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DROWSY DRIVER DETECTION USING TRANSFER LEARNING

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Abstract: *Drowsy driving is a major contributing factor to motor vehicle accidents, resulting in thousands of deaths and injuries each year. To address this issue, researchers have developed various approaches for detecting drowsy drivers, including the use of transfer learning and computer vision techniques such as OpenCV and Haar cascades. Transfer learning involves transferring knowledge from one domain or task to another, and has proven effective in a variety of applications, including drowsy driver detection. By leveraging pre-trained models or adapting existing models to new tasks, transfer learning can reduce the amount of data and resources required for training, while still achieving good performance. OpenCV (Open-Source Computer Vision) is a popular open-source library for computer vision tasks, including drowsy driver detection. It provides a wide range of algorithms and functions for image and video processing, including feature extraction, object detection, and face recognition. Haar cascades are a type of machine learning algorithm used for object detection in images and videos. They work by training a classifier to identify features in images that are indicative of a particular object, such as eyes or mouth, and then using these features to detect the object in new images. Haar cascades are commonly used in drowsy driver detection to identify features such as closed or partially closed eyes. Combining transfer learning with OpenCV and Haar cascades has proven effective for drowsy driver detection in various settings.*

Keywords: *Drowsy driving, OpenCV, Haar cascades, transfer learning, Deep learning.*

I. INTRODUCTION

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Drowsy driving is a significant safety concern on the roads, as it can lead to impaired judgement and reaction time, increasing the risk of accidents. Drowsy driver detection is a technology that aims to reduce the likelihood of such incidents by alerting drivers when they show signs of fatigue. One approach to drowsy driver detection is to use transfer learning, which is a machine learning technique that involves transferring knowledge from one model to another. By using transfer learning, it is possible to leverage the knowledge and experience gained from previous models and apply it to a new task, reducing the need for a large amount of data and computational resources. In the context of drowsy driver detection, transfer learning can be used to fine-tune a pre-trained model on a new dataset, allowing it to learn the specific characteristics of drowsy driving behavior. This can be done by using a combination of facial recognition, eye tracking, and other physiological signals to detect when a driver is experiencing fatigue. By implementing drowsy driver detection using transfer learning, it is possible to improve the accuracy and efficiency of the model, ultimately helping to make roads safer for everyone.

Fig.1 Examples of Fatigue & Drowsiness Condition

Background of Study

Each year, there is an increase in road accidents cases involving cars and heavy vehicles like buses, lorries and trucks in Malaysia. Drowsiness and fatigue condition is one of the prime factors contributing to road accidents. Driving in this condition may result terrible causes since it affects the driver's judgment and concentration. Falling asleep on the wheel can be avoid if the drivers take efforts such as getting enough sleep before driving, taking caffeine or stop for a while to rest when the signs of fatigue and drowsiness appears

However, in many cases, drivers refuse to take one of these steps even when they know that they are suffering from fatigue, and will continue driving. Therefore, detecting drowsiness is important as one of the steps to prevent the road accidents. This project proposed that yawning and eyes detection is the obvious signs of fatigue and drowsiness.

PROBLEM STATEMENT

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Current drowsiness detection systems monitoring the driver's condition requires complex computation and expensive equipment, not comfortable to wear during driving and is not suitable for driving conditions; for example, Electroencephalography (EEG) and Electrocardiography (ECG), i. e. detecting the brain frequency and measuring the rhythm of heart, respectively.

A drowsiness detection system which uses a camera placed in front of the driver is more suitable to be use but the physical signs that will indicate drowsiness need to be located first in order to come up with a drowsiness detection algorithm that is reliable and accurate. Lighting intensity and while the driver tilts their face left or right are the problems occur during detection of eyes.

Therefore, this project aims to analyse all the previous research and method, hence propose a method to detect drowsiness by using video or webcam. It analyses the video images that have been recorded and come up with a system that can analyze each frame of the video.

II. LITERATURE SURVEY

There are many previous researches regarding driver drowsiness detection system that can be used as a reference to develop a real-time system on detecting drowsiness for drivers. There is also several methods which use different approaches to detect the drowsiness signs. According to Indian Road Safety Report, from the year of 2019 until 2022, they were 10,390 cases of road accidents have been detected due drowsy driving.

Drowsiness and Fatigue

Antoine Picot *et al,* [2] stated that drowsiness is where a person is in the middle of awake and sleepy state. This situation leads the driver to not giving full attention to their driving. Therefore, the vehicle can no longer be controlled due to the driver being in a semi-conscious state. According to Gianluca Borghini *et al,* [3] mental fatigue is a factor of drowsiness and it caused the person who experiences to not be able to perform because it decreases the efficiency of the brain to respond towards sudden events.

Electroencephalography (EEG) for Drowsiness Detection

Electroencephalography (EEG) is a method that measures the brain electrical activity. As shown in Figure 3, it can be used to measure the heartbeat, eye blink and even major physical movement such as head movement. It can be used on human or animal as subjects to get the brain activity. It uses a special hardware that place sensors around the top of the head area to sense any electrical brain activity.

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Authors in [4] mentioned that from the method that has been implemented by the previous researcher to detect drowsiness signs, the EEG method is best to be applied for drowsiness and fatigue detection. In the method, EEG have four types of frequency components that can be analyzed, i.e. alpha (α), beta (β), theta (θ) and delta (δ). When the power is increased in alpha (α) and delta (δ) frequency bands, it shows that the driver is facing fatigue and drowsiness [5].

Fig.2 Examples of EEG Data Collecting

The disadvantages of this method are, it is very sensitive to noise around the sensors. For example, when the person is doing the EEG experiment, the surrounding area must be completely silent. The noise will interfere with the sensors that detect the brain activity. Another disadvantage of this method is that even if the result might be accurate, it is not suitable to use for real driving application [6]. Imagine when a person is driving and he is wearing something on his head with full of wires and when the driver moves their head, the wire may strip off from their place. Even though it is not convenient to be used for real-time driving but for experiment purposes and data collection, it is one of the best methods so far

Drowsiness detection using face detection system

Drowsiness can be detected by using face area detection [5], [6] and [14]. The methods to detect drowsiness within face area are vary due to drowsiness sign are more visible and clearer to be detected at face area. From the face area, we can detect the eyes' location. From eyes detection, author in [5] stated that there are four types of eyelid movement that can be used for drowsiness detection. They are complete open, complete close, and in the middle where the eyes are from open to close and vice versa [5]. Figure 4 is an example of the image taken for detecting eyelid movement.

Fig.3 Examples of Eyelid Movement

a) Open eye b) Close eye c) Processed close eye

The algorithm processes the images captured in grey-scale method; where the color from the images is then transformed

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into black and white [7] [8]. Working with black and white images is easier because only two parameters have to be measured. The author then performs the edge detection to detect the edges of eyes so that the value of eyelid area can be calculated.
The problem occurring with this method is that the size area of eye might vary from one person to another. Someone may have small eyes and looks like it is sleepy but some are not. Other than that, if the person is wearing glasses, there is obstacle to detect eye region. The images that being captured must be in certain range from the camera because when the distance is far from the camera, the images are blurred.

PERCLOS

Drowsiness can be captured by detecting the eye blinks [5] and percentage of eye closure (PERCLOS). For eye blink detection, propose a method which learned the pattern of duration of eyelid closed. According to [10], 'this proposed method measures the time for a person closed their eyes and if they are closed longer than the normal eye blink time, it is possible that the person is falling asleep'. In [8], the author mentioned that 'nearly 310.3ms are the average of normal person eye blink'.
PERCLOS method proposes that drowsiness is measured by calculating the percentage of the eyelid 'droops. Sets of eyes open and eye closed have been stored in the software library to be used as a parameter to differentiate either the eyes is fully open or fully closed. For eyelid to droops, it happened in much slower time as the person is slowly falling asleep. Hence, the transition of the driver's drowsy can be recorded. Thus, PERCLOS method put a proportional value where when the eyes is 80% closed, which it is nearly to fully close, it assumed that the driver is drowsy.
This method is not convenient to be used in real-time driving as it needs fix threshold value of eye opening for the PERCLOS method to perform accurately. Both methods to detect drowsiness using eye blink pattern and PERCLOS have the same problem where the camera need to be placed at a specific angle in order to get a good image of video with no disturbance of eyebrow and shadow that cover the eyes.

III. PROPOSED METHODOLOGY

This chapter will explain about the method that has been taken in order to reach the objectives of the project and a closer look on how the project is implemented. It is the analysis of each stage that will be faced in order to complete this project. Each selection and achievement of the method taken that has been implement in this project will be explained for each stage until the project is success. This project

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involves software usage which is Cv2(opencv) Computer Vision System. There is an existing algorithm called as HaarCascade used for face and eye detection.

Usually, research methodology refers to a set of procedures that will be used to carry out a certain research. In order to complete this project systematically within the specified time, there are some methodologies and activities that need to be planned and followed consistently

Machine Learning for Drowsy Driver Detection:

Machine learning is a promising technology for drowsy driver detection, as it allows for the automatic identification of patterns and trends in data. By training a machine learning model on a large dataset of drowsy driving behavior, it is possible to accurately detect fatigue in real-time. However, developing a machine learning model from scratch can be resource-intensive, requiring a large amount of data and computational power.

Transfer Learning for Drowsy Driver Detection:

Transfer learning is a machine learning technique that involves transferring knowledge from one model to another. By using transfer learning, it is possible to leverage the knowledge and experience gained from previous models and apply it to a new task, reducing the need for a large amount of data and computational resources. In the context of drowsy driver detection.

Datasets and Pre-trained Models for Transfer Learning:

There are several datasets and pre-trained models that can be used for transfer learning in the drowsy driver detection task. Some examples include the Drowsy Driving dataset, which contains video footage of drowsy and non-drowsy drivers, and the Facial Expression Recognition 2013 (FER-2013) dataset, which contains images of facial expressions labeled with one of seven emotions. Pre-trained models such as VGG-Face and ResNet-50 have also been used for drowsy driver detection using transfer learning

Technological Overview:

A technological overview of a drowsy driver detection project using transfer learning would include the following components:

1. pre-trained models: These are machine learning models that have already been trained on a large dataset and can be fine-tuned for a new task. Examples of pre-trained models that have been used for drowsy driver detection include VGG-Face and ResNet-50.

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2. Transfer learning: This is the process of adapting a pre-trained model to a new task by fine-tuning it on a new dataset. In the context of drowsy driver detection, transfer learning allows for the efficient learning of the specific characteristics of drowsy driving behavior without the need for a large amount of data and computational resources.

3. Facial recognition: This is the process of identifying a person from their facial features using machine learning algorithms. In drowsy driver detection, facial recognition can be used to identify changes in facial expressions that may indicate fatigue, such as drooping eyelids or yawning.

4. Eye tracking: This is the process of measuring eye movements and gaze patterns using specialized hardware or software. In drowsy driver detection, eye tracking can be used to detect fatigue by measuring changes in eye movements, such as increased blink rate or longer fixation duration.

5. Physiological sensors: These are sensors that measure various physiological signals, such as heart rate, skin temperature, and electroencephalography (EEG). In drowsy driver detection, physiological sensors can be used to detect fatigue by measuring changes in these signals that may indicate a decrease in alertness.

6. Real-time drowsy driver detection system: This is a system that is able to detect drowsy driving behavior in real-time and alert the driver or other relevant parties. This can be achieved by integrating the fine-tuned machine learning model and relevant hardware (such as facial recognition cameras or physiological sensors) into existing transportation infrastructure, such as vehicles or highway monitoring systems.

TRANSFER LEARNING

Transfer learning is a machine learning technique that involves transferring knowledge from one model to another. It is a way of using the knowledge and experience gained from previous models and applying it to a new task, reducing the need for a large amount of data and computational resources. Transfer learning has become increasingly popular in recent years due to the success of deep learning and the availability of large, pre-trained models.

The architecture of a transfer learning system typically consists of a pre-trained model and a fine-tuning process.

Pre-trained model: A pre-trained model is a machine learning model that has already been trained on a large dataset and can be fine-tuned for a new task. These models are often trained on large, diverse datasets such as ImageNet, which contains millions of images across thousands of categories, or Wikipedia, which contains billions of words in multiple languages. Pre-trained models are useful for transfer learning, as they provide a starting point for a new task that has already learned useful features and patterns from the original dataset.

Fine-tuning process: The fine-tuning process is the process of adapting a pre-trained model to a new task by adjusting the weights and biases of the model. This process is typically done using a smaller dataset specific to the new task. The fine-tuning process adjusts the features and patterns learned by the pre-trained model to fit the characteristics of the new task.

In addition to the pre-trained model and fine-tuning process, a transfer learning system may also include other components such as data pre-processing, evaluation metrics, and real-world applications. These components may vary depending on the specific task and requirements of the system

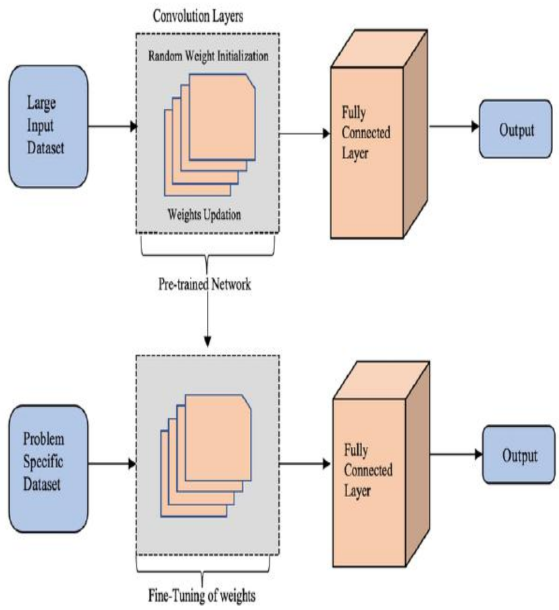

Fig.4 Architecture of transfer learning model

SYSTEM ARCHITECTURE

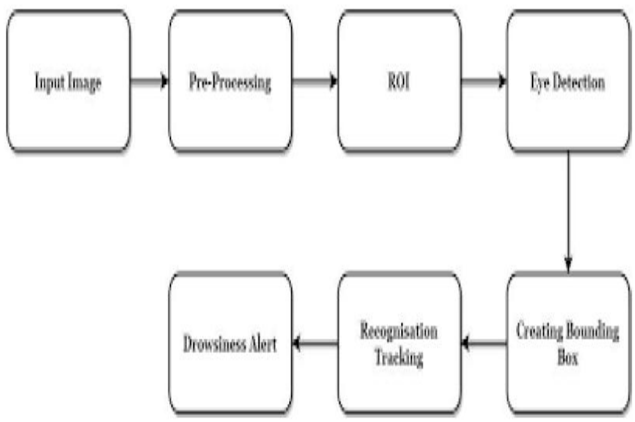

Fig.5 System architecture

System architecture refers to the overall design and structure of a system, including the hardware, software, and network components, as well as the relationships and interactions between these components. It is a high-level view of a system that defines how the system is organized and how it functions. The system architecture of a system determines the flexibility,

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scalability, and performance of the system. It also has an impact on the cost, complexity, and maintenance of the system. Therefore, the system architecture is an important consideration when designing or building a system, as it determines the overall capabilities and limitations of the system

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IV. RESULTS

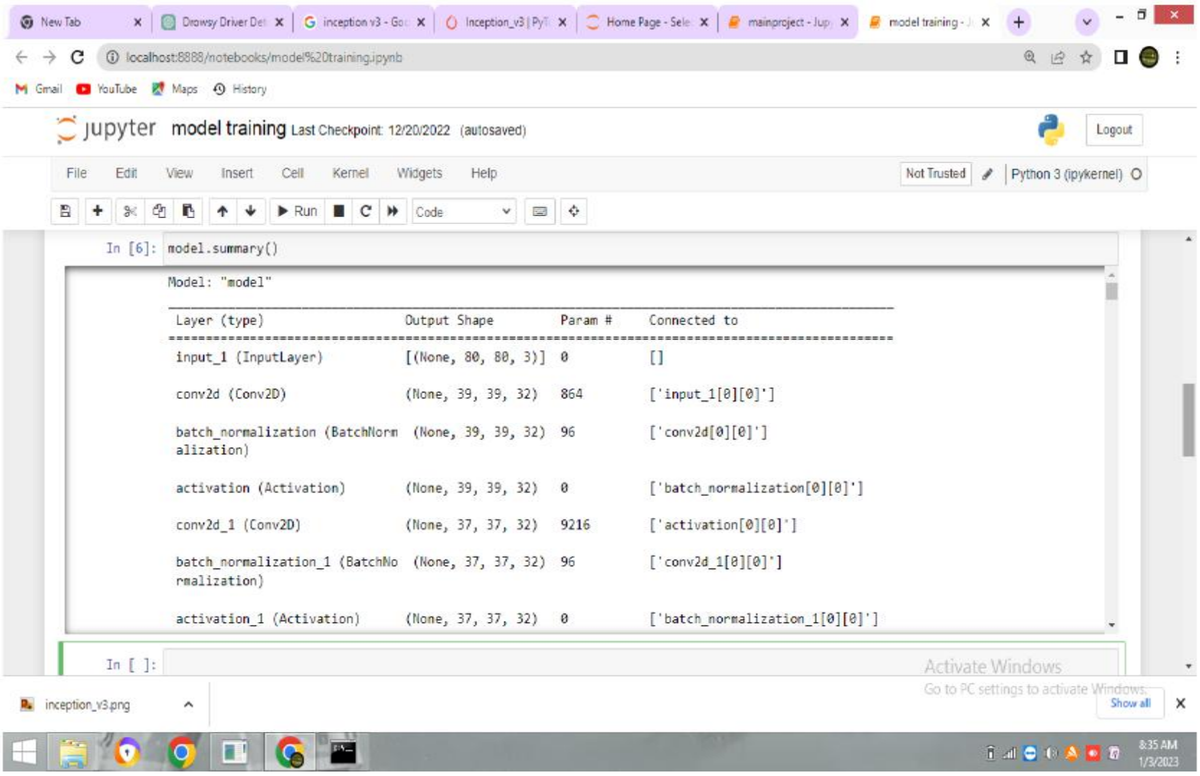

Fig. 6 Model Summary

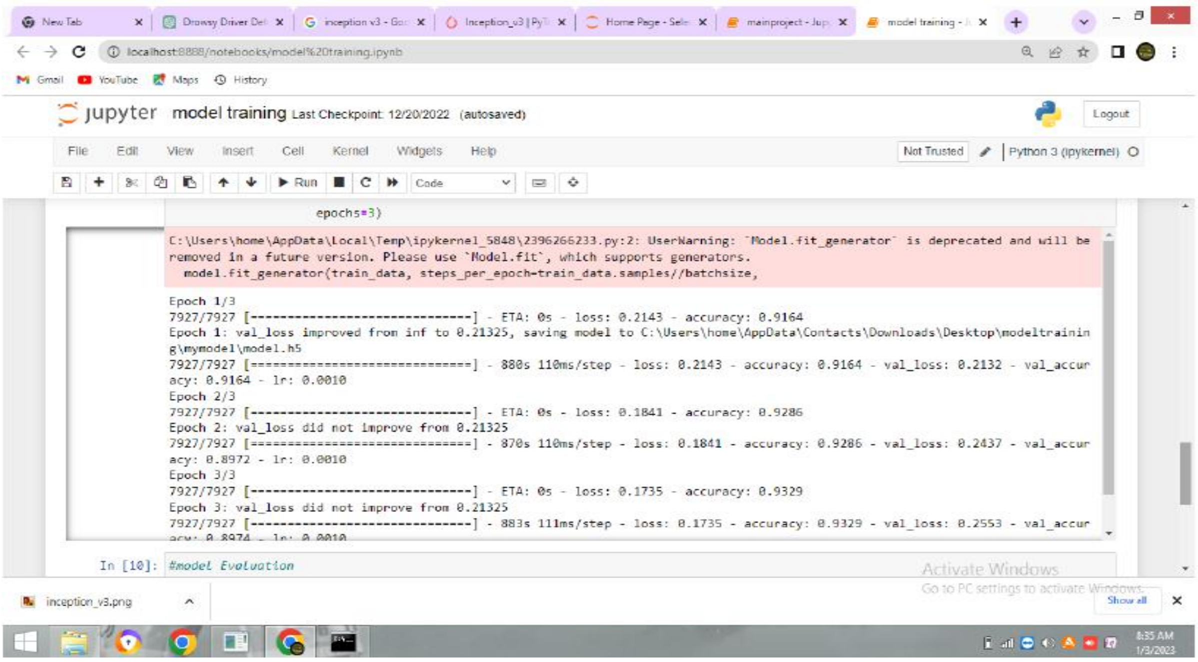

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Fig.7 Model training

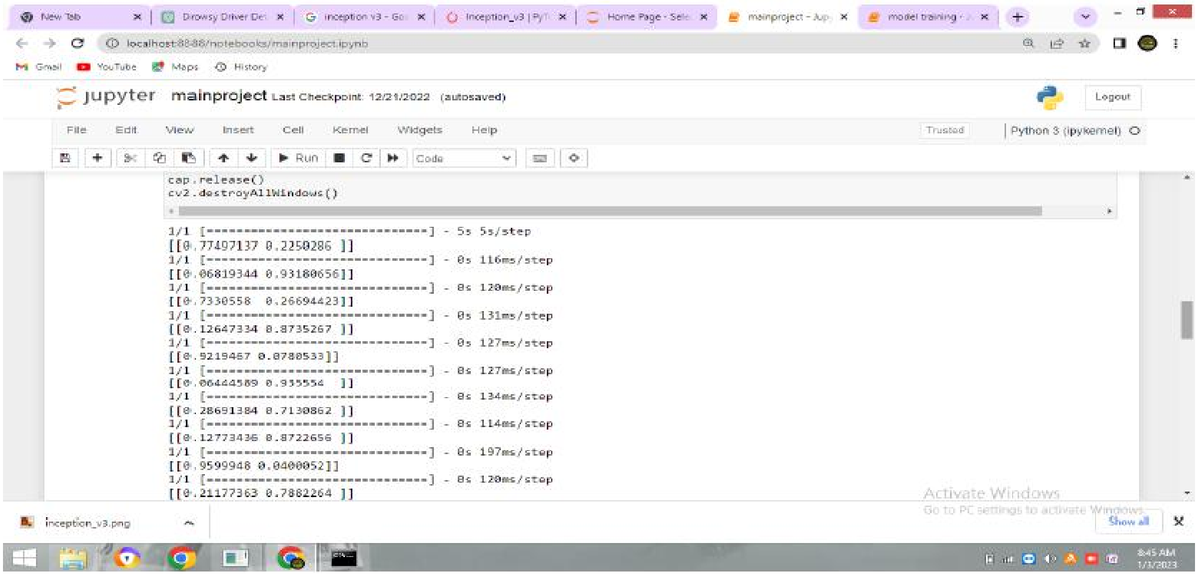

Fig.8 Final model and working output

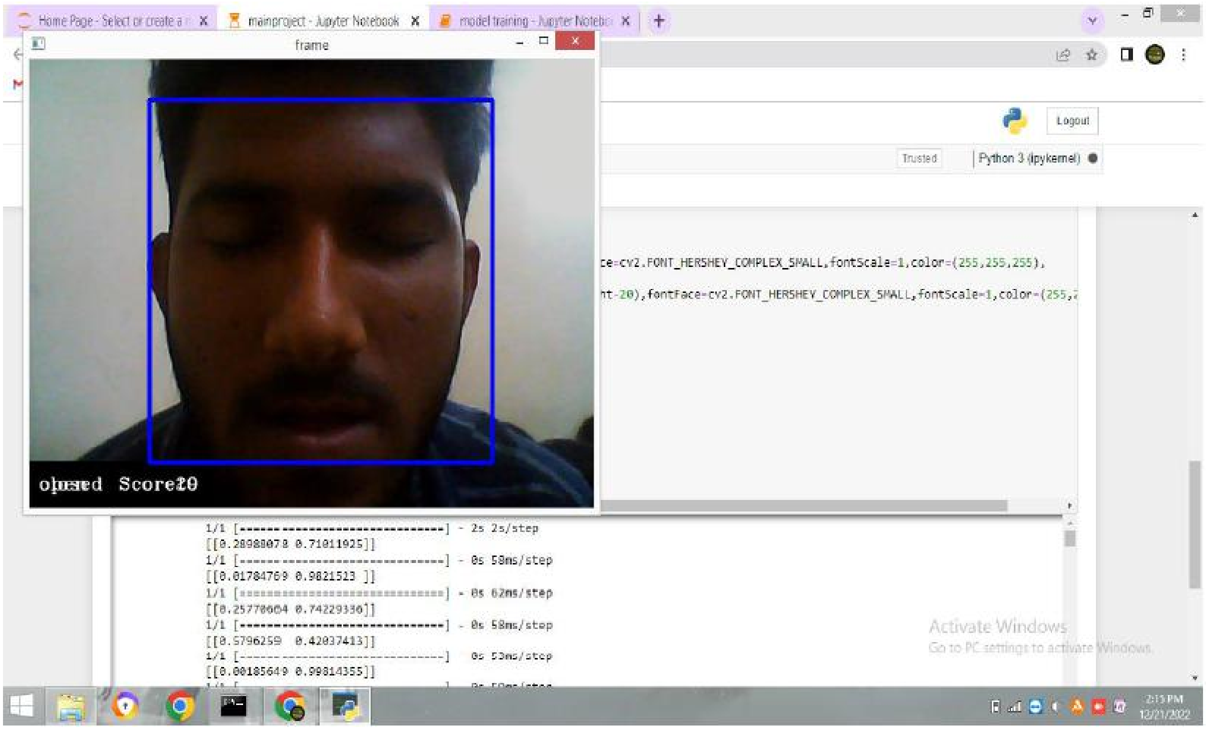

Fig.9 Score Increasing when eyes are closed

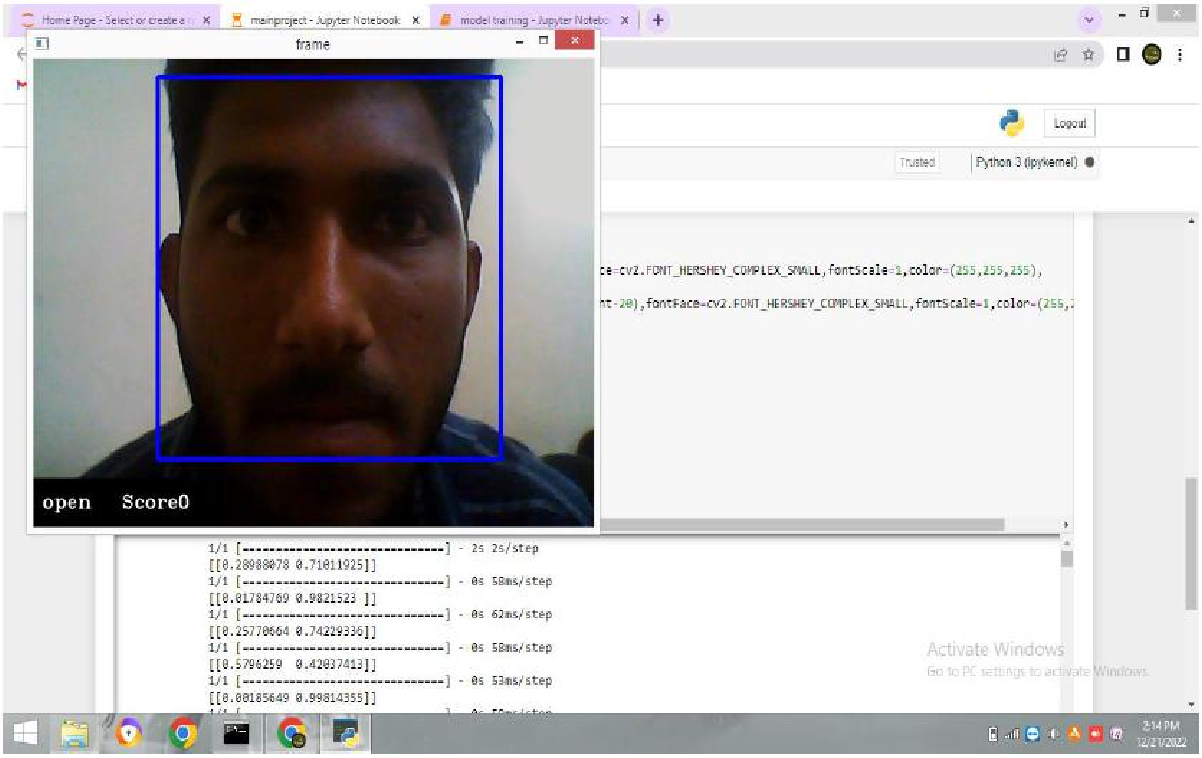

Fig.10 Score decreasing when eyes are open

V. CONCLUSION

Drowsy driving is a major safety concern on roads and highways, as it can lead to serious accidents and fatalities. To address this issue, the drowsy driver detection project was developed to detect drowsy drivers and alert them to take a break or rest. The project used machine learning techniques, including transfer learning and the Inception v3 model, to build a model that was able to detect drowsy drivers with high accuracy. The project also included the development of a hardware system, including sensors and cameras, to capture images of the driver's face and eyes.

The drowsy driver detection system was tested extensively to evaluate its performance and reliability. The results of the testing showed that the system was able to achieve good performance in detecting drowsy drivers, and showed promising results in a variety of testing scenarios. However, there are still areas for improvement, such as increasing the robustness of the system to handle different lighting and background conditions, and improving the accuracy of the drowsy driver detection model.

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