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Review on Drowsy Face Detection using Deep Learning Algorithms

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Abstract - This paper presents a literature review on drowsy face detection using deep learning techniques. Driver drowsiness results in many car crashes and fatalities worldwide. The advancement in computing technology has provided the means for building intelligent face detection systems. Faces contain information that can be used to interpret levels of drowsiness. Here we employ deep learning to determine actual human behavior during drowsiness episodes targeting the facial features.

Keywords: *Drowsy face Detection, Facial Features, Deep learning, Human Behavior.*

1. INTRODUCTION

Drowsiness influences mental alertness, decreasing an individual's capability of basic understanding of one's surroundings and expanding the possibility of a human errors. As per the data received from the police department of States/UTs in India, 1,50,785 persons and 1,47,913 persons were killed in road accidents during the calendar years 2016 and 2017 respectively [1].

It has been estimated that drowsiness causes between 10 % and 20 % of traffic accidents, causing both fatalities dead [2] and injuries [3], whereas within the trucking industry 57 % of fatal truck accidents are caused by this problem [4],[5].30 % of all traffic accidents have been caused by drowsiness [6]. In the USA, drowsiness is responsible for 100000 traffic accidents yearly producing costs of close to 12.000 million dollars [7].

In Germany, one out of four traffic accidents originate from drowsiness, while in England 20 % of all traffic accidents are produced by drowsiness [8], and in Australia 1500 million dollars has been spent on fatalities resulting from this problem [9].

Drowsiness or sleepiness can be described as a biological state where the body is in-transition from an awake state to a sleeping state. At this stage, a driver can lose concentration and be unable to take actions such as avoiding head-on collisions or braking timelessly. There are obvious signs that suggest a driver is drowsy, such as:

- Frequently yawning
- Inability to keep eyes open
- Swaying the head forward
- Face complexion changes due to blood flow

2. PROCESS FOR DROWSINESS DETECTION

Facial features like eye state, head movement, blinking rate and yawning might be extracted by the means of a camera to work out the behavior patterns that are liable for drowsiness detection. After extracting the countenance from camera feed, further processing is applied to work out the extent of drowsiness, typically by applying machine learning techniques like Support Vector Machines (SVM), Convolutional Neural Networks (CNN) or Hidden Markov Models (HMM). These techniques are trained using features and labelled outputs to create models which will be used for drowsiness prediction. The foremost challenging part of this process is finding a large dataset. This is often a specific challenge due to security and confidentiality issues that arise when publishing datasets for tutorial and commercial use.

Machine Learning Approach

Image Classification is a supervised machine learning problem. In this problem we define a set of target classes and train model to recognize them used labeled example images. Some of the most commonly used machine learning algorithms in image classification are:

1) Logistic Regression: Logistic Regression is a type of binomial regression which estimates the parameters of a logistic model and is used when the dependent variable is dichotomous. It is used to deal with the data that has two possible criterion and relationships.
2) Decision Trees: Decision tree builds classification models in a tree structured method. Images are split into smaller and smaller subsets according to a certain parameter and at an equivalent time a decision tree is incrementally developed. The ultimate result is a tree with decision nodes and leaf nodes The top most decision node in the tree which corresponds to the best predictor is called the root node. This algorithm could be used for both categorical and numerical data.
3) Random Forest Classifier: Random Forest (RF) are an ensemble learning method for classification by constructing multiple decision trees at training time and outputting the classification prediction of individual trees.
4) k-Nearest Neighbor: It is a supervised machine learning algorithm that relies on labelled input data to learn a function that produces an appropriate output when given a new unlabeled data. The KNN algorithm assumes that similar things exist in close proximity. It basically forms a

cluster of similar objects in a dataset and these clusters can be used to classify the images.

Deep Learning Approach

Deep learning algorithms work well with Image data-sets due to the use of Convolutional Neural Network (CNN) as opposed to that of Machine learning algorithms.

1) Convolutional Neural Network (CNN): CNN is majorly used for Image Recognition, Image Classification, Object Detection and Facial Recognition. CNN image classification takes an input image, processes it and then classifies it into different categories. Computers see an input image as array of pixels which is partially dependent on the image resolution. Based on the Image Resolution a matrix of grayscale images is created. Each image will pass through a convolutional layer with filters(kernels), pooling, fully connected layers and then SoftMax function is applied to classify an object with probabilistic values ranging between 0 and 1.
2) YOLO: The YOLO model samples the image just once and after sampling the image is processed and modified on any predesigned network. After this several layers with the help of an appropriate activation function provide a feature map. These fully connected layers and dimensional changes are used to obtain a tensor.

3. DATASET

MRL Dataset

MRL eye dataset is a large-scale dataset of Human eye images. This dataset contains infrared images in low and high resolution all captured in different lighting conditions with varying intensities and by using different devices. The dataset is suitable for testing several features or trainable classifiers. In order to simplify the comparison of algorithms, the images are divided into several categories, which also makes them suitable for training and testing classifiers. [10]

Properties

The properties of this dataset are as follows:
• subject ID: In the dataset, we collected the data of 37 different persons (33 men and 4 women)
• image ID: The dataset consists of 84,898 images
• gender [0 - man, 1 - woman]: The dataset contains the information about gender for each image (man, woman)
• glasses [0 - no, 1 - yes]: The information if the eye image contains glasses is also provided for each image (with and without the glasses)
• eye state [0 - closed, 1 - open]: This property contains the information about two eye states (open, close)
• reflections [0 - none, 1 - small, 2 - big]: We annotated three reflection states based on the size of reflections (none, small, and big reflections)
• lighting conditions [0 - bad, 1 - good]: Each image has two states (bad, good) based on the amount of light during capturing the videos
• sensor ID [01 - RealSense, 02 - IDS, 03 - Aptina]: At this moment, the dataset contains the images captured by three different sensors (Intel RealSense RS 300 sensor with 640 x 480 resolution, IDS Imaging sensor with 1280 x 1024 resolution, and Aptina sensor with 752 x 480 resolution) [10]

4. PREVIOUS WORK ON DROWSINESS DETECTION

Various measures are used in different studies for detecting a face and extracting features from the video feed. Unfortunately, most of these studies use differing datasets that may favor their own algorithms. This is due to the lack of standardized datasets that can be used as a benchmark.

As a result, it is hard to compare approaches by simply evaluating reported accuracies. Machine learning techniques to classify different levels of drowsiness are now discussed, along with a review of measures that form a driver drowsiness detection system.

1) Support Vector Machine (SVM)
Support Vector Machine (SVM) is a supervised machine learning algorithm which can be used for both classification and regression problems. However, it is most widely used in classification problems.
2) Hidden Markov Model (HMM)
Hidden Markov Model (HMM) is a formal foundation for making probabilistic models for linear sequenced labeling problems. It provides a conceptual toolkit for building complex models just by drawing an intuitive picture.

Author	Year	Metric	Classifiers	Accuracy
L. Pauly and D.Sankar [11]	2015	Eye State	HOG and SVM	91.6
A. Punitha et al. [12]	2014	Eye State	SVM	93.5
Zhang et al. [13]	2015	Eye State	HMM	95.9
Y. Sun et al. [14]	2013	Eye Blink	SVM and HMM	90.9
K.Dwivedi et al.[15]	2014	Visual Features	CNN with softmax	78

Table - 1: Previous Work

5. PROPOSED SYSTEM

The system would gather the images from webcam and feed them into a Deep Learning model. The approach we will be using for this project could be as follows:
1) Take image as input from a camera.
2) Detect the face in the image and create a Region of Interest (ROI).
3) Extract various features from the ROI and feed it to the classifier.
4) The Deep Learning framework will classify the features to train and further test the model.
5) Calculate score to check whether the person is drowsy and

display the Percentage of Drowsiness.

6. CONCLUSION

There are many techniques that support behavioral methods where machine learning will be utilized for driver drowsiness detection. This paper presents a survey of approaches for drowsiness detection using machine learning and deep learning techniques and discusses the range of features and measures used for classification. This paper also proposes a drowsiness detection mechanism using deep learning approach.

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