An Intelligence System for Taxi-Driver Wellbeing

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ABSTRACT
With the current development of technology, smart mobile phone is widely used as a method of observing human behavior. With the taxi drivers on roads, the amount of road accidents have also increased. Automation is crucial as the random nature of the above-stated incidents. As the goal of this research, a novel approach, a mobile phone based taxi driver wellbeing monitoring system that is capable of automatically detecting drowsiness, emotional misbehavior and high speed driving is proposed to implement using Machine Learning. This document provides an outline of the proposed system and a summary of outcomes authors have achieved when training appropriate machine learning models to work with real-time data. Systems' functionality includes identifying human sleepy eyes, irrational emotions and high speed using the mobile device.

General Terms
Taxi driver safety, Mobile application for taxi drivers

Keywords
Machine Learning, drowsiness detection, emotion detection, mask detection, taxy

1. INTRODUCTION
Road traffic accidents are horrible events that occur all over the world. Heavy vehicle road accident studies have been done, although these studies have primarily focused on the circumstances or results of the incidents rather than safe vehicle operation. In the literature, factors such vehicle characteristics, driver training, speed judgment, amount of drug or alcohol intake, hours of driving, health, driving stress and coping, and financial situation have all been studied. Drowsiness and emotional high-speed driving are two of the most common causes of taxi driver accidents.

Several strategies for detecting drowsiness have been tried in the past. One way is to collect data with physiological sensors like EOG (Electrooculography), ECG (Electrocardiography), and EEG (Electroencephalogram). EEG signals offer information about the activity of the brain. It necessitates the attachment of numerous sensors to the driver's body, which may be inconvenient. Non-intrusive approaches for bio-signals, on the other hand, are far less exact. Face feature extraction is the basis for a computer vision technique. And how Neural Network approaches have made incredible results in the area of sleepiness detection. Furthermore, because the model size is typically enormous and needs a high level of computing complexity, integrating these techniques into practical applications on embedded systems is still difficult.

In today's world, a mobile phone is a need. Apart from making phone calls, mobile phones are utilized to meet a variety of consumer needs. Sensors on mobile devices can be utilized for a variety of applications. To meet their requirements, many apps, particularly social media apps, utilize the front and rear cameras in smart phones. The smart phone has become a required item among taxi drivers, particularly among Uber and PickMe drivers in Sri Lanka. Because of the widespread use of Google Maps, the majority of taxi drivers also use their smartphones. Nowadays, using a cell phone to identify the driver's condition is an effective and practical way.

RatebJabbara, Khalifa Al-Khalifaa, Mohamed Kharbechea, WaelAlhajyaseena, Mohsen Jafaric, and Shan Jiangc employed the Dlib library, which employs OpenCV's built-in Haar feature-based cascades to recognize facial landmarks, in their research published in 2018. Sed Multilayer Perceptron Classifier was also utilized as an algorithm.

JH Hong [2] described an in-vehicle sensing platform that employs smartphone maneuvering and steering wheel movement rather than large devices or pricey systems. They used this information and machine learning to create a driver model that assesses drivers' driving behaviors based on a variety of driving-related variables, as well as a study of aggressive drivers' traits. Those drivers were categorized using their model.

DA Johnson [3] has developed a unique system (MIROAD) that employs Dynamic Time Warping (DTW) and smartphone-based sensor fusion (accelerometer, gyroscope, magnetometer, GPS, video) to detect, recognize, and record these events without the need for external processing. It keeps track of driving events but not sensor or video data unless a potentially hostile occurrence is recognized.

High-speed driving is responsible for a significant number of accidents not only in Sri Lanka but throughout the world.

Two machine learning models that combine acceleration and speed into an erratic driving detection system are presented by Zeeman, A.S., and Booysen, M.J. [4.] The first model is based on passengers' experiences and collected data, and it was produced after evaluating empirical results. To construct a speculative erratic driving detection model, the second model uses design standards that are usually employed primarily in road design. The research given by Akhtar, N., Pandey, K., and Gupta, S. [5] examined driving behavior in the areas of acceleration/deceleration, lane changes, and road abnormalities. To identify driving habits and road conditions, smartphones use accelerometer and GPS sensors. The data from the sensors is evaluated and processed here using a fuzzy system under certain conditions. After that, an alert is generated based on the output. Finally, if the driver exceeds the safety limitations, an alarm is generated depending on the output.

In Sri Lanka, there are many taxi driver communities, yet there are little safety systems for them. The primary goal of this study is to create a mobile app to protect taxi drivers from drowsiness, illogical behavior, and high-speed collisions. While doing that, researchers did not forget to add a feature to remind the drivers to wear their mask in this Covid -19 pandemic years.

2. METHODOLOGY

The research is mainly about detecting the drivers' behavior through the mobile phone front camera. So the researchers collected the information from the taxi drivers about the types of smart phones they use, and the angle of they place their phones while they drive.

In this research, researchers chose Android-based cell phones as the platform for this research because of the majority of the taxi community tend to use android platform. Also, Android operating system is free, open source, easy to program, and is expected to quickly become a dominant entry in the smartphone marketplace.

From the data collected, following images shows the angle of the driver that is captured by the front camera.

Fig 1: Mobile view angle

Then a dataset of images were collected from the taxi drivers to which the researchers needed to train their models.

2.1 Detecting driver's behavior

After doing some background research, researchers determined to use Tensorflow as the machine learning library. TensorFlow is a machine learning and artificial intelligence software library that is free and open-source. It can be used for a variety of applications, but it focuses on deep neural network training and inference[1][8]. A Tflite model was created using Teachable machine [6] by uploading the

Dataset, training the images and exporting the Model by converting to a tflite package.

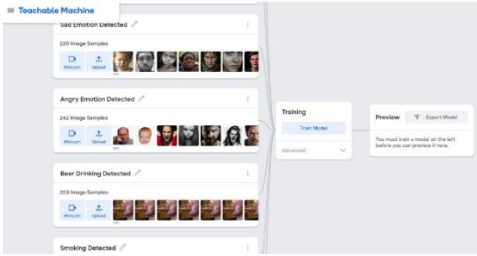

Fig 2: Teachable Machine

The mobile app was implemented in the Flutter language with Dart backend. First, implementing the code to load the camera when starting the application using imageStream.[7] When using the ImageStream, it is possible to access the camera image directly without the need to save it on the device.

Then, the researchers implemented the code to load the Model that was created at first by moving the model to the assets

folder and fetching the model.tflite file.

After that, implemented the code to run the model. After running the model it will get the camera captured images from Imagestream and adjust the image properties and match the image with the model and Labels that were inserted while training the dataset and get the output of the current captured Image Stream.

Finally, the implementation of the code to display the all the developments in a one window.

2.2 Alerting high speed

When implementing the speed meter the researchers have used flutter in-built components.

First, implemented the code for get the current stability of the mobile device by using sensors and calculate the speed by movement of the device.

There are three classes of sensor events, through three different streams.

AccelerometerEvents describe the velocity of the device, including the effects of gravity.

To put simply, you can use accelerometer readings to tell if the device is moving in a particular direction.

UserAccelerometerEvents also describe the velocity of the device, but don't include gravity.

They can also be thought of as just the user's effect on the device. GyroscopeEvents describe the rotation of the device.

Each of these are accelerometerEvents, userAccelerometerEvents, and gyroscopeEvents, respectively is exposed through a Broadcast Stream.

A Flutter plugin Accelerometer sensor mobile x y z axis was used to access the accelerometer and gyroscope sensors.

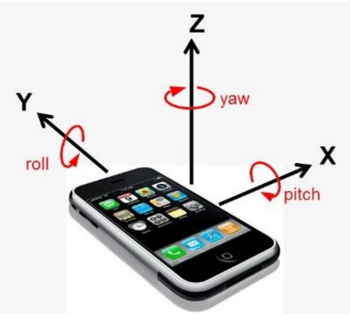

Fig 3: Mobile axis

AccelerometerEvent : used to describe the velocity of the device, which also include the effect of gravity in the mobile device, Flutter Accelerometer simply uses accelerometer reading and tell whether the device is currently moving and if moving then in which direction it's moving. UserAccelerometerEvent sensor: in function reads the velocity of the device but does not read the gravity.

GyroscopeEvent Reads the Rotations of the device. Gyroscope sensor a device that is used to know the orientation (portrait or landscape) and also the device angular velocity. Now, as we know basic about those sensor in our mobile device, let's begin implementation of Flutter Sensor Library.

Next step is implementing the code to draw the speed meter by using custom paint event in flutter. [9]

Finally, integrating all the developments and showing in a one window in the mobile device was done.

3. RESULTS AND DISCUSSION

After training the model with datasets researchers were able to make more than 90% of accuracy for detecting masks and considerable accuracy for detecting sleepy eyes and recognizing irrational behaviors.

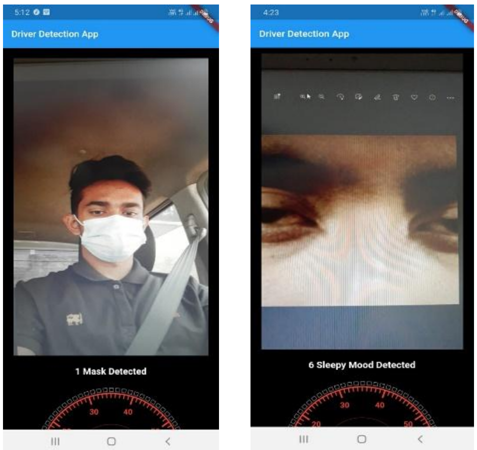

Fig 4: Mask and Sleepy mode detection

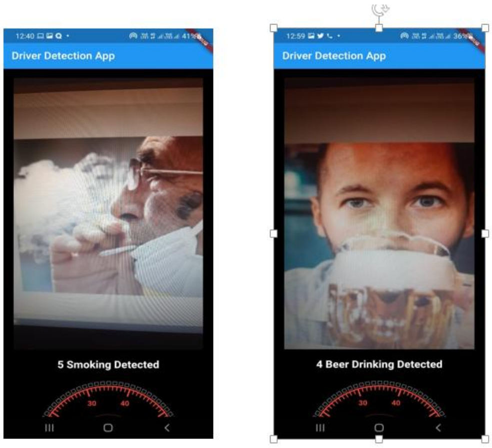

Fig 5: Smoking and Drinking

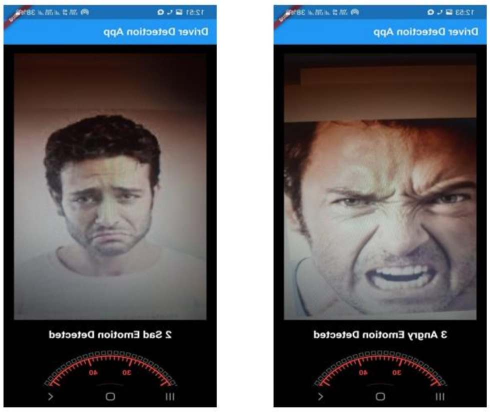

Fig 6: Emotional Change detection

As seen in Fig. 4, 5 and 6, the model is accurately identified relevant behaviors with minimum errors. The model reveals the finest accuracy as it trained with datasets that included various scenarios.

Researchers are currently working on transmitting the gathered data to the cloud use the cloud platform to improve the application in an efficient manner.

As for the speed meter, researchers currently implemented to alert the driver with a continuous vibration when he/she exceeds the speed limit.

4. CONCLUSION

This research study presents a solution to enhance the safety of Sri Lankan taxi driver community. Here it proposes an intelligent system that can detect drowsiness, emotional and irrational behaviors and check whether they are wearing masks. Researchers have discussed the current prevailing methodologies that exist within the country and how this research addresses the drawbacks. Through this research, paper authors have presented the importance of the usage of machine learning-based automatic detection utilizing the results of experimented algorithms to work with real-time data with higher accuracy. Hence, in conclusion, the proposed system will pave the way for efficient disaster management. Using the proposed methodology, the implementation of the system will be largely beneficial for the safety of the taxi driver communities like PickMe and Uber in Sri Lanka. Also, as a further development of this application can be done to run as a background application and generate real time alerts for the accident situations in the country.

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