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IoT based Accident Management System

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Abstract*: There is one death every four minutes due to a road accident in India. Around 137,000 people were killed in road accidents in 2013 alone and it has just risen exponentially over the years. Indian roads, which account for the highest fatalities in the world, became yet more dangerous in 2015 with the number of deaths rising nearly by 5% to 1.46 lakh. Such data had forced researchers to study these cases and to find solutions for reducing such fatalities. Many studies have been done and best possible solutions have been discovered. But the solutions used are expensive enough for middle and poor class people and still have scope for improvement. Hence in our country, such system is not installed in most of the vehicles due to which accidents are still in high numbers. Therefore a cost effective system has been proposed which has 4 modules. First module is alcohol detection. As soon as the person enters the car, the sensors detect the alcohol presence in the air or by the drivers touch on the steering wheel and would prevent the person from even starting the car if the person has drunk beyond the feasible limit. The second module focuses on the drowsiness check. A camera is installed which would detect if the person is watching the road or not or is sleeping and would immediately turn on an alarm. The third module is fatigue level indicator using GSR sensor. Also the driver's data will be constantly updated on our server's cloud and therefore will be monitoring whether the parameters have crossed a threshold level. If an accident occurs, the fourth module being the android app, will notify the nearby hospitals to the victim as well as send message to the close contacts to minimize the response time. The main aim is, if not eradicate, to at least minimize these accidents which occur not just because of somebody's hard luck but because of their negligence.

***Index Terms*: Alcohol detection, Accelerometer, Drowsiness detection , GSR sensor ,MQ-3 alcohol sensor, MIT App Inventor.**

I. INTRODUCTION

Nowadays accidents are in huge numbers and it is mainly due to negligence of the driver. People drink and drive and hence the roads are not at all safe for other vehicles as well as the pedestrians. Another reason why there are accidents on road is drowsiness. Driver of the vehicle tends to get tired and sleep while driving, causing accidents. After the accident, sometimes due to delay in arrival of the medical facilities, the injured person may die. These problems have been analyzed and a system has been proposed. The system consists of MQ-3 alcohol sensor, GSR sensor, and IR camera. MQ-3 sensor is fitted inside the car to check whether the driver is drunk or not and if he is not drunk, then only the car starts. GSR sensor measures the drowsiness/fatigue level of the driver as drowsiness is directly proportional to the skin resistance which is placed on the steering wheel and if the level is more than the threshold point, nearby cafeterias is notified. The IR camera continuously monitors the eyes of the driver which if closed for more than the permissible time, a buzzer will ring. Also, if the person meets an accident, the android app will notify the closest hospitals as well as send message to the close contacts so that the medical facilities arrive at the accident site in minimum time, hence increasing the chances of saving lives. The remaining section is as follows. Section III deals with the contribution of the author. Section IV shows the literature survey. Section V gives an idea of the conventional accident management system and the problems associated with it. Section VI describes the proposed IoT based accident management system and elaborates the different subparts of the system. Section VII shows the conclusions. Section VIII deals with the references for the proposed system.

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II. RELATED WORKS

T.D Prasanthi et.al proposed a system to detect alcohol consumption and therefore prevent road accidents due to drunken driving. MQ-2 breath based sensor is used to detect alcohol and this will be displayed on an LCD. This sensor is placed in the proximity of the driver and the car will start/stop depending on the alcohol concentration. The sensor is connected to a single chip microcontroller that will in turn control the relay of the car and will not allow drunken driver to start the car[1]. Prashanth KP et.al developed the project by integrating the Arduino and microcontroller. The alcohol sensor MQ-2 detects the presence of alcohol content. The ignition system of the vehicle starts based on the alcohol content in the breath of the driver. The method used here is a much quicker analysis as compared to other techniques[2]. N.Subhalakshmi et.al developed a system to prevent road accidents due to drunken driving. On detecting alcohol based on the breath based alcohol sensor MQ-3, data is sent to the Arduino that is connected to a GSM module, buzzer as well as relay. This is will ensure that on detection of alcohol blocks the engine of the vehicle, switches on a buzzer and sends information of the location of the vehicle to three emergency contact persons. To improve the system at hand, emphasis on alcohol detection can be made[3]. Sona Johnson et.al devised an automatic drunken driving prevention system with the help of the MQ-3 alcohol sensor placed on the steering wheel of the car. The sensor is activated when the driver starts the engine and then the value obtained is compared using comparator IC 358 with a predefined threshold.

If found drunk, the car automatically stops and a buzzer goes off thus preventing possible road accidents due to drunken driving. This project focuses only on breath based alcohol detection and can be improved by taking other factors like skin resistance into consideration[4].Nitin Jagtap et.al proposed a real time vision-based method to monitor driver fatigue. This paper adopts the Viola-Jones classifier which has four stages-Haar Features Selection, Creating Integral Image, Adaboost Training algorithm and Cascaded Classifiers, to detect the driver's facial features. To detect fatigue, the eye states are observed which have a high relativity with the driver's mental states. The accuracy obtained is high and hence it is a very reliable system [5]. Roop Kamal Kaur et.al used the concept of detecting and analyzing change in the electrical activity of the brain, heart and eyes depending on how drowsy the driver is using EEG, ECG and EOG respectively. Neural Networks is then applied to the data collected to detect the different levels of drowsiness. EEG data (to detect brain waves) is stored in excel sheets which makes it easier to detect 'alpha waves' that indicate drowsiness. This method of drowsiness detection has the advantage of using medical technology to achieve drowsiness detection accuracy close to 81.8% [6]. Twinkal Parmar et.al developed a prototype of drowsiness detection system. This system monitors the driver's eyes using camera and by developing an algorithm. Symptoms of driver drowsiness can be detected early enough to avoid accident. In case the driver's eyes are closed more than 80% for a specified time interval, it is defined as drowsiness. So this project will be helpful in detecting driver fatigue in advance and will gave alarming signals in the form of sound and LED blinking. This system will be helpful in preventing many accidents, and consequently save human life and reduce personal suffering [7]. Sang-joong Jung et.al uses real time driver health condition monitoring system to provide drowsiness alerts to the driver. The ECG sensor with electrically conductive fabric electrodes on the steering wheel of a car are designed to monitor the driver's health condition. The signals received from the ECG were measured and sampled at a rate of 100 Hz from the driver's palms as they are in contact with a pair of conductive fabric electrodes located on the steering wheel. Experiments conducted on this system were assessed with the help of wireless sensor nodes and the data collected was transmitted wirelessly to a server PC that would analyze the readings from the ECG and decide the state of the driver. The system is a much advanced version and gives much more accurate data for the same [8].M. Sri Sai Teja et.al along with drowsiness detection used inter-vehicular communication with vehicles that are within a short range and the messages regarding the vehicle being driven by a drowsy/intoxicated driver can be transferred wirelessly using VANETS. Drowsiness detection here is based on reading the behavior of the driver, i.e. is it normal, intoxicated or exhausted depending on his physiological factor such as alcohol consumption, blinking, etc. Here they also use other measurements to detect the behavior of the driver. They check for the distance maintained with other objects on the road, sudden acceleration/deceleration etc. This system involves the other nearby vehicles of the behavior state of the driver in question which is a good precaution for everyone on the road in the vicinity to be alert [9].Rahul Dhod et.al described an automatic emergency braking system considering head movement and eye blink as the foremost basis through which the ever increasing road accidents can be greatly controlled. A GSM module has also been incorporated in this prototype in case of an accident which is capable to send a SOS message to a family member in critical situations and also used for location tracking of vehicle [10]. Dimpu Sagar N et.al devised a system with the main objective of preventing road accidents occurring due to driver's drowsiness. Use of camera is made to track head and eye movements to determine the drowsiness level and an alcohol sensor is used to detect consumption of alcohol. Furthermore, an IR sensor and an ultrasonic sensor are used to detect objects and humans as obstacles on the road and notify the driver. Based on these values the braking mechanism and speed of the vehicle is monitored. In case of an accident, friends and family are notified using the driver's phone[11]. Aishwarya S.R et.al attempted a prototype to prevent road accidents caused due to drowsiness. The driver's head movements and eye movements are monitored by an IR sensor and if found drowsy he/she is alerted with the help of a buzzer. This is connected to an 8051 microcontroller that also helps in controlling the speed of the vehicle when found drowsy. All of the data and information will be continuously displayed on the LCD. Focus on accident detection can help improving this system[12]. Rachita Shetter et al. proposed a system that has three basic circuits-accelerometer circuits which are used for drowsiness detection, alcohol sensor circuit used for alcohol detection and the alert mechanism which is controlled by the relay which turnoff the ignition process of the vehicle if level of alcohol is higher than the threshold level of the sensor. Brake failure detection is also a part of the system which is indicated in LCD as a precaution to the driver. The advantage here is that the sensors are smaller in size not so bulky, hence can be fixed in any vehicle [13]. Pandurang N. Kathar et.al proposed an alcohol detection as well as drowsiness detection system which contains 8-megapixels digital USB camera, Raspberry-pi loaded with Raspbian-OS, alcohol sensor (MQ-3). The MQ-3 sensor uses the breath of the driver to decide if the driver is drunk or not and if the value is more than the threshold value, alert is sent to close contacts using GSM module. The Raspberry-pi system board, GSM, Bluetooth, relay circuitry and buzzers are serially interfaced with Arduino Uno to perform alarm notification switching off the car power source, hence a very effective system [14].Shailesh Bhavthankar et.al developed a wireless system using MEMS accelerometer and GPS/GSM for accident detection and reporting. If any accident occurs, this wireless device will send automated message to Emergency medical services (EMS) and family members giving the exact position of the spot where the crash had occurred. The system is used to record information related to accident like temperature data, position data etc. so that it can be used to analyze the accident easily and to settle many disputes related to accident such as insurance settlements. This system is also used to detect whether the driver was in drunken state and the vehicle would not start thereafter. The main objective is to make the medical facilities arrive on time [15]. Rajasekar .R et.al developed a system that reduces accidents due to drowsiness or any leakage or if fire breaks out inside the vehicle. For drowsiness, eye blink sensor is used to monitor the blink rate.

The data is the sent to the microcontroller which converts the analog form to digital form and alert is activated if the data crosses the threshold. With just two monitoring steps, a more accurate detection can be done. For the detecting stage, the eye blink sensor always monitor the eye blink moment. If the monitoring is over, the collected data will be transmitted to a microcontroller, and the microcontroller digitizes the analog data. If the warning feedback system is triggered, the microcontroller makes a decision on which alert needs to be activated. If any leakage is detected in the vehicle, the LED light glows. Also in case of fire, the temperature sensors senses and stops the engine[16]. Rabiya Gupta et.al used four devices, namely alcohol sensor to know if the driver is drunk, smoke sensor to detect smoke in the vehicle, rpm counter to keep the track of the speed of the vehicle and process if that vehicle is going faster than it needs on a specific road and a GPS to get the coordinates and to locate the vehicle which has these sensors on a map. Then all the data is sent to the server side from where appropriate actions are taken .These devices and sensors are going to provide context awareness to the vehicle and the driver, hence contributing to the objective of saving lives due to negligence [17]. Surekha Pinnapati et.al proposed a system which focuses on locating the vehicle that has met with an accident and shares this location via SMS with predefined numbers. A sensor, buzzer, GPRS module as well as GSM module is connected with the Arduino. In case the sensor detects an accident, the buzzer goes on. A buffer time for 15 seconds is provided in case of faulty detection by the sensor that can be manually turned off after which location is obtained and message is sent [18]. Hemantkumar G Sarode et.al designed a system for detection of accidents and for faster arrival of emergency services at the accident site, hence saving more lives.to detect and provide faster assistance for traffic accidents, to the rescue team in a short time, which will in turn help in saving the valuable lives. Each vehicle is fitted with an On-Board Unit which detects and reports accidents. The system considers relevant variables like vehicles type and speed involved in the collision and the status of the airbag and a prototype is developed which is then validated at the Applus+ IDIADA Automotive Research Corporation facilities, to alert and sent the emergency services after an accident takes place [19].V. Anupriya et.al focused more on faster and smarter accident notification system. It aims to not only detect a possible collision and alert the driver but in case of an accident it notifies the nearby hospital and ambulances to reach the location of the vehicle. The location is tracked with the help of GPS and is communicated to the main server using ZIGBEE. Smart equipment that is a part of this system is used to measure the victim's heartbeat and body temperature and the same data is sent to the hospital so that necessary arrangements can be made well before the arrival of the patient and less time is wasted and prompt medical treatment is provided. The most obvious advantage of this system is the accident notification system also focuses on the aftermath of the accident. The warning messages given out by the system is also fit for acoustically challenged drivers which is another huge advantage [20].G. Sathya et.al aimed on reducing the time taken by ambulances to reach the victim and then take them back to the hospital due to congestion on the road. Many a times, because of delay in getting medical treatment, many road accident victims lose their lives. This system allows ambulances to control the traffic signal on the road. The location of the ambulance can be tracked by a GPS module installed in it and the traffic light and ambulance can communicate using GPRS 3G modem. Along with this, they have also prevented the misuse of this system by providing RFIDs to doctors who can attain the security to do so. The advantage of such a system is reduced time of travel for the ambulance to help road accident victims [21]. Prof. Bhagya Lakshmi V et.al designed a system to locate a vehicle using GPS module which is very useful to save lives after accidents as the police and ambulance can be informed through SMS about the location of the accident site using GSM module. The whole system is controlled by FPGA which in turn gets triggered by the accelerometer circuit[22].E Krishna Priya et.al developed an accident detection project in which the accelerometer and ultrasonic sensor detects the signal from ultra sonic sensor with which a severe accident due to an obstacle can be recognized and then immediately sends it to microcontroller. Microcontroller sends the alert message through the GSM module including the location to police control room or a rescue team. So the emergency help team can immediately trace the location through the GPS module, after receiving the information. Hence provides an optimum solution to the poor emergency facilities during accidents [23]. Prof. Varsha Kshirsagar et.al determined a prototype focuses on reducing the response time of ambulances and emergency medical aid to reach the site of accident. A sensor is placed that detects if an accident has occurred and the GSM module shares the location of the vehicle with emergency numbers, in this case hospitals. The ambulance is also equipped with a traffic light unit that allows the ambulance to control the traffic lights and reach the hospital faster[24].Pooja Shindalkar et.al executed accident detection and messaging system which makes use of GSM & GPS technologies. GPS is used for taking the coordinate of the site of the accident while GSM is used for sending the message to phone. To make this process all the control is made using Arduino whereas LCD is used to display the accident, hence giving promising results [25].

III. TRADITIONAL ACCIDENT MANAGEMENT SYSTEM

Design and Implementation of Driver Drowsiness and Alcohol Intoxication Detection Using Raspberry PI, is an accident management system proposed by Pandurang N. Kathar that provides real time detection of driver's drowsiness, alcohol intoxication and subsequently alerts the driver. The conventional system contains 8-megapixels digital USB camera, Raspberry-pi loaded with Raspbian-OS, alcohol sensor which is used to detect the intake of alcohol in percentage. If the intoxication matching fails, GSM gets triggered on and transmits warning message. The traditional accident management system includes higher cost and lower efficient accident detection system which is due to no focus on reaching out to the nearby hospitals. High response time between the accident and arrival of the medical services can lead to the death of the victim. Hence, lowering the response time becomes a major objective. MQ-2 sensors are often used in the traditional system which has a lower response to alcohol detection.

IV. PROPOSED IoT BASED ACCIDENT MANAGEMENT SYSTEM

To overcome the limitations of the traditional accident management system, the proposed IoT based accident management system has used the shortest route algorithm to find the nearest hospitals and cafeterias thus lowering the response time significantly. MQ-3 sensors instead of MQ-2 sensors are used to give a better response for alcohol detection. The system is also cost effective due to the use of simple and cheap components for the purpose. Easier implementation and lower cost with higher efficiency; such factors make the proposed design of the system a more viable and a more feasible product in today's world. The main objective of the proposed system is to help reduce the road accidents up to a large extent and to shorten the response time between the accident and arrival of emergency medical services. The proposed design of our system with different modules is shown in Fig.1.

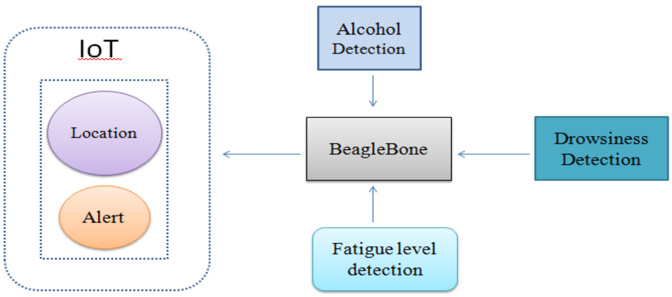

Fig.1 Proposed IoT Based Accident Management System

The microprocessor BeagleBone board is used to carry out necessary functions based on the data that the sensors provide.

A. Alcohol Detection

For the breath based alcohol detection, MQ-3 sensor is used which has a very fast response and place it near the driver's seat, on the roof top and near the steering wheel to analyze the exhaled air and detect automatically if the driver is drunk. The signal from the sensor goes to the operational amplifier and then to the microcontroller. Using the touch based technology, Galvanic Skin Response sensor (GSR) is used based on electro dermal response (EDR) to check the driver's skin resistance and based on this it would decide if the driver is drunk. If the person is found drunk, it won't allow the driver to start the vehicle as the key hole will be blocked by manual intrusion and therefore would prevent any possibility of accident due to drunk driving. It is placed on the gear shaft or on the steering wheel. Also close relatives will be informed about the driver's state and the location will be sent using Android App. Fig.2 shows the implementation of alcohol detection system.

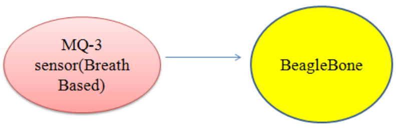

Fig.2 Alcohol Detection System

B. Drowsiness Detection

To detect drowsiness, image processing technique is used using the camera to read the driver's facial expression and alerting the driver with a buzzer if he loses his focus. Image processing is done using Open CV software toolkit. The functioning of drowsiness detection is explained in Fig.3:

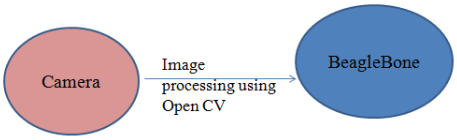

Fig.3 Drowsiness Detection System

C. Fatigue Level Detection

The GSR sensor is fitted on the steering wheel of the vehicle as shown in Fig.5 which continuously takes data from the sensor and sends the data to the BeagleBone board. If the value from the sensor crosses the threshold, alert is sent to the close contacts using the Twilio API along with the location of the driver.

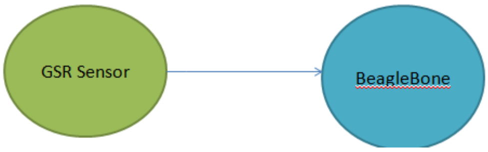

Fig.4 Fatigue Level Detection

Fig.5 The steering wheel along with the GSR sensor

D. Emergency Services

If accident occurs, the android app in the driver's phone which is being created using MIT App Inventor sends alert messages to the close contact, saved in the app design, along with the location of the accident site. Nearest hospital using the shortest route algorithm is displayed in the Google Map, hence minimizing the emergency medical services response time and reducing deaths significantly due to accidents. Fig.7.1 to Fig.7.4 are the screenshots of the android app.

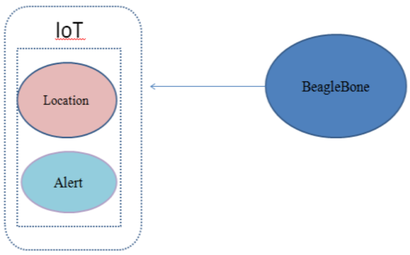

Fig.7.1 Emergency Services System

Fig.7.2 Login page of the android app

Fig.7.3 Welcome page of the app

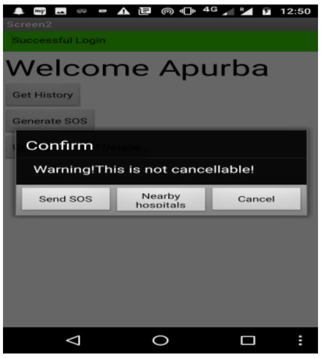

Fig.7.3 When 'Generate SOS' is clicked

The data from the MQ-3 sensor and the GSR sensor is sent to the BeagleBone board which transfers it to the Thingspeak API. This data is then stored in the Thingspeak Cloud. A server is created which acts as the brain to the Thingspeak API. Whenever a person login the android app to access the data, the Thingspeak API searches its cloud and then sends the data to the app. The app which is created using MIT App Inventor, has three applications. It sends an alert to the close relatives whenever the user meets an accident or any emergency situation using the Twilio API, along with the location of the accident site. It also shows the location of the nearest hospital using the Google Map API so that the response time between the accident and the arrival of the emergency medical services is minimum. The data from the IR camera which suggests if the driver is feeling drowsy or not, is sent to the Thingspeak API. The data is then transfered to the BeagleBone board and is checked if the values are above the threshold level, which if true, rings a buzzer immediately. The MQ-3 gas sensor is alcohol sensor which is used to detect the alcohol concentration on your breath. This sensor provides an analog resistive output based on alcohol concentration. When the alcohol gas exist, the sensor's conductivity gets higher along with the gas concentration rising. It is suitable for various applications of detecting alcohol at different concentration. It is widely used in domestic alcohol gas alarm, industrial alcohol gas alarm and portable alcohol detector.

GSR stands for galvanic skin response, is a method of measuring the electrical conductance of the skin. Strong emotion can cause stimulus to your sympathetic nervous system, resulting more sweat being secreted by the sweat glands. Grove - GSR allows you to spot such strong emotions by simple attaching two electrodes to two fingers on one hand. It is an interesting to create emotion related projects like sleep quality monitor. The BeagleBone Black is the newest member of the Beagle Board family. It is a lower-cost, high-expansion focused BeagleBoard using a low cost Sitara XAM3359AZCZ100 Cortex A8 ARM processor from Texas Instruments. It is similar to the Beagle bone, but with some features removed and some features added.

V. RESULT AND DISCUSSION

A. *MQ-3 Sensor Output*

When the driver blows on the sensor, the analog data is sent to BeagleBone Black and is then converted to digital values ranging from 52 to 87, 52 being non-alcoholic and 87 being the most. If the values are more than 72, an alarm turns on, alerting the driver that he is drunk and not fit to drive as shown in Fig. 8.1 & Fig.8.2.

Case 1: When the driver is not drunk

Fig.8.1 Output for Case

Case 2: When the driver is drunk

Fig.8.2 Output for Case 2

B. *GSR Sensor Output*

The data from the sensor is converted to digital values using the BeagleBone Black microcontroller. Initially the value from the sensor is zero due to no contact with the sensor as shown in Fig.9.1 to Fig.9.3. When the driver is in contact with the sensor, the value obtained from the sensor increases. The values range from 12 to 52, 12 being the least tired and 52 being the most. The values increase with the increase in the skin conductance which in turn is directly proportional to level of fatigue. The nearby cafeterias are shown through the app if the values cross over 38.

Case 1: When the driver hasn't touched the steering wheel

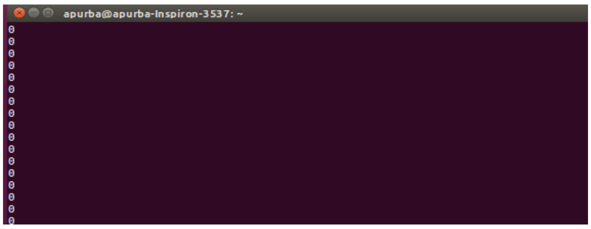

Fig.9.1 Output for Case 1

Case 2: When the driver is in contact with the GSR sensor and is in normal state

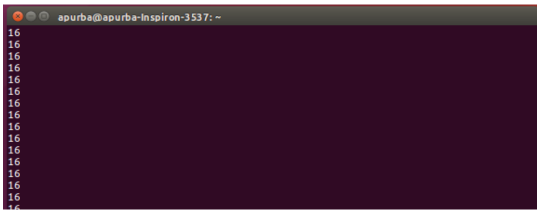

Fig.9.2 Output for Case 2

Case 3: When the driver is in contact with the GSR sensor and is tired and feeling sleepy

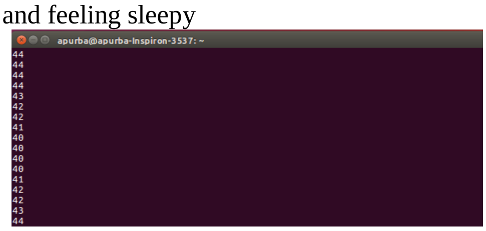

Fig.9.3 Output for Case 3

C. *Android App Output*

When the 'Generate SOS' button is clicked in the android app by the user, an alert message is sent to the contact number saved in the MIT App Inventor along with the location of the accident site as shown in the Fig.10.

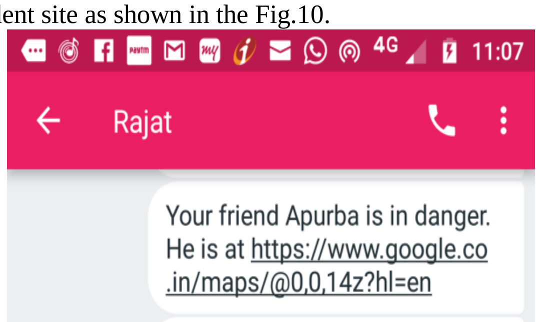

Fig.10 Alert from the android app with the location of the accident site

D. *Image Processing Output*

OpenCV comes with a trainer as well as detector. It already contains many pre-trained classifiers for face, eyes, smiles, etc. XML files containing that data are stored in the opencv/data/haarcascades/folder. We are required to load the required XML classifiers and then load the input image (or video) in grayscale mode. Faces are searched in the feed obtained from the camera. If faces are found, it returns the positions of detected faces as Rect(x,y,w,h). Once these locations are obtained, an ROI is created for the face and then eye detection is applied on this ROI. If the driver is looking forward and is aware, the alarm doesn't get activated. In case the driver is not looking forward or has his/her eyes closed for more than 3 seconds, the alarm goes off, alerting the driver to look forward as shown in Fig.11.1 to Fig.11.3.

Case 1: When the person is aware and looking forward while driving

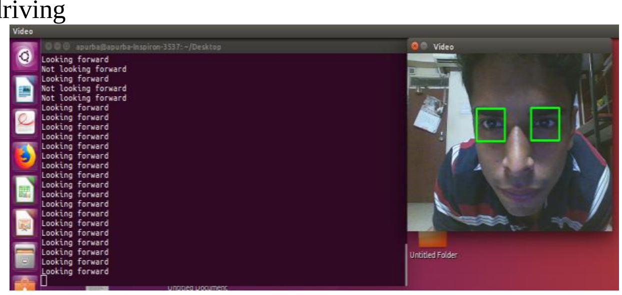

Fig.11.1 Output for Case 1

Case 2: When the person in not looking forward while driving

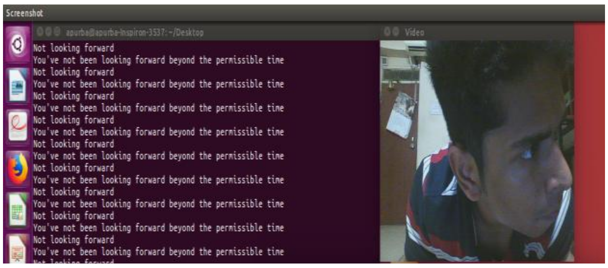

Fig.11.2 Output for Case 2

Case 3: When the person dozes off

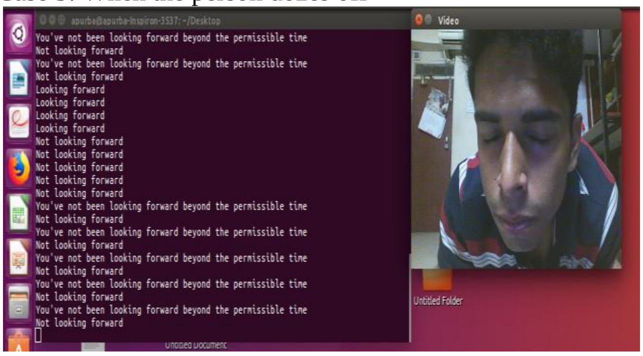

Fig.11.3 Output for Case 3

VI. CONCLUSION AND FUTURE WORK

The GSR sensor gives accurate values which are directly proportional to the skin resistance.

After the person does any physical exercise, the values from the sensor increases. The values from the alcohol sensor also increase if the person is drunk. The android app can be improved by making different accounts for different users and store all the data from the sensors in the Mongo database cloud.

From this database, data of each user can be easily accessed. Hence, the app can be useful to a large section of people due to being economically viable and can greatly contribute to saving lives and quicker emergency medical response.

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