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Accident Prevention System using Driver Drowsiness Detection

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Abstract:- According to the recent survey of National Highway Traffic Safety Administration, United States, 30% of the car accidents take place due to driver drowsiness or fatigue. This project addresses this issue by continuously monitoring the drowsiness of the driver with the help of heartbeat sensor and night vision camera. Heartbeat sensor is used to find the variation in heart beat due to drowsiness and night vision camera is used to monitor the eye blinking rate. The driver's heartbeat count and the number of eye blinks are continuously monitored for a period of 2 minutes using a heart beat sensor and night vision camera respectively. From the measured values, the proposed system mathematically manipulates the drowsiness and fatigue level of the driver. If the driveris found to be drowsy, an alarm by means of a buzzer is given to the driver to alert him not to sleep. Additionally, in case of accidents the information about the location is sent to the ambulance server through the IOT, by the virtue of Vibration Sensor.

Keywords:- *Heartbeat, Eye Blink, Vibration Sensor, Drowsiness.*

I. INTRODUCTION

Vehicles play a vital role in transportation. Transport infrastructure consists of the fixed installations including roads, railways, airways, waterways, canals and terminals such as airports, railways, warehouses, trucking terminals, refueling depots (including fueling docks and fuel stations) and seaports. Vehicles travelling on these networks include automobiles, bicycles, buses, trains, trucks, helicopters, watercraft, spacecraft and aircraft. When compared to airways railways and waterways, accidents mainly happen in roads. The number of people travelling by roads in high and therefore the accident occurring in roads is high. There are many accidents that occur in roads, among that vehicle collisions and falls are the most common causes of fatal injuries.

The main causes for road accidents are cell phone usage during driving, drunken driving, over speeding, drowsiness, red light jumping and avoiding safety gears like seat belt and helmets. Among all these most of the cause can be detected, for example, police can detect cell phone usage and drunken driving and it can be avoided. No one knows the exact moment when sleep comes over his or her body. This usually happens when a driver has not slept enough, but it can also happen due to untreated sleep disorders, medications, drinking alcohol, or shift work. Drivers who are deprived of four plus hours of sleep is 10.2 times more accident-prone.

According to survey, 30% of accidents in USA is occurring due to drowsiness. The National Highway Traffic Safety Administration estimates that drowsy driving was responsible for 72,000 crashes, 44,000 injuries, and 800 deaths in 2013. However, these numbers are underestimated and up to 6,000 fatal crashes each year may be caused by drowsy drivers. From estimation, 1 in 25 adult drivers (aged 18 years or older) report having fallen asleep while driving in the previous 30 days. Nearly one-third (31%) of the crashes were severe enough to result in injury, rollover, airbag deployment or significant property damage. The rest generally were not severe enough to report to police. Drowsiness makes the driver to pay less attention to the road, slow reaction time if you have to brake or steer suddenly and affects a driver's ability to make good decisions. The symptoms for the sleep foundation are, Difficulty in focusing, frequent blinking or heavy eyelids, Daydreaming, wandering / disconnected thoughts, Trouble remembering the last few kilometres of driving, Yawning repeatedly or rubbing your eyes often, Drifting from your lane, Feeling restless and irritable., Hitting a rumble strip on the side of the road. In this paper, using a camera and the heart beat of the driver, the drowsiness is detected and it alerts the driver. In case, if accident occurs it updates the location of the accident to the ambulance server.

The Objectives of the work include, Detecting the drowsiness of the driver, Updating the location, heartbeat and the drowsiness level of driver, In case of accident, the location is updated in the ambulance server.

II. RELATED WORKS

In [1], Joe et al proposed a module, which monitors the heartbeat and respiratory rate. It works analysing running windows of one-lead 2 minutes ECG. Once the system starts, it provides an output indicating whether the driver is sleep-deprived or not, thus after 3 minutes, the system detects whether he is suitable for driving or not. The detector evaluates the state of the driver every minute, maintaining the alarm OFF if the driver is identified as awake and triggering the alarm to ON if the driver is identified as drowsy or fatigued. The signal processing and online system algorithms were implemented in MATLAB. In [2], B.Bhavya et al proposed a two-way approach for accident detection and prevention. If there is no pupil found for the certain period of

pre-determined i.e. time greater than the human eye blinking time, the blink detector identities it and alerts the driver. The final technique for detecting level of drowsiness by monitoring the response of the driver. This involves periodically requesting the driver to send a response to the system to indicate alertness. The problem with this technique is that it will eventually become tiresome and annoying to the driver. In [3], K. Dwivedi et al discuss about the Convolutional neural nets in this paper. Convolution neural nets are a variation of feed forward neural nets which incorporates three unique features: local receptive fields, sharing of weights and sometimes spatial or temporal polling. The proposed methods aims to classify frames in videos based on special facial features learnt via convolution neural network. Using a camera the drowsiness of the driver is detected and the driver is alerted. In [4] Tereza Soukupova and Jan Cech [4] has proposed a work to detect the face andeye from the video frames. EsraVural, Marian Bartlett, Gwen Littlewort, Mujdat Cetin, AytulErcil, Javier Movellan [5] discussed a way to discriminate moderate from acute drowsiness by applying computer vision techniques to the human face. It finds which facial muscle movements are predictive of moderate and acute drowsiness. The effect of temporal dynamics of action units on prediction performances is explored by capturing temporal dynamics using an over complete representation of temporal Gabor Filters.

The main objective of the project is the detect the drowsiness of the driver in the initial stage by using a camera. Initially, the heartbeat of the driver is recorded for 2 minutes and the average of all the values is taken as a threshold value. If there is any variation in the value, the system turns on the camera and detect the drowsiness level of the driver. If the driver is found to be drowsy, then the driver is alerted using the buzzer. The location of the vehicle, the heartbeat and the level of drowsiness of the driver is sent to the cloud and it stores the information as online black box. If the accident is detected using vibration sensor, the system immediately updates the value to the ambulance server. If the recovery button is pressed within 60 seconds, the system updates that it is a minor accident. If the recovery button is not pressed within 60 seconds, the system updates that the accident is major to the ambulance server.

III. IMPLEMENTATION

The Hardware requirements include Heartbeat Sensor, Raspberry pi 3, GPS Module, Switch, Buzzer, Camera and Vibration sensor and the Software Requirements include OpenCV (Open Source Computer Vision Library) The Programming Languages used are Python and HTML. The overall block diagram of the project is shown below fig.1. . The entire project is divided into three modules. The first module is to detect the drowsiness. The heartbeat sensor reads the value of heartbeat of the driver, if there is any variation in the pre-recorded value then it alerts the system. The system turns on the camera and calculate the Eye Aspect Ratio (EAR) of the driver and if the driver is found to be drowsy then the buzzer turns on and alerts the driver and this process is explained in Fig. 2.

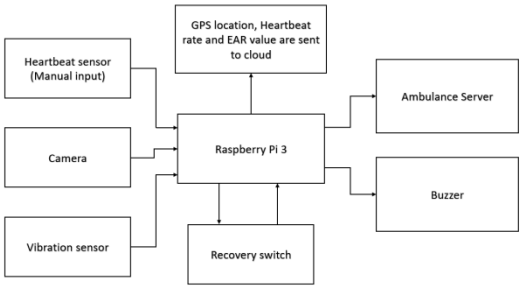

Fig 1:- Overall block diagram

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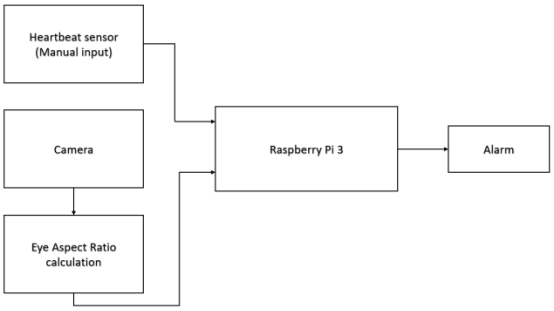

Fig 2:- Block diagram of module 1

The second module sends the GPS location, heartbeat and the level of drowsiness of the driver to the cloud. Using this the location of the vehicle can be tracked in online.

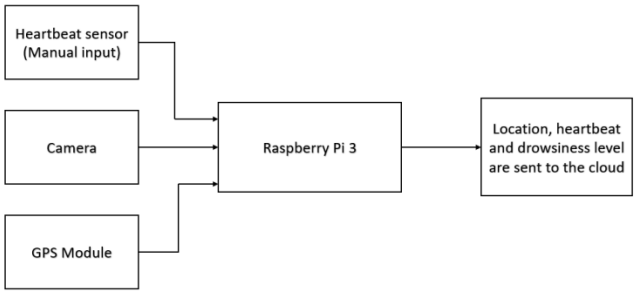

Fig 3:- Block diagram of module 2

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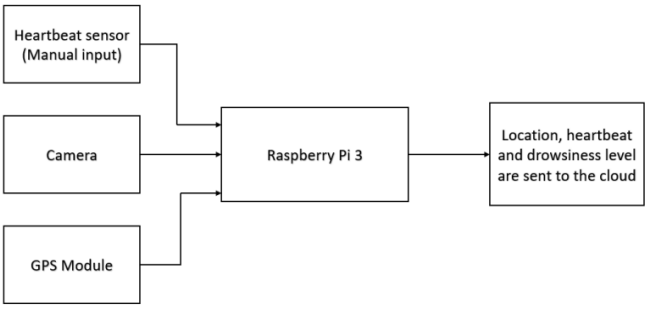

Fig 4:- Block diagram of Module 3

In this third module as shown in Fig.4, the vibration sensor detects the accident and update the location of the accident to the ambulance server. If the recovery switch is pressed within 60 seconds the accidents is mentioned as minor accident. If the recovery switch is not pressed within 60 seconds then the accident is mentioned as major accident.

A. Face Detection

Object Detection using Haar feature-based cascade classifiers is an effective object detection method proposed by Paul Viola and Michael Jones in their paper, "Rapid Object Detection using a Boosted Cascade of Simple Features" in 2001. It is a machine learning based approach where a cascade function is trained from a lot of positive and negative images. It is then used to detect objects in other images. The algorithm needs a lot of positive images (images of faces) and negative images (images without faces) to train the classifier. Then we need to extract features from it. For this, haar features shown in below image are used. They are just like our convolutional kernel. Each feature is a single value obtained by subtracting sum of pixels under white rectangle from sum of pixels under black rectangle.

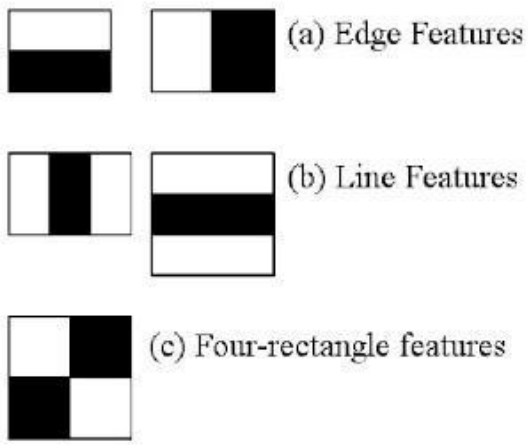

Fig 5:- Blocks for face detection

B. Heart Beat Rate Per Minute

Normally heartbeat rate of a person different from the activity done by him/ her. Table 1 shows the heartbeat variation in different activity done by a person.

Activity	Beats per minute
Normal	60-100
During rest	50-90
Sleeping	40-50
Exercise	100-150

Table 1. Heartbeat variation

C. Rapid Eye Movement (Rem) Sleep

A kind of sleep that occurs at intervals during night and is characterized by rapid eye movements, more dreaming and bodily movement, and faster pulse and breathing. REM sleep happens 90 minutes after you fall asleep. It is only about 20% of your total sleep time.

D. Non-Rem Sleep

A kind of sleep that occurs 5 – 10 minutes before deep sleep. There are three stages in Non – REM sleep.

Stages 1**:** Eyes are closed, but it is easy to wake up. This phase may last for 5 to 10 minutes.
Stages 2**:** The driver will be in light sleep. Heart rate slows down and body temperature drops. The driver is getting ready for deep sleep.
Stages 3**:** This is the deep sleep stage.

IV. UNITS

In real time, heartbeat rate varies for one another (Tachycardia is a fast heart rate, defined as above 100 bpm at rest. Bradycardia is a slow heart rate) during drowsy state. We are not using Heartbeat sensor to calculate the heartbeat rate. So we are manually giving normal heart rate as input. When the driver is about to sleep, the rate of heartbeat reduces gradually depending upon the biological condition of the driver. If there is any variation in the threshold value, the camera turns ON and reads the eye blinking rate and the Eye Aspect Ratio. If the driver is found to be drowsy, it alerts the driver using buzzer. Incase of accident occurs, vibration or mechanical force is detected through sensor. Immediately vibration sensor will detect the signal and send the location to the ambulance server.

The drowsiness of the driver is detected by the eye aspect ratio calculation (EAR) in the initial stage and the system alerts the driver. When the EAR value reduces to less than 0.15 the drowsiness level is detected. In initial stage, driver appears in front of camera it will sense the eye by using Haar cascade algorithm. Eye Aspect Ratio is used to detect whether driver is sleeping or not by variation in threshold value.

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Fig 6:- Front view Initial stage

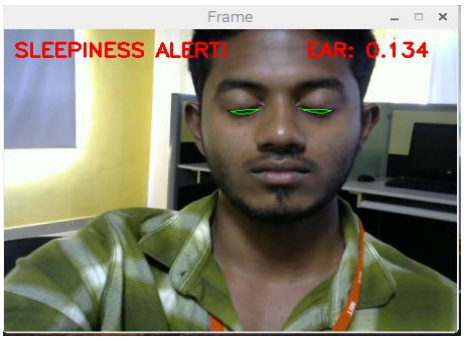

Fig 7:- When eyes are Closed

When Eye aspect Ratio value is become less than 0.15, then the driver is in drowsy state and it will indicate sleepiness alert.

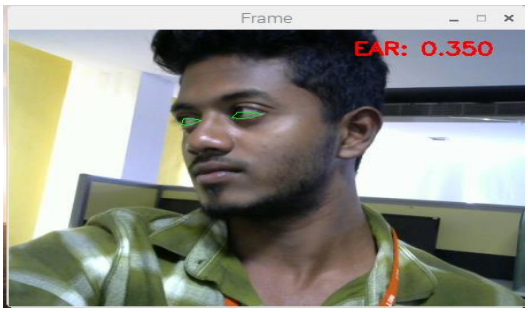

Fig 8:- Right side view

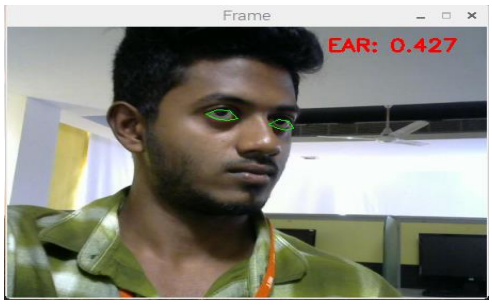

Fig 9:- Right side view

➢ *Accident Location Updation*

When driver met with an accident the sensor detects and location are updated to the ambulance servor immediately.

Fig 10:- Initial stage

At initial stage, portal shows no accidents registered since there is no data transmitted to the portal as shown in Fig. 10.

Fig 11:- During Accident

When accident occurs, the location of the accident will be updated to the portal and wait for 60 seconds for severity status as shown in Fig 11.

Fig 12:- When a minor accident switch is pressed

When accident occurs and if the victim presses the recovery button, the portal shows the accident is minor as shown in Fig. 12.

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Fig 13:- During major accident

When accident occurs and if the victim not presses the recovery button within 60 seconds, the portal shows the accident is major as in Fig 13.

V. CONCLUSION

Thus, the drowsiness of the driver is detected in the initial stage and the system alerts the driver. The location of the vehicle is update to the cloud. If there is any accident occurring, it immediately update the location of the accident to the ambulance server as Major or Minor accident. If the recovery switch is pressed within 60 secs of accident detection, it will be considered as minor accident. If the recovery switch is not pressed within 60 secs, it will be considered as major accident. By instantly updating the location, heartbeat and the level of drowsiness of the driver to the cloud as a black box, it make is easy to detect the cause of accident. However, for drowsiness detection high resolution and high frame per second recording camera is need for instant value calculation and detection. In future, in order to make the image more clear and to increase the speed of detection of drowsiness high frames per second camera should be used. To detect the drowsiness during night time, night vision IR based cameras should be used. Further, after drowsiness detection and alerting the driver, the acceleration system, the brake system and the gear system are controlled using the CAN network and the speed of the vehicle can be reduced gradually and the engine can be turned off. Ambulance stations can be implemented in more number of areas for quick response from the server.

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