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Anti-Sleep Glasses using AI and ML to Prevent Accidents

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***Abstract*—The "Anti-Sleep Glasses" uses artificial intelligence (AI) to solve the serious problem of accidents caused by sleepiness. The system uses an ESP32 AI Cam board and customized glasses to integrate a machine learning (ML) model that is trained and implemented on the ESP32 in order to identify eye conditions. An alarm sound is generated whenever the machine learning model detects that an eye has been closed for more than 300 milliseconds. This helps avert mishaps that may arise from drowsy drivers or operators. With the use of sophisticated sensors and AI algorithms, these glasses can precisely identify indicators of weariness or exhaustion by tracking the wearer's pupil dilation, eye movement, and blink rate. In order to notify the user and avert any mishaps, the system quickly activates an alarm mechanism—which may be haptic, visual, or auditory—when it notices these indicators. Since the system learns and adapts to each user's unique patterns of alertness and fatigue, the integration of AI enables a high degree of accuracy and flexibility to diverse users. The glasses may be worn for lengthy periods of time without causing pain because of their pleasant and non-intrusive design. This technique has broader uses in numerous industries where attentiveness is crucial for safety, in addition to improving road safety by warning sleepy drivers. The creation of these glasses marks a substantial advancement in the application of AI to enhance public safety and avoid accidents.**

***Index Terms*— Artificial intelligence, ESP32 AI Cam board, Machine learning ,300 milliseconds, drowsiness.**

I. INTRODUCTION

An inventive solution to a serious safety concern—drowsiness-related accidents—is provided by the Anti-Sleep Glasses project. These mishaps represent a serious risk in a number of businesses, but especially in the transportation and other areas where attention to detail and vigilance are critical. The project uses AI technology to its full extent in order to provide a proactive and useful solution. In order to explain how the Anti-Sleep Glasses project combines technology with common wearables to improve safety, this article explores the project's intricacies, consequences, and possibilities. Fatigue and drowsiness can seriously hinder someone's capacity to pay attention and respond quickly, which increases the likelihood of accidents. According to estimates from the National Highway Traffic Safety Administration in the US, in terms of road safety, intoxicated driving results in thousands of collisions annually. Similar to this, weariness may cause mistakes in sectors like

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mining, manufacturing, and healthcare, which lowers total productivity and puts lives in danger. These mishaps might result in anything from little property damage to disastrous incidents involving fatalities. Therefore, it is not only desirable but also necessary to find a way to reduce these dangers.

Drowsiness is typically characterized by a decline in alertness and a gradual transition towards sleep. This state is often accompanied by physiological changes, such as slower blinking, longer blink duration, and changes in the eyes' movement patterns. Detecting these subtle changes in real-time can serve as an early warning system for drowsiness. Traditional methods of detecting fatigue include subjective self-assessment scales and physiological measurements like EEG (electroencephalogram), which are impractical in many real-world scenarios. The advent of AI technology offers an innovative way to monitor these signs unobtrusively.

Artificial intelligence (AI), in particular machine learning and computer vision, has demonstrated significant potential in identifying patterns suggestive of sleepiness. AI models may be trained on large datasets of face and eye movements to identify the subtle indicators of exhaustion. After being taught, these algorithms may function in real-time and offer immediate feedback. An important step toward making AI usable and accessible for daily usage is the incorporation of this technology into wearables like eyewear. The ESP32 AI Cam board is a low-power, small module that houses both an AI processor and a camera. The compactness, efficiency, and ability of this board to analyze photos and run AI models directly on the device make it perfect for applications such as the Anti-Sleep Glasses.

II. Related Work

Due to the recent spike in motorization brought on by population growth and vehicle penetration based on length and width, road accidents have resulted in a significant number of fatalities and injuries [1]. Injuries from auto accidents are the main cause of mortality worldwide for those between the ages of 15 and 49. By 2020, there will be 1.3 lakh traffic accidents in India, injuring over3.4 lakh persons. Nonetheless, fewer people die in accidents in 2020 than in 2019. Better traffic management, the application of the new Motor Vehicle Act, and the COVID-19 lockdown have all contributed to a decrease in the number of deaths from traffic accidents. The number of traffic accidents decreased by 18.46% in 2020, while the average injury rate decreased by 22.84% and the overall fatality rate decreased to 12.84% [2].A model for video-based feature identification has been used for tracking in many applications over the years. The precision of performance is increased with the Personal Computer Vision Strategy by using webcams for monitoring and detecting face features. Here is a summary of the body of research on sleepiness detection to date: Based on vehicle monitoring, Aref Nezhad et al. [3] created a deep learning neural network-based non- intrusive drowsiness detection method. CNN (Convolutional Neural Network) and RNN (Recurrent Neural Network) are combined in the suggested deep learning model. Network inputs including wheel velocity, lateral deviation, acceleration, wheel angle, yaw rate, and road centerline are taken into account when performing the examination. The deep learning network's LSTM (long-short term memory) and GRU (gated recurrent unit) layers are employed as RNNs to measure the degree of sleepiness. As a result, the suggested model assesses around 44 experimental data sessions using a stationary driving simulator.

As compared to traditional classifiers like support vector machines and k-nearest neighbors, the simulation results showed that deep networks had a greater classification accuracy. With 96.0% accuracy, the suggested model performs better. A transfer learning-based framework model for the deep feature extraction from the driver faces picture was built by Bekhouche et al. [4]. With the pre-trained model using the facial recognition dataset, the model makes use of a deep convolutional neural network (DCNNN). The nine-frame sliding temporal window frame sample is used in the developed mode.

In order to create raw feature vectors, the retrieved features are aggregated with temporal characteristics in the observation matrix. The NTHU-DDD (NTHU Drowsy Driver Detection) video collection serves as the basis for the examination. The simulation results showed that, with an accuracy of 97.45%, the suggested model outperforms the state-of-the-art techniques. Cui et al. [5] created an interpretable Convolutional Neural Network (CNN) to identify driver tiredness by analyzing EEG parameters. The model's performance is based on the local area estimate in the input signal that is evaluated using the CAM (Class Activation Map) approach in conjunction with GAP (Global Average Pooling) to conduct classification. Based on the study of the simulation results, the improved model achieves around 73.22% accuracy for the 2-class cross-subject classification. The visualization technique is said to be successful when compared to the EEG signal-based method. The study also revealed that CNN is a useful instrument for assessing drivers' mental health. In order to depict the feature extraction and classification, Moujahid et al. [6] created a PML (Pyramid-Multi Level) framework for face detection. The developed framework model is assessed in relation to the NTHUDDD (NTH Drowsy Driver Detection). The investigation showed that the suggested technique achieves notable performance for sleepiness detection using deep Convolutional Neural Networks with examination of facial characteristics. Zhang et al. [7] developed a model to calculate the drivers' degree of sleepiness using the temporal cumulative effect (TCE). The evaluation is carried out utilizing the eye-tracking technology for the driving simulation and a dataset of 27 drivers. The impression of tiredness among drivers is recorded using the Karolinska Sleepiness Scale (KSS). Over time, the degree of sleepiness increases, and the MOL (Mixed-effect ordered logit) model is used to accumulate data. The experiment's findings therefore showed that when tiredness grew, so did the lateral position standard deviation and the percentage of driver eyelid closure, or PERCLOS. These increases occurred quickly. While the MGOR-TCE accuracy is tested at 61.04% and the non-TCE MOL model accuracy is assessed at 52.47%, the MOL-TCE model yields an accuracy of 62.84%.

III. PROPOSE SYSTEM

An innovative way to solve the serious problem of fatigue-related accidents and sleepy driving is the Anti-Sleep Glasses system that uses artificial intelligence (AI) to avoid mishaps. This cutting- edge technology, which makes use of the Fear of Missing Out (FOMO) paradigm, attempts to maintain people's focus and alertness when engaging in tasks that call for prolonged attention, like driving. In order to improve safety and avoid mishaps brought on by fatigue, the FOMO model capitalizes on people's natural dread of missing out on crucial information or events**.**

The system's central component is the use of artificial intelligence (AI) algorithms that track a range of physiological and behavioral cues from the user, including head position, eye movement, blink rate, and even biological data. The AI can dynamically determine the user's degree of awareness in real-time thanks to these data inputs. The FOMO model operates by examining how the user interacts with their surroundings and presenting cues that arouse feelings of being left out.

Advanced sensors and cameras included into the Anti-Sleep Glasses record and analyze the user's eye movements. Based on individual patterns and considerations such as driving conditions, time of day, and past data, the AI program creates a baseline for typical alertness and attention. The FOMO model kicks in and starts executing tactics to keep the user interested and alert when it notices indications of tiredness.

Based on the idea that there is intriguing or important information around them, people are more inclined to remain vigilant, is how the FOMO model works. The Anti-Sleep Glasses use an array of sensory inputs, including tactile, aural, and visual ones, to accomplish this. The glasses may, for example, play captivating music, show interesting visual patterns onto the lenses, or even gently vibrate the user's temples.

Moreover, the AI modifies its tactics in response to the user's reaction to the stimuli. The algorithm cleverly modifies the type and intensity of the stimuli to guarantee continuous attention if the first FOMO triggers are ineffective. In addition to preventing sleepiness, the objective is to give the user a customized, engaging experience by adapting the treatments to their preferences and sensitivities.

IV. SYSTEM ARCHITECTURE

The system architecture of anti-sleep glasses, integrating AI and ML technologies alongside the ESP32 CAM board and employing the FOMO (Fast object more object) algorithm, presents a comprehensive solution for averting accidents due to drowsiness. The ESP32 CAM board serves as the primary sensory component, capturing real-time images or videos of the wearer's face. This data is then fed into the processing module, where the FOMO algorithm, alongside other AI and ML techniques, comes into play.

The FOMO algorithm, traditionally associated with social media and marketing contexts, finds a novel application in the realm of drowsiness detection. Its core principle revolves around stimulating alertness and engagement by creating a sense of urgency or importance. In the context of anti-sleep glasses, the FOMO algorithm dynamically adjusts its approach to suit the wearer's response patterns, thereby enhancing its effectiveness in preventing drowsiness-related accidents

As the ESP32 CAM board continuously captures facial data, the processing module employs sophisticated AI and ML algorithms to analyze these visuals in real-time. The FOMO algorithm, integrated within this processing module, utilizes facial recognition techniques to monitor the wearer's expressions and eye movements. It identifies subtle indicators of drowsiness, such as drooping eyelids or prolonged eye closures exceeding 300 milliseconds.

Upon detecting signs of drowsiness, the FOMO algorithm initiates a multi-faceted approach to intervene and alert the wearer. Firstly, it triggers the activation of a buzzer sound, providing an immediate auditory alert to prompt the wearer to regain focus. Simultaneously, the algorithm may dynamically adjust the intensity or frequency of the buzzer sound based on the wearer's response patterns, leveraging the principles of FOMO to maximize its effectiveness in capturing attention and stimulating alertness.

Furthermore, the FOMO algorithm can incorporate additional stimuli or interventions to reinforce its alerting mechanism. For instance, it may activate visual cues within the wearer's field of view, such as flashing lights or visual prompts, to further enhance the sense of urgency and engagement. By dynamically adapting its approach based on the wearer's responsiveness and engagement levels, the algorithm ensures an effective response to drowsiness while minimizing false alarms.

In addition to real-time alerting, the FOMO algorithm incorporates adaptive learning mechanisms to continuously refine its efficacy over time. By analyzing feedback data regarding the wearer's response patterns and the effectiveness of alerting interventions, the algorithm iteratively adjusts its parameters to optimize performance and reduce the risk of accidents due to drowsiness.

Overall, the integration of the FOMO algorithm within the system architecture of anti-sleep glasses represents a pioneering approach to drowsiness detection and prevention. By leveraging principles of urgency, engagement, and adaptability, this algorithm enhances the effectiveness of alerting mechanisms, thereby mitigating the risk of accidents and ensuring the safety of individuals in critical environments.

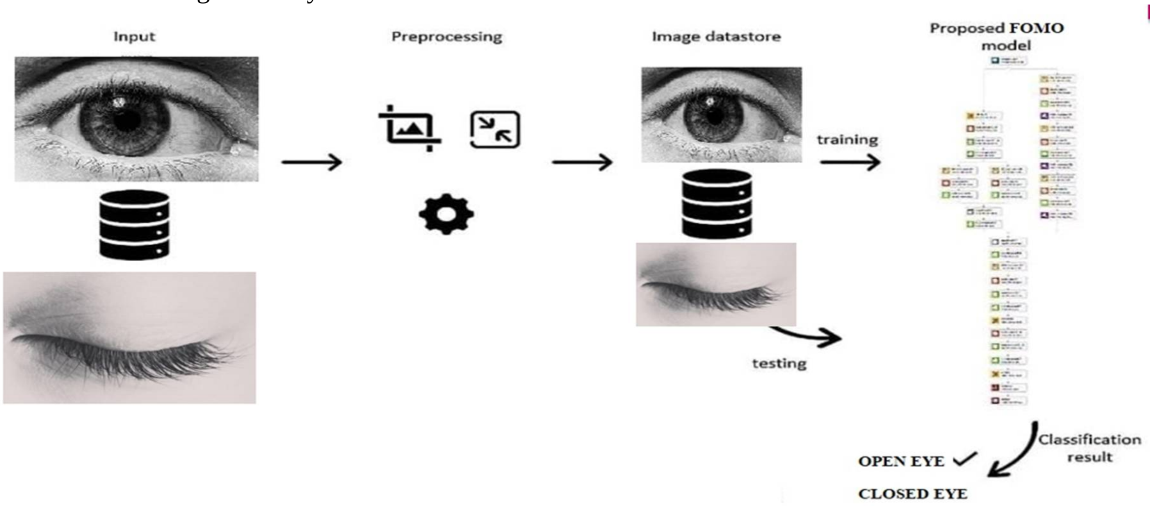

Figure No: 4.1 System Architecture

V. SUGGESTED FRAMEWORK

Developing Anti-Sleep Glasses with Artificial Intelligence (AI) to stop accidents is a novel way to tackle the serious problem of fatigue- and drowsiness-related mishaps. The Fear of Missing Out (FOMO) concept serves as the foundation for the novel glasses' proposed framework. FOMO uses artificial intelligence (AI) algorithms to identify indicators of fatigue and proactively intervene to keep users engaged and attentive during tasks that need prolonged attention, like driving. In relation to Anti-Sleep Glasses, the FOMO model focuses on developing a real-time monitoring system that continuously evaluates a range of physiological and behavioral indications that point to tiredness. This thorough method takes into account things like head nods, facial emotions, eye movements, and even minute adjustments to one's posture. The AI built into the glasses continually evaluates these signals using cutting-edge computer vision and machine learning techniques to give a dynamic and individualized estimate of the wearer's degree of awareness. The Anti-Sleep Glasses need to have a variety of sensors, including as infrared cameras, accelerometers, and electrooculography (EOG) sensors, in order to properly apply the FOMO model. Together, these sensors are able to gather and process a large amount of data, providing the AI algorithms with a multimodal input system. The combination of various sensors enables the glasses to recognize not just overt indicators of exhaustion but also more subdued indicators that may precede attention deficits caused by weariness. The AI algorithms are essential to the FOMO model because they use deep learning methods to adjust and improve their comprehension of the wearer's physiological and behavioral patterns over time. The system may be taught on a variety of datasets with different lighting conditions, situations, and human attributes using a method known as supervised learning. This allows the Anti- Sleep Glasses to learn more about each user's baseline level of alertness and adjust its interventions accordingly. By utilizing the fear of missing out on significant events or experiences during the activity, these therapies aim to prevent early indicators of weariness.

VI. Methodology

The method used to identify driver tiredness by using a drowsiness dataset. In order to avoid accidents, the entire procedure is utilized to identify driver sleepiness. First, the movie is divided into frames using a method called key frame extraction and selection. Facial characteristics are identified via the Dlib library during the key frame selection procedure. Second, the optimization-based FOMO (fear of missing out) model is applied after pre-processing to remove noise. The data was finally examined using the training and testing pictures.
The following is an explanation of the procedures used to identify drowsiness:

A. Dataset

Assemble a collection of pictures or films of people who appear tired or sleepy. An accurate machine learning model may be trained with this dataset to identify these signals. Make certain that a variety of scenarios are included in the dataset**.**

B. Keyframe Extraction And Selection

The chosen dataset's video clips are transformed into frames. Key frames are taken out and chosen once the video has been converted to frames. All of the frames in the video sequences are summarized in those key frames. The identification of face landmarks, such as lips and eyes, occurs during the selection of key frames.

C. Preprocessing

Pre-processing is a necessary step in order to carry out the learning process with correct outcome estimation. Hybrid dual tree complex wavelet transformation and cross-guided bilateral filtering are used in this work.

D. Feature Extraction

To retain information about complicated wavelet transformations, the raw data is transformed into numerical features using the feature extraction model. Then, using the Walsh- Hadamard transform, the features are retrieved from the pictures. The optimum extracted characteristics carry out the classification to identify driver sleepiness.

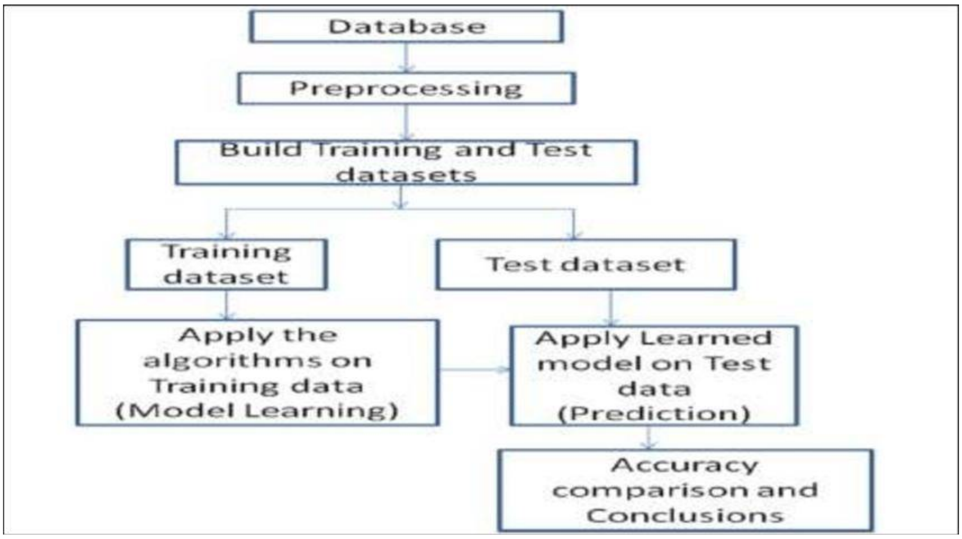

Figure No: 6.1 Dataflow Diagram

VII. Result

Spectacles are attached with ESP32 Cam Board which is already incorporated with camera and inferred light for night drive purpose, and also voltage converter is also attached to it.

Test Case for Drowsiness Detection

1. Test Case: Normal Alert State Detection
   - Step 1: Capture a video of the driver in an alert state (eyes open, not).
   - Expected Result 1: The system correctly identifies the driver as alert and does not trigger any drowsiness warnings.

Figure No 7.1: Anti Sleep Glasses

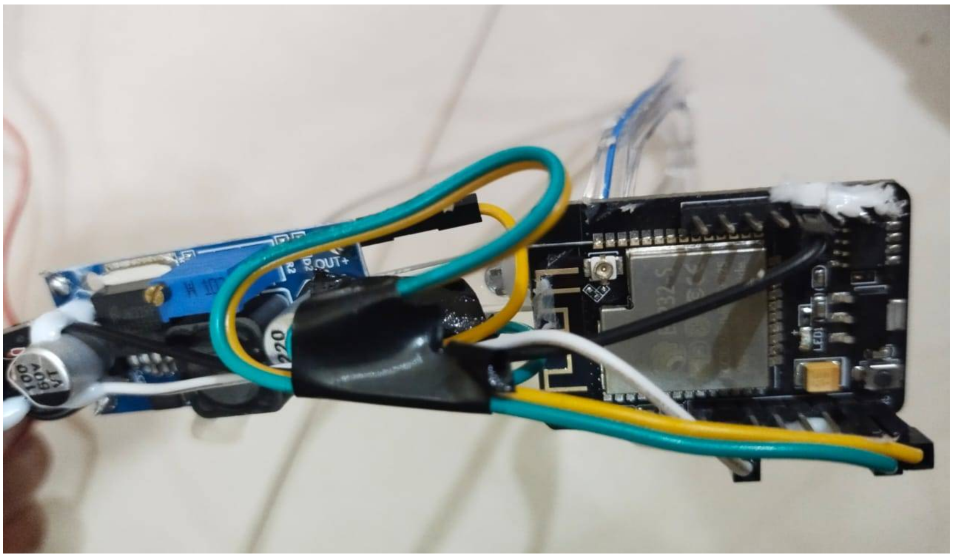

Figure No 7.2: ESP32 Cam Board

Figure No 7.3: Snapshot of Driver with Anti Sleep Glasses

2. Test Case: Eye Closure Detection
  - Step 2: Simulate a drowsy state by closing eyes for more than the threshold duration (e.g., 2 seconds).

- Expected Result 2: The system detects prolonged eye closure and triggers a drowsiness warning.

3. Test Case: Alert After Warning
   - Step 3: Return to an alert state (open eyes, stop yawning, and correct head position) after a drowsiness warning.
   - Expected Result 3: The system recognizes the alert state and stops issuing drowsiness warnings.
4. Test Case: False Positive Detection
   - Step 8.1: Perform normal activities (e.g., talking, brief eye closures, looking around).

Test Execution

- Execute each step systematically, ensuring to record observations and outcomes.
- Note any deviations from the expected results and analyze potential causes.

Post-Conditions:

- Validate that the system resets correctly after each test case.
- Ensure all data and recordings are saved for review.

Acceptance Criteria:

- The drowsiness detection system should accurately detect drowsiness in at least 95% of the test cases.
- The system should have a false positive rate of less than 5%.
- The system should function correctly under varying lighting conditions.

VIII. CONCLUSION

A significant problem is addressed by the "Anti-Sleep Glasses" project, which offers a complete solution that includes hardware integration, artificial intelligence, and real- time monitoring. Through its emphasis on closed-eye sleepiness detection and warning system implementation, the initiative seeks to improve safety across a range of sectors, especially those that need lengthy attention-demanding jobs. The strategy to accomplishing the project's goals is specified in a clear and methodical manner by the methodology. A small and wearable solution is guaranteed by the ESP32 AI Cam integration, and the FOMO ML model serves as the foundation for the sleepy detection mechanism together with real-time monitoring and an alarm system. To make the project successful overall, supporting goals like power efficiency and user-friendly design are also important.

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