Heart Health & Drowsiness Analysis of Driver for RoadSafety

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Abstract - *The "HEART HEALTH & DROWSINESS THE " ANALYSIS FOR ROAD SAFETY" project was created exclusively to ensure the safety of those who operate motor vehicles, rest in passenger seats, ride bicycles, stroll along footpaths next to roads, and engage in various other activities. According to a survey, about 1.3 million people die yearly in traffic accidents because of road conditions, driver error, car component failure, and driver error. It is said that a vehicle accident occurs every five seconds. Another study by Stanford Law School found that 90% of car crashes are the result of human error. Fatigued drivers, who drive despite being warned not to, or who have other health problems can make mistakes. 40% of all traffic mishaps are the result of sleep deprivation. By preventing drivers who are sleep deprived or have heart issues from operating a vehicle, our device seeks to decrease the enormous number of accidents. It will guarantee fewer accidents each year due to heart disease and lack of sleep, boosting the confidence of people who cross in front of moving vehicles.*

Key Words: road safety, drowsiness, heart rate analysis, road accidents.

1. INTRODUCTION

It is clear from reading studies conducted by international and national organizations like the Ministry of Road Transport & Highways and Motor Vehicle Departments that accidents caused by health issues are becoming more frequent every day. As the years go by, there are more cars on the road. As this is occurring, the number of accidents on the road brought on by human error is rising proportionally. When a fatal accident occurs due to a basic factor like lack of sleep, it is frightening for anyone driving a motorcycle or walking next to the road. The concept for this straightforward yet effective project was born out of the need to overcome this fear of the driver and other road users. If properly implemented globally, this straightforward device could assist in reducing the 40% to 0% at some point in the future. National and state highways makeup 5.04% of all roads in India and collectively account for almost 54% of accidents and 60% of fatalities, with the remaining 94% of Indian roadways accounting for 45% of accidents and 39% of fatalities. Each year, business accidents claim the lives of around 1.3 million individuals. A new 20 to 50 million people each year suffer lethal injuries, and many of them go on to have disabilities. Road traffic accidents result in huge economic losses for individuals, their families, and entire nations. These losses have an impact on the cost of medical care, missed stipends for people who pass away or become disabled as a result of their injuries, and caregiving costs for relatives who must take time off from work or school to care for the injured. Most countries lose three percent of their GNP due to transportation accidents.

1.1 Objective Of Research

We plan to create a straightforward yet effective embedded system that can capture the driver's face, analyze the data from it, and determine whether the driver is sleep deprived. Additionally, this device will have a PPG sensor to monitor heart rate and determine if there are any significant changes. If so, the driver will be prompted to rest or take safety precautions.

2. LITERATURE REVIEW

[1] Design of Drowsiness, Heart Beat Detection System, and Alertness Indicator for Driver Safety:

Accident rates are rising and there is no safety for the driver or passengers as a result of driver error. Hence, accident rates can be reduced by continuously monitoring the driver, identifying tiredness and heart rate variations, and also warning him when he deviates from his regular situation. Motion detection for predicting drowsiness and the R-peak detection algorithm for counting heartbeats are two effective techniques for performing this. For the sake of the simulation, an example is used to demonstrate the driver's condition. The insights collected can be used to create an intelligent vehicle that recognizes the driver's weariness, boosting the driver's safety and security, and lowering accident rates.

[2] A Real-Time Heart-Rate Monitor Using Noncontact Electrocardiogram for Automotive Driver:

Contact Electrocardiogram for Automotive Driver: The design and development of a quick and accurate real-time heart rate monitoring device for automobile drivers the created system used the non-contact ECG principle on a steering wheel. To provide real-time HR monitoring, the system used a straightforward analog signal conditioning circuit and a digital computing unit.

[3] A Video-based Heart Rate Monitoring System for Drivers Using Photoplethysmography Signal:

Real-Time Driver's Drowsiness Monitoring Based on Dynamically Varying Threshold: Our face detection and recognition algorithms use effective, highly accurate, and low false positive rate techniques. We have developed a concept where the system monitors the driving schedule to dynamically adjust the threshold after three hours of driving because the driver is more likely to fall asleep later on. By incorporating face recognition, we were able to successfully implement this idea and make the system work for numerous drivers. The number of traffic accidents can be decreased by using our suggested approach to inform the driver and check the driver's condition.

[4] Real-Time Driver's Drowsiness Monitoring Based on Dynamically Varying Threshold:

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[5] IoT-based System for Heart Rate Monitoring:

IoT-based system for monitoring and controlling human cardiac rate is created. For data collecting, this system makes advantage of the capabilities of a heart rate sensor. The microcontroller processes data signals representing a person's heartbeat. For additional analytics and visualization, the processed data are sent to the IoT platform. The system's ability to sense and read the user's heartbeat rate and transfer that data over Bluetooth to the Android mobile app (Blynk) led to the discovery that the experimental results were accurate. The results showed that the heartbeat rate was low if it was between40 and 60, medium if it was between 60 and 100, and highif it was between 100 and 150.

3. PROPOSED WORK

Drowsiness Check Module:

The system initializes essential libraries for image capturing and frame extraction and checks if the camera is properly initialized. If the camera is initialized, the system begins capturing and extracting frames of the driver's face. If not, the process is aborted and an exception is logged. The driver's eye aspect ratio (EAR) is calculated and compared to a predefined threshold. If the EAR is less than the threshold, it means the driver's eyes are open, and the system continues to operate normally. But if the EAR is greater than the threshold, it means the driver's eyes are closed, and an alarm system is triggered to alert the driver. This system is intended tohelp prevent accidents caused by drowsy driving. The EAR calculation involves measuring the ratio of the distance between the top and bottom eyelids to the distance between the left and right corners of the eye. The system continuously captures and processes frames, updating the EAR calculation with each new frame. The alarm system can be configured to use different types of alerts, such as a sound or a visual alert. By monitoring the driver's eyes, the system can detect when the driver is falling asleep or distracted, allowing for prompt intervention to prevent accidents. The use of a camera to capture images and frames, combined with the EAR calculation, allows for the accurate detection of driver drowsiness. Overall, this system provides a reliable and effective method for monitoring driver behavior and promoting safe driving habits. It is a useful application of computer vision and machine learning techniques to real-world problems. We are using a webcam with Raspberry Pi 4 for running the software and getting the alert when the driver gets drowsy. For the present prototype, The Pi is connected to a webcam instead of a camera module since it is a developmental prototype. If the system is to be implemented in Car, it'll be connectedto a camera module integrated into the Pi. Below in Figure 1, You can see the two devices coupled to get a favorable result.

Fig-1: Raspberry Pi with Camera

Technical Working Principle:

The module imports several libraries, including Idlib, imutils, and OpenCV (cv2). These libraries are used for face identification, image processing, and other computer vision-related activities. The facial landmark predictor file location, the minimum EAR (eye aspect ratio) value for open eyes, and the maximum number of consecutive frames in which EAR can remain less than the minimum EAR are all set after that. The module then initializes the face detector and landmark finder/predictor based on an adlib's HOG (Histogram of Oriented Gradients). Also, it sets up the webcam stream so that photographs can be taken in real-time. Next, it defines a function called "beep" that, when called, plays an audio file called "alarm.wav." Additionally, it defines a different function called "eye aspect ratio," which accepts an eye as input and determines its EAR. Lower values of the EAR indicate closed or partially closed eyes, whereas higher values indicate how much the eye is open. It then starts reading frames from the webcam feed continually while initializing a counter variable called EYE CLOSED COUNTER. The image is scaled down to 800 pixels in width and made grayscale for each frame by the code. The face detector is then used to find faces in the image. The module locates the facial landmarks for each recognized face using the landmark finder and transforms them into NumPy arrays. The left and right eyes are then separated from the facial landmarks, and each eye's EAR value is calculated. The computed EAR value is then displayed on the image, and outlines are drawn around the left and right eyes. The function increases the EYE CLOSED COUNTER if the estimated EAR value is less than the minimum EAR value. The function resets the EYE CLOSED COUNTER to 0 if the EAR value is greater than or equal to the minimum EAR value. The code shows the word "Drowsiness" on the image and activates the beep function to play an alarm sound if the EYE CLOSED COUNTER goes over the allotted frame count. Until an exception happens, this process continues. Here the frame is captured when the eye is opened and when it detects drowsy eyes as well.

Fig-2: Open eyes giving no warning since an EAR is within the threshold

Fig-3: Drowsy eyes give a warning since an EAR is less than the threshold.

Heart Rate Analysis:

To effectively monitor the driver's heart rate, several libraries are initialized to aid in the computation of the heart rate. The system then checks whether the heart rate sensor is properly initialized, and if not, an exception is raised and logged for debugging purposes. If the sensor is properly initialized, the heart rate is collected from the optical heart rate sensor. The data is then processed to remove any noise that may have been captured during collection. The cleaned heart rate data is compared to a predefined threshold value that was set to identify a potentially dangerous situation. If the driver's heart rate falls below the threshold, the system continues to operate normally, and no action is taken. However, if the heart rate exceeds the threshold, the system sends signals to theESP, which begins controlling the throttle of the vehicle and aligning it to the left side of the road. The vehicle is eventually brought to a stop, and an SMS alert is sent to the appropriate set of people. Overall, the system ensures that the driver's heart rate is continually monitored, and if any anomalies are detected, appropriate actions are taken to prevent potential accidents.

Fig-4: Raspberry Pi with PPG Sensor

Technical Working Principle*:*

The module imports several necessary libraries, such as win sound, time, statistics, and random. The module initializes lists for storing high and low readings as well asvariables for frequency, duration, and threshold values. Then it goes into an endless loop to keep track of the heartrate. First, a timer for 10 seconds of sampling time and an empty list of heart rates are initialized within the loop. Then, to simulate a real heart rate reading, it generates a random heart rate number between 0 and 160. The list of heart rates now includes this value. Up until the 10-secondsampling period has passed, the loop keeps collecting samples every 1 second. The statistics module is then usedto determine the average heart rate. The script reports thatthe heart rate has exceeded the threshold and adds the most recent heart rate measurements to the list of the highif the average heart rate is higher than the threshold high value. When this condition is satisfied twice in a row, the win sound module emits a prolonged, high-frequency beep. Similarly, to this, if the average heart rate falls belowthe threshold low value, the module reports this and adds the most recent heart rate data to the list of lows. When this condition is satisfied twice in a row, the win sound module emits a prolonged, low-frequency beep. The scriptreports that the average heart rate is within the range if it falls within the threshold range. When the heart rate has returned to the normal range, the warning count variable is reset to zero. The module then waits one second before collecting the subsequent 10-second sample.

```
HR exceeds threshold:  124.6
LOGGED: [120, 151, 136, 97, 99, 152, 103, 132, 140, 116]
HR exceeds threshold:  132.1
LOGGED: [120, 127, 159, 158, 137, 146, 92, 132, 152, 98]
LOGGED HIGH: [[120, 127, 159, 158, 137, 146, 92, 132, 152, 98]] | Avg: 132.1
```

Fig-5: Logging of Heart Rate with Average

4. HARDWARE DESCRIPTION

A. Requirement:

1. PPG Heart Rate Sensor - For Analyzing heartbeats
2. Raspberry Pi 4 - For processing the code
3. Webcam – For drowsiness check
4. Buzzer/Speaker – For alerting the driver
5. Connecting Wires – For connections

B. Raspberry Pi 4: The Raspberry Pi 4 is a single-board computer that is small, cheap, and powerful, with a variety of networking possibilities. It is perfect for a variety of crafts and uses, including DIY projects for hobbyists and commercial products. We use Raspberry Pi as a controlling and processing unit for our module.

C. PPG Heart Rate Sensor: PPG heart rate sensors are frequently found in wearable gadgets like smartwatches and fitness trackers. They work by shining a light on the skin and measuring changes in the absorption or reflection of light caused by blood flow. We used this sensor for the effective detection of heart rate.

D. Webcam: A webcam is a digital camera that records video and transmits it to a computer or over the internet. We use a webcam for drowsiness detection which will capture the whole face and send it for processing.

E. Algorithm: Algorithm uses a combination of computer vision libraries including OpenCV, dlib, imutils, and scipy to detect facial landmarks and estimate eye aspect ratio for drowsiness detection.

F. Programming: we use Python as a programming language to communicate with the hardware devices, read sensor data, work with the General-Purpose Input/Output (GPIO) pins on the Raspberry Pi, and process the data which is collected from the PPG sensor and Webcam and control the output.

5. PERFORMANCE METRIC

Drowsiness Detection Algorithm (dlib vs haar cascade)

OpenCV and Dlib provide face detection algorithms commonly used in computer vision applications. While both algorithms are effective at detecting faces in images and videos, there are some differences in their performance and capabilities that make Dlib a superior algorithm in many cases.

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Another advantage of Dlib is its ability to detect facial landmarks, such as the eyes, nose, and mouth, with high precision. This is useful for applications such as facial recognition and emotion detection, which require precise location of facial features. Dlib also provides a face recognition module that can be used to recognize faces from a database of known individuals. This module uses a deep learning-based algorithm to extract facial features and match them to a database of known faces. This feature is not available in OpenCV.

Finally, Dlib is an open-source library with an active developer community, which means that it is constantly being updated and improved. It is also available in several programming languages, including Python, C++, and Java.

Overall, while OpenCV is a solid face detection algorithm, Dlib's combination of accuracy, robustness, and additional features make it a superior choice for many computer vision applications, particularly those that require high precision and performance.

Time Consideration of dlib and haar cascade cv2
Considering loading model
dlib: 2.208890199661255
HaarCascade (cv2): 2.6401994228363037
Without model load time
dlib: 0.7304553985595703
HaarCascade: 2.6089558601379395

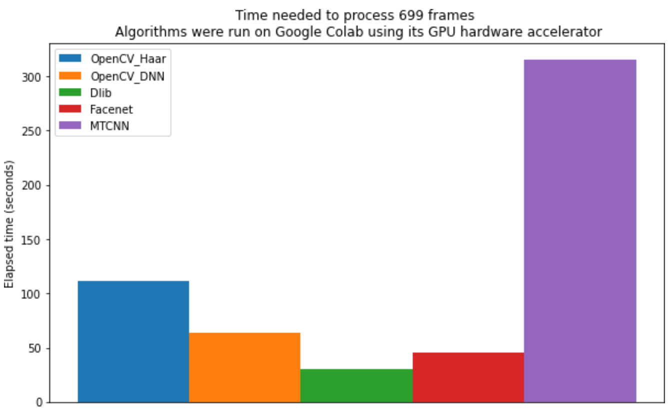

Fig 6: dlib vs other face detection algorithms

Several studies have compared the performance of different facial landmark detection models, and the shape_predictor_68_face_landmarks.dat model has been shown to be among the most accurate models. For example, in a comparative study by Zhang et al. (2016), the shape_predictor_68_face_landmarks.dat model achieved an average error of 3.68 pixels on the facial landmark detection task, which was found to be among the best-performing models in the study.

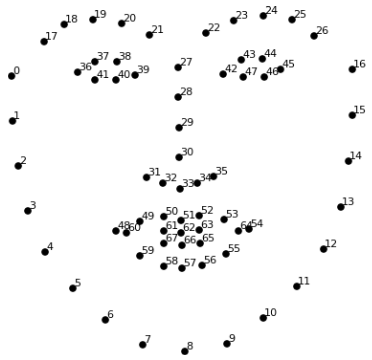

Fig 7: dlib face detection strategy

The shape_predictor_68_face_landmarks.dat model has been evaluated in various studies, with reported average errors ranging from 2.45 to 4.4 pixels depending on the specific evaluation metric and dataset used. In addition, the model has been shown to achieve high precision and recall rates on the facial landmark detection task, indicating a high level of accuracy and consistency. Overall, the shape_predictor_68_face_landmarks.dat model is widely regarded as one of the most accurate and reliable facial landmark detection models available.

Ppg Sensors

While PPG sensors may not be as accurate as ECG sensors, they are still a valuable tool for monitoring heart rate in real-world settings. PPG sensors offer several advantages over ECG sensors, including their non-invasive nature and their ability to be integrated into wearable devices such as smartwatches and fitness trackers.
PPG sensors are also less expensive and easier to use than ECG sensors, making them accessible to a wider range of users. PPG sensors can provide continuous heart rate monitoring over an extended period of time, which can be useful for tracking changes in heart rate during physical activity or throughout the day.

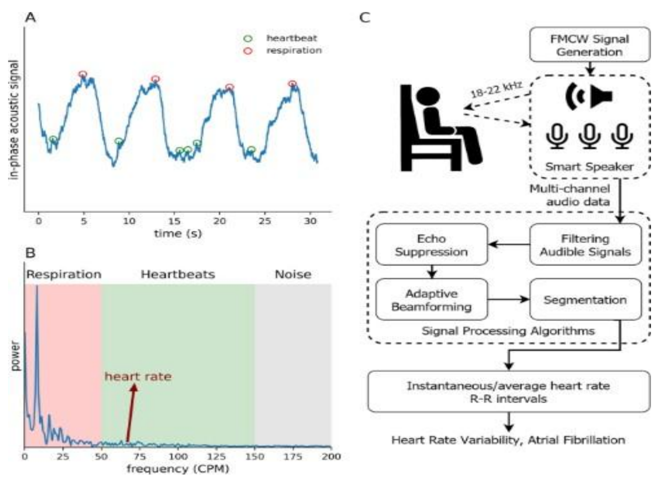

Fig 8: PPG Sensor performance

Additionally, PPG sensors have been shown to be effective in detecting certain health conditions such as sleep apnea and hypertension. One study found that a wrist-worn PPG sensor was able to detect sleep apnea with an accuracy of 92%, compared to 87% for a traditional sleep study.

6. ADVANTAGES

We have mainly 2 modules in our project one is Heart Rate Analysis and Drowsiness Detection. Both modules take a vital part in road safety and precautions for road accidents. It is challenging to pinpoint the precise number of accidents caused by sleepy driving because there are so many contributing variables, and reporting requirements differ between nations and regions. The National HighwayTraffic Safety Administration (NHTSA) in the United States estimates that drowsy driving causes 100,000 collisions, 71,000 injuries, and 1,550 deaths annually. The four-wheeler vehicle's drowsiness detection module can prevent thousands of collisions and save the lives of the driver and passengersby taking preventative measures like alerting the driver with an alarm system or vibrator on the steering whenever a sleepy face is detected. Another important module in our system is precautionary actions based on the driver's heart rate analysis. Heart-related problems can pose a serious risk to drivers and passengers, particularly during long-distance or high-stress driving situations. In some cases, a heart attack or other cardiac event can cause the driver to lose control of the vehicle, leading to a potentially fatal accident. However, if heart problems can be detected early while driving, steps can be taken to reduce the risk of an accident and save lives.We use PPG heart rate sensors on the steering and seat belt of the driver. This will effectively collect the driver'sheart rate and controls the ADAS if there is any major changes. ADAS with the help of AI applies the break smoothly and stops the vehicle. Not only does it trigger the ADAS for safe deceleration, but it also alerts the emergency contacts via SOS.

7. DISADVANTAGES

Since we have two modules in our system drowsiness detection and heart rate analysis. Both have their own set of advantages and disadvantages. When it comes to the Drowsiness detection module there can be many cases where the accuracy of our module would be less such as False alarms, which can annoy and distract the driver, are one of the major problems. Inaccurate drowsiness detection by the system could result in false alerts, giving the driver a false sense of security. Another drawback of drowsiness detection systems is that they might not be effective for all drivers due to the broad range of physiological conditions and individual sleep habits. Installation costs. To ensure optimum performance, the system might also need routine calibration and maintenance, which can be expensive andtime-consuming. Last but not least, a few drivers might find the system intrusive, leading to worries about data protection and sharing of personal information. And in the Heart Rate analysis module there can be limited accuracy of PPG sensors is one of their major drawbacks. The accuracy of the heart rate reading may be impacted by their sensitivity to skin pigmentation, ambient light, and motion artifacts. Furthermore, PPG sensors only have a small detection range, which may make them less effectivefor detecting pulse rates during vigorous exercise or otherphysical activity.

8. RESULT AND CONCLUSION

Heart-related problems can pose a serious risk to drivers and passengers, which can cause the driver to lose control of the vehicle, leading to a potentially fatal accident. However, if heart problems can be detected early while driving, steps can be taken to reduce the risk of an accident and save lives. Sensors and monitoring systems can be used to identify heart issues while driving. The driver's heart rate might be continuously monitored, for instance, by integrating a PPG heart rate sensor into the driver's seat or steering wheel. An automated mechanism may be activated to slow down the car and bring it to a stop safely if the sensor picks up aberrant heart activity. After correctly identifying the signs of heart difficulties, the system might send an SOS to the relevant group of people, suchasemergency services or a chosen contact, inaddition to automating breaking. This could ensure that the motorist receives immediate medical care, possibly saving their life. Especially on long drives or at night, driver fatigue is a frequent contributor to car accidents. Driving while fatigued can result in decreased alertness, slowed reaction times, and poor decision-making abilities, endangering both the driver and other road users. Eye movement detection devices are used to stop accidents brought on by drowsy driving. To measure the driver's level of attention and detect eye movements, we use web cameras and sensors. An alarm can be delivered to the driver if the system notices symptoms of drowsiness, suchas extended periods of eye closure or a lack of eye movement.

9. REFERENCES

[1] Rahul Kumar Singh, Archisman Sarkar Student member IEEE, Indian Institute of Technology Kharagpur, India, A Real-Time Heart-Rate Monitor Using Non-Contact Electrocardiogram for Automotive Drivers.

[2] Anil Kumar CV, Mansoor Ahmad IEEE International conference on recent trends, Design of Drowsiness, Heart Beat Detection System and Alertness Indicator for DriverSafety.

[3] po-Wei Huang, graduate student member, IEEE, Bing- Jhang Wu, graduate member, IEEE Journal of Biomedical and health informatics, a heart rate monitoring frameworkfor Real-world drivers using remote photo plethysmography.

[4] Greentheonly, Youtuber, Face Tracking during Autopilot.

[5] The Hindu Times, Accident Survey. https://www.thehindu.com/data/data-in-2021

[6] Hindustan Times, Accident due to heart attack, https://www.hindustantimes.com/man-suffers-heart-attack-dies-in-car-accident