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Drunk Driving and Drowsiness Detection

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***Abstract*—Development of safety features to prevent drunk and drowsy driving is one of the major technical challenges in the automobile industry. Driving while being drunk or drowsy is a major reason behind road accidents especially in the modern age. Driving when drowsy can lead to higher crash risk than being in alert state. Therefore, by using assistive systems to monitor driver's level of alertness can be of significant help in prevention of accidents. This paper aims towards the detection of driver's drowsiness using the visual features approach along with drunk detection using alcohol sensor. Driver drowsiness is based on real-time detection of the driver's head, face and mouth, where-in HAAR-Cascade classifier for face and eye detection and template matching in the mouth region for yawning detection. The system will also have an alcohol detection sensor which will determine whether the driver is drunk or not, thus covering the major reasons behind road accidents.**

Keywords—drowsy, drunk, visual features, HAAR-Cascade classifier, driver safety, alcohol sensor.

I. INTRODUCTION

Driving while drowsy or in drunk state, are the two main reasons for traffic accidents and the related financial losses. Researchers have been working on designing driver drowsy monitoring systems over the last decade. Though, there have been numerous improvements in driver safety, yet a significant number of serious accidents still occur all over the world. The U.S. National Highway Traffic Safety Administration each year reports roughly about 60,000 traffic accidents taking place due to sleepiness related problems. studies indicate that 25%–30% of driving accidents are caused due to drowsiness [1]. In 2008, the National Highway Traffic Safety Administration estimated about 100,000 police reports on automobile crashes which were direct results of driver being drowsy resulting in over 71 000 injuries, 1550 deaths, and $12.5 billion in financial losses [2]. To detect driver inattention, three main approaches have been developed i.e. via, Physiological, Driving-behaviour-based, and Visual-feature-based approaches. Physiological methods involve analysing of vital signals such as brain activity, heart rate, and pulse rate. However, this technique requires use of electrodes to be attached to the driver's body, which is intrusive in nature therefore, may act as annoyance to the driver [2].

Driving-behaviour-information-based approaches evaluate the driver's conduct over a period based on the variations in the speed, steering wheel angle, acceleration, lateral position and breaking, there by determining whether the driver is alert or not. Liang *et al.* demonstrated a real-time approach to detect driver distraction using the eye movements and driving performance, wherein the data was made to train and test both Support Vector Machine (SVM) and Logistic Regression Models (LRM) to recognise driver distraction. Thus, making it convenient for signal acquisition but highly dependent on the type of vehicle, driver experience, and the road conditions [2].

The feature-based approach analyses visual features from the driver's facial images having unique features such as eye blinks, yawning, and head movements. Hammoud *et al.* proposed a drowsiness detection system that would assess the eye status in the near-infrared spectrum. Moriyama *et al.* predicted the eye state by using templates to match with the eyelids. Percentage of eyelid Closure (PC) which counts the number of eye blinks of the driver is another widely used technique for drowsiness detection. For practical applications, visual-feature-based approaches are preferred since they are instinctive and does not bother the driver [2].

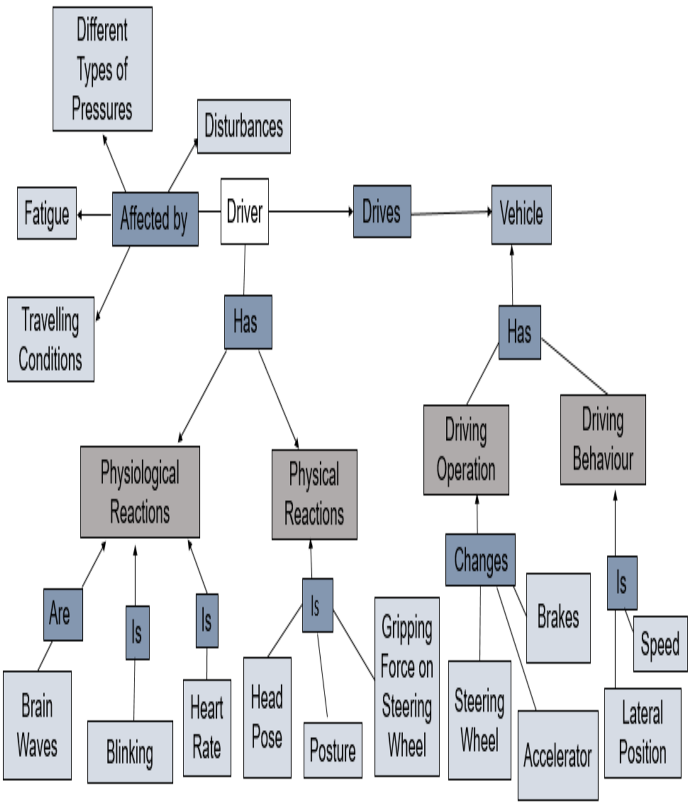

Fig. 1: Aspects that can be used to determine the level of drowsiness of a driver [3]

Table 1: Total vehicle collusion due to fatigue and inattention (2003-2007) [3]

Year	Total Vehicular Collisions	No. of collisions due to fatigue and inattention	No. of collisions due to fatigue and inattention (%)
2003	58,805	8,835	15
2004	57,729	9,122	15.5
2005	59,495	8,949	15
2006	58,094	9,837	16.9
2007	55,926	9,797	17.5

A study conducted by Alcohol & drug Information Centre (AIDC), India revealed that around 40% of the road accidents have occurred under the influence of alcohol [5]. A study was done at the University of Michigan, clearly shows the effect of Alcohol on Highway Safety which is given in Table 2.

Table 2: Effect of Alcohol on Highway Safety [5]

Blood Alcohol Content (BAC) Level in g/100ml	Effect
0.02 to 0.04	Progressive Deterioration
0.04 to 0.05	Significant involvement in Accident
0.02 to 0.04	Dominant factor in accident
0.02 to 0.04	Accident risk 7-25 times as at BAC 0.01g/100ml

II. PROJECT OBJECTIVE

Development of safety features to prevent drunk and drowsy driving, being one of the major challenges for automobile industry the objective of this project is to design a system to detect and provide driver safety by alerting the driver in case of drunk condition detection or drowsiness detection. Drowsiness detection would be implemented using visual features like Eye and Face detection along with yawn detection all done using OpenCV and Emgu with Visual Studio 2013. For drunk state detection, an alcohol sensor would be used. In case the driver found to be drunk or drowsy then the alarm would be generated via a buzzer and using a vibrator to alert the driver. If the alert would go off for more than thrice within a specified period, then the engine would be turned off with LED turning 'ON' as an emergency indicator.

III. LITERATURE REVIEW

Over the last decade, there have been various studies done related to drowsiness detection and drunk driving. Features using a driver's Visual characteristics, Physiological and Driving- behaviour based studies have been conducted each having their own advantages for drowsiness detection and by using sensors for drunk driving detection. Recent Technologies that have been examined are explained from [1-2, 4, 6-13]. Sinan Kaplan *et al.*, presented a survey that provides a comprehensive insight into the well-established techniques for driver inattention monitoring and introduces the use of most recent and futuristic solutions exploiting mobile technologies such as smartphones and wearable devices. The studies were categorized into two groups: driver drowsiness and distraction. A comprehensive compilation, used features, classification methods, accuracy rates, system parameters, and environmental details, was represented. A similar approach was also taken for the methods used for the detection of driver distraction [1]. Ralph Oyini Mbouna *et al.*, presented a visual analysis of Eye State and Head Pose (HP) for continuous monitoring of alertness of a vehicle driver. The proposed scheme used visual features such as Eye Index (EI), Pupil Activity (PA), and HP to extract critical information on non-alertness of the driver [2]. Mona Omidyeganeh *et al.*, designed and implemented an automatic system, using computer vision, which runs on a computationally limited embedded smart camera platform to detect yawning. Implementation of the Viola–Jones algorithm for face and mouth detections and, use of a back-projection theory for measuring both the rate and the amount of the changes in the mouth, to detect yawning along with the histogram of the grayscale image [4]. Anirban Dasgupta *et al.*, proposed a robust real-time embedded platform to monitor the loss of attention of the driver during day and night driving conditions. The percentage of eye closure was used to indicate the alertness level. Face detected using HAAR -like features, the eye state was classified as open or closed using support vector machines [6]. Boon-Giin Lee *et al.*, proposed a method to monitor driver safety for fatigue using two distinct methods: Eye movement monitoring and Bio-signal processing. The monitoring system was designed on an Android-based smartphone, where it receives sensory data via wireless sensor network and further processed the data to indicate the current driving aptitude of the driver. The sensors used were a video sensor to capture the driver image and a bio-signal sensor to gather the driver Photoplethysmograph (PPG) signal. A warning alarm was also sounded if driver fatigue was believed to reach a defined threshold [7]. G. M. Bhandari *et al.*, presented an efficient driver's drowsiness detection system, by using yawning detection. The consideration of eye detection and mouth detection was done, detecting the driver's face using YCbCr method. After that, eyes and mouth positions by using HAAR features. Lastly yawning detection performed by using mouth geometric features [8]. Wang dong *et al.*, aimed at the serious phenomenon of drunk driving in modern society by using a MCU electronic circuit board in the system along with alcohol sensor MQ303A, the alcohol concentration was detected. Through ADC0809, the detection signal is converted to digital signal, which is handled directly by MCU. As per the digital signal, the car will be controlled automatically wherein it can't be driven after driver found drunk, thus avoiding the occurrence of drunk driving [9]. Yue-cheng Wu *et al.*, developed an automotive anti-drunk driving system with real-time monitoring. The system guarantees the uniqueness of the driver by combining the function of alcohol detection and face identification system, putting forward the design of combination of the alcohol main detection and the image processing auxiliary surveillance. It can eradicate the fraudulent conduct that drunk driving and driver changing [10]. Anjali K U *et al.*, purposed this paper to develop a drowsiness detection system. This system works by analysing the eye movement of the driver and alerting the driver by activating the buzzer when he/she is drowsy. The system implemented is a nonintrusive real-time monitoring system for eye detection. During monitoring, the system can decide whether the eyes were opened or closed. When the eyes were detected closed for too long, a signal issued to warn the driver, the system also has an option for making vibration when drowsiness is detected [11]. T. P. Nguyen *et al.*, demonstrates an eye tracking system for drowsiness detection of a driver. It is based on the application of Viola-Jones algorithm and Percentage of Eyelid Closure (PERCLOS). The system alerts the driver if the drowsiness index exceeds a pre-specified level [12].

IV. METHODOLOGY

For drowsiness detection, we will be concentrating on the Visual Feature-based approaches as its proven to provide better results than physiological and driver behavior methods. Visual features consist of capturing Eye State, Head Position, Yawning. Drunk state detection, would be done using an Alcohol sensor to detect, whether the driver is drunk or not.

A. *Eye State*

Oyini Mbouna et al., presented a visual analysis of Eye state and Head Pose (HP) by using a single camera for constantly monitoring alertness of the driver. The proposed system would work in real time finding the eye and pupil centers from a face object in a live video stream captured by a camera. The detection of face and eyes was done using the AdaBoost algorithm and by adaptive template matching. Then, visual features such as Eye Index (EI), Pupil Activity (PA), were computed from a video segment of 4 sec. duration. An SVM classifier was trained with the visual features of EI, PA, which was used to learn the driving patterns of the driver to classify if the subject was either in alert or non-alert state. The non-alert state represented that the driver is either drowsy or distracted [2]. Error d_{eye} refers to the relative deviation between the estimated and the ground truth pupil centers, i.e.,

$$d_{eye} = \frac{\max(|C_{left} - \hat{C}_{left}|\,|C_{right} - \hat{C}_{right}|)}{|C_{left} - C_{right}|}$$

Where $|Cleft - \hat{C}left|$ and $|Cright - \hat{C}right|$ denote the Euclidean distances between the true pupil center positions $Cleft$ and $Cright$ and the estimated pupil center positions $\hat{C}left$ and $\hat{C}right$. The eyes were successfully detected if the relative error deye is less than a threshold of **0.25** [2].

From Anirban Dasgupta et al. proposed system the first approach was the estimation of PERCLOS for face detection and the second approach was for Face Detection Using HAAR-Like Features [6].

The Algorithm

- A web cam is used capture the drivers face in real time.
- The Face is detected by using HAAR- Cascade classifier.
- An ROI is selected on the detected facial image.
- Then Eyes are detected in selected ROI.

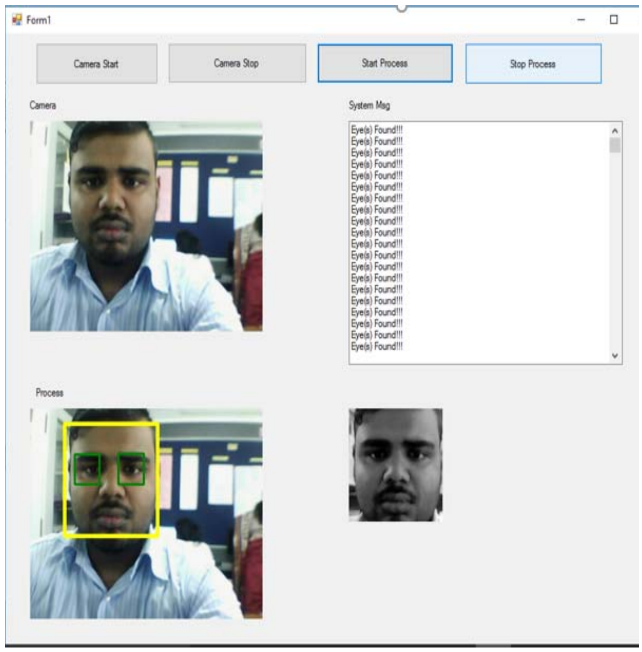

Fig. 2: Scheme of Eye and Face detection.

B. *Head Position*

There are various methods available for object tracking, such as mean shift tracking, optical tracking, and Kalman-filter based tracking. The first two methods relied on image intensity values in subsequent frames. As there are illumination dependent, they are not appropriate for our application. As the face size and position is known from the detection results of the HAAR classifier, a rectangle is circumscribed around the detected face for subsequent face detection. Using the Kalman-based tracking, the search areas for the face can be reduced; hence, the HAAR classifier can detect at a faster rate without loss in accuracy [6]. To track the changes in the head position, Ralph Oyini Mbouna et. al. applied Lucas–Kanade optical flow method. The optical flow finds an estimate of the feature points between two video frames extracted using the good features to track method [2].

C. *Yawn Detection*

Yawn detection has a become an integral part in driver drowsiness detection. An automatic system, using computer vision, with a camera to detect yawning has been implemented by Omidyegane *et al.* [4]. First, detection of the driver's face would be done using the Viola–Jones algorithm, which has already been implemented in the OpenCV software library.

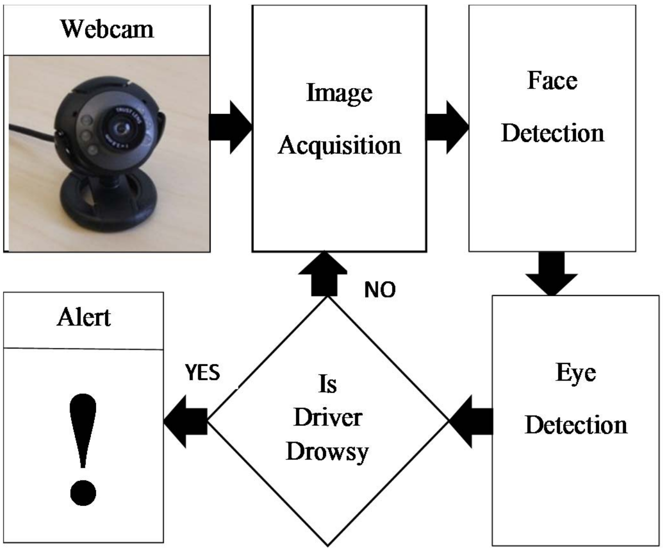

Fig. 3: Generalized system diagram of Eye and Face Detection.

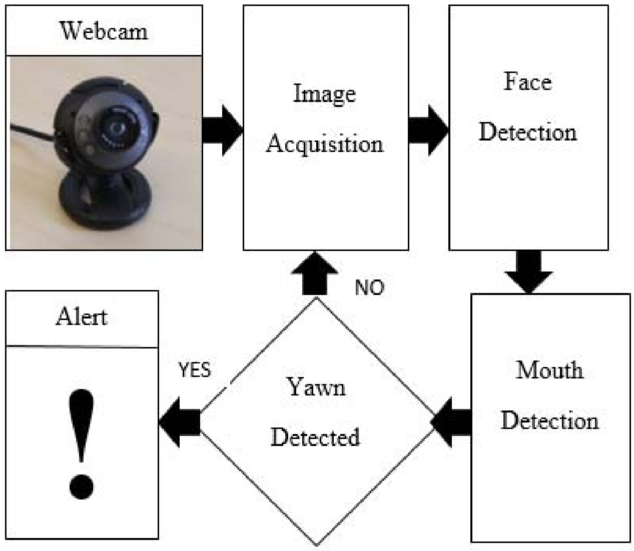

Fig. 4: Generalized system diagram of mouth detection for yawning analysis.

The AdaBoost algorithm helps to select critical features that play an important role in the classification decision and train the classifier. On finding the first face on each frame the system stops searching for other faces, thus face search time is reduced. The next step is mouth detection, where the trained features from the XML file are extracted and saved in the camera to reduce the computational time and make the system more suitable for practical operations. The color image for each mouth detected in the video is converted into a grayscale image, then the histogram of the grayscale image is acquired. The histogram of a normally closed mouth position in the first frame will be saved as a reference for further calculations. To determine yawning, a back-projection-theory can also be used. The basic idea in the back-projection theory is to create a similar image giving the similarity of each pixel of the candidate object to be matched (the candidate) with the object of interest (the reference) [4]. Yawn detection is done to verify the validity of the detected component. When driver yawns, the mouth starts to open resulting in increased threshold pixel value compared to the normal position which is nothing but yawning state, following are the steps [11].

- Select the eye highlighted region.
- Select the mouth highlighted region.
- Get Open (yawn) Mouth pixel count (YM) and Normal Mouth pixel count (NM).
- Get Closed (yawn) Eye pixel count (YE) and Normal Eye pixel count (NE).
- If (YM >NM) or (YE<NE)
- Then (if yes: driver is yawning otherwise go back to step 3)

D. Drunk State Detection.

Over the years several attempts have been made to prevent drunk driving mainly through a system of laws, enforcement, and sanctions. However, these laws are frequently violated. Hence by using vehicle-based alcohol detection system, prevents a person with a positive blood alcohol concentration from starting or operating a vehicle. From Sakairi *et al.* [13], we learn that water clusters in an expired gas can be easily differentiated into positive and negative charged clusters by applying an electric field. The charged water clusters in the breath of a person is easily detected by blowing between parallel plate electrodes, to which a voltage is applied, and a detection electrode connected to a pico-ammeter. Small charged water clusters are easily deflected by using an electric field to collide with the detection electrode to generate electric currents, with this configuration, breath and alcohol peaks for one exhalation of air can be simultaneously detected.

Drunk driving is a major contributor to traffic deaths in India, which is approximately 70 percent of road fatalities. Nearly 10 percent of road accident casualties worldwide are reportedly from India [5]. Wang Dong et al. [9] demonstrates a basic low-cost system setup using alcohol sensor MQ303A, the sensor output voltage signal passes through ADC0809 after converting the input to MCU. After logic processing of MCU, the driver alcohol level is compared with the calibration value, to control the car motor to start or stop along with voice warning if the user is above or within alcohol limit. From [10], we learn about a system that can eradicate the fraudulent conduct of finding a replacer to pass the test for starting the car, this is done by using a CCD camera. On system activation, it captures drivers image, image A and stores in MCU then checks driver's alcohol concentration in air around driver, if high then the system is turned 'OFF' and sound-light alarm activated, it then continuously keeps checking the alcohol concentration, once the level drops to the specified standard then another image captured, image B.

Both image A and B are verified to check whether they are identical or not. If identical only then will the engine activate thus eradicating fraudulent conduct of driver replacement.

V. Principle, Design and Implementation

Developing safety measures to prevent drunk and drowsy driving is a major challenge for the car industry. Here are some of the ideas on how to prevent drowsiness and drunk driving while driving. When a driver enters a car, starts the ignition at first, he would be told to provide breath sample, by using an alcohol sensor, it would be detected whether the driver is in drunk state or not. If yes, then the ignition would turn off. If driver not drunk, then next step would be face capture. Face capture would be done by a web camera that would be placed in front of the driver near dashboard. The camera would capture the face of driver along with eye and mouth tracking. Eye tracking is done to detect whether the driver eyes are open or closed to measure drowsiness level and mouth capture done to check for yawning while driving. After detection and tracking of face, eyes and mouth capture while driving, the system continuously keeps checking for any variations in above parameters. By using Visual Studio 2013 and OpenCV with Emgu tracking and detection of facial features is being done. OpenCV using Emgu being open library contains all XML files for eye closeness detection and yawn detection would be carried out using template matching where picture already stored will be compared to find whether the driver is in a drowsy state or not. If any one of the parameters gets checked that is if driver found drunk while driving or in drowsy state then an alarm would go off and seats would vibrate, thus making the driver alert again. If the alarm goes off again and again within a certain time interval, then the system would turn off the ignition and turn on the indicator lights to warn vehicles coming from behind to avoid crashing of vehicles.

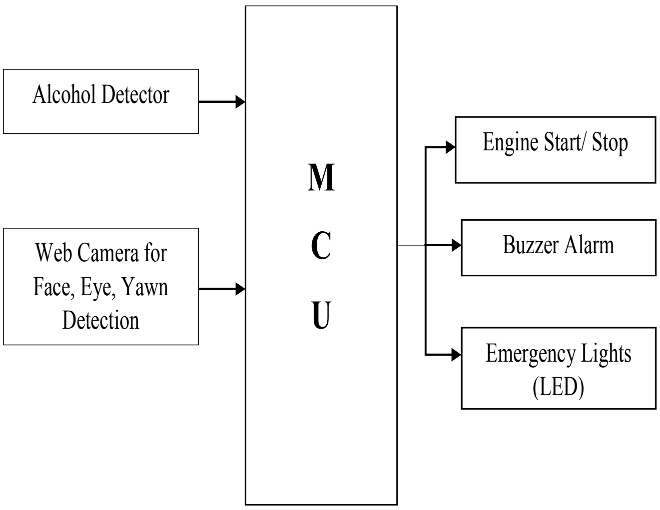

Fig. 5: A basic system setup for Alcohol Detection.

A. Flow Chart:

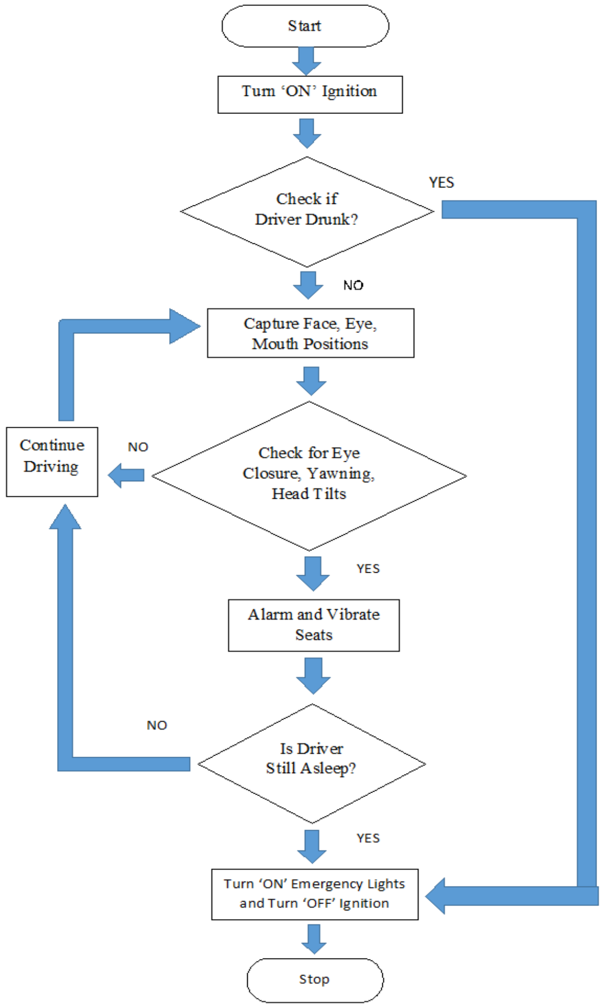

Fig. 6: A sequence flow of the events for drowsiness and drunk driving detection with alert.

The flow diagram for 'Driver Drunk State and Drowsiness Detection Alert System is as explained in fig.6. The procedure of events occurring is explained below;

Step 1: The driver on entering the car turns 'ON' the ignition.
Step 2: To check whether the driver is drunk; this would be done manually by the driver by using an alcohol sensor.
Step 3: If driver found drunk that would lead to turning 'OFF' the ignition.
Step 4: If driver not drunk then capture of visual features like face, eye and mouth position will begin for drowsiness detection. The visual features would be captured in continuous real-time monitoring, by a web cam.
Step 5: If Eye closure, Head Tilts or Yawn detected this will lead to activation of buzzer and vibrator, if not then driver continues to drive.
Step 6: If the driver is still found to be drowsy even after continuous alertness within a short span of time, this would lead to turning 'OFF' the ignition and then the emergency lights would be turned 'ON', to alert other vehicles to avoid collusion.

B. System Diagram

The basic block diagram that is to be implemented for driver drunk state and drowsiness detection alertness system is as shown in fig. 8. Where-in a webcam is used for face and yawn detection, an alcohol sensor for drunk state detection. The USB to TTL converter is a device that is used to provide connectivity between PC and Microcontroller. The microcontroller is used to activate the alarm, vibrators, LED's, and turn ON/OFF the engine when the driver found to be in drunk or drowsy state, with the LCD used to display messages regarding the alert.

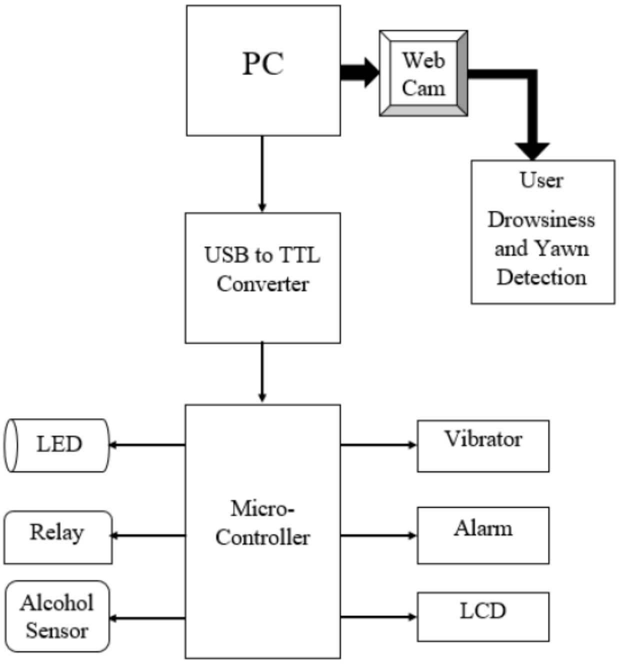

Fig. 7: Basic block diagram for drunk state and drowsiness detection with alert system.

For drowsiness detection, we use a Web Cam interfaced to PC to check the visual features of the driver while driving. The detection would be done in Real Time and the web cam output visible on the PC screen. Direct communication will take place between PC and microcontroller by using an USB to TTL converter. If the driver is found to be drowsy, then an alert would be generated, this would be made by using the buzzer (alarm) and vibrator. For Drunk State Detection, an Alcohol sensor used, wherein the driver should manually feed input. The relay would be used as car engine which would start on ignition and stop working if driver found to be in drunk or drowsy state with the LED's used for Emergency lighting to indicate that the car would be coming to a halt. Based on the alert type, messages will be displayed on the LCD screen.

References

[1] Sinan Kaplan, Mehmet Amac Guvensan, Member, IEEE, Ali Gokhan Yavuz, and Yasin Karalurt, Driver Behavior Analysis for Safe Driving: A Survey, IEEE Transactions on Intelligent Transportation Systems, Vol. 16, No. 6, December 2015.

[2] Ralph Oyini Mbouna, Seong G. Kong, Senior Member, IEEE, and Myung-Geun Chun, "Visual Analysis of Eye State and Head Pose for Driver Alertness Monitoring", IEEE Transactions on Intelligent Transportation Systems, Vol. 14, No. 3, September 2013.

[3] Mario I. Chacon-Murguia and Claudia Prieto-Resendiz, "Detecting Driver Drowsiness: A survey of system designs and technology", IEEE Consumer Electronics Magazine, October 2015.

[4] Mona Omidyeganeh, Member, IEEE, Shervin Shirmohammadi, Senior Member, IEEE, Shabnam Abtahi, Aasim Khurshid, Muhammad Farhan, Jacob Scharcanski, Senior Member, IEEE, Behnoosh Hariri, Daniel Laroche, and Luc Martel, "Yawning Detection Using Embedded Smart Cameras", IEEE Transactions on Instrumentation and Measurement, Vol. 65, No. 3, March 2016.

[5] T. Sivakumar, Dr. R. Krishnaraj, "Road Traffic Accidents (Rtas) Due to Drunken Driving in India Challenges In Prevention", IRACST- International Journal of Research in Management & Technology (IJRMT), Vol. 2, No. 4, August 2012.

[6] Anirban Dasgupta, Anjith George, S. L. Happy, and Aurobinda Routray, Member, IEEE, "A Vision-Based System for Monitoring the Loss of Attention in Automotive Drivers", IEEE Transactions on Intelligent Transportation Systems, Vol. 14, No. 4, December 2013.

[7] Boon-Giin Lee and Wan-Young Chung, Member, IEEE, "Driver Alertness Monitoring Using Fusion of Facial Features and Bio-Signals", IEEE Sensors Journal, Vol. 12, No. 7, July 2012.

[8] G. M. Bhandari, Archana Durge, Aparna Bidwai, Urmila Aware, "Yawning Analysis for Driver Drowsiness Detection", IJRET: International Journal of Research in Engineering and Technology, Volume: 03 Issue: 02, Feb-2014.

[9] Wang Dong, Cheng Quan Cheng, Li Kai, Fang Bao-hua, "The automatic control system of anti-drunk-driving", The National Natural Science Founds, IEEE, 2011.

[10] Yue-cheng Wu, Yun-qing Xia, Pei Xie and Xiao-wei Ji, The Design of an Automotive Anti-Drunk Driving System to Guarantee the Uniqueness of Driver, IEEE 2009.

[11] Anjali K U, Athiramol K Thampi, Athira Vijayaraman, Franiya Francis M, Jeffy James N, Bindhu K Rajan, "Real-Time Nonintrusive Monitoring and Detection of Eye Blinking in view of Accident Prevention due to Drowsiness", International Conference on Circuit, Power and Computing Technologies [ICCPCT], IEEE, 2016.

[12] T. P. Nguyen, M. T. Chew, S. Demidenko, "Eye Tracking System to Detect Driver Drowsiness", Proceedings of the 6th International Conference on Automation, Robotics and Applications, Queenstown, New Zealand, IEEE, Feb.17-19,2015.

[13] Minoru Sakairi, "Water-Cluster-Detecting Breath Sensor and Applications in Cars for Detecting Drunk or Drowsy Driving", IEEE Sensors Journal, Vol.12, No.5, May 2012.