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Vehicle Accident Detection and Rescue Information System Using IOT

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Abstract: Many times, the person involved in accidents does not receive help from others; therefore, auto-detection of the accident and informing the victim's family or emergency services about the location of the accident plays a critical part in saving a person's life. The clock period between the commencement of the misfortune and the arrival of a hospital wagon to the incident site is a crucial in the survivability following the accident. By reducing the amount of time in between accident and the arrival of a medical facility on the scene, casualty rates can be reduced, allowing more lives to be saved. One solution is to deploy an Internet - of - things based Vehicle Accident Detection and Rescue Information System to minimize the delay. This system provides an alarm if an accident occurs and promptly notifies emergency responders. The system major application is to alert the driver in case of Drowsiness using the Pi Camera and to spot accident using a gyroscope and an ultrasonic sensor and send alert message through GSM Module to the emergency contacts. The location coordinates from GPS Module of an accident are included in the alert message.

Keywords: Haar cascade, Drowsiness detection, GPS, GSM, Pi Camera, Raspberry Pi, Sensors- Ultrasonic sensor, Gyroscope sensor.

I. INTRODUCTION

Every day, many individuals die as a result of traffic accidents that occur on the road. Humans in this densely packed mechanical world are more reliant on automobiles at a shootup rate on a daily basis. The impact of thousands of vehicles across the world's roads has worsened traffic problems and accidents. Casualties occur as a result of road traffic injuries mixed with a lack of immediate medical treatment. Even with technological developments, road safety tactics such as signs and speed bumps remain same as they are generations earlier. Despite the extensive efforts made by the governments and non-government groups through various programs to raise awareness about irresponsible driving, still accidents occur on a regular basis. Many lives, could be saved if the rescue teams had received the accident information in time. The average ambulance response time in India is 18-20 minutes [1] in cities, however it varies greatly in rural and suburban areas. Inadequate infrastructure and flaws in road architecture are concerning, but falling asleep [6] or poor driver training remain the most significant challenges. An effective technique to reduce accidents is to alert the driver about potential hazards on the road. The proposed system facilitates in the speedier transmission of information to the victim's guardians or another rescue squad, allowing medical assistance to be provided to the victim as soon as possible. When an emergency occurs, the system analyses the seriousness of the occurrence and notifies to a guardian or rescue squad, along with the geolocation, allowing the rescue squad to reach the victim as soon as possible and provide medical assistance. The main push to this project is to save the lives of the people who meet with the accident on the remote places who are in helpless position.

II. LITERATURE SURVEY

[1] Hemangi S. Badhan and Shruti K. Oza observed that, Road traffic injuries remain one of the primary causes of death. The clock period between the commencement of the misfortune and the arrival of a hospital wagon to the incident site is a crucial ingredient in the survivability following the accident. By shortening the time in between accident and the arrival of a medical facility on the scene, fatality rates are reduced, allowing more lives to be saved. One solution for eliminating the downtime.

[4] Aravind Sampath B V and Vidhyapathi also observed that, one of the leading reasons of an accident is speed. The detection is dependent on the vehicle's current speed at the time. As a result, this is a good way to identify a threat. Speed can be measured using a variety of methods. The most popular is the accelerometer in an automobile. Whenever the vehicle is involved in an accident, the accelerometer will experience some delay (negative acceleration). At this point, the vibration sensor switches from low to high. The driver is wounded when the impact of an accident causes a significant shift in the driver's heartbeat.

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[2] Praharsha Sarma et al emphasized that, Ultrasonic sensors can be installed on the vehicle to recognize potential hazards. Along with the accelerometer, the vibration sensor mounted to axle of the vehicle is utilized to detect any unexpected movement. When an unexpected movement is detected, the system warns the driver, and when the accident is recognized, a message is sent via GSM module using the Arduino Uno. A GPS module (Longitude and Latitude) is used to determine the location, and the message is relayed via GPRS module [2]. Through the use of an eye movement sensor, a sensor which analyses eye movements, it is possible to determine whether the driver is attentive while driving and to alert the driver if he is tired.

[5] D. Indu, et al also observed that, Driver fatigue has been recognized as one of leading causes of traffic accidents. It causes significant physical injury, the threat to human life, and financial loss. It is claimed that 40% of highway accidents caused by drivers nodding off while driving.

[3] D Selvakumar et al emphasized that, to detect fatigue, an image processing technology is used, with the camera reading the driver's countenance and a buzzer warning the driver if he loses focus. The Open CV software toolbox is used to process the images.

This strategy is a minimal cost and successful way of reducing misfortune caused by driver fatigue and enhancing transportation safety.

[6] Other causes of accidents besides falling asleep on the road include heart attacks and alcohol usage. The alarm system continuously checks the driver's heartbeat and consumption of alcohol levels and notifies the emergency contacts if anything goes wrong. [3]

[13] V.V. Mhaske et al emphasized that An eye blink sensor is built into the device. The sensors detect an eye blink once the driver starts their vehicle. This gadget provides sensor output for comparison with ARDUINO. The buzzer rattles, the LED flashes, and the vehicle comes to a complete stop when the value hits the predetermined level.

[15] M.Ashok Kumar et al emphasized that An Arduino is used to interface a heartbeat sensor, an eye blink sensor, and an alcohol sensor in the system. If any of these sensors detects an abnormal driving state, the vehicle will automatically slow down and stop. A buzzer is installed in the car to inform other vehicles or the occupants within the vehicle. Simultaneously, an SMS alert with the driver's location and condition is delivered to the registered mobile number.

[17] Shabnam Abtahi et al also observed that to reduce accidents caused by driver weariness and to improve transportation safety.

Many distinctive body and face signals, such as yawning, eye exhaustion, and eye movement, are utilized as indicators of driver fatigue, indicating that the driver is no longer in suitable driving condition. A method to detect yawning based on the change in the geometric features of the mouth is presented.

Observation of The Survey

The surveying of the recognized papers gives an outcome that, the system architecture was limited to Arduino, Raspberry pi older version. The parameters used for detection of the accident were accelerometer, vibration sensor. Only use of these sensors doesn't give us an accurate conclusion of the accident. The data computed by the sensors for processing of the accident detection is not stored on any log file or cloud. If the data stored can be helpful for the analysis of the accident. In case of claiming an insurance, it would be a proof of how the accident occurred. The sensor system is not combined with any drowsiness detection even driver falling asleep is also one serious cause of the accident. Even the yarn of the person defines that the person is falling asleep. The eyeblink sensor used for drowsiness can't be accurate has it considers the normal blink of the eye. The alcohol sensor and heart beat sensor used to monitor the behavior and identify the abnormal behavior. Some of the alerting system uses Telegram [10] or What's app to alert but these can't be effective in case if the receiver mobile doesn't have the internet. This led to late notification of the accident.

III. PROPOSED SYSTEM

A. Objectives

The main objective of the proposed system is to

- Prevent an accident by monitoring the tilt of the vehicle, object approaching the vehicle and drowsiness of the driver and alerting the driver based on the reading of the sensors.
- Detect the vehicle accident with the on-going prevention parameters and detect the location coordinates of the accident.
- Sending the location coordinates through the SMS to the near ones and save lives by informing the rescue service at the earliest.

B. System Architecture

There are two phases in this system

Phase 1: accident detection using sensors and sending alert message.

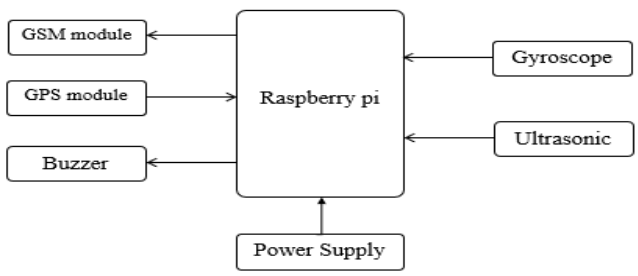

Figure 1: Phase 1 System Architecture

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Phase 2: Drowsiness Detection and alert system

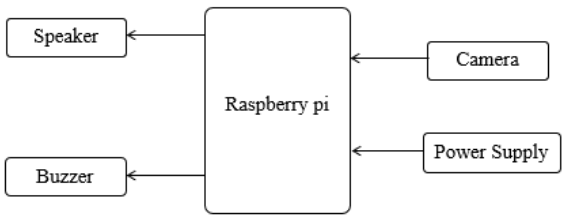

Figure 2: Phase 2 System Architecture

IV. SYSTEM REQUIREMENTS

The hardware and software requirements of the developed prototype are as follows

A. Hardware Requirements

1) Raspberry pi

The 64 Bit, 1.5GHz Quad-Core Cortex-A72 Processor, with 2 GB LPDDR4 RAM, the next version Raspberry Pi 4 Model B is quicker and also more efficient than its predecessors, with a Micro SD slot for loading the operating system & storing information. It becomes the ideal IoT ready solution with built-in wireless and Bluetooth connectivity. The Raspberry Control system continuously records each component of the car depending on Tilt angle, Objects approaching, and sleepiness in order to recognize and inform the driver to an impending issue. In the sad event of a disaster, the location of car is promptly relayed to the emergency numbers through GPS and GSM modules in order to get first aid and avert the unnecessary loss of lives. We need two Raspberry Pi, one for alert system and one for driver sleepiness detection just.

Figure 3: Raspberry Pi

2) Gyroscope Sensor

Gyroscope sensor with 2000dps, operating at voltage 2.3/3.4V is a device that can measure and maintain the orientation of vehicle. This is used to identify the tilt position of the vehicle.

Figure 4: Gyroscope Sensor

3) Ultrasonic Sensor

The sensor covers a distance of 4-4.5m, Sensing angle of 15º This sensor is used to identify the distance of the objects around the vehicle and notify the driver if the vehicle has crossed the threshold distance. When the vehicle collides with an object in the surrounding area, the accident is detected.

Figure 5: Ultrasonic Sensor

4) GPS Module

Covering a range of 3m position accuracy with data transfer rate of 9600 bps. The Global Positioning System (GPS) is a space-based navigation system operated by the United States. It provides continuous location, navigation, and time services to users globally in all weather conditions, day and night. This device has been used to trace the location of a vehicle and assists in determining where the car is when an accident happens.

Figure 6: GPS Module

GSM Module

GPRS a multi-slot with class12 connectivity 85.6kbps supporting a standard SIM Card. Supports Real-Time Clock. A GSM module is a device that connects to a remote network using GSM cellular telephone technology. In terms of the mobile phone network, they are nearly equivalent to a standard mobile phone, including the demand for a SIM to recognize oneself to the network. After detecting an accident, this module interacts with Raspberry Pi and relays the vehicle location where the accident occurred.

Figure 7: GSM Module

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5) Pi Camera

With Picture Resolution 2592 x 1944 and 5MP. Model A, Model B, and Model B+ have all been compatible. The Raspberry Pi To detect fatigueness, an image processing technology is used, with the camera reading the driver's countenance and a voice notifying the driver if he drops his focus.

Figure 8: Pi Camera

6) Speaker/Buzzer

With 0.5W. This is used to alert the driver when the thresholds of the parameters are crossed where it gives a voice message alert to the driver

Figure 9: Speaker

B. Software Requirements

1) Raspbian OS

To function, the Raspberry Pi requires an operating system. Our supporting operating system is Raspberry Pi OS (formerly known as Raspbian). Raspbian (previously Raspberry Pi OS) is a Debian-based OS for the Raspberry Pi. When coupled with a 2GB Pi board, the 64-bit version should demonstrate the debit card-sized maker board's multitasking and general computational power. Because it is based on Linux, Raspberry Pi OS may be easily adapted for specific use cases. Raspberry Pi OS provides probably the finest distribution for the majority of Pi users. It's a versatile operating system that will undoubtedly be improved and benefit from further development.

2) Thonny Python IDE

Thonny is a new integrated development environment (IDE) that comes with the newest Raspbian operating system. Thonny includes Python 3.6, so you don't need to build anything. Thonny offers a number of extra features that are ideal for learning programming. One of the most useful features is a robust yet simple debug mode. Instead of executing your programs, it goes line by line through the code. Variables and objects are being created, and values are being passed into functions.

V. METHODOLOGY

Phase 1: accident detection using sensors and sending alert message.

Working Principle

Integrate all individual models with raspberry pi to work it as per our flow chart (Figure 10) and setup the system with pin-to-pin connection (Figure 12). Using the ultrasonic sensor, we detect the objects approaching towards the vehicle either from the front or rear and alert the driver with a buzzer if the approaching object is near to the vehicle (Approx. 10cm)

Using the gyroscope sensor, we find the tilt position of the vehicle. Calculating gyroscope readings to recognize occurrence of vehicle accident. If the gyro sensor value is close to the threshold(50º), the driver receives a beep indication. Alternatively, if the readings above the threshold, a SMS alert containing latitude and longitude data is transmitted to emergency responders. All of the data is saved in a log file, that can be used to track or for future analysis.

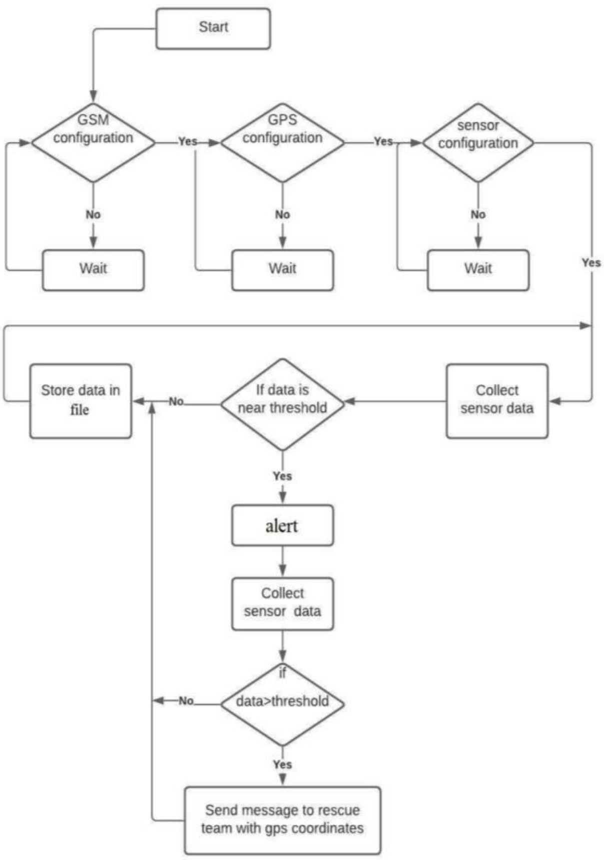

Figure 10: Flow Chart of accident detection

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Test cases	Ultrasonic	Gyroscope	Action
T1	<10cm	>Threshold	Alert to rescue
T2	>10cm	>Threshold	Alert to rescue
Warning			
T3	>10cm	>Threshold	Warning
T4	<10cm	<Threshold	Warning
T5	<10cm	>Threshold	Warning
T6	>10cm	<Threshold	No warning

Figure 11: Sensors Threshold Table for Alert and Warnings

Note: This is a prototype model so the threshold for ultrasonic is 10cm and gyroscope is greater than 50°

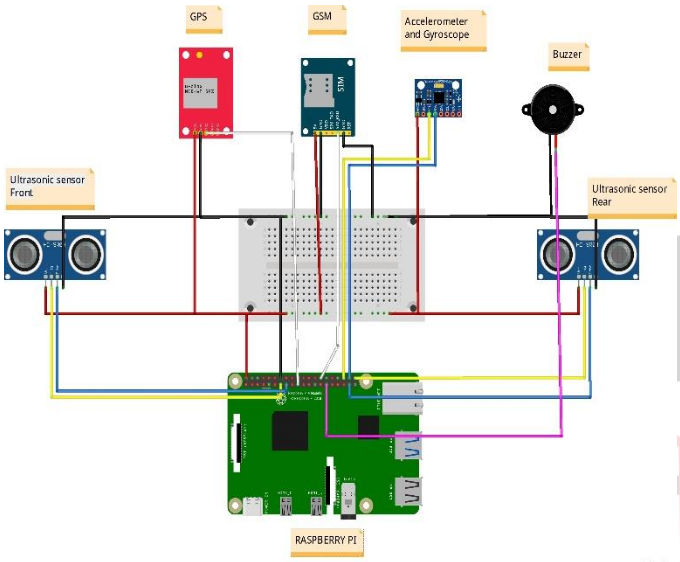

Figure 12: Integration of Individual Models to Raspberry Pi

Phase 2: Drowsiness Detection and alert system

Working Principle

Initialize the camera and start capturing the video with the pi camera. Extract the frame and convert the color image to grey image. The Haar Cascade Classifier files included with Open CV offer many classifiers for face and eye detection.

To search for and detect the face, the Open CV xml "haarcascade_frontalface_default.xml" is utilized, followed immediately by individual frames. Each frame of the driver's facial image is subjected to face recognition and open eye detection. We apply the Haar cascade on the eye region to detect the open eye region.

Compute the Eye Aspect Ratio (EAR). The eye state is determined by the eye aspect ratio. It is the ratio of difference between the coordinates on the edges of the eyes.

The EAR is computed using the formula.

$$EAR = \frac{\|p2 - p6\| + \|p3 - p5\|}{2\|p1 - p4\|}$$

Compare it with the threshold when the values go beyond the threshold which indicates the eyes to be closed. When the eyes are found to be closed in successive frames, a variable initially set to 0 will incremented by one. when the variable count go beyond the threshold frames an alert voice and buzzer message is given to driver.

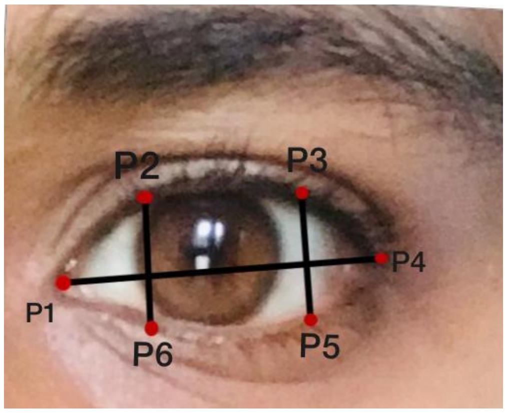

Figure 13: Coordinates of Eye

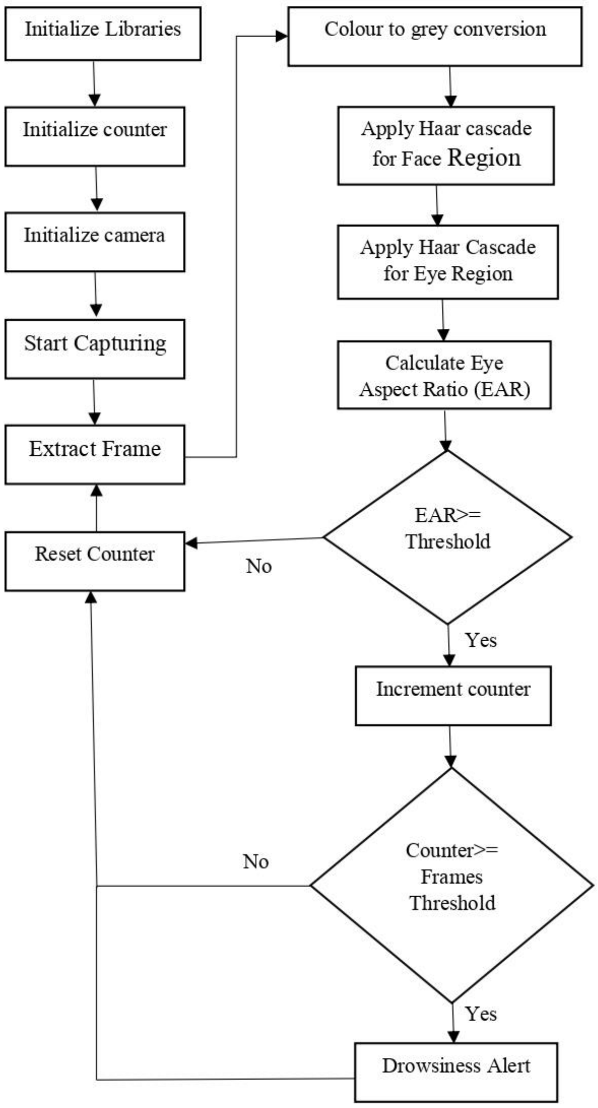

Figure 14: Flow Chart of Drowsiness Detection

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Note: This is a prototype model so the threshold considered for EAR is 0.3 and frames is 7

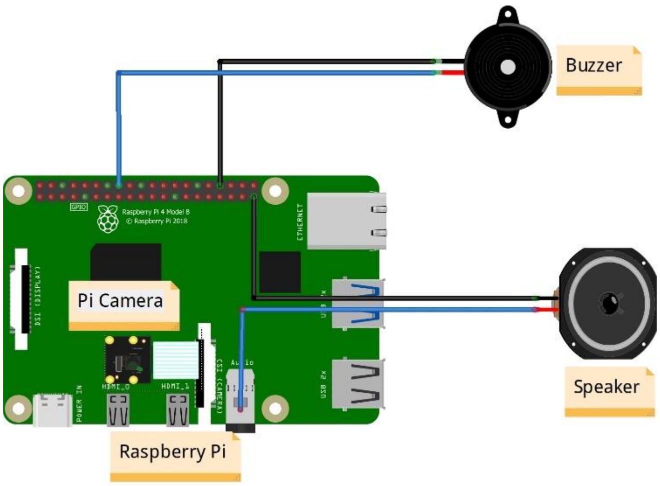

Figure 15: Integration of Models for Drowsiness Detection

Steps For Drowsiness Detection

- **Step 1: Take an image from a camera as input.**

We will use a Pi Camera to capture images as input. So, in accessing a Pi Camera, we create an endless loop that captures each frame.

vs=VideoStream(usePiCamera=True).

Start to access the camera and set the capture object,use start (). Each frame is read and saved to a frame variable using vs.read().

- **Step 2: Create a Region of Interest (ROI) based on the detection of a face in an image.**

The OpenCV object detection technique only accepts grayscale image as an input, we should first transform to grayscale in order to find the face. It is not necessary to have color information to detect the things. To recognize faces, we will use the Haar cascade classifier.

detector=cv2.CascadeClassifier(cv2.data.haarcascades+ "haarcascade_frontalface_default.xml").

The detection is then carried out using faces **rects = detector.detectMultiScale()**. It returns a list of observations with x and y coordinates as well as the height of the object's border box. We can now go through the faces and draw boundary boxes for each one.

The dlib facial landmark detector generates 68 (x, y)-coordinates referring to different facial structures. A form predictor was trained to produce this 68-point mapping.

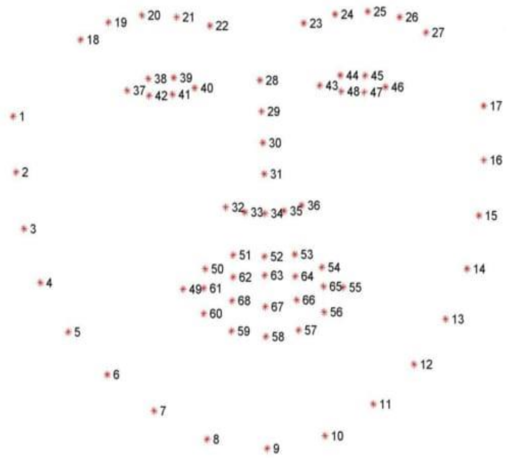

Figure 16: Visualizing the 68 facial landmark coordinates

The figure shows that face regions can be reached using simple Python indexing. (the image above is one-indexed, Python is assuming zero-indexing):

- [48, 68] Coordinates of mouth.
- [17, 22] Coordinates of right eyebrow.
- [22, 27] Coordinates of left eyebrow.
- [36,42] Coordinates of righteye.
- [42, 48] Coordinates of left eye.
- [27, 35] Coordinates of nose.
- [0, 17] Coordinates of jaw.

- **Step 3: Detect the eyes from ROI**

The mappings are saved as the FACIAL_ LANDMARKS_IDXS dictionary in the imutils library's face_utils.

Using these indexes, we retrieve the eye locations using an array slice.

Using NumPy array slicing, we get the (x, y)-coordinates of both left and right eyes.

We loop through each identified face, assuming there is only one driver face.

- **Step 4: detect the status of the eyes**

Relying on their (x, y)-coordinates, we then calculate the eye aspect ratios for the both eyes. Take the average of both eye's EAR

- **Step 5: Compute score to determine whether a person is drowsy.**

Score is a variable initialized to 0 that is used to know for how long the person has closed the eyes the score is incremented by 1 when both the eyes are closed and is decreased by one when the eyes are open or again reset to zero. When the score goes beyond the defined threshold this indicates that the driver's eyes have been closed for a longer

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period of time. This is when the driver hears an alarm, a buzzer alert, or a voice message.

VI. RESULTS

when the object approaches the system if it comes within a range of 10cm (due to it's a prototype model) the driver gets an alert message saying from which side the object is approaching i.e., either from front or back

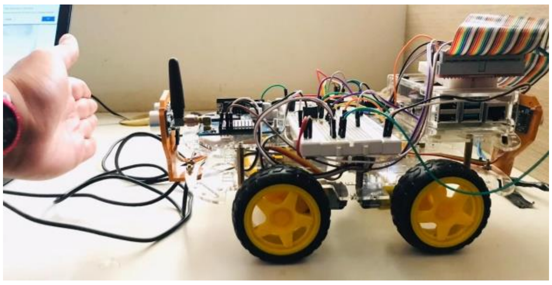

Figure 17: Object approaching the vehicle

The vehicle being tilt at angle 50º (due to it's a prototype model) indicates the safe zone if it goes beyond that then the system starts to alert the driver

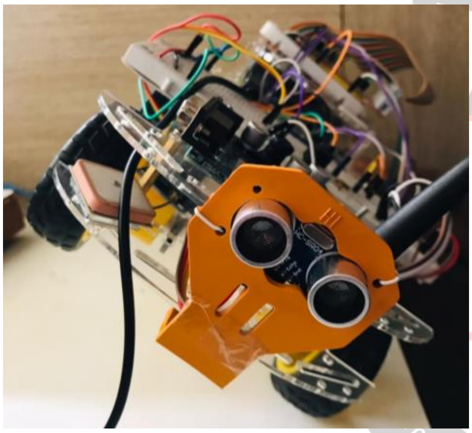

Figure 18: Vehicle being tilt

When the vehicle gets completely tilted it indicates that the accident has occurred

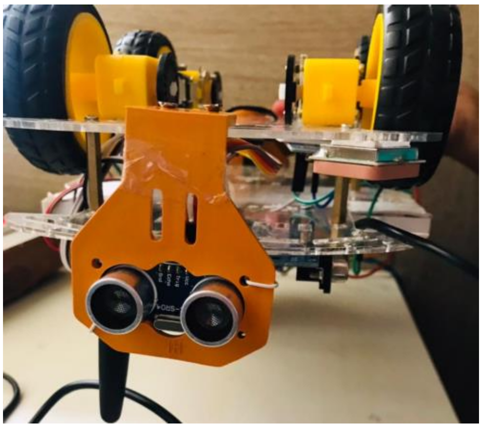

Figure 19: Vehicle tilted completely

When the accident occurs, it sends a rescue message consisting of vehicle location coordinates to the emergency contacts

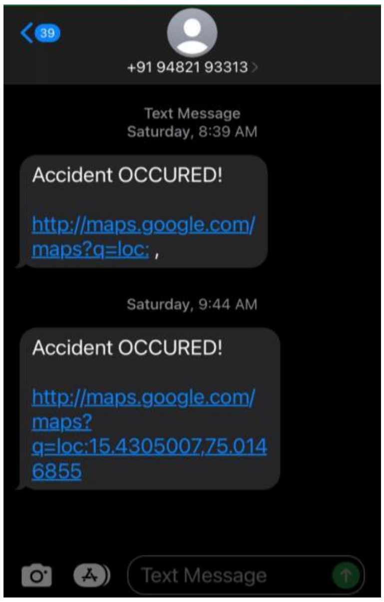

Figure 20: SMS sent to emergency contacts

The Pi Camera used for drowsiness detection alerts the driver if he falls asleep with a buzzer and a voice message.

Figure 21: Drowsiness Detection System

The camera first recognizes the face (blue square box) followed by the eyes (Green border around the eye)

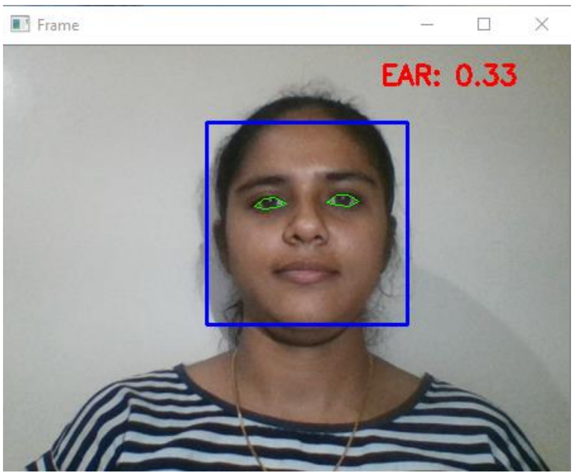

Figure 22: Detection of the Face and Eyes(T4)

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The system gives an alert when the person falling asleep is detected.

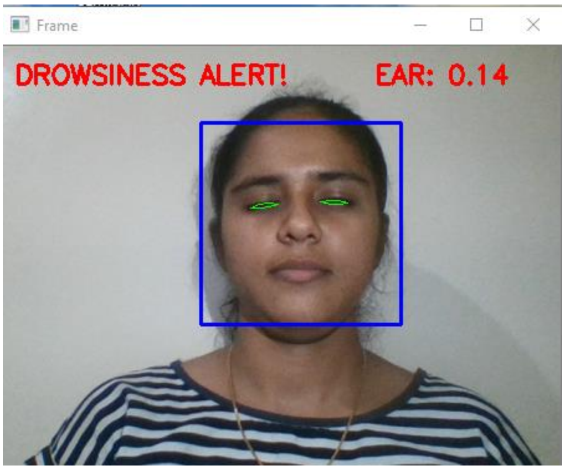

Figure 23: Alert when the drowsiness detected

Test case	Threshold EAR	Alerted EAR	Accuracy
T1	0.15	0.13	86.7
T2	0.3	0.20	66.7
T3	0.25	0.17	68
T4	0.15	0.14	93.3
T5	0.2	0.14	70
T6	0.3	0.24	80
T7	0.2	0.16	80
T8	0.15	0.11	73.3

Figure 24: Test case table of Drowsiness Detection

Note: This is a prototype model so the threshold considered range from 0.15-0.3.

$$Accuracy = \frac{\text{Alerted EAR}}{\text{Threshold EAR}} * 100$$

The System gives an average accuracy of 77.25% for an EAR threshold of range 0.15-0.3(for a prototype). The average threshold is 0.2 and the average EAR at which the system alert is 0.21.

VII. CONCLUSION

The proposed system alerts the driver when any object is approaching the vehicle, when the vehicle gets into a tilt position and when the driver is falling asleep and when the accident occurs due to complete upside down tilt of the vehicle the vehicle coordinates are sent to the emergency contacts through SMS. This system can be a life saver for the people who meet with the accident in remote places. This prototype model can be enhanced in real-time in future and it can be an advanced level safety system in automotive industry.

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