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Real-Time Drowsiness Detection System using Artificial Intelligence

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Abstract: Many factors have led to car accidents, and one of the main causes is drowsiness. Drinking coffee and getting enough rest are examples of precautions to avoid drowsiness. This study proposes a drowsiness detection technique using artificial intelligence. In this project, a webcam is used to record a video that focuses on the face of the driver. The Viola-Jones algorithm is applied for the face detection process to locate the eyes of the driver in the face region. After doing some training analysis, the system will decide whether the eye of the driver is in a normal or drowsy condition. At the end of this project, a real-time drowsiness detection system using artificial intelligence is introduced. This proposed project needs to be conducted by using a high-spec device to run smoothly in the future.

Keywords: Drowsiness, Artificial Intelligence, Road accidents, Transfer learning

1. Introduction

Many traffic fatalities have been reported in the news in this new era. It may be claimed that drowsy driving is one of the leading causes of road fatalities. This is due to the driver's state, which is that he or she is driving when fatigued, which can lead to drowsiness, culminating in road casualties or accidents. Drowsiness is a term that has been used to describe a state in which a person feels sleepy. Drowsy driving accidents are caused by two main factors. The first people who come to mind are those who fall asleep behind the wheel while handling the steering. The most common cause, however, is microsleep, which causes a temporary lack of focus [1].

Artificial intelligence can be categorized as one of the recently introduced technologies. Artificial intelligence is referred to as machine learning. Artificial intelligence, in general, is a system that works by consuming a huge amount of labeled training data, evaluating the data for correlation and patterns, and then using these patterns to forecast future states or conditions [2]. Artificial intelligence has been widely used in this era since it can be said to focus on learning, reasoning, and self-correction.

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Because tiredness can manifest itself in a variety of ways, such as yawning or being unable to keep one's eyes open, machine learning is required. This can be done by observing the driver's eyes, behaviour, or characteristics [3]. Thus, the machine needs to be trained to recognize and track the behaviour of the eyes or face of the driver so that it can monitor the driver's eyes in the future. By monitoring the driver's eyes, the symptom of drowsiness can be detected early, thus avoiding the probability of having microsleep during driving.

2. Methodology

A simulation will be simulated using MATLAB. The training will be conducted to train the machine to recognize the desired parameter, which is the eyes state. The webcam will be used to detect the driver's eyes and using the Viola-Jones Algorithm, the location of the eyes on faces can be detected. All the training and testing processes will be done using MATLAB GUI. By using the MATLAB GUI, the Viola-Jones algorithm and transfer learning are already set in this software.

2.1 Block diagram

The proposed system consists of a few tasks to detect drowsiness in the driver. The system starts with the webcam. The video was recorded by the webcam in live mode as this is a real-time system. Then the system will find the face, whether any faces are appearing on the webcam, and if there are any, it will detect the face in one frame. After that, face detection was started, which means the system will start to detect the location of the driver's face. By detecting the driver's face, it can then locates the eyes of the driver in the face region. The Viola-Jones algorithm was applied in this process. Then, from the eyes' state, the system will decide whether the eyes are in a normal or drowsy condition. In this proposed system, the detection focuses more on the person's face since the training involves the person. This means that the datasets that will be collected consist of normal faces and drowsy faces. Thus, the machine will recognize the drowsiness sign based on the face. This is the reason the Viola-Jones algorithm needs to be used since the function of the Viola-Jones algorithm is to detect the position of the face. Figure 1 shows the block diagram of the proposed system, which starts with the web camera capturing the video, which is the real event, and finishes when the system detects someone's face and displays the result of the detection.

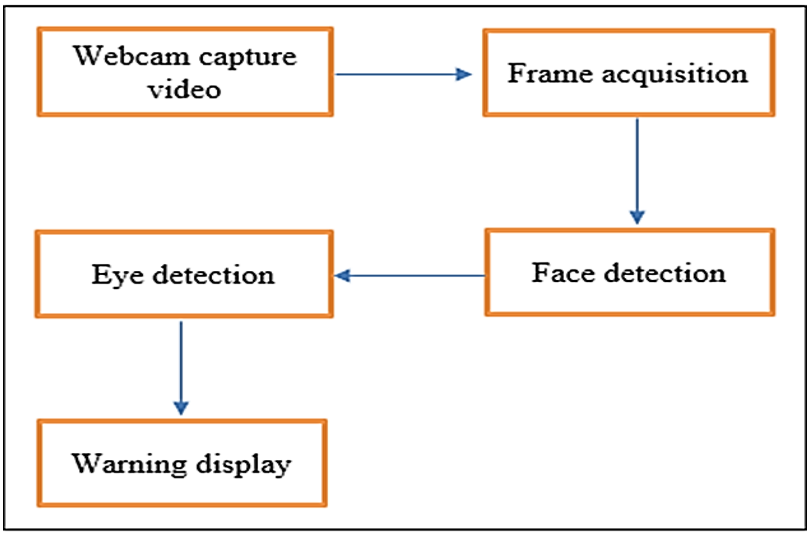

Figure 1: Block diagram of the system

2.2 Detection Flowchart

The system starts as the webcam captures the live video of the driver's face. Then the number of faces that appeared was detected. If there is no face detected, the system returns to start. If the system detects more than 0 faces, which is equal to 1, the system then sets the specific area on the face. As soon as the specific area has been set, the system starts to detect the eye's location. Then it will determine the state of the eyes, whether they are open or closed.

If the eyes are determined to be open, the system will return to start, while if the eyes are determined to be closed, it will start to monitor the eye's blink. If the eyes are closed for 10 seconds, then the system will consider the eyes as normal blinks. If the eyes are closed for more than 10 seconds, the system will consider that the driver is in a drowsy condition, which is it will trigger the alarm to wake the driver to consciousness. Figure 2 shows the flowchart of this proposed system.

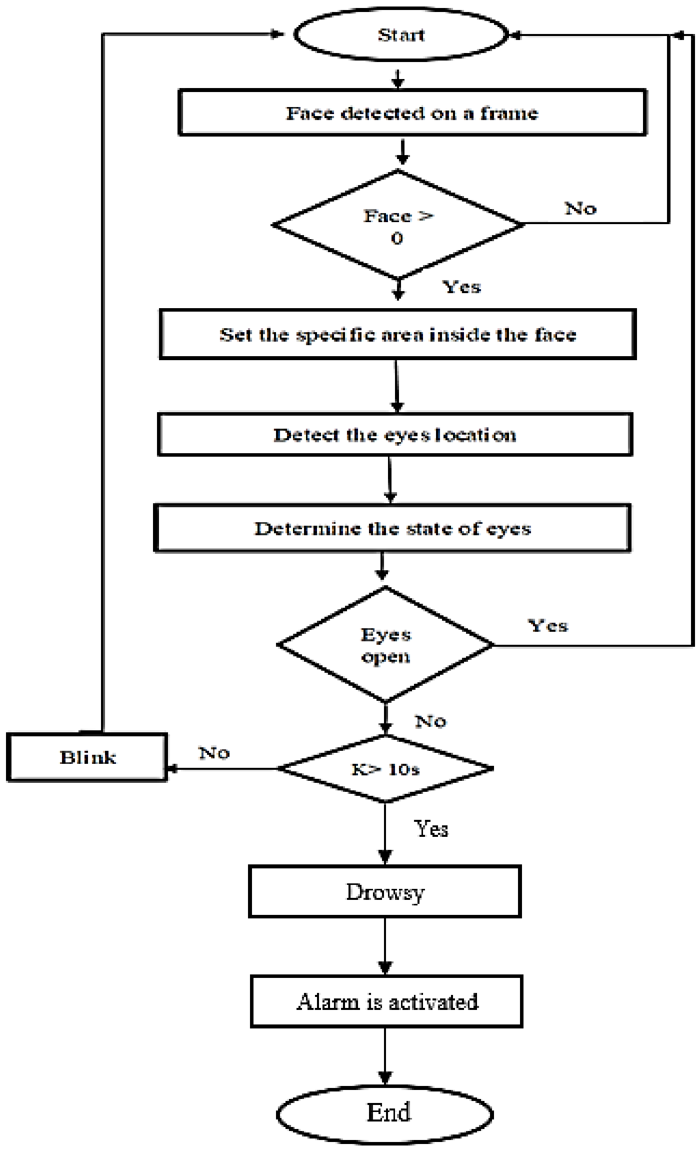

Figure 2: Flowchart of the proposed system

2.3 Training process

The size of the images of the dataset has been converted from 86x86 to 224x224, the image then can be proceeded into the training process. By using the GoogleNet pre-trained network, the system can be used to recognize and classify the trained image in the future. In this Neural Network, there is a condition where the Neural Network is just memorizing the example of training data without understanding the concept. The condition will result in working well in training data, but failure in learning the real concept. As a result, training Neural networks cannot work well with the new data. This condition is known as Overfitting. To overcome Overfitting, GoogleNet will use a method known as Data Augmentation. Since the dataset image has the same features or characteristics, Data Augmentation needs to be used to train the network that the dataset image consists of different features and characteristics even though they look similar. The more the dataset the better the result.

2.4 Implementing Real-time Video

As for the output, the driver's state during driving will be shown through real-time video. In other words, the driver's drowsiness can be monitored by live video, which means the video is in real-time. The drowsiness can be detected and will be monitored through live video after the machine has detected the drivers' faces. The consciousness of the driver then shows whether the driver is in a normal state or a drowsy state. The real-time event will be captured by the webcam, which will capture the driver's condition. Then the machine will predict the condition based on the training process to decide the driver's condition.

In this live video, the Viola-Jones algorithm will be applied to track the driver's face and thus will monitor the eye's state. Figure 3 shows the command used in MATLAB to start the real-time drowsiness detection. In the command, the Viola-Jones algorithm command was used to detect the driver's face since the position of the faces is always moving. As for the recognition, the training will be conducted to introduce the features or signs of normal and drowsiness so that the system can predict the condition when the driver's face was fed into the live webcam. The training progress then will be loaded into the real-time command.

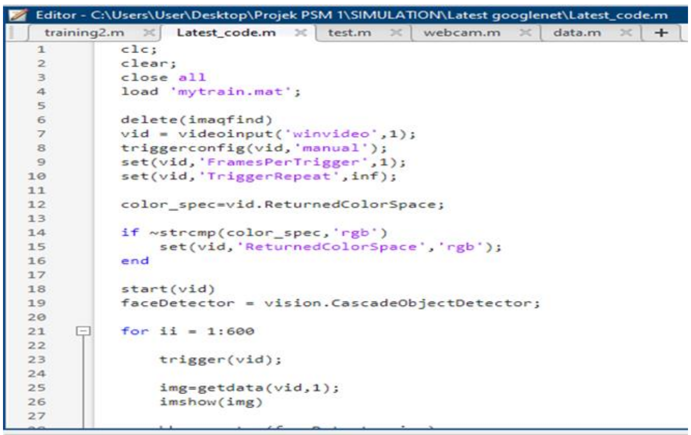

Figure 3: Real-time command

3. Results and Discussion

The results obtained using the software, which is MATLAB GUI software. The analysis of training and detection will be explained in this chapter. The accuracy and loss of the training process are obtained during the training of the data set. Besides, testing results for detecting faces and eyes are also obtained during this process. Once the training has been conducted, the training progress can then be loaded into a real-time application, which can then be used as a real-time drowsiness detection system.

3.1 Training

During the training process, a set of modified data is fed into the GoogleNet pre-trained network to train and teach the machine to recognize the new image in the future. The training process has 7 epochs with the iteration per epoch being 2 and the maximum iteration was set to 20. The duration of this training process is 65 minutes, which is considered a long time since the total image that was being fed is 300 images which consist of 150 images of closed eyes and 150 images of opened eyes.

During this training, 2 things were measured, which are accuracy and loss. As for the graph of the training progress, the accuracy is in an increasing pattern while the loss is in a decreasing pattern. Based on Figure 4 illustrates the accuracy of the training reached 97%, which is considered excellent. This rate can be achieved when the dataset has almost the same features, which can make the machine predict the output precisely. The training has been conducted a few times to achieve the highest accuracy. To achieve higher accuracy, the dataset images need to have the same features as the training datasets, and the number of datasets that were used in training must be large. As for this proposed system, the dataset used only 300 images. The images in the dataset were collected by using a snapshot from a webcam, so the images have the same features, which can lead to higher accuracy even though the dataset only has 300 images.

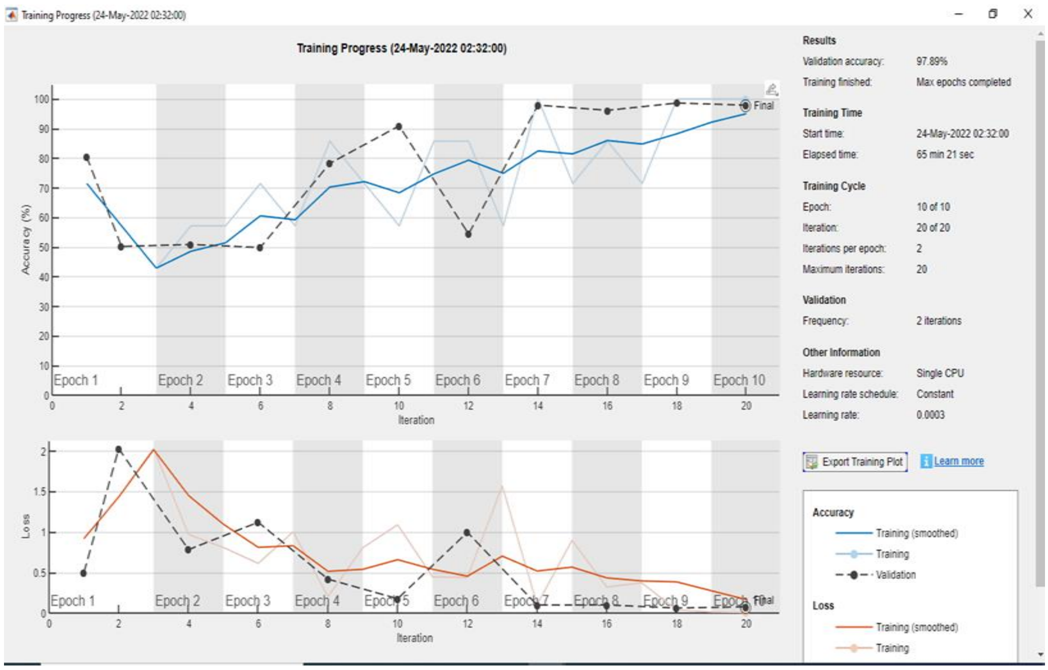

Figure 4: Training graph

3.2 Detection testing on the face

In detecting the face, the CascadeObjectDetector is being used, which is available in MATLAB. The CascadeObjectDetector is considered a part of the Computer Vision Toolbox which creates a system to detect faces, which is the Viola-Jones algorithm. The CascadeObjectDetector was the first setup by using a constructor which has a built-in Viola-Jones algorithm. Then the image selected will be read. After the face detector is run, the face will be detected with a bounding box around the face. The bounding box represents the area desired by the face detector. The result from the face detector is shown in Figure 5.

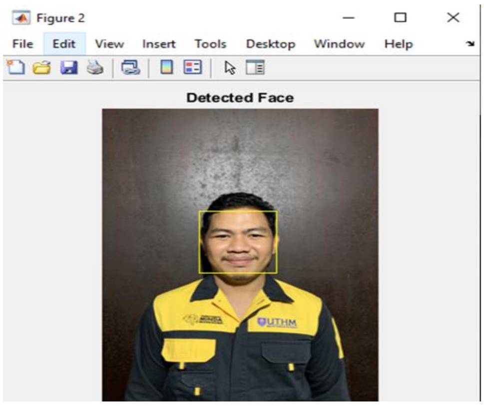

Figure 5: Face detector

3.3 Applying real-time program to the image

The trained program was used before the training data was loaded into the program by using the image. The test was conducted on two images, which were open eyes and closed eyes. This process aims to observe whether the trained data can work as it was trained before it was loaded into the real-time system. The process uses CascadeObjectDetector to detect the face, thus making the prediction possible. Figure 6 and Figure 7 show the results after the program is run on the image, which is the prediction shown on top of the image. Figure 6 shows the prediction for open eyes, and it was predicted as normal, while Figure 7 shows the prediction for closed eyes, and the machine predicted it as drowsy.

Figure 6: Prediction of open eyes

Figure 7: Prediction of close eyes

3.4 Implementing training process in real-time

After completing the training process and achieving greater accuracy in detecting and recognizing signs of drowsiness, the training program is loaded into real-time commands in MATLAB. Once it has been run, the MATLAB will automatically open the webcam and capture the image of a person in front of the webcam in live video, which means the webcam will capture the real-time event that happens at a particular time as shown in Figure 8 and Figure 9. The blue square indicates that the machine has detected the person’s face in one frame. This will make the machine recognize someone's face, whether they are in a normal or drowsy condition. The prediction will appear at the corner of the live video which states the condition of the drivers, which is normal and drowsy. The prediction of the event is based on the training conducted. This is the reason why the training is very important and needs to achieve higher accuracy so that the machine can predict the sign more accurately.

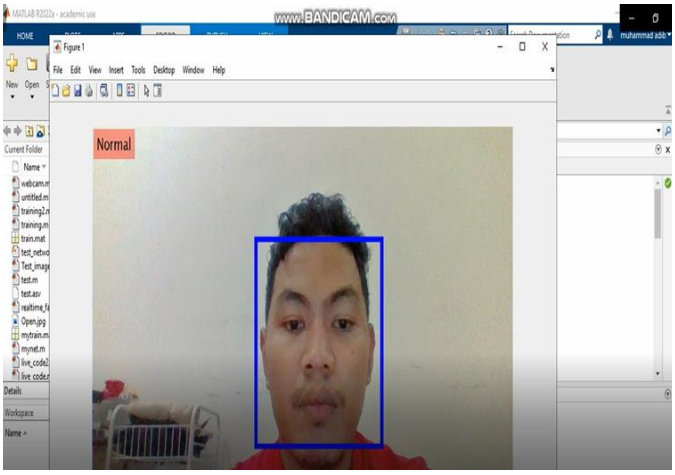

Figure 8: Prediction when eyes open

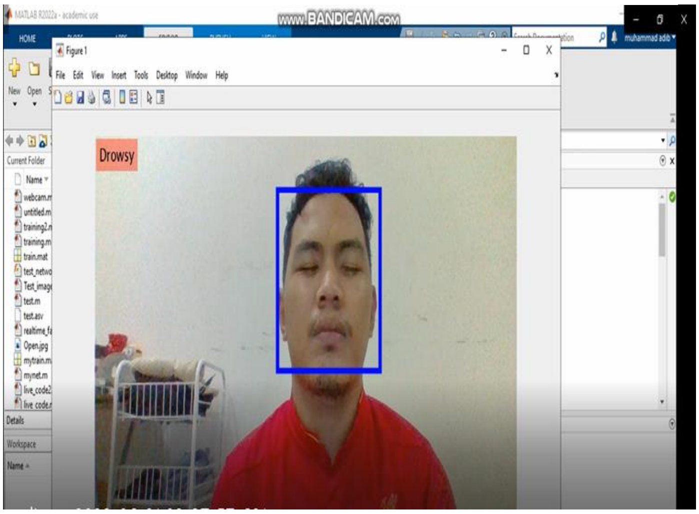

Figure 3: Prediction when eyes close

3.5 Final result

The output does not appear as desired, which means that when the real-time program was being run, there was a delay in the live video in which there is an error between the detected face and the predicted face as illustrated in Figure 10. The delay was between 2 and 5 seconds. In other words, when the webcam captured the person’s face, there was a delay that occurred when the person moved around. Thus, the detection of the face also faced a delay. This problem affected the result since when a delay occurred, the detection of the face and the prediction were not synchronized. For example, after the program is run, the program will have a delay, which means in the real event, the eyes of the person are open, but because of the delay in the live video, the program captures the eyes in a closed state, thus the prediction states the person is in a drowsy condition.

As the final output of the program is to produce an alarm when drowsiness is detected for more than 10 seconds, the program is not capable of producing the alarm due to the delay in capturing live video. The delay in capturing live video does not affect the accuracy of the training since the training has been proven to have high accuracy.

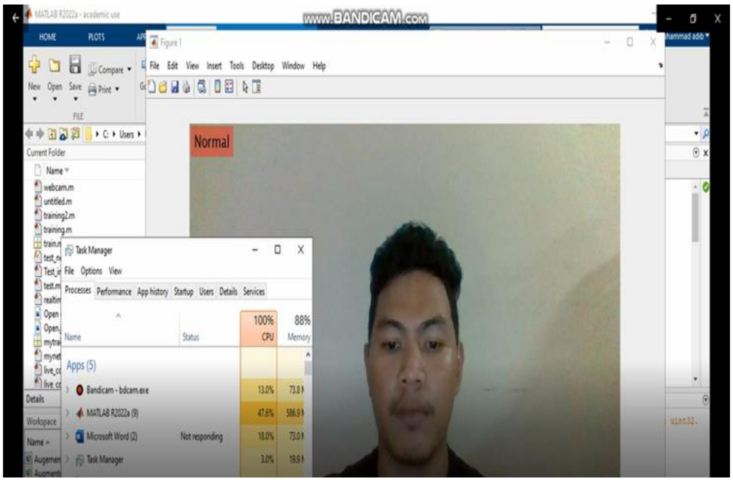

Figure 10: Error in detecting and predicting

This error unexpectedly occurred due to the usage capacity of the CPU. According to the task manager, the capacity of CPU usage has reached 100% of its capacity. When the program has been run, the capacity has increased rapidly to its maximum capacity. Before the program was run, the CPU capacity only reached 40% to 60%. Once the real-time program has been run, the capacity has increased.

4. Conclusion

In conclusion, real-time driver drowsiness by using artificial intelligence has been proposed. In this analysis, a pre-trained network was used to train the dataset. Following that, testing has been conducted to test whether the training was successful. Furthermore, the accuracy and loss during the training have been examined and analyzed to ensure that they can be used in the future to detect drowsiness. Besides, results for the face and eye detection were obtained. The real-time drowsiness detection program has been shown and explained in detail regarding its effectiveness of the program. The program was not able to work 100% due to an error from the maximum CPU usage, which caused a delay in capturing live video when the program was run. Since the program is not capable of capturing the live video smoothly, the final output or result that produces an alarm when drowsiness is detected was not obtained. The failure in producing the alarm does not affect the accuracy of the training through deep learning.

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References

[1] Cheah C.F, “Microsleep a Factor in a Road Accident, ” 9 July 2020.[Online] Available:https://www.nst.com.my/opinion/letters/2020/07/607009/microsleep-factor-road-accidents [Accessed 31 October 2021]

[2] Burns, E., “What is Artificial Intelligence (AI)? - AI Definition and How it Works.’[online]SearchEnterpriseAI:Available: https://searchenterpriseai.techtarget.com/definition/AI-Artificial-Intelligence [Accessed 31 October 2021]

[3] S. E. Viswapriya, Singamsetti Balabalaji , Yedida Sireesha, 2021, “A Machine-Learning Approach for Driver-Drowsiness Detection based on Eye-State”, INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) Volume 10, Issue 04 (April 2021)