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DriveGuard: Driver-Drowsiness Detection Using Convolution Neural Networks

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Abstract* – India has reported a massive number of over 151,000 fatalities in 2019, with youth being involved in almost 70 percent of the road accidents. This research paper is based on the study of "DriveGuard" . The main objective ofthis paper is to create a drowsiness detection application, automatic for handling the drowsy driver detection problem. It is recommended for travelers who avoid regular breaks in between their travel and hence mightsufferfromdrowsiness. DriveGuard assistance can make the driver aware of his/her state and avoid carelessness in long extended drives. The paper focuses on the signs of drowsiness while driving that can be observed and hence how Kotlin based DriveGuard can be used to detect and prevent road accidents. Physical signs such as the inability to keep eyes wide open, frequent yawning, extending the head forward, can indicate driver fatigue and serve as early warning signs for potential accidents. By detecting these signs,measures can be taken to prevent accidents, saving lives and reducing the number of fatalities on the road.

Keywords: Drowsiness, Drowsiness Dataset, GPS, CNN, Deep Learning

1. INTRODUCTION

Humans tend to pursue carelessness and try to recover from these mistakes ultimately with the use of technology. Hence they created cars, Planes etc. just to overcome difficulty of mode of transportation. However, there are some guidelines that need to be abided while taking control of these machines and gaining access to them. The priority of saving drivers and passengers on the road is an ever growing need in the wake of high number of fatalities caused from road accidents in recent years. Driver drowsiness has been identified as a leading cause of road accidents, identifying the following signs: such as the inability tokeep yourself wide awake, yawning, inability to keep head straight, all those being common indicators of driver fatigue [1].To overcome this problem, this application focuses on identifying the signs and tackling driverdrowsiness that can be observed on all face shapes while driving and how they can be used to prevent road accidents[10]. Earlier, drowsiness applications were primarily directed towards logistics-based firms such as Amazon in the US. However, many drivers had registered for a complaint about the unauthorized access of their privacy when such monitoring systems were used. As of now , this paper aims to make the overall software less intrusive and asystem to monitor eye movements[2]. This allows for a more low-key system for drivers, ensuring that they feel at ease while driving. Additionally, the paper will make use of the driver's own phone as the source of data input, making the system even more accessible and user-friendly. Through this paper, our goal is to contribute to the development of safer roadways and reducing the number of accidents caused by driver drowsiness [3]. By detecting early warning signs of fatigue, our objective is to prevent accidents and prevent life loss. Additionally, by creating an application that is less intrusive and more low-key user-friendly,we aim to encourage wider acceptance of such systems, leading to safer roadways for everyone. Driver fatigue is a major cause for road accidents and mis-happenings and thus has huge ramifications for accident prevention [9]. Most damaging mismanagements might get prevented if the drivers were alerted on time. Driver Drowsiness is one of those situations that need to be avoided at all cost . A lot of scholars have studies written articles on driver sleepiness recognition, so , to improve the quality of our application, we have developed this software using new technologies using Machine Learning and Kotlin.

2. OBJECTIVE

Road accidents are a major cause of deathsworldwide. In Asian countries like India where there is a lack of proper infrastructure for roads more accidents take place. A major reason for this is fatigue and drowsiness among the operator . A drowsy driver not only puts his own life at risk but also the life of fellow passengers. In this paper, we have attempted to detect the drowsystate of a driver and trigger a buzzing alarm upon detection.The first couple signs of lethargy can be analyzed by using cameras, face tracking sensors, and other inbuilt equipment. Most primitive methods that were used required surveillance by high cost sensors for time to time detection. Therefore, in thiscase, we have developed, a real time , low-cost, accident prevention system using Deep Learning and Android App Development. The system captures driver's face in every image array by using image processing techniques. The software is reliable for checking the facial attributes of eyes and mouth, whether they are open or closed. The DL module and methods have been implemented in the proposed approach to check for high efficiency.Observations revolving the application present that the android model was able to achieve correctness of up to 95% using CNN- based algorithms.The system not only employs DL but also smart sensors such as accelerometer to confirm the state of the driver. In case of any mishap, GPS is used to coordinate the exact location to emergency contacts and any nearby resting places and hospitals. The overall objectives include

Detecting Driver Drowsiness using Object detectionfor classification, implementing AI Technologies like, OpenCV, Convolution NeuralNetwork (CNN), Tensorflow, Keras etc., detecting vehicular crash via Motion Sensors, Employing a Software by building an Android app using Kotlin, detecting critical information and forwarding to a given Emergency Contact , detecting Real-time GPS location of driver and sending in the automated critical report.

3. LITERATURE SURVEY

Driver drowsiness is considered a leading cause of road accidents and fatalities, with studies suggesting that upto 20% of all crashes are caused by driver fatigue (National Safety Council, 2020). Various methodologies have been proposed , including monitoring eye movements, heart rate, mouth movement for yawn and vehicle control patterns[6][7] .Face landmarking technology, CNN, shows promising results in detecting drowsiness, as it can recognize changes in blink rate and the gaze direction (Kim et al., 2018)[4]. Driver control pattern analysis, such as the steering wheel pattern movement, can also provide useful indicators of driver drowsiness (Drowsy DrivingPrevention, n.d.)[5]. The usage of software-based geolocation, accident reporting systems has become increasingly usual in recent years, with latest tools such as Google Maps and Waze that supply real time notifications in case of accidents and road closures .Advanced accident reporting applications survive using AI and machinelearning algorithms and possess the potential to improve their response times and reduce fatalities, as they can analyze data from multiple sources to predict and prevent accidents (Larson et al., 2019). However, privacy concerns over data and its security have a direct correlation to these applications, and further research in depth is needed to ensure the safety of clients and users and the overall ethical implementation (National Institute of Standards and Technology, 2018). Overall, the advanced development andadoption of driver drowsiness detection systems possess the potential to significantly reduce the number of road accidents and fatalities, saving countless lives and improving the safety by warning verbally and visually[8]. Contemporary research and development in this area is crucial for ensuring that these applications are effectively safeguarding for drivers. The application will then capture data by tracking the drivers eyes using the device's inbuilt camera. By constructing the algorithm, the symptoms of lethargy and fatigue can be checked early on to avoid the mishap. When the gestures or signals of fatigue have been identified output in the form of buzzer sound is provided to alert the driver. Alert message will then be deactivated manually by the user , rather automatically.

4. SCOPE OF WORK

The system can be made more accurate using various other parameters such as current State of the Car, presence of foreign substances on the Face etc. It can be further used to develop an IOT device that can be installed in the carto detect driver's drowsiness. Various other models and methods have been used for several other use cases such as Hotstar, Netflix and other streaming serviceplatforms that can check whether the person is sleeping or in a state of being drowsy and hence pause the stream/show accordingly.

5. RESEARCH METHODOLOGY

The drowsiness study applies a research based methodology to analyze the tasks faced by the drivers on roads. A traffic accident investigation report is mostly dependent on the regular work that goes into Recruitment process. Observations and perceptions are usually generated through subjectiveself-reporting and the recruiter's personal work familiarization. A literature review of various popular research papers, articles, blog posts, websites, and survey papers was done to verify the authenticity of the problem faced, check into its presence and to come up with a desired goal in mind to solve the specified problem in road accidents across the globe. Observational studies of drivers were conducted to evaluate the driver behavior and their response to different stimuli while driving. The data was collected as mentioned in research papers and it was then analyzed using both qualitative and quantitative methods. Qualitative data analysis involved coding and categorizing data to identify themes and patternsin the data. Quantitative data analysis involved statistical analysis of numerical data to identify relationships and correlations between variables and how we further set them up.

5.1 SECONDARY DATA SOURCES

It consists of information collected through blogs, journals, presentations, magazines, published articles and other media.

5.2 LITERATURE REVIEW

The research methodology for this paper involved a multi-disciplinary approach that combinedliterature review, data analysis, implementation andevaluation of drowsiness detection techniques.

6. MATERIALS AND METHODS

We have built the DriveGuard using Python Libraries : Numpy , Pandas , os ,cv2, Keras , Input, Lambda , Dense functions etc. and built the Kotlin application for the respective Machine Learning model. We hence classified the datasets using Library classification report and predicted the data as :1)-yawn 2)-No_yawn 3)-Closed 4)-Open

The Training dataset was fetched from Kaggle as the "drowsiness-dataset". The dataset was a collection of images. For the development of Kotlin Application we have used Android Studio IDE. Various classes such as GraphicOverlay and CameraSourcePreview have been defined and used for overlaying and processing the Facial Features onto theMobile Screen and by taking the Graphics into consideration and calculating the facial array points. "LocationService" is used to fetch the location whenever slightest collision is observed or detected, "MainActivity" is used to display the Alert message onto the screen , face is detected and start the camera for facial detection."FaceGraphic" is used to mark the facial ID and the facial ratio and position."CrashDetector" is used to manage the sensors and the accelerometer and thus detect the collision.
A) Eye detection : Eye Aspect ratio can be calculated by the duration and movement of eye ,blinking , and considering the width and height.

B) Yawn Detection : The distance between the upper lip and the lower lip, and the feature points of inner lips are calculated, if it is greater than the threshold distance or fulfills the specific aspect ratio , then yawning is detected. In case, if it is less than the expected threshold, no such data gets acquired as output and no yawn will be detected.

Ambient light sensor: This sensor calculates the amount of light from the environment. The camera uses this information to adjust its settings, to capture better images in low-light conditions, using shutter speed and aperture.

7. SYSTEM REQUIREMENT SPECIFICATION

The established application must be capable of identifying and recognizing fatigue given by a real-time driving environment. The performance of the software will solely depend on the quality of the camera lens. The proposed application must be neatly produced and should be easy to use in day and night as well. The application should be able to get deployed whenever we want. It is necessary for the driver to meet the set guidelines.The application must be able to get re-evaluated and recovered in case of damage or accident and should be ready to use after its repair and proper handling.

7.1 PROCEDURE

The process starts with capturing live feed from the camera. The live feed images are then fed to the deep learning model where CNN based algorithm is employed to detect eyes opening and yawning. Simultaneously the accelerometer will also be deployed to check the driver state. In case of Drowsiness, the driver and the passengers would be alerted by an alarm buzzer followed by a notification in case of collision.

7.2 DL MODEL

We picked up the "*Drowsiness_dataset*" from "Kaggle.com" . The data consist of 2900 images belongingto four broad classes – closed eyes, open eyes, yawn ,no_yawn. This will add into our training dataset.

Procedure that was followed:

Images were converted to greyscale for ease of processing. Then their size was made into 128*128 and were converted into numerical features. Lenet-5 model - one of the smallest CNN architectures with some minor modifications was deployed for the job at hand. Being one of the smallest models, it is faster to act and hence reliable during live detection. Total of 50 epochs were run and Adam optimizer was used .

7.3 LENET-5 ARCHITECTURE

Lenet-5 ,being one of the most primitive and pre-trained models, was proposed in the year 1998. Its CNN architecture is based on 7 layers. Its architecture is used for recognizing the handwritten digits , symbols, alphabets and other typed characters. The main cause behind the influence of this model was its basic ,practical and straightforward structure. It is a multi-layered convolution neural network(CNN) for implementing binary image classifiers, "Yes or No". The network consists of 5 layers of learnable parameters .It has three sets of convolution layers, two subsampling layers and two fully connected layers with a combination of average pooling. There are 2 more layers within the network, flatten layer and dense layers. At last, there is a Soft-max classifier ,an activation function, utilized to derive distribution. Hence the core components of Lenet-5 signify the overall emergence of CNN.IMPORTANCE OF LENET 5

LeNet-5 helps classify the handwritten digits of accountbooks like Journal entries, ledger, and others for day by day entry. However, overfitting might be one of the disadvantages of Lenet-5 , CNNs are the epitome of present day deep learning modelling and is primarily based on computer vision. A CNN absorbs an input array or an input image, it is assigned importance within the image and is able to differentiate among those varied aspects/objects. Most of the architectures defined under convolutional layers take up a single shape or another. LeNet is essential and effective because of its structure, basic, practical and straightforward. Earlier when it was not invented, OCR (Optimal Character Recognition)was performed with the help and support of feature engineering by the manual hand, accompanied with the aim of using a machine learning models to find ways to classify properties derived from various algorithms in an image.

7.4 USE OF SENSORS

7.4.1 GPS MODULE

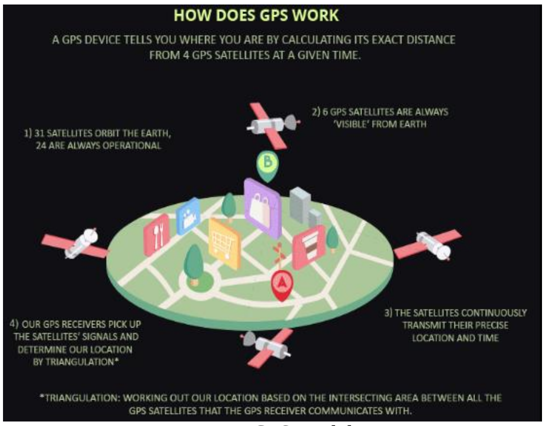

Fig 1: GPS Module

The GPS module transmits signal over radio frequencies and is used to track the driver's location. It consists of Location , Navigation, Mapping attributes to detect the latitude and longitude of any area on the Earth for that date and time using a satellite. In our application, the accident location can be easily detected and the location is traced back using it.

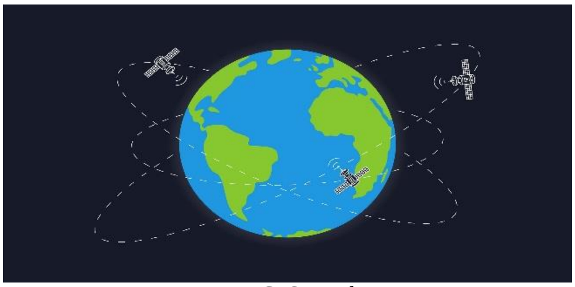

Fig 2: GPS Interface

7.4.2 ACCELEROMETER

An accelerometer present in the mobile device can be used to detect accidents.

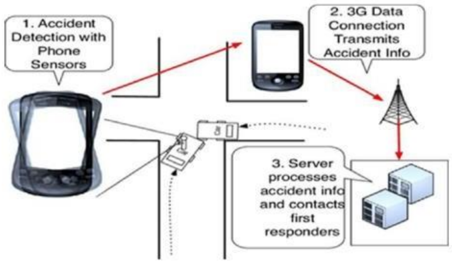

Fig 3: Motion Detection using Accelerometer

Accelerometer can be used to detect sudden changes in the motion of the device, which is sudden retardation due to a possible collision or contact. When an accident occurs, the device will immediately trigger a 5 sec alert in order to eliminate false positives. Post 5 sec window ,an accident alert will be issued to the concerned connections or authority figures with the GPS coordinates of the device.This will ensure the alert is issued even if the front screen breaks.

7.5 ANDROID APPLICATION

The empirical part of the overall procedure is the technology that is used to register the image data and send it for pre-processing and augmentation. As depicted in Fig.16-19, the Kotlin mobile application takes pictures of the driver while driving. This image is analyzed using the Dlib library. Dlib library consists of machine learning algorithms and tools for creating complex face detection applications . Its open source libraries allow us to use the application free of cost. Dlib along with OpenCV and Numpy with the Java Native Interface (JNI) transmits the image information from the native Android application which is programmed in Kotlin. The Dlib is a C++ library that consists of object-tracking, face-detection and face recognition functions. When we receive the image data, we extract the facial landmarks and the data gets sent to the above developed CNN model. To further make this application practical for the drivers, there are few additional features for theirassistance and safety:

a) There is a 5 second timer for the driver to confirm if he is actually languid or not. After the 5 second timer his correct location is sent to the emergency contacts or any other authoritarian figures. This might help in saving his precious life.

b) The android Kotlin application accesses the phone's inbuilt GPS and accelerometer sensor. These sensors, as demonstrated above, will eliminate any false positives found in the results of the algorithm.

7.6 DROWSINESS DATASET

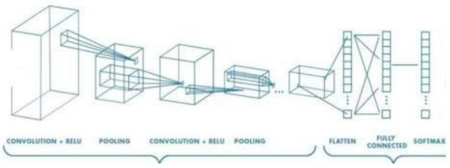

Fig 4: CNN Model Overview

Drowsiness dataset has been picked up from Kaggle.

- This dataset consists of 2900 images belonging to class – closed, open, yawn, no yawn
- Images in greyscale and of size 128*128 converted into numerical features
- Classes to predict – 2
- Classes – closed, open, yawn, no yawn

8. EXPERIMENTAL RESULTS

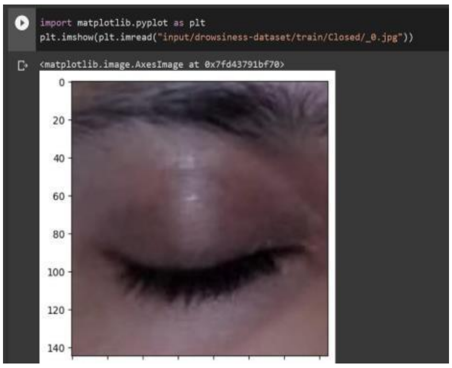

Fig 5: Data Visualization – Closed eye

Fig 6: Data Visualization – Open mouth

Fig 7: Pre processing of data- Yawn and no_yawn

Fig 8: Pre-processing of data- Closed and Open eyes

Fig 9: Splitting and training Data

Fig 10: Data Augmentation

Fig 11: Model Architecture Code

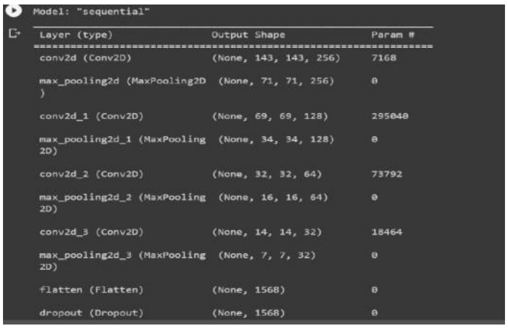

Fig 12: Model Architecture Output

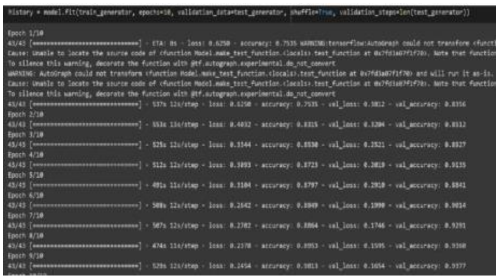

Fig 13: Loss and Accuracy Output

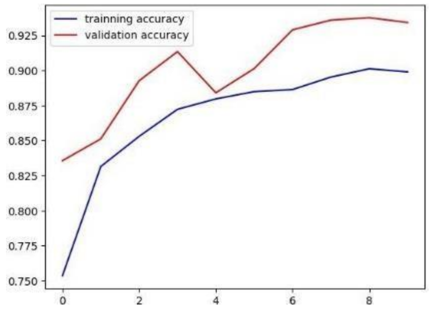

Fig 14: Epoch vs Accuracy Graph

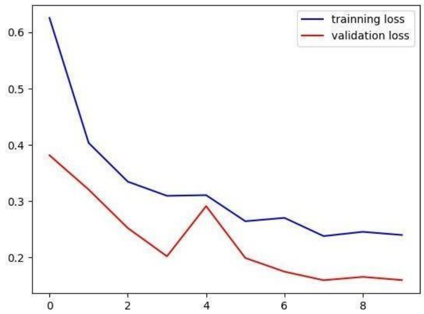

Fig 15: Epoch vs Loss Graph

8.1 Android App Demo:

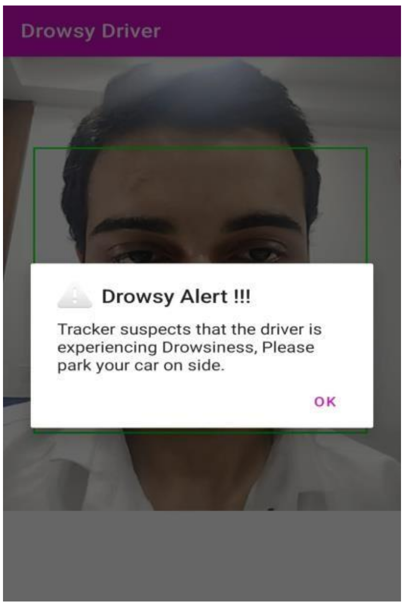

Fig 16: Drowsy Alert

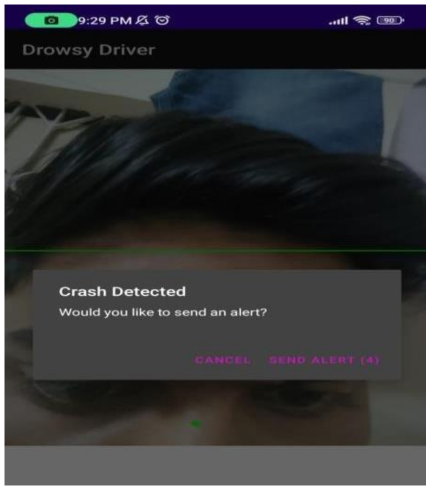

Fig 17: Crash Detected

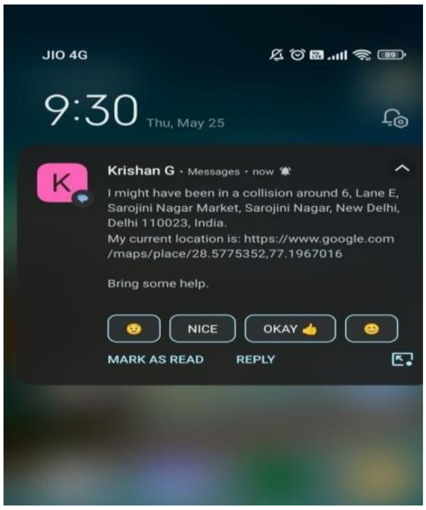

Fig 18: Collision Notification

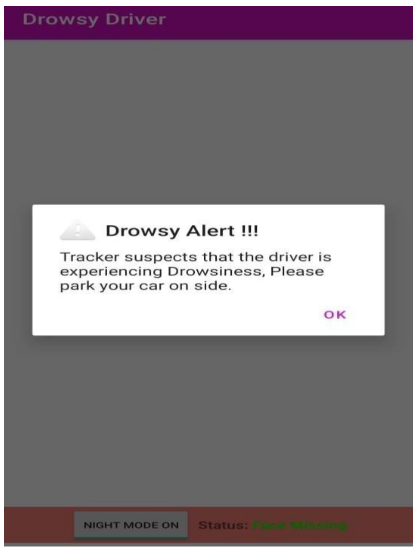

Fig 19: Night Mode On

Training CNN Model on drowsiness data. Combination of convolutional, max pooling layer, linear layer and activation functions is used to create a sequential model.

Classes : [“yawn”,”no_yawn”,”Closed”,”Open”]

Loss used - Categorical cross entropy loss Optimizer

– Adam. Accuracy metrics used for calculating accuracy Accuracy Testing using Accuracy metrics. Plotting of accuracy and loss graph with Matplotlib against epoch.

9. LIMITATIONS

The Kotlin application seeks delivery on a large scale, however ,it requires lot of computational power and lot of data management to achieve higher accuracy results. The model might seem to be disadvantageous in the matter of Overfitting. To achieve better results, a good-quality camera would be suggested , as drivers would have to be at the frontal part of the camera most of the times ,for real-time capture and must have continuous power and signal strength for time to time monitoring of the user.

10. RESULT AND DISCUSSION

The lethargy and irresponsible behavior of drivers has caused countless casualties on the road. Driver drowsiness is a very likely problem that has ruined lives and its consequences can be disastrous. It has impaired judgement and reasoning of drivers at the last moment, leading to fatal traffic accidents. Hence, alarm buzzer gets activated as soon as drowsiness is detected to wake the driver. Notification feature is added whenever a collision is detected , just to make sure the driver gets located to a safe destination.

11. CONCLUSION

DriveGuard,a real time,affordable driver-drowsiness detector has been developed using Kotlin Android Application on the basis of facial behavior such as eye detection and yawn detection by capturing real time facial data. DriveGuards’s eye detection technology tracks the movement and behavior of the driver’s eyes. The identified facial features on the basis of how prolonged the eye closure is and how erratic the eye movement is , which are clearly indicative of the fatigue. By providing real time monitoring alert , DriveGuard aims to prevent potential accidents. With Kotlin’s powerful capabilities and the CNN’s facial detection this innovative application offers an effective solution for combating driver drowsiness in real time.

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