Detection of Alcohol in Drivers Using Computer Vision through Analysis of Ocular Indicators

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Abstract - *India continues to have the most road fatalities in the world, with a total of 1,51,113 deaths in 2019 alone. Due to the fact that approximately 70% of them are solely due to drunk driving, concerns now arise as to whether these inebriating beverages are to blame for the tragic loss of so many lives. Bearing this in mind, the main objective of the proposed system is the detection of drunk driving and prevention of road accidents caused as a result of it. This project utilises Ocular Indicators and Image Processing Systems, coupled with an Ignition Interlock Device (IID) to effectively counter the global issue of drunk driving.*

Key Words: Drunk Driving, Image Processing Systems, Ignition Interlock Device, Ocular Indicators, Detection, Prevention

1.INTRODUCTION

Consumption of alcohol has been associated with several adverse impacts on the human body - causing neurotoxicity and detrimental consequences to the liver, the heart and the immune system. This is especially the case in modern society, as the level of alcohol consumption has significantly increased. However, apart from health effects, alcohol consumption can often lead to accidents on the road as well, resulting in injuries, trauma and deaths. Close to 28 million people around the world were booked for drunk driving in 2013 alone. This goes to show that driving under the influence of alcohol is indeed a global issue, and that there is definitely a necessity for innovation to solve this problem.

Consequently, in order to combat this problem, a few procedures are put to use in India by the traffic police taskforce, called the 'Field Sobriety Tests'. These tests are conducted when officers suspect certain individuals of alcohol intoxication. It includes a few simple physical and mental tasks to test for drunkenness in the individual:

Nystagmus Test: 'Horizontal Gaze Nystagmus' refers to involuntary horizontal jerking movements of the eyeball which occur when the eyes gaze in one direction at high peripheral angles. However, in individuals under the influence of alcohol, Nystagmus may occur at lesser angles. [0] Usually, if Nystagmus is observed before the gaze reaches an angle of 45 degrees, it might be indicative of BAC (Blood Alcohol Content) of over 0.05%.

Divided Attention Test: Here, the individuals suspected of intoxication are made to listen and follow basic instructions while doing simple physical exercises. The logic behind this is that intoxicated people will generally find it harder to divide their attention between these basic physical and mental tasks.

One-Leg Stand: In this test, the suspected individual is required to raise either leg 6 inches off the ground, with both their arms by their side. They are required to remain in this position for 30 seconds. During this duration, officers look for certain signs that are indicative of intoxication such as: swaying while balancing, using arms to keep balance, hopping on the anchor foot and resting the raised foot on the ground.

Another mechanism that Traffic Police Officers use is the 'Breathalyzer'. Here, individuals are required to blow into the breathalyzer, which then analyses the amount of alcohol present in that breath sample.

However, there are a few flaws with these procedures:

1. The 'Field Sobriety Tests' are based on certain general symptoms of drunkenness and hence cannot precisely determine intoxication. A drunk individual may not experience these symptoms and so may end up clearing these tests. On the other hand, sober individuals may end up not clearing these tests possibly due to other factors such as weakness, diseases, etc
2. Furthermore, the officers who administer these tests are usually not medically trained, which implies that their analysis and assessment of the signs/symptoms in these tests is often skewed.
3. Breathalyzers output an indirectly calculated value for the Blood Alcohol Content (BAC) level as it only detects the amount of alcohol present in one sample of breath, not the blood itself. Additionally, it requires the individual to do multiple tests in order to provide a fairly accurate reading.
4. Additionally, these procedures are inefficient and time consuming. It is highly unlikely that the police officers will be able to check every single driver on the road, and hence they are ineffective for drunk driving prevention.

2. PROPOSED SYSTEM

In the wake of numerous drunk driving accidents, and the ineffective and flawed procedures followed by traffic authorities, the proposed system aims to provide an alternative solution to the problem of drunk driving. This is achieved by detecting the presence of alcohol in drivers through a simple eye scan. This system primarily consists of two devices:

- A Mobile Application installed in an Android Smartphone with a Dual-Camera
- An Ignition Interlock Device (IID)

2.1 FUNCTIONING

1. **Eye Scan:** The test starts off with the driver taking an eye scan through the mobile application installed on the smartphone. A video is captured by the dual-camera setup present in smartphones for a stipulated time of 10 seconds, which is passed onto the next component of the system.

2. **Image Enhancement:** In this part, Multichromatic Stimulation is utilised in order to obtain processed images of the pupils from the eye scan. These images are resized and are then converted to gray scale in order to facilitate the functioning of the algorithms.

3. **Face Detection:** Here, a Haar feature-based cascade classifier is trained and employed to detect the face of the driver in the frames. It is trained by using an image dataset containing images of two types: those that have faces (positive) and those that do not (negative). Once the classifier detects the face, the image is then cropped to remove the complex background to the maximum possible extent

4. **Ocular Detection:** Similar to facial detection, another Haar Cascade classifier is trained to detect eyes within each cropped image. An image dataset containing two types of images is used here yet again. Those that contain eyes in them are considered to be positive samples, and those that do not contain eyes are taken as negative samples. The classifier then detects the eyes in the cropped image obtained from face detection.

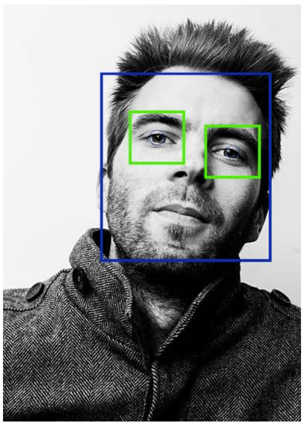

Fig -1: Haar Cascade Classifiers Detecting Eyes and Facial Region

5. Ocular Indicators: In order to successfully output accurate alcohol levels, three Ocular Indicators are used on the images after detection of eyes in those images. These Ocular Indicators are all heavily linked to drunkenness by scientific research [2].

A. Pupil Dilation: Computer Vision (CV) Architectures are used to quantify the pupil size in the images obtained from the eye scan. These CV Architectures assess the major and minor axes of the pupil and output a numerical value. This numerical value is used for comparison purposes as seen in the next indicator.

B. Pupil Size vs Light Intensity (Pupillary Light Reflex): 250 volunteers had their pupils measured under three varying levels of light (Room Light, Near-Total Darkness and Direct Light) [2]. The mean pupil measurements for each of these conditions were-

Room Light: 3.86 mm, Near-Total Darkness: 6.41 mm, and Direct Light: 3.35 mm.

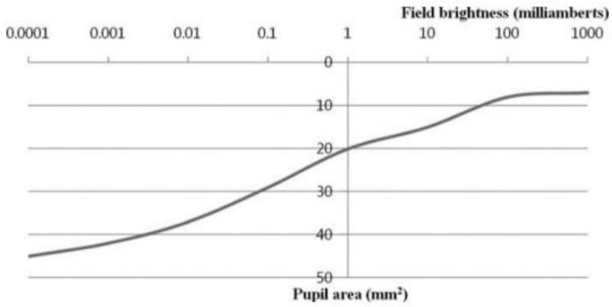

Chart -1: Curve of Pupil vs Light Intensity

This data is inputted into the system and is used for comparison purposes in the algorithm. Now, we compare the obtained Pupil Size value with the data obtained [1] to determine whether the driver is drunk or not. If the driver's Pupil Size is normal with respect to the data [1], then the driver is sober. However, if the Pupil Size is abnormal with co-relation to the Intensity of Light, then there is a high chance that the driver is intoxicated.

C. Eye Redness: Blood shot eyes are also often an ocular symptom of excessive alcohol consumption [2]. Similar to the case of Pupillary Eye Reflex, data for normal Eye Redness levels are inputted into the system. The images (taken in rapid succession) obtained from the eye scan are passed through a neural network to detect any deviations from expected measurements.

Based on these Ocular Indicators, Blood Alcohol Content (BAC) level with an unprecedented level of accuracy is outputted. The algorithms and necessary files for Image Processing, Face detection, Eye Detection and Ocular Indicators are stored in the cloud database. The calculation and quantification by the algorithms hosted in the cloud is done through cloud-computing. This allows for the BAC level to be produced in a faster and more efficient manner.

6. **Ignition Interlock Device (IID):** A check for the assessed BAC level is performed in this component. If the BAC level is within government regulations, i.e, .08% (in

the US), then the IID unlocks the engine and the driver can start the vehicle. However, if the BAC level is higher than government regulations on the first try of the test, the driver is required to take a retest after a 30s delay. If the BAC level is higher than permissible levels even in the second try, then the respective authorities/emergency contacts are alerted. Throughout this process, the engine is locked by the IID and therefore, the driver is prevented from starting the vehicle.

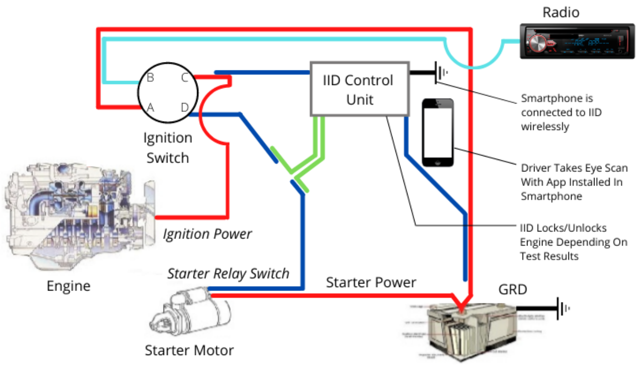

Fig -2: Circuit Diagram for Proposed System

3. DISCUSSION

The proposed system utilises Image Recognition and Processing Systems, coupled with IIDs. This combination prevents the driver from starting the vehicle if they are under the influence of alcohol and forces them to take the test in order to start their vehicle, thus preventing the potential drunk driving incident then and there itself. Furthermore, the use of Ocular Indicators and other such metrics results in a less invasive experience, free of hassle.

Appropriate mechanisms such as the locking of the engine by the IID until the test has been cleared have been put in place to prevent fraudulent manipulation of the proposed system. The implementation of the cloud based algorithms for face detection and ocular detection further makes it virtually impossible to cheat the proposed system. Since these algorithms are hosted on the cloud, the quantification and calculations are done by utilising cloud computing. This, coupled with the use of high-precision optics results in BAC levels being outputted at significantly faster rates.

4. CONCLUSION

In this proposal, we aim to solve the issue of driving under the influence of alcohol. To do so, we utilise Ocular Indicators that are all scientifically proven to be heavily associated with excessive alcohol consumption. To detect these indicators, we use cloud-based algorithms and image processing systems. Additionally, an Ignition Interlock Device (IID) is used to lock the engine. The engine will only be unlocked when the eye scan test (which can be taken on the mobile app on the smartphone) has been cleared. If the driver fails the test, then the engine will be locked by the IID and the respective local authorities/emergency contacts will be alerted. Thus, in this way, the proposed system offers a more time-efficient and effective way to prevent the problem of drunk driving, as compared to current procedures and technologies.

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