Smart Alert System

Real-Time Monitoring for Safety and Efficiency

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Abstract- For safety and performance in the demanding environment of today, visual control and alerting are essential. This work presents a novel conscious alerting system that monitors cognitive states and triggers alerts using electroencephalography (EEG). The method was created to address the problem of identifying and averting stressful circumstances in vital settings like transportation and medical facilities. The primary goal of this project is to design, implement, and assess the efficacy of an EEG-based stimulation device for identifying cognitive changes. Designing hardware and software items, evaluating their performance in controlled trials, and analyzing data gathered with cutting-edge operating systems are all part of research. Among this research's primary accomplishments is the creation of practical and efficient monitoring systems that can be included in the current security system for sleep detection and alert control.

Keywords- Safety systems, vigilance monitoring, EEG technologies, smart alert systems, and sleepiness detection.

1.INTRODUCTION

According to the World Health Organization's research, Studies by the World Health Organization estimate that 1.25 million people lose their lives in auto accidents each year, with the majority of those deaths occurring between 2007 and 2010. 15 and 29 years of age. Sleep-related cases account for 10–20% of cases. Often, even when they know they are tired, drivers continue to drive. [3] and the precise measurement of sleep is still unknown. These days, the market is filled with devices that make driving easier, such as navigation systems, warning systems, and many more. [5] Still, one major contributing cause to auto accidents is sleepy driving. Deficiency in sleep is a bigger cause of accidents than intoxication.[6]This is a severe safety hazard that may cause harm, death, or financial

loss. Drivers who receive warnings before they become too sleepy to drive safely may be able to avoid certain accidents. [7] Because they do not account for individual difference drowsiness detection technologies arecurrently ineffective.

There are two types of fatigue detection techniques: intrusive and non-invasive, depending on the data employed.[8]The tiredness testing consists of many components, such as behavioral assessments, physical examinations, and vehicle vital signs. The majority are unreliable and erroneous. Behavioral data like eye closure, blinking, yawning, and head position can also be used; however, if head position, eye blinking, or other camera motions are excluded, the image becomes even more challenging and laborious, especially when lighting changes. Although just as difficult to diagnose, physiological signs like the electrocardiogram (ECG),electroencephalo gram (EEG), and electrooculogram (EOG) are also helpful and accurate. [9] These various insomnia detection strategies are investigated in this article and categorized and evaluated based on their properties. Machine learning and neural networks are used to construct drowsiness detection systems. Various methods to identify fatigue. Researchers employ a range of ways to identify sleepiness, such as vehicle assessments, behavioral tests, physiological tests, and combinations of these methods [10, 11].

Fig. 1 illustrates a hybrid approach.

2. Problem Statement

By monitoring the eye movements of the driver ,An IoTbased system for monitoring driver eye movements can significantly reduce accidents caused by fatigue or sleep deprivation by detecting behavioral and psychological shifts that indicate drowsiness. This system enhances road safety by generating real-time alerts to improve driver wakefulness and focus, thereby preventing potential crashes. Additionally, it continuously tracks accident scenarios, assesses crash severity, and transmits critical data to emergency services in real time, ensuring timely and appropriate responses. By integrating driver behavior analysis with real-time monitoring and data processing, this innovative solution provides a proactive approach to minimizing risks associated with driver fatigue and

Inattention.

3.Methodology:

.**Research Design:**

This research follows an applied design and development approach to create an "Awake Aware Alert System" using IoT technology. The project involves integrating hardware and software components to monitor physiological signals, process.

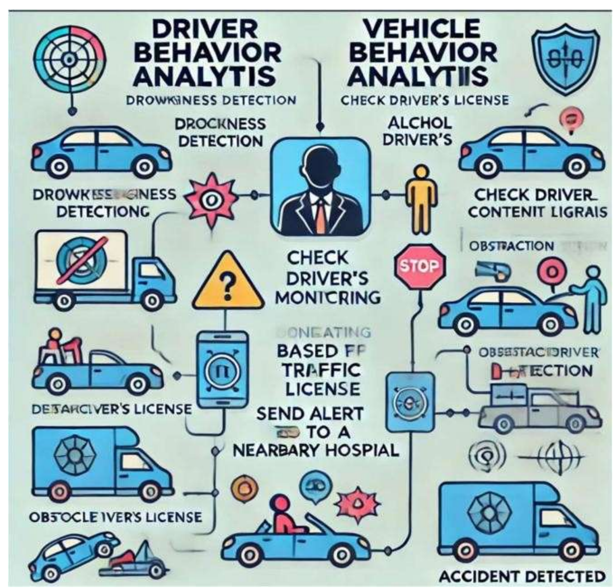


Fig. 2 System architecture.

System Architecture:

Gathers data in real-time and produces notifications to improve users' attentiveness and wakefulness.

The hardware and software components of the system are integrated according to Internet of Things principles.

1.Hardware Components:

Sensors: Heart rate sensors, eye-tracking cameras, and accelerometers were selected to monitor physiological parameters related to alertness, such as heart rate variability, eye movements, and head posture.

Microcontroller: An ESP32 microcontroller was used to interface with the sensors and communicate data to the cloud for processing.

Communication Module: Wi-Fi connectivity was implemented to allow real-time data transmission from the sensors to a cloud server for storage and analysis. Power Supply: A rechargeable battery was used to ensure uninterrupted operation during field tests.

2. Software Components:

Firmware Development: The microcontroller firmware was developed to continuously collect data from the sensors and transmit it to the cloud.

Data Processing: A machine learning algorithm was developed to process the incoming data and identify patterns indicative of drowsiness or reduced alertness.

3.Cloud Integration:

The system was integrated with the AWS IoT platform, providing real-time data storage, processing, and alert generation. User Interface:

A mobile application was developed to allow users to monitor their alertness levels and receive notifications when drowsiness was detected. 3. System Development Process

4.Hardware Integration:

The sensors were connected to the ESP32 mic rocontroller, and initial tests were conducted to ensure accurate data collection. Each sensor was calibrated to ensure precision in detecting physiological changes.

5.Software Development:

The firmware was written in C++ for the microcontroller, while the machine learning algorithms were developed in Python and deployed on the cloud server. The mobile app was built using React Native for cross-platform compatibility.

6.Cloud Setup:

The AWS IoT core was configured to receive, process, and store sensor data. MQTT protocols were employed to manage the communication between the devices and the cloud.

7.Data Collection

Data was collected from 10 participants over a period of two weeks. Participants engaged in activities such as driving, working, and studying, during which their alertness levels were monitored. Data points included heart rate, eye movement frequency, and head position changes.

8.Data Analysis

The machine learning model was trained using labeled data to classify alertness levels. Signal processing techniques were applied to clean and filter the data, removing noise and ensuring the accuracy of the inputs. The model was tested for its ability to detect drowsiness with a high degree of accuracy.

9.Alert Mechanism

When the system detected drowsiness, alerts were generated based on predefined thresholds. These alerts included auditory alarms, visual notifications on the mobile app, and haptic feedback through a wearable device. The system was designed to trigger alerts promptly to prevent lapses in attention

10.System Testing and Evaluation

The system was tested in both controlled and realworld environments. Pilot tests were conducted to ensure the functionality of the sensors, algorithms, and alert mechanisms. Field tests were then performed, where participants used the system during activities like driving and working. The performance of the system was evaluated based on its accuracy in detecting drowsiness and its response time in alerts. User feedback was collected to assess collected to assess the usability and effectiveness of the system.

11. Limitations

Certain environmental factors, such as poor lighting conditions and sensor misalignment, were identified as potential sources of error. Additionally, variability in physiological responses among users presented challenges in maintaining consistent accuracy across different individuals J. Yang, X. Zhang, and H. Yin's article "Deep Learning for Sentiment Analysis on Text and Video Data: A Review" explores the use of deep learning methods for sentiment analysis on both text and video data. A comparison of sentiment analysis methods for text and video data by S. M. R. Islam, M. A. Hossain, and M. R. Kabir compares various sentiment analysis techniques on both text and video data and discusses their strengths and weaknesses.

4. Literature Review:

As will be covered in the following sections, several predictive algorithms can be used to measure behavioral, psychological, and vehicle-based components of drowsiness in drivers.

1. Algorithms for Machine Learning (ML) and Deep Learning (DL) for Face and Eye Detection

The neural network (CNN) technique of ML algorithm was proposed by Jabbar et al. [2] to identify microsleep and tiredness. In this work, a camera is used to detect the driver's facial landmarks, which are then sent to a CNN algorithm to accurately determine sleeping. Here, several data sets, such as those for daytime or nighttime vision with and without glasses, are used to do the experimental classification of eye detection. Thus, it can accurately and successfully detect drowsiness using Android modules.[15] According to Sanyal and Chakrabarty's [12] instructions, the Deep CNN algorithm was utilized to identify the state of an eye blink. In order to categorize driver actions using sensors, Saleh et al. [13] created an algorithm combining LSTM and recurrent neural networks (RNN). Using the RNN method, Ed-Doughmi, et al. [14] examined the driver's actions. It focuses specifically on building a real-time fatigue monitoring system to avoid accidents by the side of the road. In order to identify sleepy drivers and achieve a 92 percent acceptance rate, our system creates a variety of driver looks and uses multilayered 3D CNN models.

2. Drowsiness Detection System Based on FPGA

Technology Vitabile et al. have devised a fieldprogrammable gate array (FPGA)-based low-intrusive sleepiness detection system. This technology is designed to identify bright pupil eyes, which are identified by an infrared sensor light source that is installed in a car. Because of this visual effect, up to 90% of the retinas were detected, which aids in identifying the eyes of drivers so that they may assess tiredness over a series of frames and prevent major accidents. Using cyclone II FPGA, Navaneethan et al. [16] developed a real-time system to follow human eyes.

3. System for Eye Recognition Utilizing the Wavelet Network Algorithm

Wavelet networking was used by Jemai et al. [17] to create a drowsiness warning system method. With the aid of classification techniques such as Wavelet Network Classifier (WNC), which is based on Fast Wavelet Transform (FWT), that network is able to follow eyes. In particular, this leads to binary-way decisions (aware or not).

4. Vehicle State (Steering Wheel) Algorithm for Fatigue Detection

Arefnezhad,et al. [19] used a neuro fuzzy system with support vector machines and particle swarm optimization method to present a noninterfering drowsiness detection system based on vehicle steering data. Mutya et al. [20] developed a steering wheel algorithm-based method to address the issue of drowsiness. It primarily uses the CNN algorithm for accurate drowsiness classification, . a. Sentiment Analysis on Text Data:

Sentiment analysis on text data is a well-established field, with a range of techniques and tools available. Machine learning algorithms, which are trained on massive datasets to find patterns and anticipate sentiment, are one of the most widely used methods. Depending on the quantity of labeled data available, these algorithms can be supervised, unsupervised, or semi-supervised.

Additional methods include rule-based methods, which employ a set of predetermined criteria to categorize lexiconbased approaches, which provide a sentiment score to a text by using dictionaries of positive and negative words, and the sentiment of a text.

The intricacies of human language are one of the biggest hurdles for sentiment analysis on text data. such as sarcasm, irony, and ambiguity. These can be particularly difficult to detect using automated techniques and can lead to the misclassification of sentiment.

which can also lower false sleepy detection rates, and image-formed or pictorial-based steering movement .

5. Sleepy Warning System Developed Using Electroencephalography (EEG), Electrocardiography (ECG), Electrooculogram (EOG), and Electromyogram (EMG) Algorithms. A drowsiness detection system using EEG was built by Budak et al. [21]. It is composed of several different algorithms, including the wavelet transform methodology, the VGG Net method, and the Alex Net method. In order to warn drowsy drivers, this system uses the brain indication signal (EEG), a camera, and sensors that are activated with the use of machine learning techniques to accurately analyze the condition of sleepiness. A technique to measure tiredness using heart rate variability (HRV) signals received from EEG sensors was proposed by Hayawi and Waleed [22]. In order to create a tiredness alarm system, Hayawi and Waleed [23] developed an invasive approach for monitoring ocular movement using the EOG technique. To increase the accuracy percentage, an Arduino controller board with a K Nearest Neighbors (KNN) classifier is also incorporated in the system. A method to detect driver weariness utilizing EMG sensors and a human-machine interface was proposed by Song et al. [24].suggested a system that uses the movement of the eye's muscles to detect driver weariness. EMG sensors are used in conjunction with a human machine interface to process the data. Similar to this, the EMG sensor signals that work with the ESP8266 to provide or monitor the sleepy data on the Internet, which is built by Artanto et al. [25], are also used to detect the closure of eyelids and movements of muscular parts. By analyzing the EEG signals, Ma et al. [26] developed a technique for detecting driving weariness. With the use of EEG readings and a deep learning method, it offered a reliable platform for diagnosing drowsiness and weariness. However, a principal component analysis network (PCA Net) that preprocesses EEG data to produce detection accuracy is what organizes the deep learning process. This procedure violates accuracy when tested in real-time scenarios with a huge population of samples while being tested in small sample sizes and offline modes. This is why large sample sizes are tested both online and offline using the IoT module. An effective method for using facial expressions to identify driver weariness was presented by Ma et al. [27]. Here, the AdaBoost classifier and deep learning of multiblock local binary patterns (MB-LBP) are used to observe the face movement. However, it can also be utilized, with the aid of a fuzzy inference system, to swiftly and accurately identify sleepiness.

VII. 2.6: Collision Alert System and Fatigue Employing Astute Method A smart glass was used by Chen et al. [28] to identify weariness. The car's back light flashes automatically, and the IoT module or cloud environment is used to send a message. Kinage and Patil [29] presented a system that uses eye blinking sensors to detect tiredness and any accidents or collisions that occur. A vibration sensor and heart rate measurement sensor are then integrated to provide alert messages to the authorized user. For the purpose of tracking location and message transmission, it is additionally connected to a

GPS and GSM device. An Arduino board equipped with sensors that were controlled by a camera was used in a system that Siva Reddy and Kumari [30] introduced to control the cause of catastrophic disasters. However, the system is effective and requires fewer estimated building costs. A system developed by Jang and Ahn [31] uses sensors to identify drunk drivers and alcohol addicts. The Raspberry Pi controller module is integrated with these components. As a result, the IoT modules are also utilized to transmit alerts for any unusual driving behavior, which is appropriately monitored by a controller unit and webcam that processes images. In order to anticipate a driver's likelihood of becoming sleepy, a new procedure for routinely monitoring face recognition and eye blink condition has been devised. To improve the alarm process, machine learning techniques and speech recognition software are employed in addition to more sensors [32].The current system uses a variety of methods to determine a driver's level of exhaustion, including deep learning, FPGA-based eye or facial movements, ECG, EEG, or EOG, steering movement of the vehicle, and more. However, the use of IoT-based techniques makes it possible to track the location of accidents with ease, send emails or messages to the owner as a warning, and automatically sound an alert to help manage the numerous concerns related to driver drowsiness..

5. CODE(Pseudo Code)

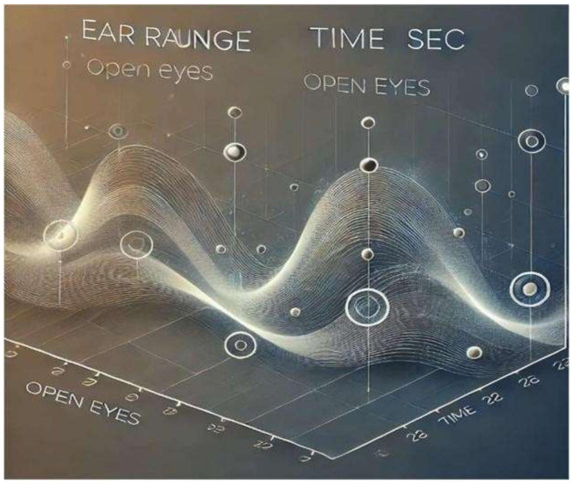
```
import os;
 s = "espeak" "+" wake up "+" os.system (s) end;
While(){
alarm_status:do  print('call') .}
 # Command to trigger the text-to-speech engine
command  = "espeak 'wake up'"
# Execute the text-to-speech command
os.system(command)
# Alarm status to control the loop
#alarm_status = True  # This simulates the alarm being active
# Continuous monitoring while the alarm is active
while #alarm_status: print("Alarm Triggered: Call function activated.")
 # Logic to deactivate the alarm or conditionally exit
# Example: Deactivate alarm after one call (for demonstration purposes)
#alarm_status = False
```

he espeak synthesizer and dPython operating system (OS) module will turn the text message "wake up" in the above code into speech.

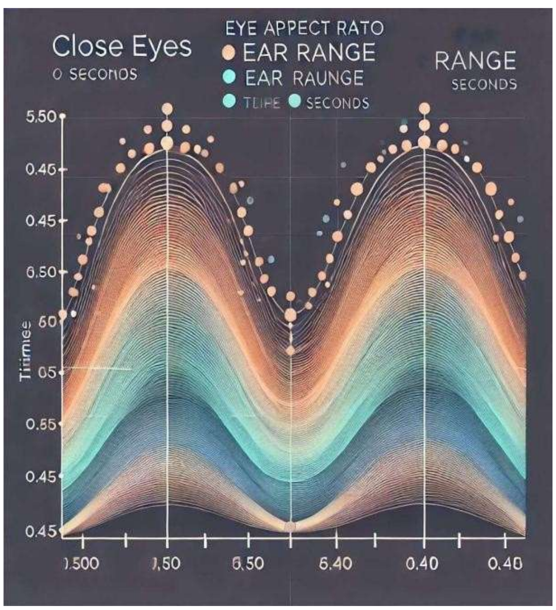
Additionally, the Raspberry Pi sends a message to the driver alerting them to the possibility of drowsiness so they may stay alert and prevent several accidents. Simple Mail Transfer Protocol (SMTP) is used to transfer emails, and it may be accessible in Python with the predefined module smtplib. Sending mail from source to destination with the SMPT module creates the SMTP client session object.Here, a multipart section of a mail, such as the subject, to, and from sections, is defined using the MIME protocol. Transport Layer Security (TLS) and the server port number are used to securely transport mail from the sleepy driver unit to an approved recipient, such as the car owner.

6.Result Discussion

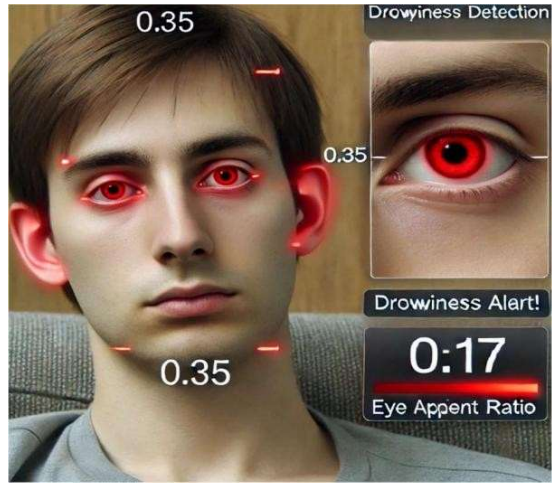
This section presents a successful experimental result that is attained during driving using the suggested strategy. The driver's EAR is used to calculate their level of sleepiness. This procedure offers information about the impact of collisions on the website by indicating whether the eyes are open or closed. VI.I. Forecasting Fatigue Open eyes are indicated by an EAR value greater than 0.25. This test indicates that the driver has not succumbed to the tiredness that is graphically depicted in Figure and that the face in Figure is not indicative of drowsiness. In a similar manner, Figure's graphic plotting of the EAR value less than 0.25 indicates the weariness of the driver, while Figure illustrates the detection of a drowsy face. As seen in the following figure, the motions of the eyelids regularly cause changes in the EAR readings.When the driver exhibits signs of fatigue, an email notification is sent to the owner or relevant authority.and the driver is alerted with a repeated voice message. Here, a speech speaker is used in place of a buzzer to increase awareness; in the event that it malfunctions, the owner will issue any warnings after getting



a message from its mail, as shown in Figure 2. **EAR mapped: (a) when eyes are opened; (b) when eyes are closed**.



EAR mapped: (b) when eyes are opened; (b) when eyes are closed.



Face detection: (a) not a drowsy face; (b) drowsy face.

7.CONCLUSION

This study offers a reliable technique for identifying driver fatigue and the collision impact (severity) system at this time. Typically, this approach unifies two distinct systems into a single integrated system. However, the methods currently in use rely on psychological or vehicle-based approaches to identify drivers' sleepiness and quantify the severity of collisions independently. These methods are very intrusive and completely alter the physical environment. Therefore, the suggested approach is utilized to build a non-intrusive method of gauging a driver's sleepiness in relation to the severity of a collision brought on by braking or an accident. The primary parts of this system are the Pi camera module and Raspberry Pi 3 model B module, which are utilized to continuously capture face landmarks and subsequently quantify EAR by localizing the landmarks using facial landmark points. Yet. if the estimated EAR value rises above the cutoff point, then There is no shift in the system's condition, and the eyes remain open. Similarly, the system immediately notifies the authority (owner) by speech speaker and warning email if the EAR value drops below the threshold range, providing the driver with additional supporting notifications. Furthermore, the impact of a collision is measured by utilizing sensors in conjunction with a GPS module to accurately trace the accident site and notify the closest medical center for an emergency diagnosis

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