DESIGN AND IMPLEMENTATION OF A DROWSINESS DETECTION SYSTEM USING TRANSFER LEARNING.

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ABSTRACT

***In recent years, the casualties of traffic accidents caused by drowsiness have been on the rise. In particular, heavy cargo trucks and high-speed bus accidents during driving in the middle of the night have emerged as a severe social problem. Drivers' drowsiness can be attributed to many factors such as long hours of driving and sleep deprivation. As a result, drivers tend to lose control of the vehicle gradually, and if consciousness is not regained in time, they may drift off their lane and crash into another vehicle. To prevent such a mishap, there should be a way to help drivers gain consciousness when dizzy. This paper proposes a method to detect drowsiness at its early stages by studying behavioral patterns such as opening and closing eyelids. The proposed system uses a camera that points directly to the driver's face. The proposed algorithm captures and isolates the eye regions and passes them through a trained machine learning model that checks if the eyes are opened or closed. If the computation output proposes that the driver is drowsy, an alarm alerts the driver. After implementation, the results reveal that the proposed detection technique used has good accuracy, with low processing time and error rates [Fig 2 is a diagram of the result]. In addition, the proposed approach detects drowsiness in its early stages without raising any false alarm.***

# INTRODUCTION

The National Highway Traffic Safety Administration (NHTSA) statistics show that about 2.5% of fatalities during a crash are attributed to drowsy driving [1]. In 2015 alone, the total number of crashes related to drowsy driving was over 72,000. Remarkably, vehicle crashes caused by impaired driving are much more frequent than those caused by intoxicated drivers [2]. As nearly as 1.4 million people die on the road every year, making it the 7th global cause of death in 2016 [3].

Real Time Drowsiness behaviors related to fatigue are in the form of eye closing, head nodding, or brain activity. Hence, we can either measure change using physiological signals, such as brain waves, heart rate and eye blinking to monitor drowsiness. We can also consider physical changes such as sagging posture, leaning of driver's head and open or closed state of eyes. While more accurate, the former technique is not realistic since highly sensitive and complex technologies would have to be attached directly to the driver's body, which can irritate and distract the driver. In addition, long hours of working result in perspiration or sweat on the sensors, weakening their ability to monitor accurately.

The vehicle-based method is another technique used in drowsiness detection. This method assesses the driver's driving performance by analyzing the capabilities of the driver and the way they control the vehicle. The measurements are taken by placing sensors on various components of the vehicle – the steering wheel and the acceleration pedal. The signals sent by these sensors are then analyzed and used to evaluate the level of drowsiness. The standard deviation of lane positions and the steering wheel movement are the two most frequently used vehicle-based techniques. A significant limitation of this method is that variations in steering wheel movement mostly happens in the penultimate phase of drowsiness after it is almost impossible to stop an accident from occurring.

Another technique used in drowsiness detection is the Subjective method. With this method, drivers are personally allowed to estimate their level of sleepiness, after which various tools are used to translate these estimations to a measure of drowsiness [4]. There are various scales used in the translation. The generally used sleepiness scales are the Stanford Sleepiness Scale (SSS) and the Karolinska Sleepiness Scale (KSS) [5] [6].

For the work described in this paper, we adopt a subset of the behavioral method of driver drowsiness detection. This method measures physical changes (i.e., open or closed eyes to detect fatigue), which is a very good use case since it is non-intrusive by using a video camera to detect changes. In addition, micro sleeps that are short periods of sleep lasting 2 to 3 minutes are good indicators of fatigue. Thus, by continuously monitoring the driver's eyes, one can detect the sleepy state of the driver, and a timely warning is issued. The driver is alerted with a mild alarm to gain consciousness in a less abrupt manner to prevent shock from waking up suddenly from one's sleep. Sound frequencies between the range of 400 and 520 Hz is most effective for waking hearing-impaired sleepers [7].

The traditional approaches involving the use of behavioral methods come with many limitations, including poor detection of eye positions. These methods make use of some mathematical calculation in other to get the positions of the eyes. These calculations involve the use of the eye aspect ratio, this is done by computing the Euclidean distance between the two sets of vertical and horizontal eye landmarks. This approach fails because sometimes the computations come with inaccuracies which results in false alarms [8]. These drawbacks led to the adaptation of Machine Learning techniques for drowsiness detection.

Machine Learning approaches have been used over the years as an efficient means of classifying data [9]. These approaches are divided into three broad categories, depending on the nature of the "signal" or "feedback" available to the learning system. These are Supervised Learning, Unsupervised Learning and Semi-supervised Learning. Supervised Learning makes use of labelled datasets. The labels give information on what to expect at the end of the classification. Unsupervised Learning has no labels; therefore, features and correlations between flows are used to predict the kind of class for the dataset contents. Semi-supervised Learning falls between unsupervised Learning and (without any labelled training data) and supervised Learning (with completely labelled training data).

Transfer Learning is a machine learning method where pre-trained models developed for a particular task are used as a starting point for a model of a similar task. For instance, when training a classifier to determine whether a picture includes a car, the knowledge gained during training can recognize a motorcycle. The general idea behind transfer learning is to use the data a model has been trained with from a task with a lot of available labelled training data and apply these data in a new task that doesn't have much data. Transfer learning is primarily used in computer vision which makes it well suited for this project. Various deep learning classifiers used for transfer learning include AlexNet, MobileNetv2, VGG19, and LeNet5. For this paper we used the GoogleNet classifier.

GoogleNet is a 22-layer deep convolutional neural network that is a variant of the inception network which was developed by researchers at Google. The GoogleNet architecture presented in the ImageNet Large-Scale Visual Recognition challenge 2014 (ILSVRC14) solved computer vision tasks such as image classification and object detection. Today GoogleNet is used for other computer vision tasks such as face detection and recognition and adversarial training etc. [10]