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Real-Time Driver Drowsiness Detection and Alert System

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Abstract: ***Nowadays, road accidents have become really high and is causing severe physical injuries, deaths etc, mainly in India. India has become the highest in the world in case of road accidents, recording 53 road crashes per hour. Drowsy driving is one of the reasons for road accidents. Increasing road accidents due to drowsy driving indicate the need of system that detect the drowsiness of the driver and alert them at the correct time. "Researchers have attempted to determine driver drowsiness using the following measures: (1) vehicle-based measures; (2) behavioral measures and (3) physiological measures"[13]. Rate of using physiological measures to detect drowsiness is high; vehicle-based measures are affected by construction of the street, driving ability of the driver, type of vehicle etc; some methodologies use mental measures for which some anodes are put on the head and body. So here we have used much more feasible method. In this paper we discuss a method which is non-intrusive. In our proposed system, the main data we use to detect driver drowsiness is the eye conclusion proportion, its duration etc. Eyes opening and closing ratio reflects a person's mind status and attention and therefore, it can be potentially used to indicate driver fatigue levels[14]. We keep a value as the threshold value, if the eye conclusion proportion goes below the threshold value, then we alert the driver using a buzzer and provide tips to get rid of the drowsiness through an audio message. For continuously detecting the driver's eye we use a camera. We also use an LED light to alert the co-passengers about the drowsiness of the driver.***
Keywords: Drowsy Driving, Eye Aspect Ratio, Facial Landmark, Computer Vision, Arduino UNO, 12v DC pump, Camera Module.

I. INTRODUCTION

Drowsy driving, additionally referred to as driver fatigue or tired driving, is the act of riding or running a motor automobile even as worn-out and feeling fatigued or sleepy. Job strain or interrupted nights with younger kids are not unusualplace motives to be quick on sleep. However, different elements can make a contribution to drowsy driving, inclusive of a medicinal drug you're taking or an untreated sleep problem that leaves you depleted and not able to live wide conscious for the duration of the day. Some effects of driver becoming drowsy are: poor judgment, inability to focus, unable to judge the speed and distance, delayed reaction time and finally falling asleep. We took a few attempts to identify the sleepiness of the drivers by keeping in mind the different boundaries. Some existing approaches executed vehicle-based estimates, in which we mount sensors on different parts of the vehicle[1]. The cycle of executing car-primarily based totally measures may be similarly separated into classes. The evaluation may be finished depending on methodologies, particularly Steering Wheel Movement (SWM) and Standard Deviation of Lane Position (SDLP). In any case, tests primarily based totally car-placed together limitations profoundly rely with appreciate to the real components of the popular weather and the driving force himself. These elements essentially consist of the development of the street, the type of car applied and the riding instance of the driving force which impact the precision of the evaluation [2]. Subsequently, vehicle-based estimations don't give us the chance to identify the reason for laziness[3],[4]. Some methodologies took mental measures to detect the weakness of the driver. One main benefit we get by using this mental measures is that it can foresee tiredness in better way because the psychological exercises of the cerebrum can be well addressed by mental signs[6]. But these methods are not practically feasible, since it need sensors to be attached to the driver's body in order to collect information. This may make the driver feel uncomfortable and awkward while driving and it may also distract the driver's concentration which may lead to an accident[7]. Considering the recently indicated issues [3]-[5],[7],[8]; we proposed a technique, which depend on conduct estimation, for which we use eye conclusion proportion as an input for identifying tiredness of the driver. Procedures depended upon conduct estimations include observing the eye squinting example, yawning, eye conclusion, facial developments furthermore, head present by means of an outside camera [9],[10]. Also, because the framework is deliberate considering the behavior boundaries, it fills in as a non-meddlesome approach of finding out the drivers languor because it doesn't want any preparations of sensors at the drivers body and alongside those traces doesn't interfere on him at the same time as driving.

In our proposed system, we use a camera to continuously capture the eye of the driver. To successfully capture driver's face, we can attach the camera on to the vehicle dashboard and is roughly 20cm far from the face of the driver[11]. At first, the facial milestones were recognized. When the different regions of the face were distinguished, the eye locales were separated to quantify the eye conclusion proportion[12]. In the event that the eye conclusion proportion of the driver falls apart based on what is viewed as the standard proportion of a person in an ordinary express, the driver is immediately alarmed with the assistance of the buzzer[12] and spay water on face using small water pump. In order to help the driver to not get drowsy again, we provide them some tips through an audio message. In case of taxies, the co-passengers may not be knowing if the driver is drowsy so we use an LED light to notify the co-passengers, and send email to the owner of the vehicle which will help them take some measures. For executing the system we use Arduino UNO, LED, speaker and a camera.

II. PROPOSED SYSTEM

The proposed system help us overcome main drawbacks of existing transport and drivers management systems and also we can reduce the number of road accidents due to drowsy driving through more feasible method of alerting the driver and co-passengers. Through our proposed system we try to build a smart system that automatically detect the drowsiness of the driver and alert them. For this we continuously monitor the eyes using camera. From the captured images we calculate eye conclusion proportion and the eye closing duration, then waking the driver up using a buzzer, spraying water on face and give a voice message about some tips to avoid drowsiness, through speaker, whenever he found drowsy and also notify the other passengers of the vehicle using LED light so that the necessary steps can be taken. We also send email to the owner of the vehicle if driver is detected to be drowsy more than 3 times. Eye Aspect Ratio (EAR) is calculated in each frame and the threshold value is calculated from EAR of initially captured 20 frames. When a person become drowsy his eyes will start to shut down, this will decrease the EAR value, which will help us detect the drowsiness[12]. When the EAR value goes below the threshold value, the duration of eye closure is considered. In order to distinguish the drowsy eyes of the driver from the normal eye blink pattern, a threshold value (in our code 10 frames), representing the total number of video frames the driver has closed his eyes, is used[12]. If the number of successive frames exceeds this threshold value, the system detects the driver with drowsiness and the connected buzzer and water pump is turned on immediately to wake the driver up and a voice message is generated. To continuously record drivers eye movements a Camera Module is used, so that the EAR can be calculated in real time. For our proposed system we have used Arduino UNO which make our system a smart drowsiness detection system.

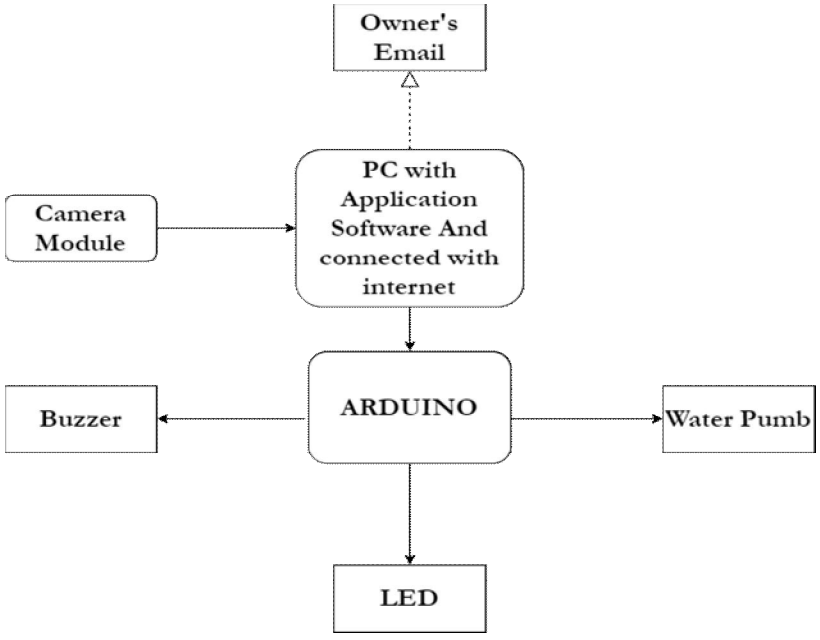

Fig. 1 Working model of our proposed system

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III.SYSTEM DESIGN

In system design we have included the flow chart, circuit diagram and major components used for our proposed system.

A. Circuit Diagram

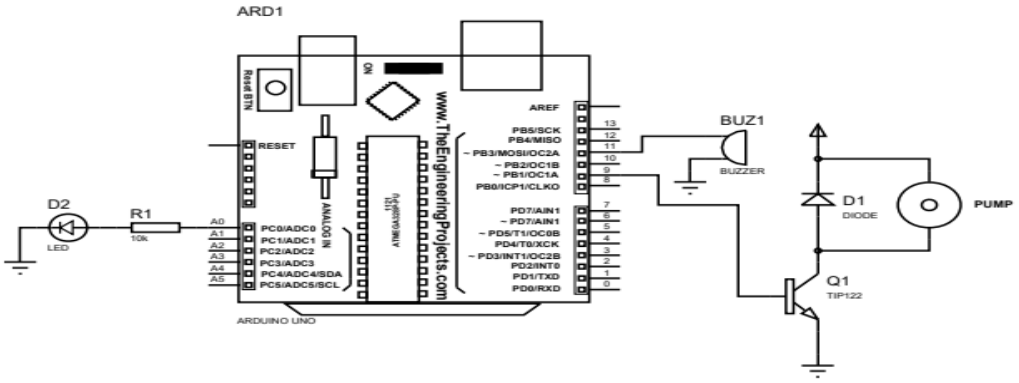
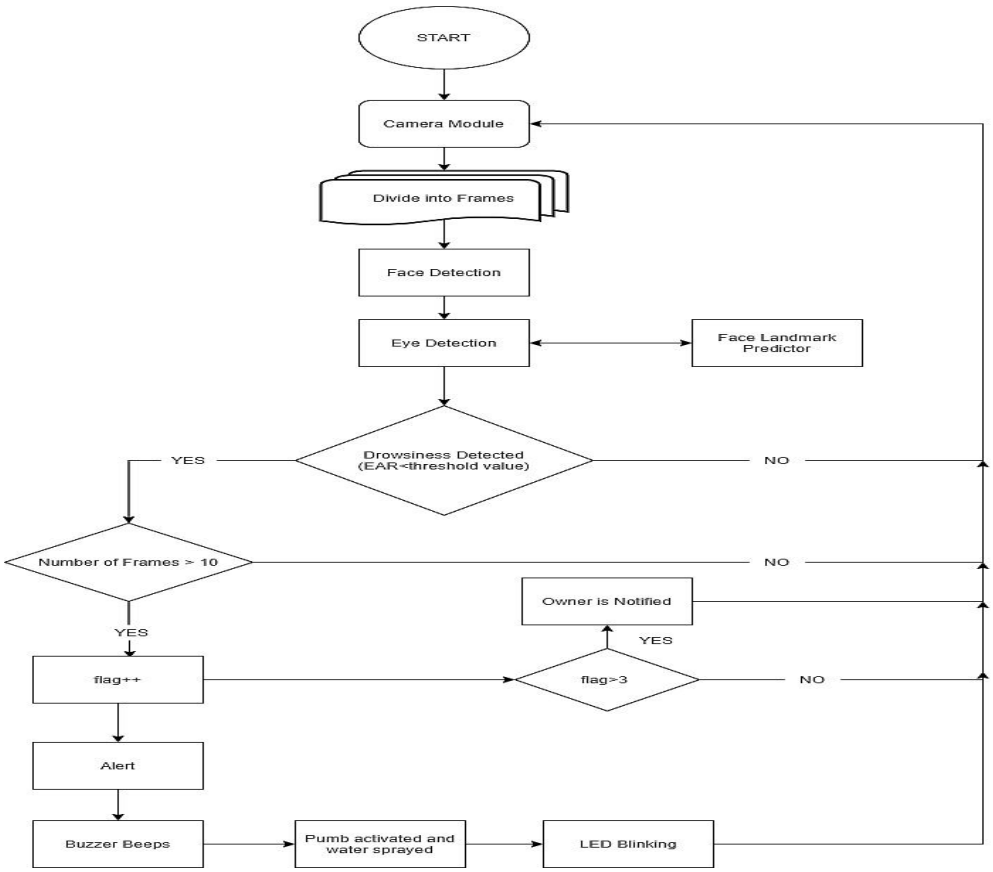


Fig2: Arduino UNO board with LED, Buzzer and water pump connected to it

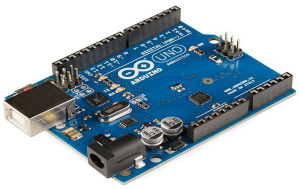
In above circuit diagram, on the arduino UNO board, an LED (D2) is connected to the port A0 through a register R1. This is used to alert co-passengers about driver's drowsiness. Then a buzzer (BUZ1) is directly connected to port 11 which is used to alert a drowsy driver through beep sound generated from it. Next a water pump (PUMP) is connected to the arduino board via a diode (D1) and an amplifier TIP122 (Q1). Diode is used to allow an electric current to pass in one direction and TIP122 is used to amplify the volt. TIP122 is a Darlington braces NPN Transistor. One main feature of TIP122 is that it is used for velocity controller of Motors. Water pump is used to spray water on the driver's face if detected drowsy.

B. Flow Chart



C. Major Components Of Proposed System

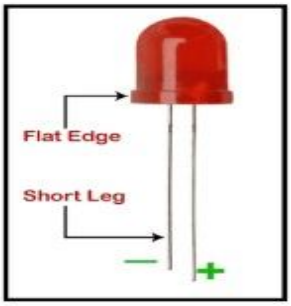
1) *Arduino UNO*: Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button.



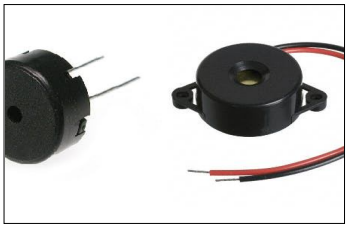
2) *Camera Module:* Used to capture the face of the driver in real time.

3) *12v DC Pump:* DC powered pumps use direct current from motor, battery, or solar power to move fluid in a variety of ways. Here we use 12v DC pump to spray water on driver's face when he is detected drowsy.

4) *LED:* Used to alert co- passengers when driver is detected drowsy by blinking it.



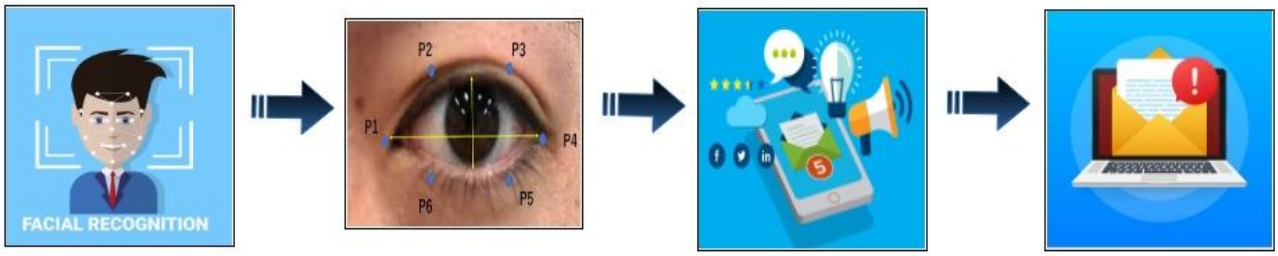
5) *Buzzer*: Used to alert the drowsy driver by generating a beep sound from the buzzer.



6) PC connected to internet: In this we run the code to activate or deactivate the drowsy driver detection system.

IV. WORKING PRINCIPLE

The main modules of our proposed system are shown below:



A. *Detection of Face*

First we capture video of driver in real time using the camera module. Then it is divided into different frames. From each frame, first we need to detect the face portion. For this we us Dlib open source library which is an advanced machine learning library that was created to solve complex real-world problems. shape_predictor_68_face_landmarks data set helps to map 68 facial landmarks. We use this to determine main features of our face like eyes, nose, mouth etc. The 68 facial landmarks detected using this dataset is shown below:

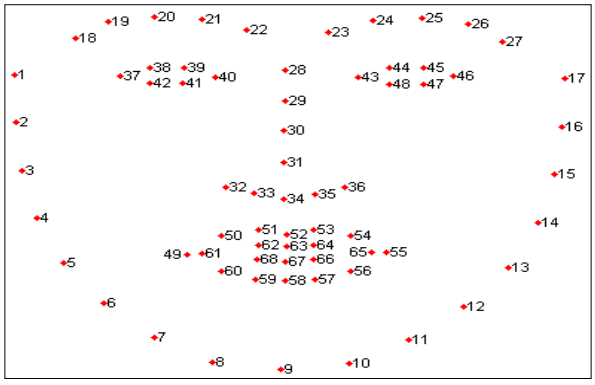


Fig. 3 68 facial landmarks on face

From this, the data we use are landmark points of the following:

1) Nose Points = 28–36
2) Right Eye Points = 37–42
3) Left Eye Points = 43–48
4) Mouth Points = 49–60
5) Lips Points = 61–68

B. Determining the Eye Aspect Ratio(EAR)

After detecting the face, we determine the eye portion and convert it into grayscale. Now we calculate EAR of eyes in each frame. For this first we calculate euclidean distance of eye landmarks. For this we have created a function which take two parameters each(two opposite points). The equation to calculate euclidean distance between two points is given below:

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

The distance of eye is calculated as value pairs (37,41), (38,40), (36,39). Now using this we calculate EAR of eye with the following equation of EAR:

$$\text{EAR} = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|}$$

Here p1, p2, p3, p4, p5, p6 are 2D landmark locations of eye. After collecting EAR of eye for first 20 frames, we calculate a threshold value and continue calculating EAR for all further frames. If the driver become drowsy his eyes will start to close and as a result EAR will decline. Inorder to distinguish between eye blinking and drowsy eye, we set a threshold value for number of frames (in our program 10) the eye is closed. If the eye is closed in successive 10 frames, then drowsiness is detected. Similarly, we find euclidean distance of mouth to detect yawning and find threshold value for length of nose to find the head bend. Because during head bend the length of nose will decline.

C. Alerting the Driver

After detecting drowsiness of driver we need to alert the driver. We use different ways of alerting the driver. First, we generate beep sound using a buzzer for 10sec and then spray water on driver's face using a 12v DC water pump for 1sec. After that, using a sound message we provide some tips to the driver inorder to avoid the drowsiness. These tips are also displayed on the screen. Furthermore, we blink an LED light for 10sec inorder to alert the co-passengers about the driver's drowsiness. This LED will be attached on a place were co-passengers will easily notice when it is blinking.

D. Notifying the Owner

As an additional step of alerting, we also alert the owner of the vehicle through emails. If the driver is detected drowsy continuously for 3 times then an email is send to the owner of the vehicle for him to take further actions. The subject, message content, and Email ID are all entered into the system through python scripts(smtplib is used).

V. RESULT ANALYSIS AND FUTURE SCOPE

In our proposed system, when it is activated, the camera module will capture the video which is displayed on a PC screen with 68 facial landmarks highlighted in it.

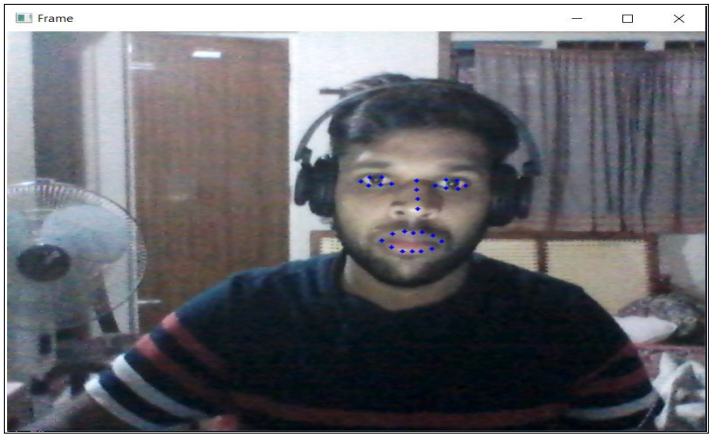


Fig. 4 Screenshot of 68 facial landmarks highlighted on face displayed in PC screen.

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The yawning done by the driver is also considered as a sign of drowsiness. Yawning is detected using the mouth opening ratio calculated. So a warning message is displayed on the frame when driver is detected to be yawning.

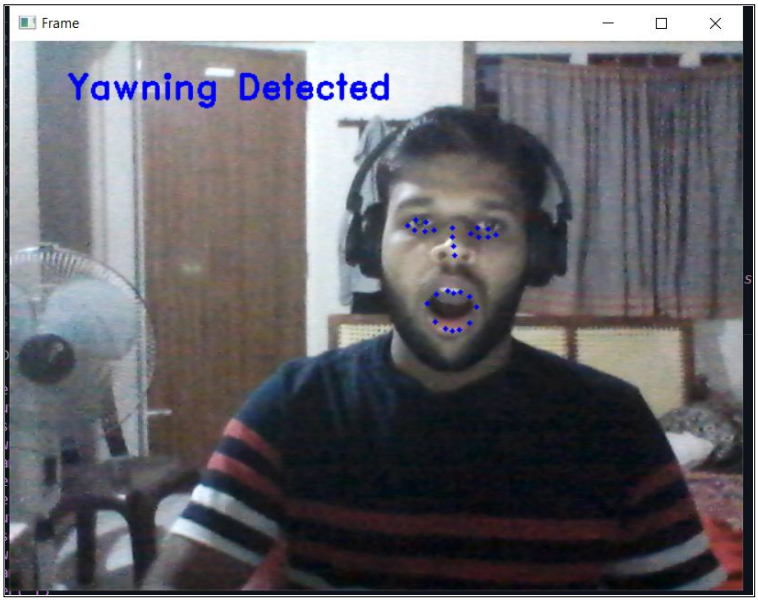

Fig. 5 Screenshot of warning message for yawning detection displayed on PC screen.

We also detect the head bend as nodding off while driving is also a sign of drowsiness. This is calculated using variation in nose length. For this we display a warning message on PC screen.

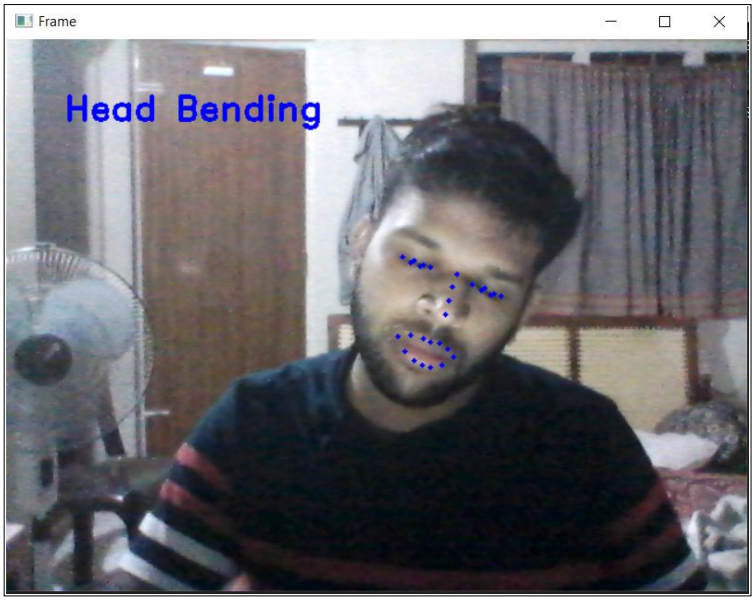

Fig. 6 Screenshot of warning message for head bend detection displayed on PC screen.

Apart from this, the main sign of drowsiness is closed eyes or sleepy eyes. This is the main drowsiness signal we consider to alert the driver. When driver is detected with this signal, the EAR of eyes will decline and as a result the alert systems are activated. First a warning message and pop-up message is displayed on screen with a voice message about tips to avoid drowsiness generated from speaker. In addition to that an LED blinking and email message sending is done to alert the co-passengers and owner of vehicle respectively.

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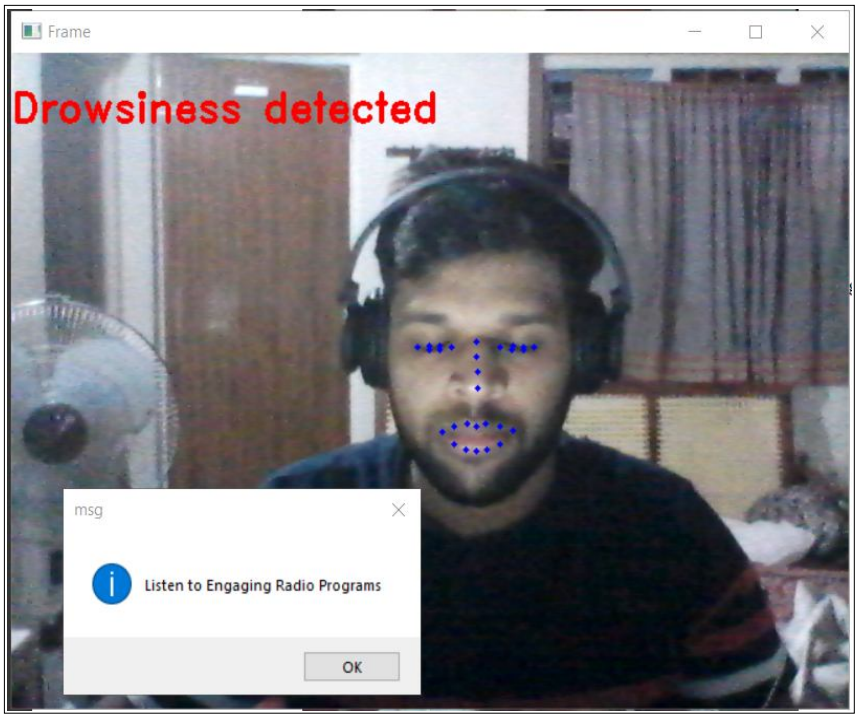

Fig. 7 Screenshot of warning message and pop-up for drowsiness detection displayed on PC screen.

This pop-up message is generated every time the driver is found drowsy. If the driver is detected drowsy continuously for 3 times, then a mail is send to the owner of the vehicle to help him take further action on it. A sample of message generated is shown below.

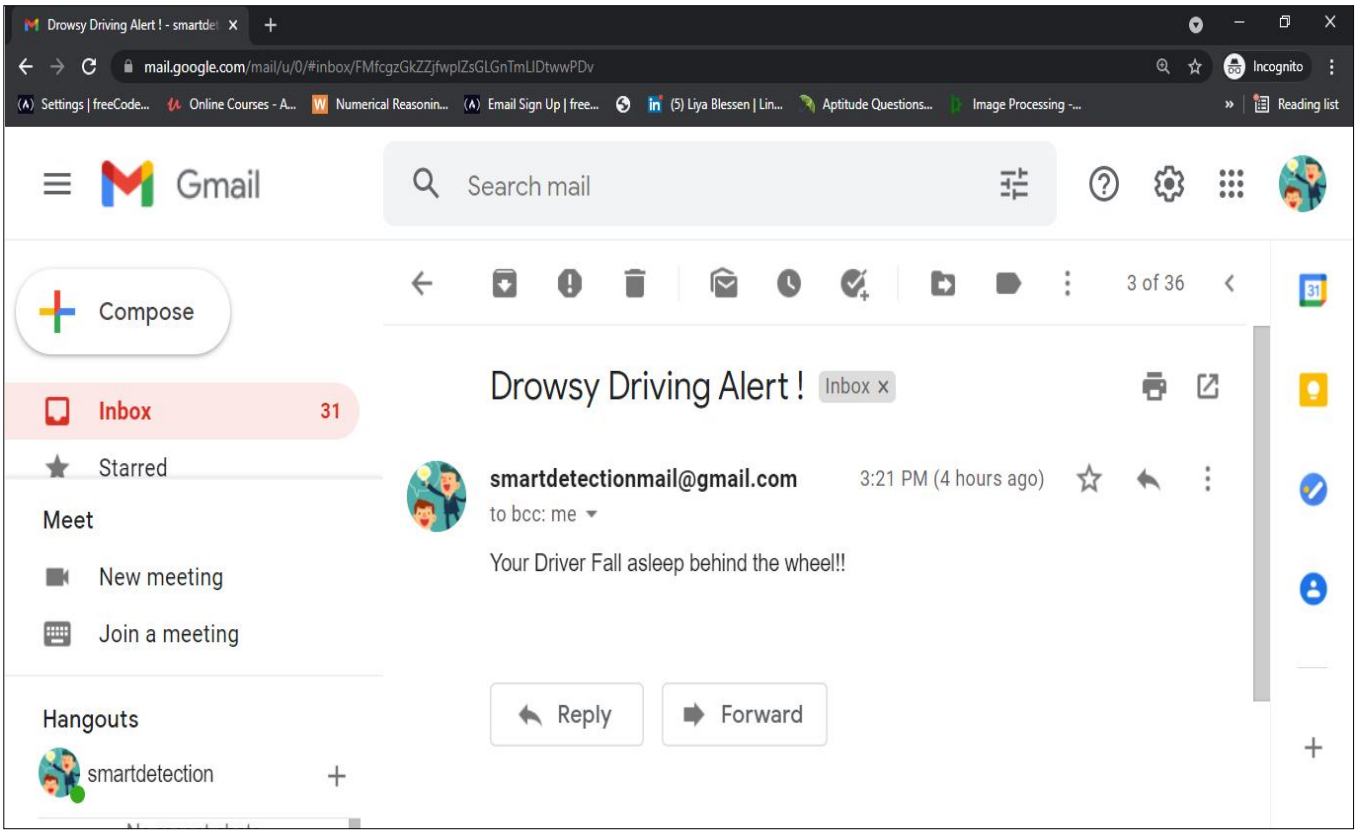

Fig. 8 Screenshot of email message generated when driver detected drowsy continuously for 3 times.

In future, we would like to improve our system by attaining a compact design and also by making it appropriate to serve under any physical environments. Apart from this, we would also like to work on recognising the sleep pattern of the driver in order to detect his fatigue level beforehand in the future. We believe that if we can recognise the sleep pattern and combine it with the eye closure pattern, it is possible to form a positive correlation between these two patterns which may help us design more perfect drowsy detection system[12]. We can also consider the case of alerting co-passengers with vision or hearing disabilities if the driver fall asleep and drowsiness detection during dark or less lighting conditions.

VI. CONCLUSIONS

The number one purpose of this studies is to offer a drowsiness detection device and a way that detects the drivers drowsiness in real-time. Existing procedures have used vehicle-primarily based totally and mental measurements to discover the drowsiness of the driver. However, such strategies are highly intrusive and rely upon the bodily traits of the surrounding environment. In contrast to the previously determined issues, we proposed a system which implements a non-intrusive technique to determine the tiredness of the driver. Comparing with other systems, our system give 94% accuracy. Our system, in order to continuously keeps scanning for facial landmarks, consists of Arduino and a camera module; LED light, speaker, water pump and buzzer for providing alert. For localising these landmarks we use facial landmark detector and to calculate the eye aspect ratio (EAR) we use the eye landmarks[12]. If the EAR value decreases from the threshold value and the eyes remain closed for too long then the system immediately alerts the driver with the aid of a buzzer which generate beep sound, a water pump which sprays water on driver's face and produce a voice message via speaker. Furthermore, we alert the co-passengers using an LED light and alert the owner of the vehicle via email if the driver is continuously detected drowsy for 3 times. This method is useful to people in the car rental and driving business such as truckers and taxi cab drivers. However, there is one issue that remains to be addressed in the system, which is its incapability to serve its purpose in less light.

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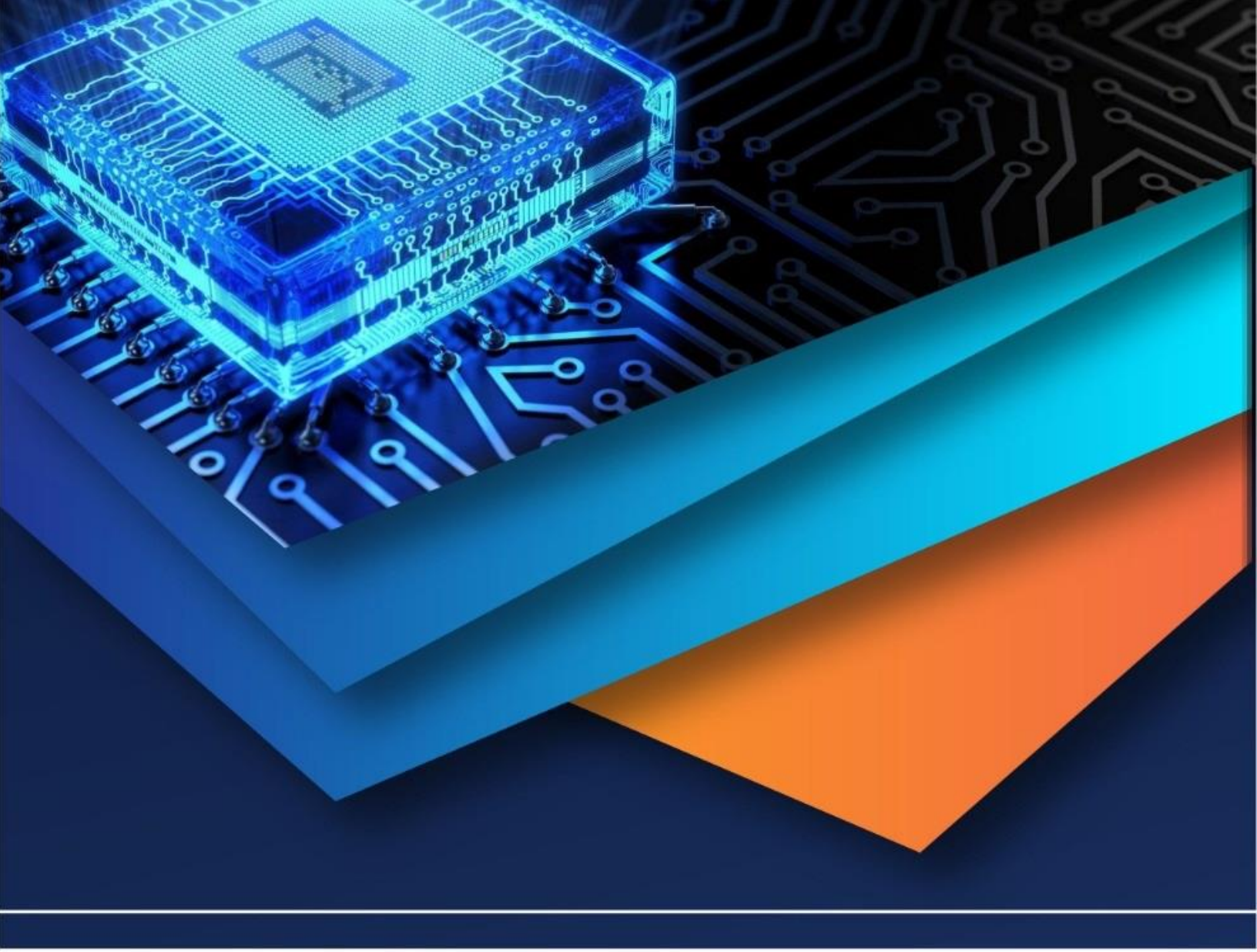

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