Vision Based Driver Drowsiness Detection Using Deep Learning

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***Abstract*—Every year many people lose their lives in road accidents, according to a survey many road accidents occur due to driver fatigue condition. Feeling sleepy, tiredness due to long journeys, being on alcohol while driving has costed many lives. In order to save lives a perfect technique must be implemented to detect driver drowsiness and alarm the driver before it costs the driver life. Deep Learning is an emerging technology has given solution to many problems in different domains. Deep Learning can solve this problem using Convolutional Neural Networks and Image Processing techniques. Proposed system solves the above-mentioned problem using object detection, driver video from the embedded devices in the vehicles is taken as input and identifies if eyes of driver in video are closed or opened and eventually an alarm sent. Object detection is done using MobileNet convolutional neural network architecture along with SSD (Single Shot Detector) . On the output given from MobileNet and SSD architecture an algorithm is applied to detect drowsiness of the driver.We take 6000 images from different datasets which consists of images of people driving, eyes open, eyes closed, yawning and use them to train the model and then we label the images into different classes like face, open eyes, closed eyes. The trained model is then tested using 300 images taken randomly from the same dataset. Also we calculate evaluation measures like accuracy, precision, recall and F1 score for the model which is trained. The proposed model gives highest accuracy with less cost of implementation. Since, we use video of the driver taken from the embedded devices like mobile without any expensive hardware. The proposed model is efficient in accuracy, computation and also cost. This model can be deployed on to different embedded devices present in vehicles without any difficulty. The results of proposed model has shown accuracy of 97% and average mean precision of 0.84.**

Keywords-Deep Learning, Image processing, Embedded devices, Accuracy, Mean Average Precision, Trained model, MobileNet-SSD architecture, computation, Convolutional Neural Networks.

I. Introduction

Accidents were declared as global public health problem by World Health Organization. Every year millions of people lose their lives or get injured in road accidents worldwide. It was identified that many accidents occur due to drowsiness of the driver while driving. Drowsiness is a state where a person is not completely sleepy or in active condition it's an intermediate state. According to a survey driver drowsiness while driving has resulted in shocking number of deaths and left many people physically handicapped. As a solution to this problem an accurate model must be implemented to ensure the safety of the driver and passengers. Deep Learning gives a perfect solution by analyzing driver fatigue condition using a real stream video of driver while driving and caution the driver. We develop a system to detect Driver Drowsiness by visually examining driver face while driving through embedded systems in vehicles. This system is developed using Convolutional Neural networks trained on different images collected from different datasets of human faces. All traditional approaches like using classification and clustering algorithms to classify images are not feasible to develop Drowsiness Detection System by using Convolutional Neural Networks model can achieve highest accuracy.

II. Literature Survey

To solve this problem, there are some previous methods like:1)Identifying eyelid closure to detect driver drowsiness2) Drowsiness Detection using compressed Neural Networks. 3) Drowsiness Detection system using compressed light weight neural network. 4) Drowsiness Detection using Long Term Multi Granularity framework.

A. Identifying eyelid closure to detect drowsiness.

This method identifies if a driver is in drowsy condition or not by checking eyelids of the person [1-2]. If the driver closes his/her eyelid then the system identifies that the driver as sleepy. Many systems have been developed based on this concept, but driver drowsiness doesn't depend on single factor. It depends on many other factors like driver tiredness, yawning, long term blinking, facial expressions, nodding etc.

B. Drowsiness Detection using compressed Neural Networks.

This method is proposed by Bhargava Reddy for detection of driver drowsiness using convolutional neural networks [3]. This model compresses the Neural Network and is cost efficient. But the drawback of this model is though the neural network is compressed the algorithm used in preparation of model is not efficient enough to deploy it on embedded devices like mobile, raspberry Pi etc.

C. Drowsiness Detection using light weight compressed Neural Networks.

This method is proposed by Rateb Jabbar for detection of driver drowsiness using neural networks [4]. Proposed system involves developing a light weight neural network model.

Drawback of this model is though it can be deployed on to embedded devices the accuracy of the model is very low.

D. Drowsiness Detection using Long Term Multi Granularity framework.

This method is proposed by Jie Lyu for detection of drowsiness using framework of Long Term Multi Granularity [5]. This model has achieved accuracy of 90%. The drawback of this model is since this model has high complexity it cannot be deployed to embedded systems.

III. PROPOSED SYSTEM

The objective of the proposed system is to design an accurate, computationally effective and cost effective visually based drowsiness detection system. An accurate and efficient algorithm is designed using Mobile Net deep learning architecture [6]. The developed model will be deployed on to embedded devices like Raspberry Pi, mobile devices etc….., where these devices will be embedded in vehicles to monitor driver and to detect drowsiness [15]. The proposed system uses Convolutional Neural Networks since the system has visual tasks to perform. Proposed system achieves highest accuracies by using Convolutional Neural Networks [16]. The main goal of the system is to be work efficient and cost efficient by deploying it to cheap embedded devices. Drowsiness detection system is done as object detection to achieve our goal to develop most accurate, cost and work effective system. We need to develop lightweight neural network model in order to deploy it so we use most accurate light weighted CNN architecture called Mobile Net [17-20]. Mobile Net architecture is the best architecture mainly designed for mobile applications. An SSD (single shot multibook detector) framework along with Mobile Net is best for object detection tasks. Mobile Net along with SSD is best suited to detect multiple objects from a frame [7]. We train the model to detect different parts in human face like whether the eye lids are open or not which are taken as two different objects. The model will be trained taking images from different datasets which consists of images of human faces doing tasks like yawning, closing their eyes, nodding, blinking. These images are divided into classes and we label them. The model takes a video as input and divide them into frames these frames will be analyzed and a class will be predicted then we calculate average mean precision and decide overall output as whether the driver is drowsy or not. Fig. 1. shows how data flows in drowsiness detection system.

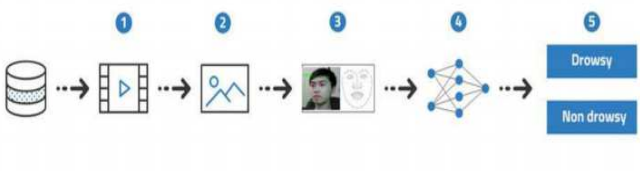

Fig.1. Proposed system outline

A. System Architecture

System Architecture explains how operations flow from one module to other and gives us clear idea about the implementation flow of system model. Fig. 2. explains how data flow from one module to another.

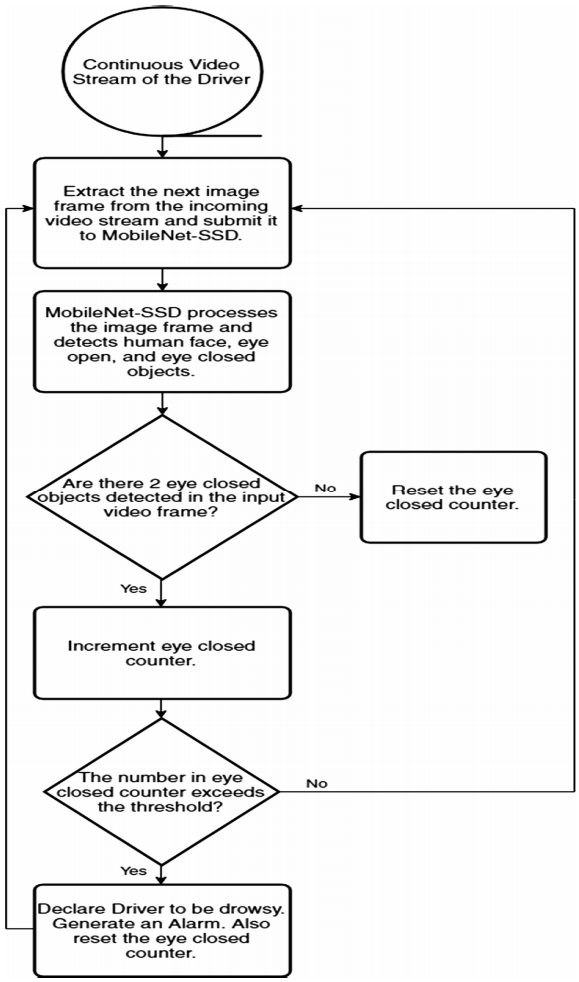

Fig. 2. System Architecture

The above architecture is divided into three modules.

1) Data Collection and preprocessing

In order to develop the proposed system, we need different images. Images are collected from different datasets. Images of face, eyes open, eyes closed, yawning and few custom images are collected [21-24]. We also have collected images from online stock websites in order to make the model more accurate. Different techniques are applied to preprocess these images Techniques involved in this module are:

a. **Data Acquisition** – Images of human faces, eyes open, eyes close, Yawning are collected in different

scenario. All these factors are considered and decides the percentage of drowsiness of the driver.

b. **Data Preprocessing** – Image preprocessing is done to remove noise from images [8]. All the negative factors are ignored and replaced with zeros. Since images are taken from different datasets the formats and camera settings will be different this makes it difficult to identify features from images [14]. So, to avoid this problem we convert RGB images to grayscale.

c. **Data Segmentation** – To extract useful information from the images we do data segmentation [9]. Segmentation makes it easier to analyse data. Segmentation involves partitioning image into different segments to learn more features from same image.

2) Training of the model and classification

In this module a Deep Neural Network using a CNN algorithm is designed. Images that are pre-processed will be used to train the model. To design the model first a convolution layer along with pooling and activation function is designed. Activation function is used to learn complex patterns in the image. RELU activation is used to avoid vanishing gradient problem [10].

3) Testing

In this module, we test the trained model using different evaluation measures like F1 score, precision, accuracy, mean average precision. We have achieved 0.84 mean average precision for our trained model.

B. Algorithms

CNN algorithm is used to design the model. CNN is preferred since other classification algorithm require a lot of pre-processing and segmentation [11].

- **Step 1:** Extracting video from the front-end application.
- **Step 2:** Dividing video frames. we take images from video at the rate 26 frames for second.
- **Step 3:** We assign weighted coordinates to each image.
- **Step 4:** Images are sent to convolution layer and feature map is extracted.
- **Step 5:** Padding to avoid overfitting.
- **Step 6:** Max pooling is applied to extract main features from the images.
- **Step 7:** After a series of batch normalization and dropout operations we flatten the matrix and connect it to fully connected layer.

IV. EVALUATION

. Data used to develop model:

Images are collected from different datasets. Images of face, eyes open, eyes closed, yawning and few custom images are collected. We also have collected images from online stock websites in order to make the model more accurate. Fig. 3. shows images in the dataset. Fig. 4. shows images in drowsy dataset.

Fig. 3. NTHU dataset images.

Fig. 4. Drowsy Dataset images

A. Results:

We calculate mean average precision in three different cases. Trained model has achieved accuracy of 97% with mean average precision of 0.8.

	Average precision when eyes are closed	**Average precision when eyes open**	**Average precision of face images**	**Mean average precision**
Drowsy dataset	0.776	0.763	0.971	0.837

Table. 1. Experimental series

Fig. 5. shows action of trained model and accuracy score for each action.

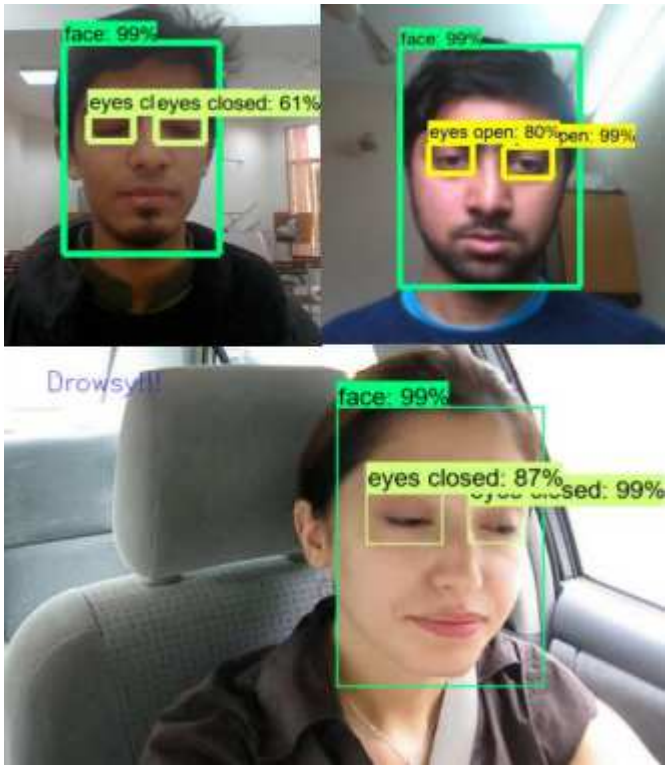

Fig. 5. Trained model

Fig. 6 and Fig. 7 shows the results of the drowsiness detection system.

Fig. 6. Identifying the Eyes

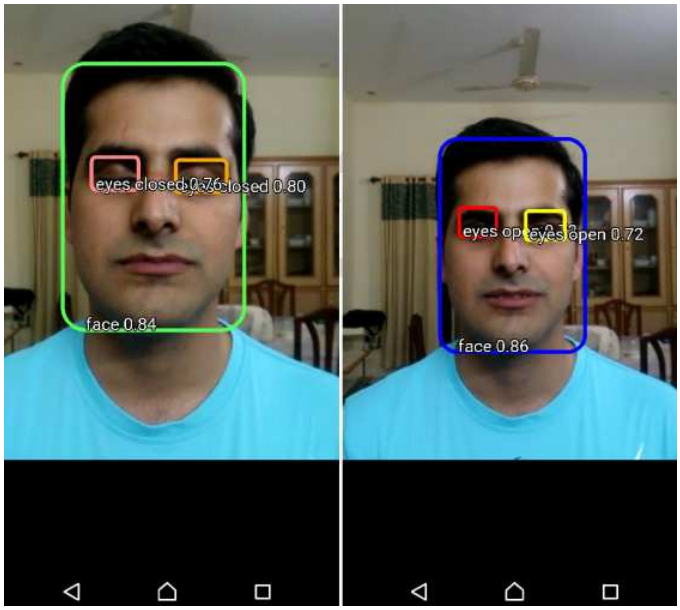

Fig. 7. Identifying the Face

V. CONCLUSION

In this project, we have designed Drowsiness Detection System by considering the model as object detection task [12]. This model enables us to develop cost efficient, source efficient model. The model can be deployed on to embedded devices which can be placed in vehicles and can continuously monitor driver while driving and cautions the driver if the drowsiness level of the driver is more than threshold value.

VI. FUTURE WORK

In future work to make the model efficient we can take images in the low light. Since most of the accidents happen at the night time. Low light and blurred images can help the model to become more reliable [13]. Modifying Mobile Net architecture can also improve the model.

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