ISSN: 2582 - 6379
Orange Publications
International Journal for Interdisciplinary Sciences and Engineering Applications
IJISEA - An International Peer- Reviewed Journal
2025, May, Volume 5 Issue 1
www.ijisea.org

Driver Fatigue and Obstacle Detection System

Maradani Phani Kumar[1], V. Ramesh Babu[2]
PG Scholar[1], Professor and H.O.D.[2]
Department of Electronics and Communication Engineering, Amrita Sai Institute of Science and Technology,
Paritala, Kanchikacherla, NTR District, Andhrapradesh, India
Phani.kumar621@gmail.com[1]

ABSTRACT

The increasing occurrence of accidents attributed to driver drowsiness and fatigue poses a significant threat to transportation safety. In response to this critical issue, we propose a novel Driver Drowsiness Detection System that employs image processing techniques to monitor drivers continuously. The core focus lies in the analysis of the driver's face and eyes for early detection of signs of drowsiness. The system utilizes a Raspberry Pi processor for efficient image processing. The proposed system consists of three main phases: Face Detection, Eye Detection, and Drowsiness Detection. The integration of these phases creates a comprehensive Driver Road Safety System, aimed at reducing accidents caused by driver drowsiness. The system's efficacy in improving road safety is attributed to its real-time monitoring capabilities, capacity to adjust to changing circumstances, and compatibility with warning systems. The results demonstrate the potential of this system to significantly contribute to the reduction of accidents caused by drowsy driving, thereby enhancing transportation safety.

Key words: Night Vision Camera, Alcohol Sensor, GSM Module, Ultrasonic Obstacle Sensor, GPS Module and GPS Antenna, Seatbelt Sensor, Raspberry pi, USB to TTL Module.

Abbreviations: GSM, Global system for Mobile communication; GPS, Global Positioning System; USB, Universal Serial Bus; TTL, Time to Live.

I. INTRODUCTION

Driver drowsiness poses a significant risk on road safety, contributing to around 30 percent of accidents, as identified in various surveys. The deteriorating attention levels of drivers, often due to insufficient sleep, prolonged driving, or medical conditions like brain disorders, underscore the need for effective drowsiness detection systems. This projectaimstoaddressthisissuethroughanintelligentdriverassistance system utilizing image processing techniques. The initial section explores various methods for measuring driver drowsiness, including vehicle based, physiological, and behavioral measures. An intelligent system is proposed to integrate these methods for timely driver alerts, preventing accidents. Advantages and disadvantages of each method are discussed, leading to the selection of the most suitable approach. The system's development approach is outlined using a flow chart, emphasizing continuous real-time image capture, face and eye detection, and drowsiness condition assessment.

Detailed discussions on object detection, face detection, and eye detection are provided. As faces are a type of object, object detection studies are conducted. Various approaches for face and eye detection are proposed and explained to form the foundation for the system.

The theoretical foundation for system design is established, highlighting the complexity of face structure. Facial mapping using harr-cascade algorithm is introduced as a method to recognize faces by projecting images onto a face space representing significant variations. Eigen face approach, incorporating Eigen values and vectors, face image representation, mean-centred images, covariance matrix, and Eigen face space, is explored for effective face recognition.[1] The hardware chosen for implementation is the Raspberry Pi, and the theoretical approach to drowsiness detection is detailed. Techniques such as Integral Image formation, A da boost, and Cascading are employed. Code is developed to implement the proposed algorithm, and the Raspberry Pi is set up accordingly.[2] The system's response is recorded using subjects, with visual indications of eye opening and closure, demonstrating the algorithm's functionality.

II. RELATED WORK

In recent times, there has been a growing focus on researching remote access models for detecting driver drowsiness and monitoring health parameters. Previous studies have delved into understanding the causes of fatigue. Omkar Dharmadhikari's research paper titled "Survey on Driver's Drowsiness Detection System" [1] introduced a method

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based on measuring yawning and analyzing the driver's head position for detecting drowsiness. In the research paper titled "Drowsy Driver Detection Through Facial Movement Analysis" [2], Esra Vura and Mujdat Cetin proposed a system based on the Facial ActionCodingsystem.Theymaintainedadatabaseusingmachinelearningtechniques to analyze facial movements for drowsiness detection. On the contrary, a system that recognizes a driver's sleepiness making use of physiological movements, behavior- based methods, and vehicle-based methods had been developed in research titled "Detecting Driver Drowsiness using Wireless Wearables" [3].

In a study named “A Multi-Stage, Multi-Feature Machine Learning Approach to Detect Driver Sleepiness in Naturalistic Road Driving Conditions” [4] demonstrates how machine learning combined with deep learning is capable of precisely recognizing a weary driver. The paper titled "IoT-Based Driver Alertness and Health Monitoring System" [5] by T. Shwetha, J. Panduranga Rao, and B. Sreenivasu presented a model based on the Internet of Things (IoT). This system utilized a webcam to detect the driver's eye state and incorporated temperature and pulse rate sensors for monitoring the driver's health.

III. METHODOLOGY

In our real-time applications, we've successfully implemented a unique Haar cascade technique to pinpoint the area associated with a driver's face.[7] This technology enables us to identify facial expressions by focusing solely on facial structures, ignoring Other objects. If the system detects an intoxicated driver, it triggers a buzzer and utilizes a GSM module to send alert messages to the driver's mobile device while tracking the vehicle's location through a GPS module. Our alcohol sensor, connected to a Rasp berry Pi, efficiently detects ethanol in the air when a driver exhales, providing a quick response to determine alcohol levels. This sensor activates the GSM module to send SMSalertstoanemergencycontactaftersoundingthebuzzer.Thesystemaidsdrivers by addressing issues like alcohol consumption, recognizing hazards, ensuring seatbelt usage, and preventing drowsiness.

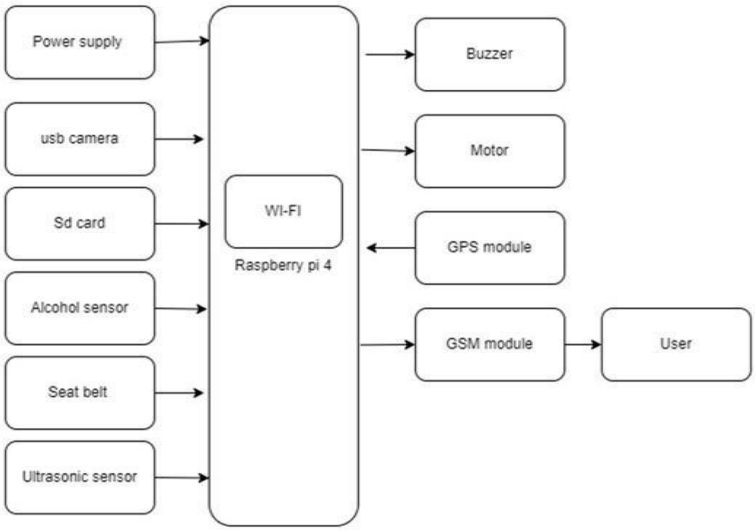


Figure 1: Shows block diagram of the Driver Fatigue and Obstacle Detection System using Raspberry Pi

The architecture of a DFODS encompasses various components, including sensors, data processing units, alerting mechanisms, and connectivity interfaces. Cutting-edge technologies such as computer vision, machine learning, and IoT play pivotal roles in realizing the system's functionality. Sensor Integration: Cameras: High-resolution cameras - time video feed of the driver's face, allowing for the detection of drowsiness cues such as eye closure and head nodding. Infrared Sensors: Infrared sensors monitor the driver's eye movement and blink rate, providing additional inputs for fatigue detection. Seatbelt Sensors: Seatbelt sensors detect the presence and proper usage of seat belts, ensuring compliance with safety measures.

Data Processing: Image Processing Algorithms: Advanced algorithms analyse the video feed to identify patterns indicative of driver fatigue or distraction. Machine Learning Models: Machine learning models trained on extensive

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datasets enable the system to recognize specific fatigue indicators with high accuracy. Real-time Processing: Processing units with sufficient computational power ensure timely detection of fatigue and obstacle detection.

It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. It's capable of doing everything you'd expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word-processing, and playing games.

What's more, the Raspberry Pi has the ability to interact with the outside world and has been used in a wide array of digital maker projects, from music machines and parent detectorstoweatherstationsandtweetingbirdhouseswithinfra-redcameras. We want to see the Raspberry Pi being used by kids all over the world to learn to program and understand how computers work.

The Raspberry Pi 4 Model B+ is a single-board computer developed by the Raspberry Pi Foundation. It is an upgraded version of the Raspberry Pi 3 Model B+ and offers improved performance and features. Here are the key features of the Raspberry Pi 4 Model B+.

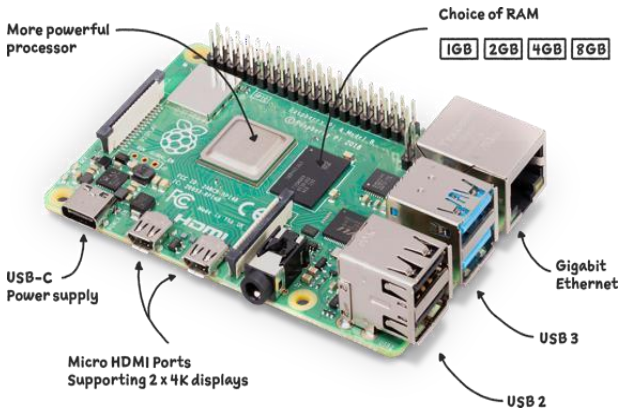


Figure 2: Shows Raspberry PiModel4 B+

PYTHON IDLE: IDLE stands for Integrated Development and Learning Environment. The story behind the name IDLE is similar to Python. Guido Van Rossum named Python after the British comedy group Monty Python while the name IDLE was chosen to pay tribute to Eric Idle, who was one of the Monty Python's founding members. IDLE comes bundled with the default implementation of the Python language since the 01.5.2b1 release. It is packaged as an optional part of the Python packaging with many Linux, Windows, and Mac distributions.

HAAR- CASCADE SOFTWARE: A detailed description of Haar classifiers can be seen in Paul Viola and Michael Jones's paper "Rapid Object Detection using a Boosted Cascade of Simple Features", linked over here. Note that the article goes into some mathematics, and assumes knowledge of machine learning terminology.

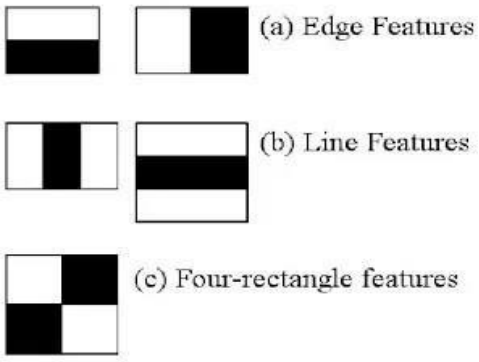


Figure 3: Shows Types of Haar Features

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Creating Integral Images: Without going into too much of the mathematics behind it (check out the paper if you're interested in that), integral images essentially speed up the calculation of these Haar features. Instead of computing at every pixel, it instead creates sub-rectangles and creates array references for each of those sub-rectangles.

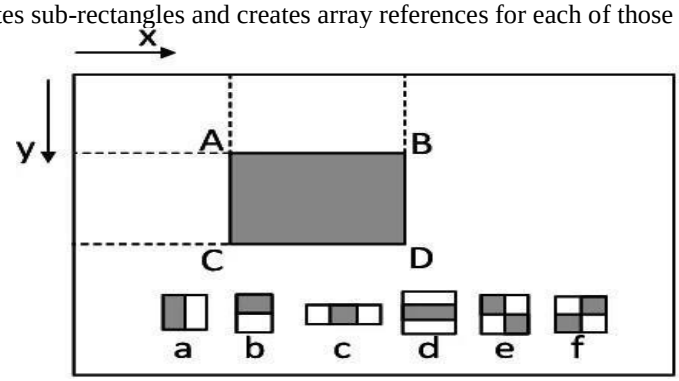
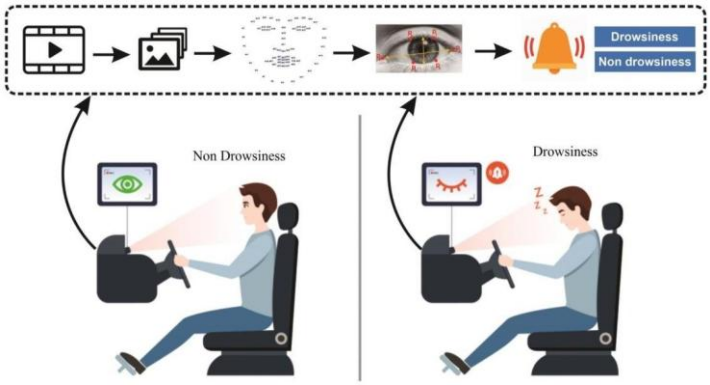


Figure 4: Shows Illustration for how an integral image works.

IV. RESULTS

The illustration of the experimental configuration for the proposed" Driver Fatigue and Obstacle Detection System using Raspberry Pi" is presented in Figure 7.2. This setup Comprises all the designated sensors, each of which has undergone thorough testing and functions seamlessly. The hardware is designed for effortless integration with advanced devices or any forthcoming technological enhancements. Additionally, it offers seamless integration into automobiles, allowing for straight forward connection to their power supply and system. The system is adaptable and can be easily incorporated into future advancements or integrated into various automotive setups



. **Figure 5: Shows the Working of the driver fatigue detection system.**

In real-time video feeds, the shape predictor predicts the face and eye regions. The EAR, calculated as the Euclidean distance between the two eyes, determines the level of drowsiness. Face landmark identification is performed by referencing the created dataset. The algorithm calculates the EAR across multiple frames, displaying one blink at a time. If the Raspberry Pi module detects driver fatigue, it triggers a high-pitched alarm through the buzzer as the initial safety measure. As a secondary safety measure, the GSM module is activated to establish communication with an operator or an emergency contact in a remote location.

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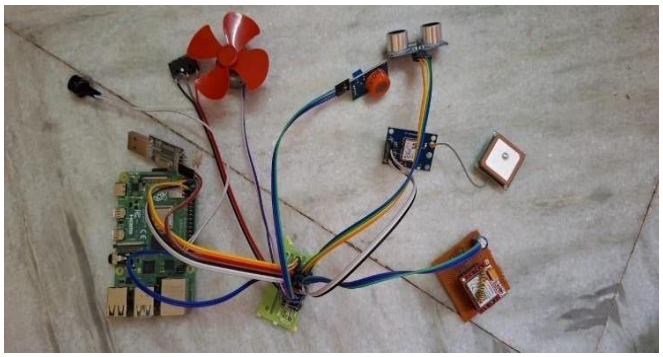


Figure 6: Shows the Experimental proposed system

The console output serves as a system-specific display appearing on the screen of the system executing the Python program, and it is transmitted to the Raspberry Pi module. Within the framework of the proposed project, the system generates various emergency messages and console outputs. Examples of these messages include prompts such as "Please reduce speed, vehicle detected ahead," "Driver in abnormal condition," and "Driver under the influence of alcohol," among others. These messages are triggered based on the inputs received by the system, enhancing the overall functionality and safety features of the project.

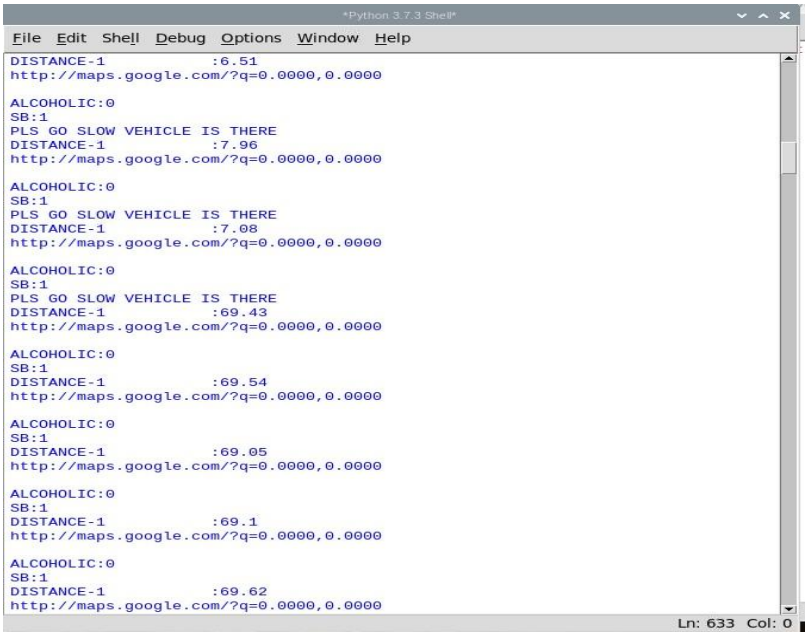


Figure 7: Shows the Console output

V. CONCLUSIONS

The primary objective of driver fatigue detection is to prevent accidents caused by drowsiness by ensuring drivers remain alert while operating a vehicle. To achieve this, a buzzer emits an alert signal to awaken the driver if signs of fatigue are detected. The Raspberry Pi, in conjunction with a USB camera, continuously assesses the driver's fatigue level in real- time. The assessment involves utilizing the Haar Cascade Classifier to identify facial features, with a focus on the eyes. Facial landmarks are pinpointed using a shape predictor, and the Eye Aspect Ratio (EAR) is computed by measuring the Euclidean distance between the eyes. Precise identification of facial and eye features in each image enables the calculation of the driver's level of sleepiness. The system accurately records frequent head tilting and eye blinking, providing valuable indicators of drowsiness. Additionally, the inclusion of a seat belt sensor, an alcohol sensor, and an obstruction sensor adds an extra layer of precaution for the driver. In the event that the driver's sleepiness approaches a critical threshold, a loud warning is triggered to rouse them from their drowsy state.

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VI. DISCUSSIONS

In the future, the implementation may be done in a well-lit space with constant illumination, for various lighting scenarios, and it can also be taken into consideration for those with dark skin. The future scope of driver drowsiness detection holds significant potential for further advancements and improvements in road safety. Several avenues can be explored to enhance the effectiveness and features of such systems.

Advanced Sensing Technologies: Integration of more advanced sensors, such as EEG (Electroencephalogram) sensors or advanced computer vision systems, can provide a more comprehensive analysis of the driver's physiological and behavioural indicators of drowsiness.

Machine Learning and AI Integration: Utilizing machine learning algorithms and artificial intelligence (AI) can enhance the system's ability to adapt and learn from diverse driving scenarios, making it more accurate in detecting subtle signs of driver fatigue.

Biometric Authentication: Incorporating biometric authentication methods, such as facial recognition or fingerprint scanning, could add an additional layer of security, ensuring that the detected drowsiness is associated with the authorized driver.

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