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DRIVER DROWSINESS AND DISTRACTION MONITORING AND WARNING SYSTEM

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ABSTRACT:

Safety of passengers and the driver in a vehicle is becoming of vital importance because of the increasing number of road accidents. The number of road accidents because of a drowsy and distracted driver is among the major causes of vehicle crashes. Not only does it cause damage to the vehicles but it also causes a lot of fatalities and a monetary loss of thousands of dollars. In this project, we have proposed a system that detects a drowsy and distracted driver using simple CNN and VGG-16 architecture. This method involves the raspberry pi integrated with pi camera which captures live stream and if drowsy state is found gives warning through speaker and buzzer until they come out of their drowsy state. In addition, to address distracted drivers, we employed the VGG16 architecture to detect 10 different states of distracted drivers. Also, we have used pulse sensors to monitor the driver's condition for more accurate results. This includes use of Arduino UNO along with a 16x2 LCD display, buzzer and LED light.

Keywords — ***VGG16, CNN, Pulse Sensing***

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I. INTRODUCTION

Fatigue combined with bad infrastructure in developing countries like Nepal is a recipe for disaster. Fatigue, in general, is very difficult to measure or observe unlike alcohol and drugs, which have clear key indicators and tests that are available easily. When there is an increased need for a job, the wages associated with it increases leading to more and more people adopting it. Such is the case for driving transport vehicles at night. Money motivates drivers to make unwise decisions like driving all night even with fatigue. This is mainly because the drivers are not themselves aware of the huge risk associated with driving when fatigued. Some countries have imposed restrictions on the number of hours a driver can drive at a stretch, but it is still not enough to solve this problem as its implementation is very difficult and costly.

YEARLY ACCIDENT REPORT[1]

Fiscal Year	No of Accidents	Fatality	Serious Accidents	Normal Accidents
070/071	4672	143	229	3481
071/072	4999	133	233	3643
072/073	5568	166	275	3901
073/074	5530	182	201	3914
074/075	6381	194	219	4333
075/076	8511	245	317	5890
076/077	10030	153	240	6684
077/078	9545	166	229	7095

Driver carelessness along with bad road conditions is the main reason for vehicle accidents in Nepal. According to the Traffic Police Nepal, in 2076/77 there were about ten thousand road accidents, out of those one hundred and fifty-three people lost their life. There has been a seventeen percent increase in road accidents in 2076/77 compared to 2076/75. According to the studies around sixty percent of the accidents on the road is due to the carelessness of the driver which contains distracted drivers and overspeed of the vehicles [2].

So, we have designed a system that works by analyzing real-time video feed of the driver and their surrounding environment using a CNN. The CNN model is trained to identify signs of drowsiness such as eye closure and yawning, as well as distractions such as using a phone, talking to passengers, drinking and so on. In addition to this, we are also monitoring the drowsy state of the driver using a pulse sensor. If our system detects signs of drowsiness, it alerts the driver through a speaker and a buzzer to take corrective action. This system could potentially save lives and reduce the number of accidents caused by drowsy or distracted driving.

II. LITERATURE REVIEW

Driver's fatigue detection using pulse rate has been proposed by Salvati et al. [3]. They used a fatigue-related sleepiness detection algorithm based on the analysis of the pulse rate variability generated by the heartbeat and validates the proposed method by comparing it with an objective indicator of sleepiness (PERCLOS). In this, changes in alert conditions affect the autonomic nervous system (ANS) and therefore heart rate variability (HRV), modulated in the form of a wave and monitored to detect long-term changes in the driver's condition using real-time control.

Eye and mouth detection has been done using Haar Cascade algorithm and Dlib as studied by Badiuzaman in [4]. They have explained about a designed system that deals with detecting the face area of the image captured from a video. The video was changed into images frames per second. From there, locating the eyes and mouth was performed. If the eyes are found closed for 4 consecutive frames, it is confirmed that the driver is drowsy.

Zhao et al. [5] proposed an algorithm in which the multitask cascaded convolutional network (MTCNN) architecture is employed in face detection and feature point location, and the region of interest (ROI) is extracted using feature points. A convolutional neural network, named EM-CNN, is proposed to detect the states of the eyes and mouth from the ROI images. The percentage of eyelid closure over the pupil over time (PERCLOS) and mouth opening degree (POM) are two parameters used for fatigue detection.

Sai and Chinvar [6] designed a system to detect and warn drowsy drivers using a haar cascade algorithm. This method involves the raspberry pi to refer to a predefined image stored in it and compare it with the live stream, then if the live stream captured image doesn't match with the predefined image it triggers an alarm inside the car which alerts the driver until he comes out of his drowsy state. When a driver feels drowsy it also flashes the double indicator on the outside to indicate to the co-drivers to be cautious. Only eye parameter was taken into account in this system which might not be that efficient.

Male and female BPM has been monitored in the study proposed by Rahim et al. [7]. They have explained about the difference in BPM in normal condition and drowsy stage condition. The experiment was conducted for male drivers and female drivers and important differences in their heartbeats were analyzed. The male's BPM was between 50 to 65 BPM while the female's BPM was around 45 to 63 BPM during drowsy state according to the experiment.

Oberoi et al. [8] explained about the modified VGG-16 architecture for identifying the driver distraction. With the accuracy of 96.31% the proposed system outperforms earlier approaches of distracted driver detection from literature on this dataset. The system processes 42 images per second on NVIDIA P5000 GPU with 16GB RAM. They also proposed a thinned version of VGG-16 with just 15M parameters and still achieving satisfactory classification accuracy.

In case of our project, we are using Haar Cascade for the face detection and tracking part for drowsiness detection. Alternatively, the same is done using CNN for better accuracy. We are also incorporating a pulse sensor as a physiological factor for detecting the drowsiness of the driver. We are performing this by taking the average value of male and female drivers' bpm to take a threshold value to give a warning signal using a buzzer and LCD display.

III. SYSTEM DESIGN

Our project aims to develop a system to detect driver drowsiness and distraction, which are significant causes of road accidents. For this purpose, we have utilized a Raspberry Pi, which is capable of performing various tasks. We have connected the Pi-Camera to the Raspberry Pi, which enables us to capture real-time video footage of the driver's face. Once the system detects the drowsy state, a warning message is displayed on the screen, and an alarm is played through the speaker to alert the driver to take corrective action.

To detect driver drowsiness using a pulse sensor, we have used an Arduino UNO board, which is a popular microcontroller board. The pulse sensor is connected to the driver's finger, and it measures the pulse rate. The pulse rate is an essential indicator of the driver's alertness and can be used to detect drowsiness. To make the driver aware of their drowsy state, we have used a warning and alert system. When the pulse rate goes below the threshold level, indicating the driver's drowsy state, a buzzer, LED, and LCD display are activated to warn the driver. The warning system is designed to attract the driver's attention and alert them to take corrective measures to avoid an accident.

A. Proposed system

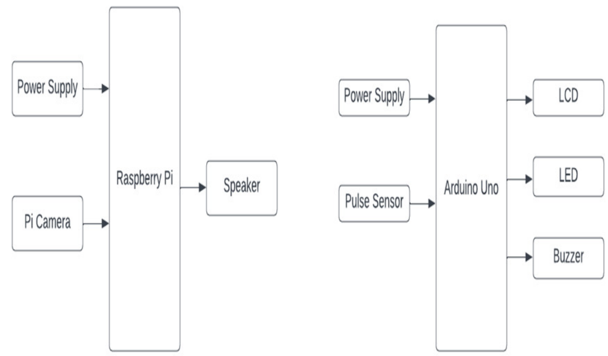


Figure 1: System Block Diagram

B. System Flowchart

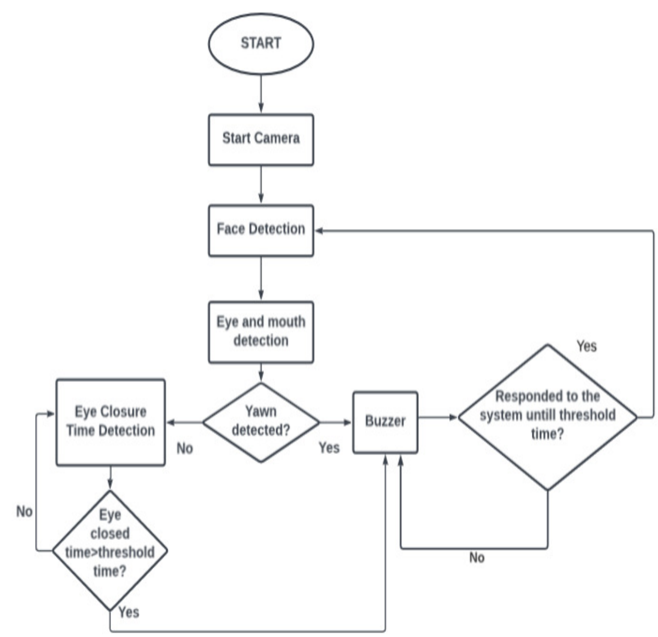


Figure 2: Flowchart for Drowsiness Detection

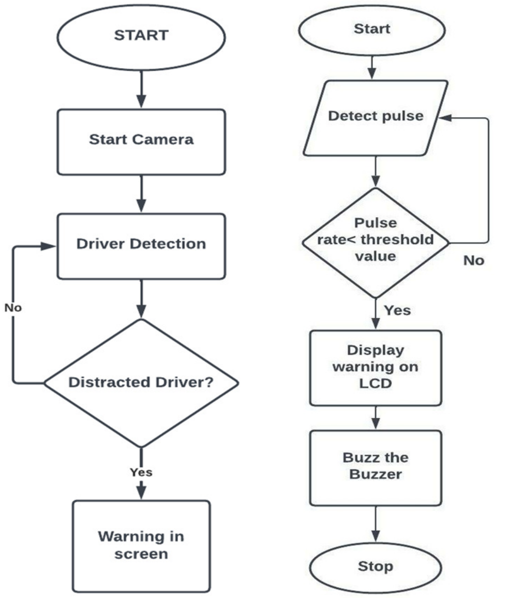


Figure 3: Flowchart for distraction detection and pulse sensing

IV. RESULT

A. *Drowsiness detection using Haar Cascade and Dlib*

We have used the Haar Cascade algorithm and dlib module for face recognition.

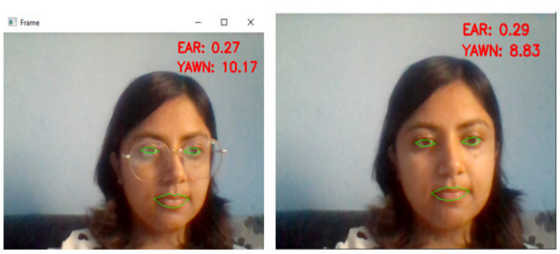
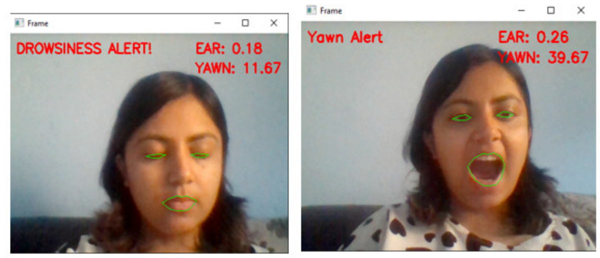


Figure 4: Active State



Here, once the camera is set, the region of interest is now the face, as the next step involves detecting eyes. To detect the eyes, instead of processing the entire face region, we mark a region of interest within the face region which further helps in achieving the primary goal of the proposed system. Next, we make use of a Haar cascade Xml file constructed for eye detection, and detect the eyes by processing only the region of interest. Once the eyes have been detected, the next step is to determine whether the eyes are in an open/closed state, which is achieved by extracting and examining the pixel values from the eye region and calculating eye aspect ratio (EAR) using Euclidean distance. If the eyes are detected to be open, no action is taken. But, if eyes are detected to be closed continuously for two seconds and Eye Aspect Ratio (EAR) is less than threshold EAR=0.3, then it means that the automobile driver is feeling drowsy and a warning is given. However, if the closed states of the eyes are not continuous, then it is declared as a blink.

For yawn detection, first we initialize the Video Rendering Object using the VideoCapture method in OpenCV and create a grayscale image. Then we instantiate model objects both for face and landmark detection and detect the face and pass the face as input to the landmark detection model. Then we calculate the upper and lower lip distance and create an If the condition for the lip distance. Lastly, we show the frame/image. The threshold for yawning is 30, if the input image or frame exceeds the threshold, then yawning is detected and a warning is given to the driver.

B. Alternative method for drowsiness detection using CNN

The model is a convolutional neural network (CNN) with a relatively simple architecture. The convolutional layers apply a set of filters to the input image to extract features, while the max pooling layers down sample the feature maps to reduce the dimensionality of the data. The fully-connected layers then use the extracted features to make a prediction.

Haar Cascades are used by OpenCV to detect objects in the video frames captured from a webcam. We make use of a Haar cascade Xml file constructed for eye and mouth detection, and detect the eyes by processing only the region of interest. Once the eyes and mouth have been detected, the next step is to determine whether the eyes/mouth are in an open/closed state, which is achieved by trained CNN models. If the eyes are detected as closed or mouth is detected as open for a certain number of consecutive frames, the code will start an alarm sound in a separate thread. The alarm sound will continue until the mouth is closed and eyes are detected as open again.

Figure 6: Active State detection using CNN

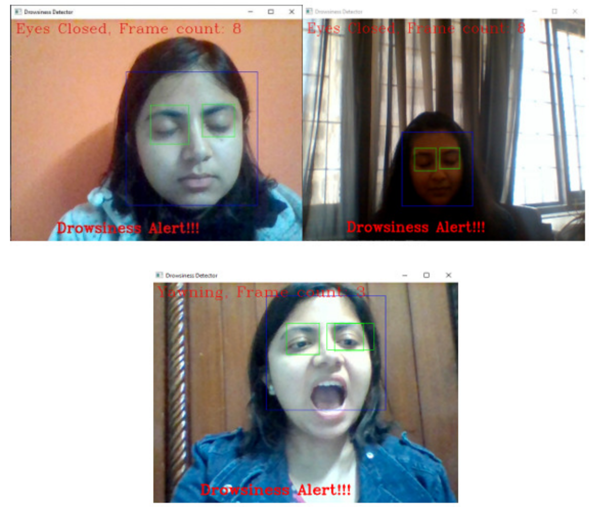


Figure 7: Drowsy State detection using CNN

C. Driver Distraction Detection

For the distraction model, the VGG16 model is loaded without the top (fully connected) layers and the output tensor of the base model is used as input for custom layers. A global average pooling layer is added to reduce the spatial dimensions of the output tensor to a single vector, and a fully connected output layer with 10 units and a softmax activation function is added to output a probability distribution over the 10 classes to be classified. The model is then trained for classification tasks of 10 different driver distraction states. We modified the VGG-16 architecture for this particular task and applied regularization techniques namely the ReLU Activation function and Adam optimizer to prevent overfitting to the training data.

We divided the classes into 10 types which are: safe driving, texting - right, talking on the phone - right, texting - left, talking on the phone - left, operating the radio, drinking, reaching behind, hair and makeup and talking to passenger.

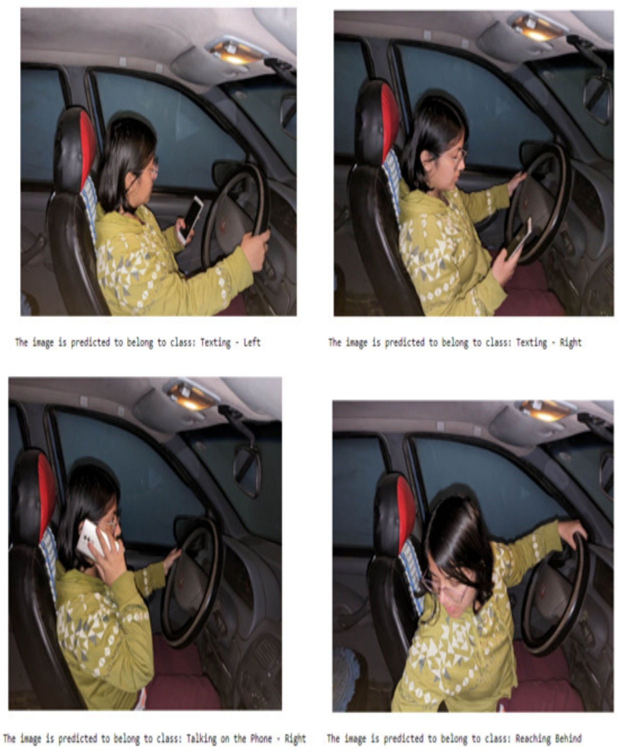


Figure 8: Output of driver distraction model

D. Pulse sensor for drowsiness detection

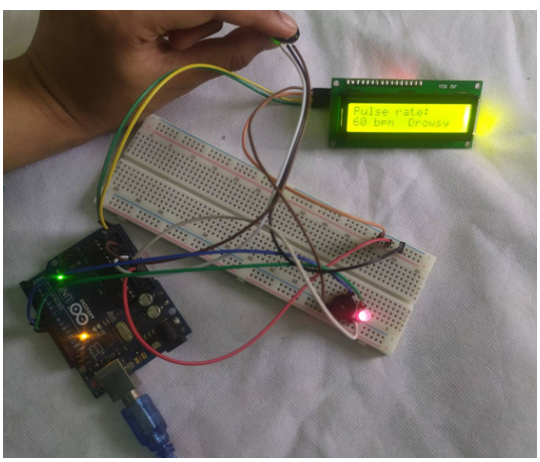


Figure 9: Circuit connection for pulse sensor

Pulse sensor, LED, LCD display with I2C and buzzer is connected to Arduino Uno. The pulse sensor monitors the pulse rate. The threshold set for this project is 65 bpm. When the pulse rate is less than or equal to 65 bpm, a warning is displayed on the LCD display along with buzzer sound and red light from LED. This shows that the driver is drowsy.

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