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Smart Alert System for Driver's Drowsiness Detection System

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ABSTRACT
In recent years, the detection of a sleepy driver has become a necessary procedure in order to prevent any roadaccidents, possibly globally. This project's purpose is to develop a comprehensive warning system for intelligent cars that can automatically prevent damage caused by a tired driver from occurring. The human body is capable of drowsiness, and it occurs for a variety of causes. In order to avoid the cause of the accident, it is vital to create a powerful warning system.Video Stream Processing (VSP) is used in this study to construct a drowsy driver warning system that uses the EAR and Euclidean distance to evaluate video streams in the blink of an eye. Adoption of a facial recognition algorithm can be detected visually as well. Any time the IoT module detects driver fatigue, a warning message is sent out, along with information on the conflicting impact of local knowledge.

Keywords
IoT module, Cloud Server, EAR, Raspberry pi, sensors, GSM module, GPS module, Blink count, Image processing.

1. INTRODUCTION
The mixture of long driving hours, dull road conditions, and inclement weather has contributed significantly to the high number of car accidents caused by exhausted drivers. According to the National Highway Traffic Safety Administration and the World Health Organization, at least 1.35 million people die each year as a result of traffic-related injuries and deaths globally. Inadequate driving is the most common cause of car accidents. When the driver is under the effect of alcohol or tiredness, certain circumstances arise. One of the most common causes of driver weariness is an accident. Control of a stolen vehicle occurs when drivers fall asleep behind the wheel. In order to create a smart or intelligent automobile, advanced technologies must be used. An alarm system for drivers is being developed as part of the scope of this work.

In the behavior-based approach, the camera measures the Driver's blink, facial recognition, head position, and other factors related to facial significance and Euclidean distance.

2. BACKGROUND STUDY
2.1 Detection of drowsy eyes and face
There are steps to detect the drowsiness of the driver. They are
Step 1: Video recording
Step 2: Face detection
Step 3: Eye detection
Step 4: Drowsiness detection
The first step involves continuous video recording of the face through a raspberry Pi camera of 5MP. This continuous video stream of high quality is divided into several frames. These frames are passed onto the next step i.e. Face detection. The face detection step uses a face recognition algorithm which is useful to detect eyes, nose and mouth. This algorithm uses OpenCV which is useful for real-time Image processing implemented by computer algorithm. After successful facial feature detection, the detection of the eyes is done via a facial recognition algorithm and thereby converting the image frame format into grayscale and capturing the six coordinates of the eyes.

2.2 Euclidean distance (ED)
In order to determine the distance between the coordinates, Euclidean distance is used which is also used to calculate the Eye Aspect Ratio [EAR]. This EAR measures the distance between a vertical eyemark and a horizontal eyemark. The calculation is done as follows -

$$iED(X_i, Y_i) = \sqrt{\sum_{n=1}^{n} (Y_i - X_i)^2}, \quad (1)$$

Here, the Euclidean distance between Xi and Yi ,which are the Cartesian coordinates, is ED(X,Y). The below is the representation in python program.

$$\text{(i)}\ A = \text{dist.euclidean}(\text{eye}[2], \text{eye}[6])$$
$$\text{(ii)}\ B = \text{dist.euclidean}(\text{eye}[3], \text{eye}[5])$$
$$\text{(iii)}\ C = \text{dist.euclidean}(\text{eye}[1], \text{eye}[4])$$

The distance package object that belongs to Scipy library file called Euclid is represented by distance. The A, B and C variables are used to calculate EAR along with the two (Xi,Yi) coordinates. To find EAR, the following formula is used where x1, x2, x3, x4, x5 and x6 are the six coordinates.

$$\text{EAR} = \frac{\|x_2 - x_6\| + \|x_3 - x_5\|}{2\|x_1 - x_4\|}, \quad (2)$$

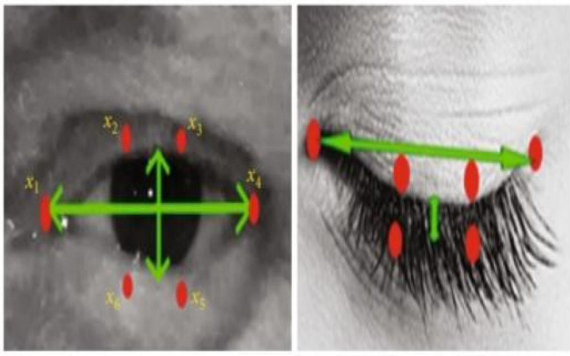


Figure 1: Eye landmark of opening and closing eye

The average of the left and right eye EAR values is done during synchronous blinking. If both eyes are open, the EAR threshold remains constant. If the EAR falls above the threshold i.e 0.25 then there's no drowsiness detected. If the EAR falls below 0.25 then the drowsiness is detected.

2.3 Facial landmark algorithm

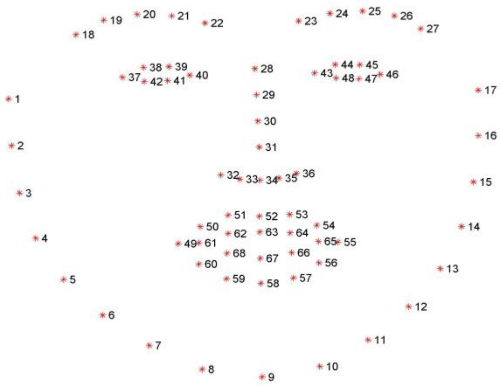


Figure 2: Face landmarks

In this concept, the recorded video stream is converted into number of frames that are passed to Face recognition process. Face recognition algorithm is used to detect eyes, nose and mouth. This algorithm is used along with python based packages like OpenCV. If both eyes remain open, the EAR threshold remains constant and the value changes during synchronous blinking. The EAR threshold range is around 0.25. This means that the eyes of the driver are not latched. If driver drowsiness is detected in the video frame, this is due to a threshold below 0.25. If the number of frames exceeds 30, the buzzer is activated in order to alert the driver and an alert message is sent through GSM module. SMS will be sent to the authorized person who can alert the sleepy driver over the phone.

2.4 Accelerometer, Gyroscope and Force sensitive resistor [FSR]

Accelerometer: It is a device which measures the linear acceleration of anybody in its instantaneous rest state.

Gyroscope: It is a tool which measures the angular acceleration of an object in its instantaneous rest state through roll, pitch and yaw.

Force sensitive resistor [FSR]: It is a resistor which is capable of changing its resistance or its voltage value when a there is detection of any pressure or a mechanical force externally.

3. METHODOLOGY

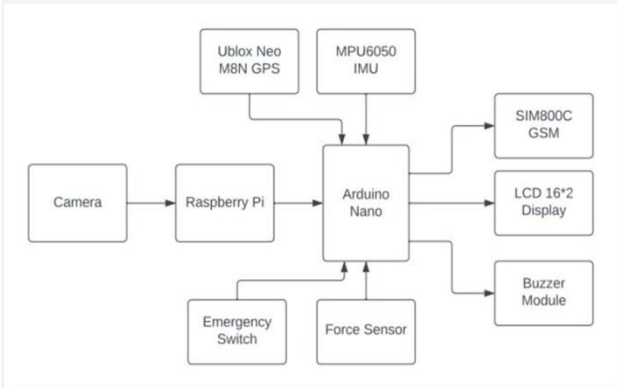


Figure 3: Proposed system

If the pi camera and raspberry pi3 are properly integrated, the driver's face movements will be continuously recorded. In this case, one of the most important indicators of driver fatigue is the eye aspect ratio. The accurate calculation of EAR is enabled by the continuous recording of face landmarks that are localized by face mark points using raspberry pi3 and camera modules. If the EAR exceeds the range, the buzzer will alert the driver. Even if the driver is not awake, an email is sent to the driver's family number using the GSM module.

Here, an Arduino Nano will be connected to a Raspberry Pi in order to detect collisions. The MPU 6050 IMU is a sensor that monitors triaxial acceleration and triaxial velocity. This region detects the force of an impact brought on by a collision brought on by the car brakes using a force-sensitive sensor. Following a collision, the sensor gathers information, which the GPS module then uses to relay the data's location to the proper parties. The emergency switch in this instance is a safety element that notifies the proper person if the driver experiences any difficulties. Here, serial transmission is used to display the message on an LCD panel. and the GSM module receives the data here after being connected to the Arduino nano by the GPS module.

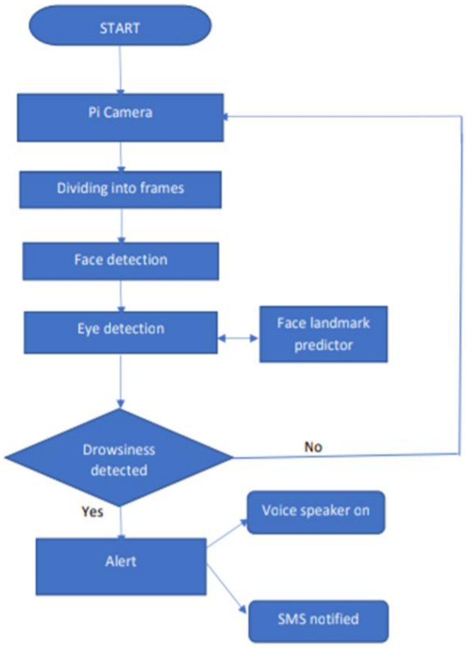


Figure 4: Flowchart of drowsy detection system

The methods for detecting drowsy drivers in the scenario are as follows

(i) Make a video. (ii) Facial recognition.

(iii) Detect the Eye (iv) Sleepiness Detection

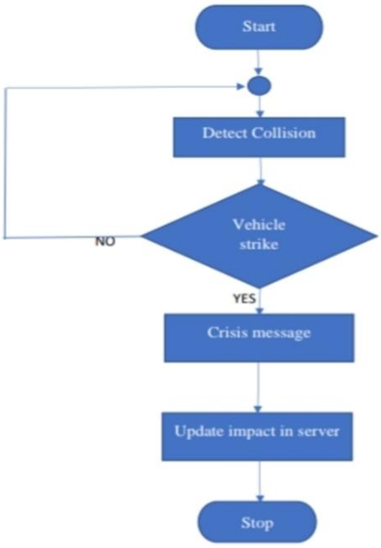


Figure 5 : Flowchart of collision detection system

A force sensitive register is typically used in collision alert systems to provide data about the collision impact. As a result, data on collision impacts is gathered in order to assess the severity of accidents caused by drowsiness or unconscious driving. When a vehicle collides, the sensors generate data that detects the severity of the collision as well as its location, which is stored in a database. The location of the accident is obtained in google maps with the help of GPS tracker, all data of which are accessed via the Raspberry Pi4 . A location's longitude and latitude are calculated specifically by measuring the distance between two points on the earth's surface using the MPU6050 IMU.

4. IMPLEMENTATION

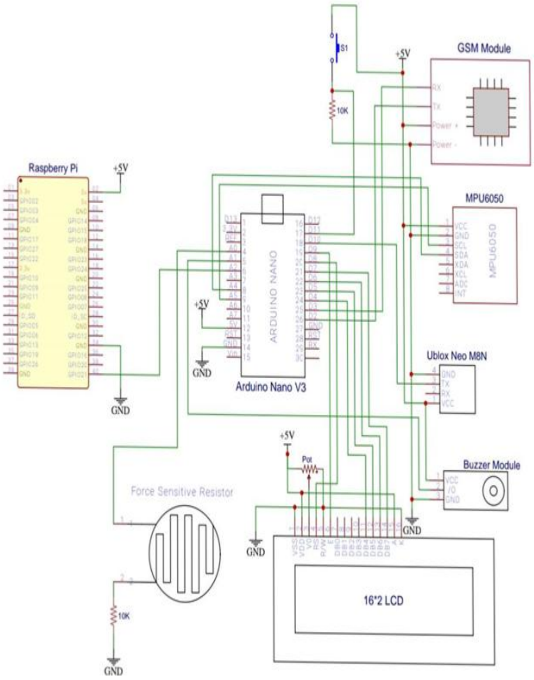


Figure 6 : Implementation

The proposed system is divided into two parts. One to detect drowsiness of the driver and the other to measure the severity of collision. The system to detect drowsiness of the driver uses Raspberry Pi model 4 4gb RAM. The IDE used to incorporate software program into the Raspberry Pi is Jupyter notebook and the programming language used is Python.

The 5MP Raspberry Pi camera is used to capture the drowsiness. It is connected to the Raspberry Pi which sends the input after video stream processing and calculating Eye Aspect Ratio [EAR] using Face landmark algorithm and Euclidian distance. A +5 voltage and a ground connection is applied. A connection between a buzzer module and the GSM module is made in order to alert the driver when the EAR falls below the threshold value which is 0.25 and to send an SMS to the intended person respectively. It is also connected to the LCD to display the message.

The other part of the system to measure the severity of collision is implemented by Arduino Nano V3 8 bits Atmega328. A +5 voltage and a ground connection is applied. The collision detector is divided into two parts based on the type of sensors used.

The first part of the collision includes a Force sensitive resistor which has a range of 0 to +5V which is converted into digital values which becomes 0 to 1023. The threshold is 850 that means if the applied force is above 850, then there is an occurrence of a collision. This input is given to the Arduino Nano V3. The pin 4 i.e AO is connected to the Force sensitive resistor along with a 10k ohm resistor to the ground.

The other part of the collision includes an accelerometer MPU6050 along with a gyroscope which detects the linear acceleration and angular acceleration respectively. This uses Roll, Pitch and Yaw coordinates. The input of this module is connected to the Arduino Nano V3 through Pin 3 and Pin 4 which are connected to Analog pins of Arduino Nano i.e A4 and A5 respectively along with Vcc and GND connections. The GPS module Ublox Neo M8N is used to track the location of the occurred mishap. It sends data to the Arduino V3 through Pin 3 and Pin 4 which are connected to Analog pins of Arduino Nano i.e A4 and A5 respectively along with Vcc and GND connections. The GPS module Ublox Neo M8N is used to track the location of the occurred mishap. It sends data to the Arduino Nano using Pin 2 which is connected to the digital pin D10 of Arduino Nano. It also connects Pin 1 and Pin 4 to the Buzzer module and the GSM module respectively.

5. RESULTS AND DISCUSSIONS

This section presents a successful experimental result that was attained using the suggested approach while driving. By observation of the driver's eye, calculated EAR, sleepiness is determined. Using this method, can tell if someone's eyes are open or closed, providing information regarding the impact of a collision.

i) An alert message is delivered to a family member when the system is turned ON (Arduino-nano - 5v battery, Raspberry Pi - 15.3W adaptor type - C) as shown in figure7

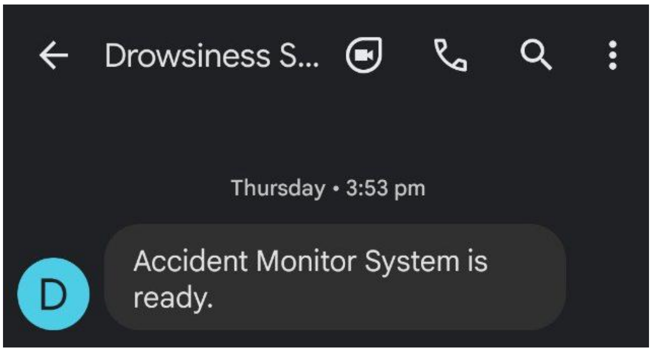
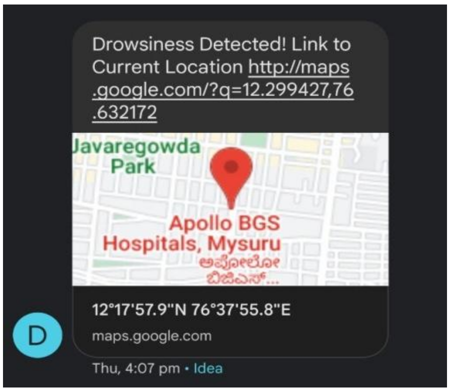


Figure 7: Message showing system is ready

ii) If EAR value has higher than 0.25, can say that you're awake. This test demonstrates, as shown in Figure 8.a), that the driver did not nod off. Similarly, when the EAR value is less than 0.25 and a tired face is observed, as shown in Figure 8 b), the driver's drowsiness is identified. The movement of the eyelids frequently modifies the EAR value. As seen in Figure 8.c), when drowsiness is detected, the driver is repeatedly warned with a voice tone, and the message is sent to the family or the appropriate authorities. Here, a buzzer is used to alert users who may be falling asleep.

a)

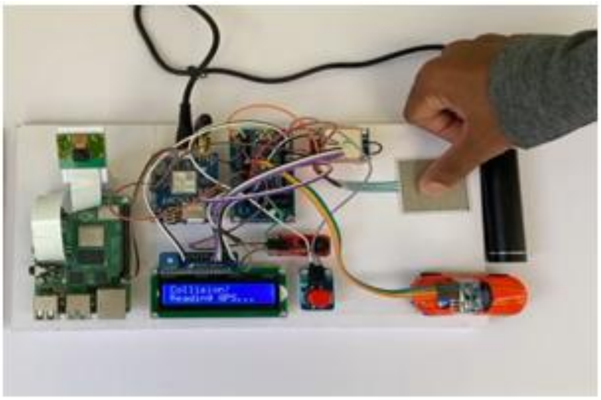
b)



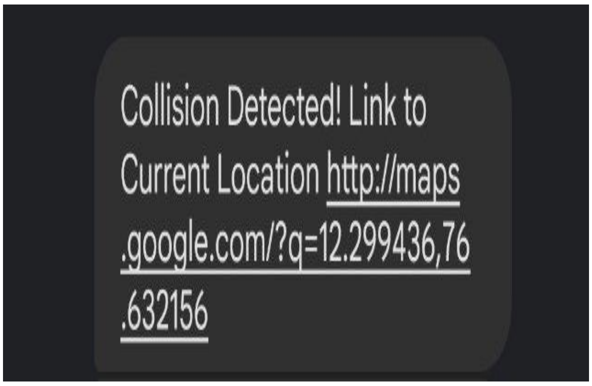
c)

Figure 8: a) Active face b) Drowsy face c) Alert message.

iii) The system predicts that a collision has happened when pressure is applied to a force-sensitive resistor, and the same information is presented on the LCD display, as shown in figure 8 a). Figure b) depicts how the concerned party is provided an alert message with the collision's location.



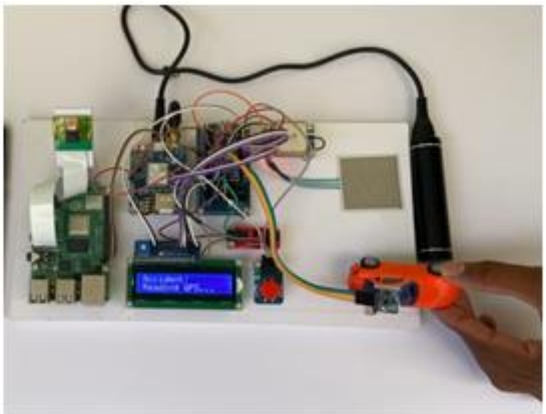
a)



b)

Figure 9: a) Collision detection b) Alert message

iv) If the absolute value of x and y coordinates are greater than or equal to 60 degree than the system predicts that accident has occurred and same message is displayed on LCD display which is shown in figure 9 a). As seen in figure 9b), an alert message with the accident's location is delivered to the person how belongs to his family



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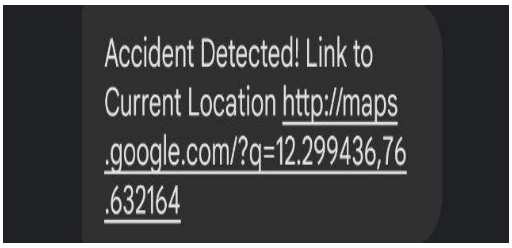
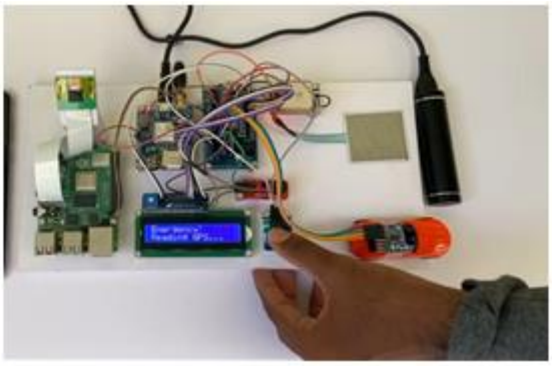


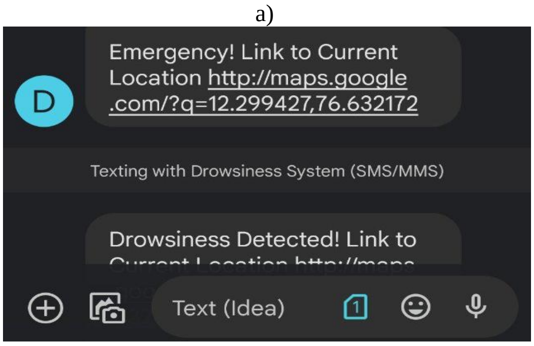
b)

Figure 10: a) Showing Inclination of car is greater than 60 degree b) alert message

v)When the emergency button is pressed, a message containing link of current location is sent to concerned person which is shown in figure 10 b)



a)



b)

Figure 11 a) Emergency button pressed b) Alert message

6. CONCLUSION

This study relies upon a variety of papers to create a comprehensive sleepiness-ready framework. While sleepiness discovery generally focuses on the first location, the delayed effect is rarely considered. The proposed framework attempts to beat this limitation. In addition, a framework for alerting drivers when they are getting fatigued has been devised using the Eye aspect ratio (EAR). When a message alarm sounds, the driver is alerted. The seriousness of the crash is determined independently, yet such a procedure is profoundly disruptive as well as transforms the actual setting. Thus, the proposed framework is utilized to develop a non-intruding strategy for estimating the drowsiness of the driver with the seriousness of crash due to slowing down or disaster. To compute EAR, a Raspberry Pi version 4 and Pi camera module are utilized in this present architecture to collect face tourist places constrained by facial milestone restrictions and then to compute EAR. In contrast, if the value of the calculated EAR esteem rises above a predetermined level, then the eyes remain open and the status of the framework is adversely influenced by this. It will also notify you via email and loud speaker if your EAR value is outside of the acceptable limits. So that the driver is fully informed of any changes, this is done to guarantee that they are fully informed. In addition, sensors with GPS modules are employed to correctly monitor the position of a mishap, therefore alerting the concerned person.

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