e-ISSN:2582-7219

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

Volume 7, Issue 4, April 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.521

6381 907 438 6381 907 438 ijmrset@gmail.com www.ijmrset.com

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 4, April 2024 |

| DOI:10.15680/IJMRSET.2024.0704023|

Driver Drowsiness Detection System with OpenCV & Keras

Dr. N. Mahendiran, V. Ganesan

Department of Computer Science, Sri Ramakrishna College of Arts and Science, Coimbatore, India

ABSTRACT: Enhancing Road Safety: "Driver Drowsiness Detection System Using OpenCV & Keras". Driving long distances on highways poses a significant risk of drowsiness-induced accidents, particularly for professionals like taxi, bus, and truck drivers. To address this peril, we propose a project employing Python, OpenCV, and Keras to develop a drowsiness detection system. Our project's core objective is to create a system capable of detecting prolonged eye closure, a telltale sign of drowsiness in drivers, and promptly alert them. By harnessing computer vision techniques and deep learning models, we can effectively monitor the driver's condition and intervene as needed. Our methodology revolves around utilizing OpenCV to capture real-time images from a webcam. These images are then inputted into a deep learning model built using Keras, which categorizes the state of the driver's eyes as either "Open" or "Closed".

Through this Python-based initiative, our goal is to deploy a dependable and efficient drowsiness detection system. By alerting drivers when they display signs of drowsiness, we aim to enhance road safety and mitigate the risk of accidents caused by driver fatigue.

KEYFRAMES: Python, OpenCV, and Keras

I. INTRODUCTION

The Driver Drowsiness Detection System using OpenCV & Keras tackles the pressing issue of drowsy driving, a significant contributor to road accidents worldwide. Each year, numerous lives are lost and injuries sustained due to drivers operating vehicles while fatigued. This project represents a proactive approach to mitigating such risks by employing advanced computer vision and deep learning methodologies [5]. Utilizing OpenCV for image processing and Keras for deep learning model development, the system offers a sophisticated means of real-time monitoring of driver alertness levels. By analyzing eye movements and blink patterns, it can accurately detect signs of drowsiness and promptly alert the driver to take necessary actions, thereby preventing potential accidents [6]. The significance of this project lies in its potential to save lives and reduce injuries on the roads. Drowsy driving is a widespread issue that affects not only individual drivers but also their passengers and other road users. By integrating cutting-edge technology into vehicle safety systems, we can significantly enhance road safety and prevent countless accidents [1,3].

Moreover, this project underscores the transformative impact of technology in addressing critical societal challenges. It demonstrates how innovations in computer vision and deep learning can be harnessed to create practical solutions that improve public safety and well-being. As continue to advance in the fields of artificial intelligence and machine learning, there is immense potential for similar applications to address various safety concerns across different domains [2]. In conclusion, the Driver Drowsiness Detection System represents a crucial step towards combating drowsy driving and enhancing road safety. Through the integration of OpenCV and Keras, this project showcases the power of technology in creating intelligent systems capable of safeguarding lives and preventing accidents on the road [4].

II. RELATED WORK

Srivastava, M., Idrisi, S. A., & Gupta, T et.al [1] Introducted Driver drowsiness detection system with OpenCV & keras in 2021. The stopping score of the eyes is measured and if it goes beyond a given score then one is considered sleepy and in-that case, an alarm is raised by the system immediately.

V. Mansur and K. Shambavi et.al [2] Suggest Highway Drivers Drowsiness Detection System Model with R-Pi and CNN technique in 2021. The standalone hardware module is uploaded with the complete training AI software. Real time image acquisition by the design platform and predicting the driver drowsiness detection, depicts an accuracy

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of 95% to 96%. The activation function ReLU used during the prediction state in CNN improves the computational efficiency of the design model.

B. Jyothi, K. Seethina, P. Bhavani and C. Jayanth et.al [3] Introduced the Drowsiness Detection of Driver in 2022. adapt to learn the Perclos or Euclidian algorithm, cascade classifier based on haar, OpenCV, Python that are crucially employed to detect the driver. At last, undergo the future study and scope with regarding to advancements on the study with particular project.

R. Rajasekaran, N. M, R. Solanki, V. Sanghavi and Y. S et.al [4] Introduce Enhancing Driver Safety: Real-Time Drowsiness Detection through Eye Aspect Ratio and CNN-Based Eye State Analysis. The heart of our DDS relies on deep learning models implemented through Keras, trained on a diverse dataset of driver behavior examples. These Keras models can dynamically adapt to varying lighting conditions, driver appearances, and different vehicle environments, ensuring reliable performance. The DDS promptly alerts the driver upon detecting signs of drowsiness, using both audible alerts and visual prompts.

J. Jothi Mary A, S. Goswami, B. G. Rahul, T. Sakthika, D. Mahajan and B. Pant et.al [5] Suggest the Drowsiness Detection System Using the Movement of the Eye of A Human Through Machine Learning Algorithms in Order to Avoid Accidents in 2023. In this study, the development of ADAS is shown, with a focus on driver fatigue identification as the main goal of decreasing traffic fatalities. In this situation, use artificial intelligence to anticipate the condition and sentiments of the operator, improving traffic safety.

G. -W. Gao and M. -Y. Chen et.al [6] gave the Base on Long Short-term Memory Network for Fatigue Detection in 2022. The system uses tensor flow and keras and builds up a long short-term memory (LSTM) model to be able to predict the action which is being shown on the screen. To do is collect a bunch of data on all of our different key points, so collect data on our face and save those as numpy arrays. The face detection method is based on a deep neural network using LSTM layers to go on ahead and predict that temporal component, which be able to predict action from a number of frames not just a single frame.

III. METHODOLOGY

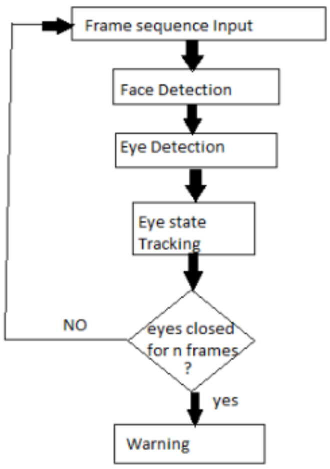

Fig1: Methodology

Step 1: Image Input

Utilize a camera to capture images in real-time.

Step 2: Face Detection and ROI Creation

Apply a face detection algorithm to identify faces within the captured image. Once a face is detected, create a Region of Interest (ROI) around the detected face for further processing.

Step 3: Eye Detection

Within the ROI, employ an eye detection algorithm to locate the eyes of the individual.

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Step 4: Eye State Classification

Utilize a pre-trained classifier, such as a Convolutional Neural Network (CNN) implemented using frameworks like Keras or TensorFlow, to classify the state of the eyes as either "open" or "closed".

Step 5: Drowsiness Score Calculation

Based on the classification results from the classifier, calculate a drowsiness score. This score could be determined based on factors such as the duration of eye closures or the frequency of eye closures over a specific time period.

Step 6: Drowsiness Assessment

Evaluate the drowsiness score against predefined thresholds to determine if the individual is exhibiting signs of drowsiness. If the score exceeds the threshold, trigger an alert mechanism to notify the individual of their drowsy state.

Figure 2: shows how the system would work and look in real world

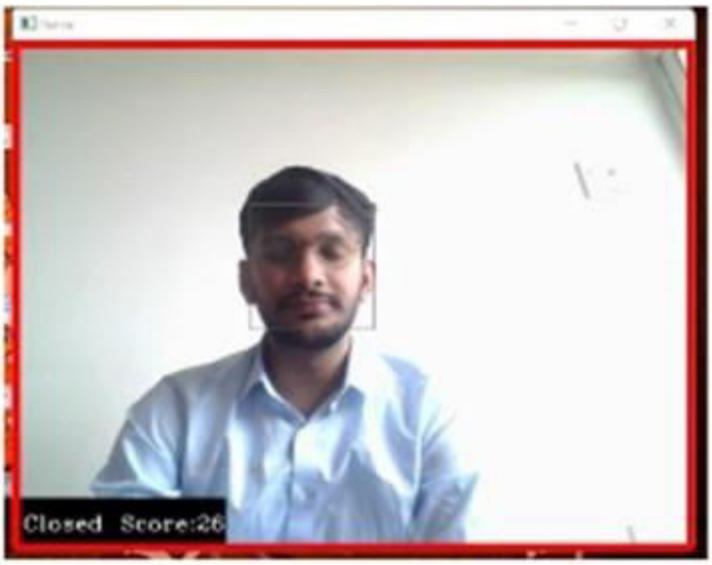

Figure 3: Show the real time test case generating a score based on the time the eyes were closed and sounding an alarm when reaching certain threshold.

OpenCV

OpenCV is a Python-accessible, open-source computer vision library that revolutionizes smart PC capabilities with advanced visual processing functionalities. Engineered for swift computational execution, it specializes in real-

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time image detection and recognition tasks. Through its adept use of optimized C coding, OpenCV maximizes performance by tapping into the potential of multicore processors. Moreover, it seamlessly integrates low-level routines from the Intel Integrated Performance Primitives (IPP) library, particularly beneficial for swift development on Intel architectures. This fusion of capabilities at runtime ensures efficient and effective utilization of hardware resources, rendering OpenCV an indispensable tool for an extensive array of computer vision applications.

Why Open CV?

OpenCV was specifically engineered for image processing tasks, with meticulous attention given to each data structure and operation as outlined in the Image Processing Plan. Although Matlab offers a wide range of toolboxes for various applications, its execution speed can be sluggish. This is due to Matlab's dependence on Java, which in turn relies on C. Consequently, running a Matlab program involves extensive translation and integration of code, resulting in performance slowdowns. On the contrary, OpenCV operates efficiently and conserves system resources. For instance, it can operate with as little as 10MB of RAM for continuous applications. While RAM usage might not be a major concern for modern computers in general, it becomes critical for specialized applications such as fatigue detection systems in vehicles, where minimizing power consumption is essential.

Machine Learning

Machine learning, particularly utilizing Keras, is integral to the Driver Drowsiness Detection System. It facilitates feature extraction from images, trains models to classify drowsiness, conducts real-time inference, and optimizes performance. Integrated with OpenCV, it greatly enhances drowsiness detection accuracy, thereby enhancing road safety.

OpenCV's Machine Learning Algorithms

For the Driver Drowsiness Detection System, OpenCV's machine learning algorithms can be used for tasks like face and eye detection, facial landmark detection, and feature extraction. These algorithms enable quick identification of the driver's face and eyes, tracking eye movements, and extracting features like blink frequency. OpenCV also provides support for SVM, PCA, and limited neural network capabilities, which can be utilized for classification tasks to detect drowsiness based on predefined criteria. Leveraging these algorithms enhances the system's ability to monitor driver behavior and ensure road safety

IV. SYSTEM ARCHITECTURE

The architecture for a Driver Drowsiness Detection System using OpenCV and Keras typically involves several key components:

1. **Data Collection**: Images or video frames are captured in real-time from a webcam mounted inside the vehicle.
2. **Preprocessing**: The captured images undergo preprocessing steps to enhance quality and reduce noise. This may involve techniques like resizing, normalization, and grayscale conversion.
3. **Eye Detection**: OpenCV is used to detect and locate the driver's eyes within the captured images. Techniques like Haar cascades or deep learning-based methods may be employed for accurate eye detection.
4. **Eye Tracking**: Once the eyes are detected, their movements are tracked to monitor for signs of drowsiness. This can involve tracking the position, size, and shape of the eyes over time.
5. **Feature Extraction**: Relevant features are extracted from the tracked eye movements, such as blink frequency, eye closure duration, and other indicators of drowsiness.
6. **Deep Learning Model**: A deep learning model, typically implemented using Keras, is trained to classify the extracted features as indicative of drowsiness or alertness. This model may be based on convolutional neural networks (CNNs), recurrent neural networks (RNNs), or a combination of both, depending on the complexity of the task.
7. **Model Training**: The deep learning model is trained using labeled data, where examples of drowsy and alert states are provided along with their corresponding features. The model learns to accurately classify new instances based on this training data.
8. **Real-time Inference:** During operation, the trained model is used to classify the features extracted from the driver's eye movements in real-time. If the model predicts drowsiness with high confidence, an alert is triggered to notify the driver.

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9. Alert Mechanism: When drowsiness is detected, an alert is generated to notify the driver and prompt them to take corrective action. This may involve auditory alerts, visual warnings, or other feedback mechanisms to ensure the driver remains alert and focused on the road.

10. Integration with Vehicle Systems: Optionally, the drowsiness detection system can be integrated with other vehicle systems, such as automatic braking or lane departure warning systems, to provide additional layers of safety.

Overall, the architecture combines computer vision techniques for eye detection and tracking with deep learning models for drowsiness classification, providing an effective solution for preventing accidents caused by driver drowsiness.

V. SYSTEM TESTING

System testing encompasses a series of tests aimed at thoroughly exercising the computer-based system. Each test serves a unique purpose, collectively ensuring that all system elements integrate and function correctly. It involves two main activities:

- **Integrated Testing:** Integrated testing is a methodical approach to creating tests that expose errors related to interfaces between modules and program units. This phase focuses on verifying the seamless integration of system components.
- **Acceptance Testing:** Acceptance testing involves testing the system with sample data to ensure that it meets the specified requirements and performs the intended functions satisfactorily. This phase evaluates the system's compliance with user expectations and acceptance criteria.

Block diagram

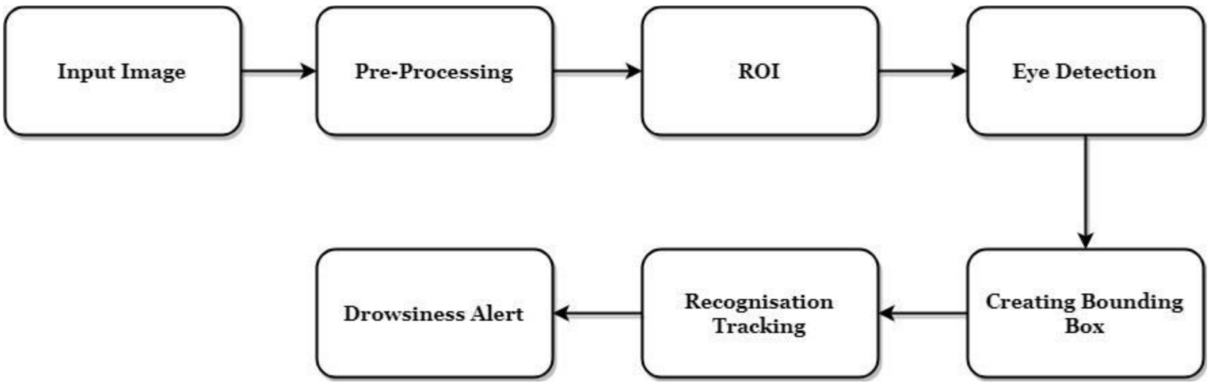

Figure 4: block diagram

VI. CONCLUSION AND FUTURE ENHANCEMENT

The proposed system developed is capable of detecting drowsiness in a rapid manner. The system which can differentiate normal eye blink and drowsiness which can prevent the driver from entering the state of sleepiness while driving. The system works well even in case of drivers wearing spectacles and under low light conditions also. During the monitoring, the system is able to decide if the eyes are opened or closed. When the eyes have been closed for about two seconds, alert the driver. By doing this many accidents will be reduced and provides safe life to the driver and vehicle safety.

The future works may focus on the utilization of outer factors such as vehicle states, sleeping hours, weather conditions, mechanical data, etc, for fatigue measurement. Driver drowsiness poses a major threat to highway safety, and the problem is particularly severe for commercial motor vehicle operators. Twenty-four hour operations, high annual mileage, exposure to challenging environmental conditions, and demanding work schedules all contribute to this serious safety issue. Monitoring the driver's state of drowsiness and vigilance and providing feedback on their condition so that they can take appropriate action is one crucial step in a series of preventive measures necessary to address this problem. Currently there is not adjustment in zoom or direction of the camera during operation. Future work may be to automatically zoom in on the eyes once they are localized.

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VII. RESULT

In the results and discussion Driver Drowsiness Detection System utilizing OpenCV and Keras, the focus is on evaluating the system's performance and addressing its implications. Firstly, the accuracy of the system in correctly identifying drowsy and alert states of the driver is reported, along with precision and recall scores to assess its ability to minimize false positives and false negatives. Additionally, metrics such as response time, F1 score, ROC curve, and confusion matrix are included to provide a comprehensive understanding of the system's performance. Moving on to the discussion, the accuracy achieved by the system is analyzed and compared with existing benchmarks or similar systems described in the literature. Potential limitations encountered during implementation or testing, such as variability in lighting conditions or facial expressions, are addressed. Furthermore, instances of false positives or false negatives are explored, and suggestions for improvements are offered to mitigate such occurrences. Consideration is given to the real-world applicability of the system, including its effectiveness in diverse driving conditions and its potential impact on road safety.

Test case	Eye detection	Eye closer	Result
Case1	No	NO	No result
Case2	NO	NO	No result
Case 4	YES	YES	Alarm beeps

Table1: Test Cases: In scenarios where a driver exhibits signs of drowsiness, prominently displayed alerts are triggered when the system detects closed eyes beyond a specified threshold of eye blinks. Efforts were made to achieve accurate results without the need for high-resolution images, focusing on detecting eye blinks and drowsiness. The project utilized a PC equipped with a 5-megapixel webcam, which featured a built-in white LED for operational indication. For real-time applications, infrared LEDs were recommended for framing instead of white LEDs. Additionally, the system utilized the PC's built-in speaker to deliver auditory alerts aimed at awakening the driver upon detecting drowsiness. The framework was meticulously designed to accommodate various individuals under diverse lighting conditions, including both daytime and nighttime settings. Achieving optimal results requires proper alignment of the webcam's background lighting with the driver's face, ensuring that the framework can detect blinking and drowsiness with a remarkable accuracy exceeding 95%.

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