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Alert System for Driver's Drowsiness

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Abstract: *Monotonous driving for longer distances results in drowsiness and mental fatigue. Consumption of alcohol can also make the driver feel sleepy. Thus, drowsiness and drunken driving cause road accidents. This paper proposes a real-time detection of drivers' drowsiness and subsequently alerting them. The main aim of this proposed system is to reduce the number of accidents due to driver's Drowsiness and alcohol intake to increase transportation safety. The proposed system contains the use of the Raspberry Pi system and Pi camera module for drowsiness detection of the driver and alerting the driver using an alarm system.*

Keywords: Drowsiness Detection, Raspberry Pi, Pi camera, Alarm

I. Introduction

The term Drowsy Driving is used while operating a motor vehicle when sleeping, affecting anyone who gets behind the wheels. Drowsy driving increases the risk of accidents, leading to an alarming rise in deaths and injuries every year. According to the AIIMS survey, 20% of all road accident victims suffer from sleep disorders and around 23% of truck drivers suffer from insomnia and 31% of road accidents are caused due drinking and driving cases. Humans working for hours experience active fatigue and even don't get proper sleep. Lack of sleep leads to working ineffectively and the mind moves into a drowsy state. Driving at midnight also increases the possibility of one experiencing sleep-related fatigue. One cannot miss the fact that drivers feel sleepy when consuming alcohol.

Hence it is necessary to tackle such situations and this can be achieved with the help of IoT also known as the Internet of Things. The Internet of Things (IoT) depicts a network of objects that contain physical devices such as sensors, physical devices like routers, switches, etc and other technologies to communicate and exchange data with other objects/devices over the internet.

1.1 Project Purpose

The purpose of this system is detection of driver's eyes and checking wether they are closed or not. If closed then alerting the driver with the help of a buzzer. The system gathers the images from Pi Camera Module with the help of OpenCV and then gives it to the classification model which categorizes them into open or closed.

1.2 Project Objective

- When the drowsy state of the driver is detected the system will alert the driver by ringing the buzzer.
- The proposed system will keep the driver alert thus preventing accidents.
- This will save the life of the driver as well as the other humans/animals walking on the road and also prevent property loss.

II. Requirements Specification

2.1 Software

- Opencv (for face and eye detection)
- Tensorflow (Numerical computations and creating deep learning models)
- Keras (Provides python interface to TensorFlow to create deep learning models)
- Pygame (To play alarm sounds)
- Python

2.2 Hardware

- Raspberry Pi 3
- Pi camera
- Buzzer

A. Raspberry Pi 3b+

Fig.1. Raspberry Pi 3b

We will be using the raspberry pi 3b+ model which has 1GB LPDDR2 RAM with a processing power of 1.4 gigahertz 64 bit. which is sufficient for image processing that is to be done by libraries such as open cv, Keras, etc. It can take images of 1080p resolution. It has GPIO pins that will supply power to the buzzer and sensors. The proposed system will also use an SD card for booting.

B. Pi Camera Module

Fig. 2. Pi Camera Module

The Pi camera has resolution of 2592x1944pixels.Can capture static images. It works best on the latest version of Raspbian (raspberry pi default operating system). The camera is compact and thus can be placed conveniently on the dashboard.

2.3 Technology Used

- **OpenCV:** OpenCV (Open Source Computer Vision Library) is an open-source library which deals in computer vision and machine learning. OpenCV was created in order to provide a common platform/infrastructure for applications that use computer vision and also enhance the perception ability of machines in commercial applications.
- **Haar Cascade Algorithm**: *It is an algorithm which is used for object detection and face detection too*. Edge or Line detection features are used here as per the paper "Rapid Object Detection using a Boosted Cascade of Simple Features" proposed by by Viola and Jones. To train the algorithm many number of positive images(which contain the object that needs to be detected) and negative images(which don't contain the object that needs to be detected) are fed to the algorithm.

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- **Keras:** Keras contains numerous implementations of commonly used neural-network building blocks such as layers, objectives, activation functions, optimizers, and it hosts a set of tools which makes it easy to work with image data and text data, leading to simplifying the coding necessary for deep neural networks. In addition to standard neural networks, Kerasalso supports convolutional neural networks and recurrent neural networks. Common utility layers like dropout layer, batch normalization and pooling layer are also supported by Keras.

2.4 Method Followed

1. The camera captures and uses detection algorithms to detect faces and eyes.
2. The system should have a continuous power supply.
3. The system should have internet connectivity.

A. Face Detection Algorithm

1. In the proposed system the frames will be captured by the camera and then sent to Raspberry Pi.
2. The frames are stored in any preferable memory.
3. Classifiers in OpenCV are used for the detection of the face and eyes.
4. With the help ofOpenCV, the landmark points on the eyes are marked.
5. The below figure depicts the landmark points on the eyes used for calculating the EAR Ratio when there is any movement of the eyelids.

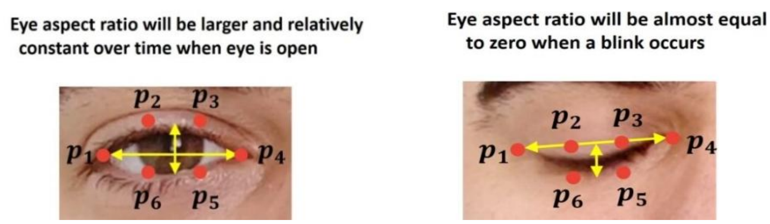

Figure 3: EAR Diagram

The formula for Eye Aspect Ratio(EAR) is given as follows:

$$EAR = \frac{\| p_2 - p_6 \| + \| p_3 - p_5 \|}{2 \| p_1 - p_4 \|}$$

Implies that when the eye closes, the distance between points [P2 and P6, P3 and P5] decreases which in turn decreases the whole valueof EAR as the distance between points P1 and P4(Denominator) doesn't change much.

If EAR is below the threshold value it will start the buzzer and notify the server which in turn will send an e-mail to the driver's trusted contacts.

B. Face Detection Algorithm

The face detection will be carried out by classifiers of OpenCV. In the proposed system we have used Haar Cascade classifiers. This classifier will be trained by feeding it samples of positive and negative images where the positive image contains the object we want the classifier to identify and the negative image where the object is not present. Haar features shown in the below image are used. The sum of pixels under the white rectangle are subtracted from the sum of pixels under the black rectangle to get a feature.

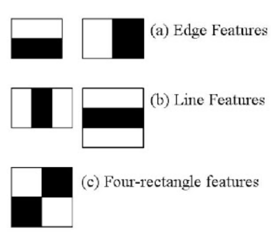

Figure 4: Haar Cascade Classifier

Among the many features available, the best features which can detect faces with minimum errors are chosen. Then these features are grouped into different stages of classifiers and applied one by one. Features on the human face are depicted in the below figure.

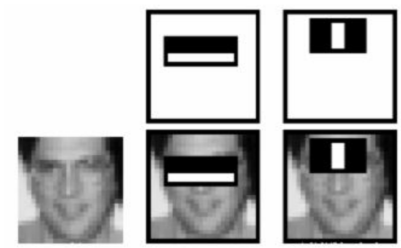

Figure 5: Haar Cascade Classifier

The received images are converted into grayscale as the OpenCV algorithm for object detection only takes gray images in the input.Color information is not needed for object detection. After the conversion of the image into grayscale, we need to resize its dimensions and set it as the same as the dimensions on which our model was trained (This system's model was trained in 24*24 pixels).

The data we get from detection will be normalized by dividing it by 255(as a single-pixel holds a value between 0 to 256). This will reduce the range from 0-256 to 0-1 which will speed up the calculations.

C. Convolutional Neural Networks (CNN)

The classification model we used is built with Keras with Tensorflow as the backend using **Convolutional Neural Networks.** While OpenCV deals with detection, the classification model will predict eye status after being fed the eyes portion of the captured image. The CNN model architecture consists of the following layers:

- Convolutional layer; 32 nodes, kernel size 3
- Activation layer; 32 nodes, kernel size 3
- Pooling layer; 64 nodes, kernel size 3
- Fully connected layer; 128 nodes

The image will be converted to grayscale and each input image will pass through a series of convolution layers with filters. There are four layers:-

1. **Convolutional layer:** It is the core building block and does most of the computational heavy lifting. The simple application of filters/kernels to input is done in this layer. The concept behind this is that adjacent or nearby pixels's information can be approximated with the help of maximum information-carrying pixel.

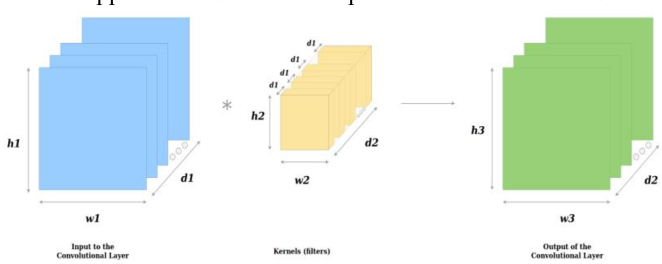

Fig. 6. Convolutional layers

2. **Activation layer:** This layer is responsible for applying the activation function. In this system, we have used ReLu(Rectified Linear Unit) activation function. ReLu function sets all negative values to zero and passes the positive value as it is. Luis is faster to compute than its peer functions and significantly reduces the training time for neural networks as it does not activate all neurons at the same time.
3. **Pooling Layer:** It is responsible for reduction of number of parameters to learn while retaining most of the information as long as the information is not changed. This may cause some information loss but it can be tolerated.

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4. **Max pooling:** Highest value from each position is taken and put into the corresponding position of the output matrix. Refer to figure 7:

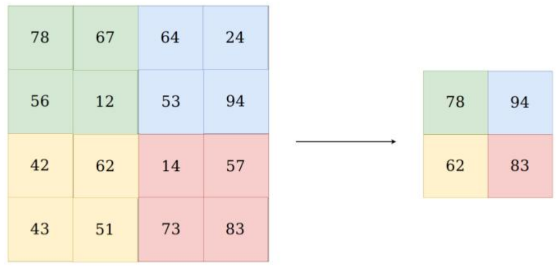


Fig. 7. Output Matrix

5. **Fully connected layer:** The entire pooled map matrix is transformed into a column, this process is called Flattening. With the fully connected layers, we combine these features to create a model.

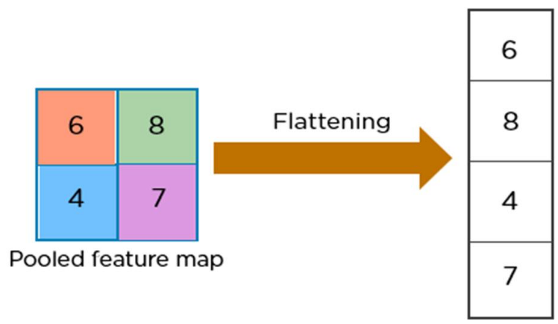
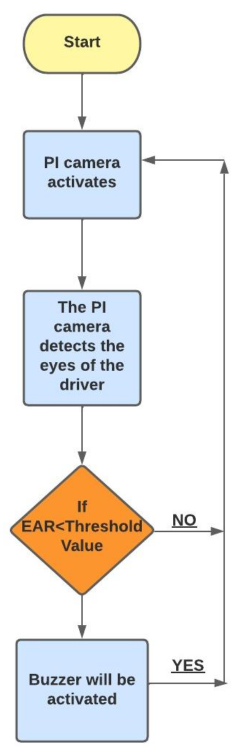


Fig. 8. Flattening process

D. Flowchart



III. Conclusion

Thus the main aim of the system is to detect the drowsiness state of the driver, and take appropriate action that is alerting the driver and thus preventing the accident. This will be done using the Pi camera module for eye and face detection and alerting the driver using a buzzer when detected as eyes are closed. As a result future accidents due to drowsiness or drunk and drive will be reduced thus saving life and property.

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