. Messages are critical to surrounding vehicles for their situational awareness. The system could prevent rear-end or side collisions due to pedestrian or vehicle congestion in a high-traffic situation. An additional GSM/GPRS module is used to report live location to emergency contacts or healthcare centers for health-related rescues in unfortunate cases.

Vehicles establish a mesh network using LoRa technology to facilitate the sharing of real-time data. Each vehicle transmits speed and alert information to its surrounding vehicles. Local data processing allows a real-time estimation of traffic density, congestion, and risk areas. Real-time alerts to the driver are displayed on the dashboard for slow traffic or nearby hazards. This system presents a cost-efficient traffic monitoring solution, devoid of infrastructure, to promote safety.

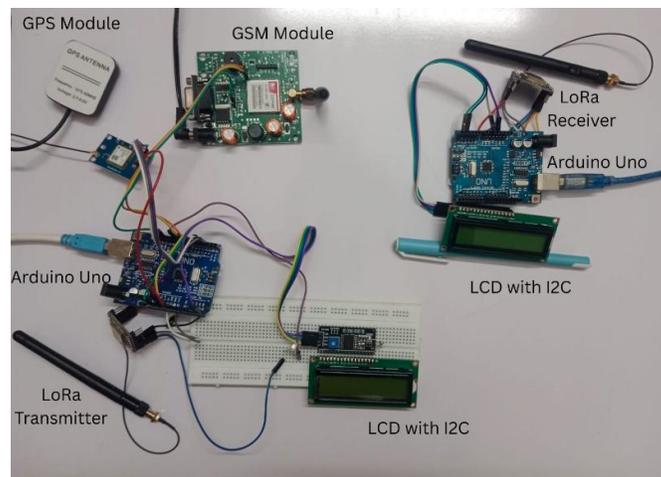


Fig. 1. Hardware Setup

To improve accident prevention, the proposed system takes advantage of the Controller Area Network (CAN) protocol to communicate with the vehicle's Electronic Control Unit (ECU) when the driver has been asleep for too long. If the driver is in a state of prolonged drowsiness, with the ability to use CAN, the proposed system could take corrective action, minimizing, for example, the vehicle's speed or even limiting the engine's power without any driver input needed. This provides an additional barrier of safety in situations where the driver may not respond quickly to alerts.

The system's architecture is compatible with real-time operation on embedded platforms, is lightweight, inexpensive, and can be embedded into a commercial vehicle. By integrating non-intrusive monitoring capabilities, alerting the



driver locally through LoRa, communicating externally through GSM, and taking automated actions inside the vehicle through CAN, the proposed system provides added functionality on existing systems ultimately providing a unified solution to preventing accidents caused by driver fatigue

### V. METHODOLOGY

The concept behind the application of the proposed system is the design and implementation of a smart monitoring framework in-vehicle to prevent accidents caused by driver drowsiness and enable congestion avoidance using real-time vehicle-to-vehicle communications. The system includes computer vision, communication modules, and CAN Bus protocol to detect drowsiness, alert the driver, and take corrective action automatically. The method relies on a hardware–software co-design, with sensors, microcontrollers, and communication modules operating with sophisticated algorithms to achieve accuracy and reliability.

#### Drowsiness Detection Module

In this module, the detection of drowsiness is executed via a camera fixed to the dashboard to assess the driver via the driver’s facial expressions and eye movements. The camera data is processed using computer vision algorithms based on Eye Aspect Ratio (EAR) and yawning detection algorithms by utilizing the Open CV and Dlib libraries on the Raspberry Pi/Jetson Nano hardware. The driver will receive an alarm when either prolonged eye closure or yawning is detected. This non-intrusive technique allows for continuous monitoring without discomfort and has the benefit of being user-friendly compared with wearable sensors.

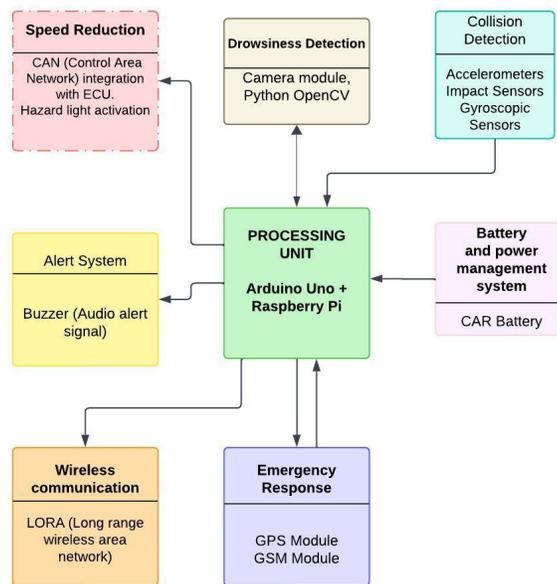


Fig. 2. Block Diagram

#### Communication Subsystem

The system consists of LoRa and GSM/GPRS modules for communication purposes. LoRa provides low-power and long-range connectivity to nearby vehicles operating at the same time within a 3–5 km range, integrating a warning to nearby vehicles of a drowsy driver that would help prevent to collisions. The GSM/GPRS module continuously transmits the driver's live location to the registered emergency contacts or healthcare center, enabling rapid response leading to emergency care if needed.



### **CAN Bus Integration**

The Controller Area Network (CAN) protocol will act as the backbone for intra-vehicle communications. The system allows the ECUs to work with the CAN bus to reduce the vehicle speed, limit engine torque or mitigate the onset of loss of control by activating the braking assist after confirming that drowsiness occurred. The warning not only is meant to notify nearby vehicle, but it is intended to help mitigate the possibility of an undesired outcome, thereby improving the overall safety of vehicle.

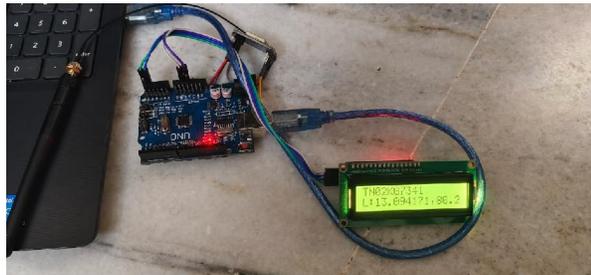


Fig. 3. LoRa receiver Output

### **Traffic Analysis**

Traffic analysis is accomplished with a LoRa mesh network embedded in vehicles, which do not require roadside infrastructure or gateways. Each vehicle is equipped with a LoRa module, GPS, and CAN interface to become a moving traffic sensor. Vehicles transmit packets of speed, location, and drowsiness warnings to other vehicles nearby (within LoRa range). By processing the received data locally, each vehicle can immediately determine vehicle density, average speed, and possible traffic congestion. Abnormal conditions, such as sudden slowing or several nearby drowsiness alerts, are also displayed immediately on the display to warn a driver of hazards or congested areas to be vigilant of. This cost-effective, real-time solution enables dynamic traffic awareness for drivers, enhancing safety in vehicles while providing a distributed, peer-to-peer traffic analysis system

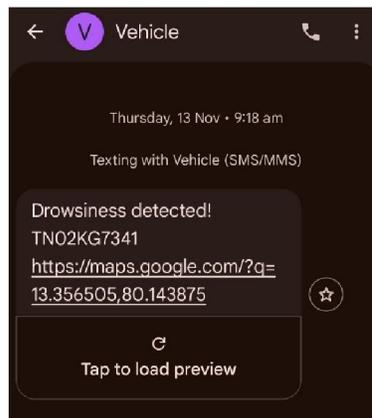


Fig. 4. SMS Alert

### **Power System**

The system features a 12V Li-Ion battery pack, which has step-down converters powering various modules with regulated 5V and 3.3V power outputs so that it can operate indefinitely with low-power modules like LoRa. Power monitoring happens continuously throughout the drive and beyond to ensure power reliability over long distance drives.  
Processing Unit



A dual-processor architecture is employed, where the Raspberry Pi is the primary processor for camera-based detection of drowsiness. It runs real-time computer vision algorithms mainly based on OpenCV. The Arduino is used as the secondary controller, handling sensor interfaces and LoRa and GSM/GPRS communication, and controlling vehicle subsystems through the CAN protocol. The Raspberry Pi and Arduino exchange information over a serial interface, so that any detected drowsiness events could be quickly communicated back to the Arduino for action such as alerting the driver, altering vehicle speed, or sending safety messages.

```
Drowsiness detection started...
W0000 00:00:1760140004.868923 3804 landmark_projection_calcu
without IMAGE_DIMENSIONS is only supported for the square ROI.
use PROJECTION_MATRIX.
👁️ Drowsiness detected! Count: 1/3
🔔 Sent alert level 1 to Arduino
👁️ Drowsiness detected! Count: 2/3
🔔 Sent alert level 2 to Arduino
👁️ Drowsiness detected! Count: 3/3
🔔 Sent alert level 3 to Arduino
```

Fig. 5. Software Output

## VI. OUTCOME AND ANALYSIS

The proposed system A Smart Vehicle Safety System using LoRa and CAN Integration, illustrated notable advancements over existing systems. By leveraging computer vision on Raspberry Pi, the system provided accurate and non-intrusive facial approximation for drowsiness detection while resolving the similar discomfort associated with wearable detection systems. The use of Arduino interfaced with a CAN connection ensured instantaneous communication with in-vehicle electronic control units (ECUs), which enabled controlling behaviors such as reducing speed when drowsiness signals were detected. The LoRa module extended the ability to communicate safety information to vehicles in proximity and real-time traffic analysis, with a much-extended range than traditional wireless methods. In addition, adding GSM/GPRS provided the control of live location sharing to family members or healthcare centers for healthcare response in emergencies where current systems could not provide that capability. The proposed system demonstrated reduced false alarms and multiple safety tiers (self-alert, vehicle-to-vehicle alert, and vehicle control), while also being more dependable with little human involvement than prior systems had.

## VII. FUTURE SCOPE

Future enhancements to the system will be directed at increasing adaptability and intelligence to handle challenges encountered in the field. Integration with Advanced Driver Assistance Systems (ADAS), such as lane departure warning, and automatic braking, will significantly enhance accident avoidance. Utilizing a hybrid communication method that combines LoRa with 5G, or DSRC will enhance coverage and reliability of car to car communications. Cloud data storage and predictive analytics will be used for power and long-term assessment of driving behavior, with the ability to impact health, and could inform traffic authorities. Public transport personal safety technology and research is also planned for wider implementation in the future. For greater levels of detection accuracy multiple modalities would be used such as steering behavior, and biological data feedback from the driver. Long term, a successful scaling of the platform developed here to include commercial vehicles and public transportation systems would prevent rate of major roadway accidents that result in deaths/injuries, and have sustainable impact on society

## VIII. CONCLUSION

A Smart vehicle Safety System using LoRa and CAN integration has been effectively created to solve the shortcomings of the available driver monitoring systems that came before it. The system uses computer vision-based facial detection, which does not require the use of uncomfortable wearable sensors in which drivers would raise concerns. The GSM and GPRS modules ensure that drivers can send emergency alerts in real time, with the level of precision of the location tracking capability being possible due to the use of the LoRa module in terms of the potential distance for vehicle-to-



vehicle communications and traffic analysis can be done without any gateway or external infrastructure. The CAN protocol allows for in-vehicle electronic control units to detect driver drowsiness and automatically reduce the vehicle's speed, preventing accidents. The proposed system to improve driver and road safety that is reliable, comfortable, and scalable.

#### REFERENCES

- [1]. Kusuma Kumari B.M, Sampada Sethi, Ramakanth Kumar P, Nishant Kumar, Atulit Shankar, "Detection of Driver Drowsiness using Eye Blink Sensor"2018.
- [2]. Kwang Chee Seng, Siti Fatimah Abdul Razak, Sumendra Yogarayan, "Enhancing Vehicle Overtaking System via LoRa-Enabled Vehicular Communication Approach", Computer Systems Science and Engineering 2025, <https://doi.org/10.32604/csse.2024.056582>
- [3]. ANWAR JARNDAL, HISSAM TAWFIK, ALI I. SIAM,IMAD ALSYOUF, ALI CHEAITOU, "A Real-Time Vision Transformers-Based System for Enhanced Driver Drowsiness Detection and Vehicle Safety", IEEE Conference, 2024
- [4]. Guosi Liu, Shaoqi Bei, Bo Li, Tao Liu, Walid Daoud, Haoran Tang, Jinfei Guo and Zhaoxin Zhu " Research on Collision Avoidance Systems for Intelligent Vehicles Considering Driver Collision Avoidance Behaviour" 2023
- [5]. Mahek Jain, Bhavya Bhagerathi, Sowmyarani C N "Real-Time Driver Drowsiness Detection using Computer Vision", 2021 .
- [6]. Dina Salem and Mohamed Waleed " Drowsiness detection in real-time via convolutional neural networks and transfer learning", 2024
- [7]. Iqra Adnana , Tariq Umer , Ahmad Arsalan , Maryam M. Al Dabel , Ali Kashif Bashir , Arooj Ansif , "Data driven vehicular heterogeneity based intelligent collision avoidance system for Internet of Vehicles (IoV)",Digital Communications and Networks, 2025, <https://doi.org/10.1016/j.dcan.2025.03.010>
- [8]. DEVAM DHINGRA and PRIYANSHI SINGH "DROWSINESS DETECTION USING MACHINE LEARNING A PROJECT REPORT", 2022
- [9]. Yi Xuan Chew, Siti Fatimah Abdul Razak, Sumendra Yogarayan, Sharifah Noor Masidayu Sayed Ismail, "Dual-Modal Drowsiness Detection to Enhance Driver Safety", 2025, <https://doi.org/10.32604/cmc.2024.056367>
- [10]. Charlotte Jacobe de Nauris, Christophe Bourdin, Anca Melania Stratulat, Emmanuelle Diaz, Jean-Louis Vercher" Detection and prediction of driver drowsiness using artificial neural network models"2018
- [11]. Swapnil Titare 1 , Shubham Chinchghare1 , K. N. Hande, "Driver Drowsiness Detection and Alert System" 2021
- [12]. K. Avinash Babu, G Eswara Rao "Driver Drowsiness Detection System for Accident Prevention" 2024
- [13]. Thuong-Cang Phan, Anh-Cang Phan, Ngoc-Hoang-Quyen Nguyen, "A novel approach of drowsiness levels detection using Vis-Net combined with facial emotion",Systems and Soft Computing, 2025, <https://doi.org/10.1016/j.sasc.2025.200>
- [14]. Santhosh B; Chandan K S; Likith S; M S Poorna; C Y Prajwal, "Vehicle communication and Traffic analysis using LoRa Technology", 2023 Global Conference on Information Technologies and Communications, DOI: 10.1109/GCITC60406.2023.10425913
- [15]. Kithil, Philip W., Roger D. Jones, and M. Jone, —"Development of driver alertness detection system using overhead capacitive sensor array", SAE Technical Paper Series 982292: pg35-56, 1998.

