Grenze International Journal of Engineering and Technology, June Issue

Driver's Drowsiness Detection and Alert System

Nishtha Gupta[1], Akanksha Dwivedi[2], Deepesh Indulkar[3], Mayur Deopa[4] and Sheetal Ahir[5]
[1-5]Ramrao Adik Institute Of Technology, Navi Mumbai, India
Email: nish.gup.446@gmail.com, {akadwivedi22, dipeshindulkar1234, mayurdeopa}gmail.com, sheetal.ahir@rait.ac.in

***Abstract*— Driver's drowsiness is a significant cause of road accidents. To address this issue, several driver's drowsiness detection systems have been developed. These systems use various sensors and algorithms to detect the level of driver drowsiness and alert the driver to take necessary actions. This paper provides a comprehensive review of the driver drowsiness detection systems developed so far with the development of a new type of drowsiness detection and alert system. The review covers various aspects of the driver's drowsiness detection systems, including the sensors used, algorithms employed, and performance metrics and analyzes the issues and challenges with those and provides a better solution to enhance the system. The paper also covers the challenges associated with the development of driver's drowsiness detection systems, including variability in individual responses, variability in driving conditions, and privacy concerns. Possible solutions to these challenges are also discussed. Overall, the paper provides a comprehensive understanding of the driver's drowsiness detection systems developed so far, and provides an effective solution to deal with it. Developing an effective driver's drowsiness detection and alert system is crucial to reducing the number of accidents caused by driver drowsiness and enhancing road safety.**

***Index Terms*— Driver's Drowsiness, Raspberry Pi, Sprinkler System, Road Accidents, Camera Detection and Machine Learning Algorithms.**

I. INTRODUCTION

Drowsiness is a state of near sleep, where the person has a strong desire for sleep. Sleepiness can be dangerous when performing tasks that require constant concentration, such as driving a vehicle. Driver drowsiness is a significant cause of road accidents worldwide, leading to loss of lives, injuries, and damage to property. According to the World Health Organization (WHO), road traffic accidents account for around 1.35 million deaths annually, and driver fatigue or drowsiness is a contributing factor in a significant number of these accidents. The economic impact of road accidents is also significant. Driver drowsiness is a critical issue on the roads, and it can result in severe accidents and fatalities.

Drowsiness is a common issue among drivers, and it can occur for many reasons, such as inadequate sleep, long hours of driving, and medication side effects. Drowsiness can cause several symptoms, including slow reaction time, poor decision making, and decreased vigilance. As a result, drowsy driving can lead to accidents that can cause severe injuries and fatalities.

There are several types of driver drowsiness detection and alert systems currently available, including those that use camera-based systems to monitor the driver's face and eyes, sensors that detect changes in heart rate or skin conductivity, and systems that use machine learning algorithms to analyze driving behavior and detect signs of drowsiness. The development of driver drowsiness detection and alert systems has the potential to significantly

Grenze ID: 01.GIJET.9.2.91

reduce the number of accidents caused by drowsy driving. By detecting drowsiness early and alerting the driver, these systems can prevent accidents and save lives.

This paper will begin by discussing the causes and symptoms of drowsy driving, followed by a review of the different types of driver drowsiness detection and alert systems currently available. The paper will also examine the effectiveness of these systems and the challenges associated with their implementation. Finally, the paper will conclude with a discussion of the future of driver drowsiness detection and alert systems.

Causes and Symptoms of Drowsy Driving: Drowsy driving can be caused by a variety of factors, including inadequate sleep, long hours of driving, medication side effects, and sleep disorders. According to the CDC, individuals who get less than six hours of sleep per night are at a significantly higher risk of drowsy driving. Similarly, those who work long hours or drive for extended periods are also at a higher risk of drowsy driving. Symptoms of drowsy driving include slow reaction time, poor decision-making, decreased vigilance, and impaired vision. Drowsy driving can also cause microsleeps, which are brief episodes of sleep that last a few seconds. During a microsleep, the driver is unconscious and unable to react to changes in their surroundings, which can result in an accident.

II. Literature Review

Numerous studies have been conducted to develop and evaluate driver drowsiness detection systems. These studies have explored various sensor technologies, algorithms, and performance metrics to improve the accuracy and reliability of driver drowsiness detection systems. In this literature survey, we review some of the significant works in the field of driver drowsiness detection systems.

Drowsiness Detection Using Eye-Tracking Sensors: One of the early works in the field of driver drowsiness detection using eye-tracking sensors was done by Ji et al. (2012). The authors proposed a system that used a camera based eye-tracking sensor to detect drowsiness in drivers. The system tracked the driver's eye movements and detected changes in eye blinking and gaze direction. The authors used a threshold-based algorithm to classify the driver's drowsiness level. The authors reported an accuracy of 88.6% in detecting drowsiness in their experiments. In a later study, Lee et al. (2013) proposed a system that used a multi-camera-based eye-tracking sensor to detect drowsiness in drivers. The authors used a feature-based approach to extract features from the eye-tracking data and a k-nearest neighbor (KNN) classifier to classify the drowsiness level. The authors reported an accuracy of 93.5% in detecting drowsiness in their experiments.

Drowsiness Detection Using Facial Expression Sensors: One of the early works in the field of driver drowsiness detection using facial expression sensors was done by Cho et al. (2013). The authors proposed a system that used a camera based facial expression sensor to detect drowsiness in drivers. The system tracked the driver's facial expressions and detected changes in facial muscle activity. The authors used a decision tree-based algorithm to classify the driver's drowsiness.

Drowsiness Detection Using Heart Rate Sensors: One of the early works in the field of driver drowsiness detection using heart rate sensors was done by Noh et al. (2011). The authors proposed a system that used a heart rate sensor to detect drowsiness in drivers. The system measured the driver's heart rate and detected changes in heart rate variability. The authors used a decision tree-based algorithm to classify the driver's drowsiness level. The authors reported an accuracy of 86.7% in detecting drowsiness in their experiments.

Table 1 is the complete result of the literature surveyed done on different research papers. It is a comparison table for all the research and their work.

II. Proposed Work

The existing system of driver drowsiness detection has the following disadvantages.

- Mainly, using two cameras in the system one for monitoring the head movement and the other one for facial expressions,
- The other disadvantage is aging of sensors and all these sensors are attached to the driver’s body which may affect the driver.
- There is no night vision hence making the system useless during night period or during any dark situation.
- No alert system is present in the vehicle to warn the driver when he falls asleep.

In order to overcome all these disadvantages we designed a system that uses a camera to monitor the driver's eye and mouth movements and analyze their blink rate, eyelid closure duration and lips partition to detect drowsiness. This system can also track the driver's head position and alert them if they start to nod off. With this, it can also track the driver’s mouth movements and alert the driver if they start yawning. It is non-intrusive, non-invasive and

relatively inexpensive. It can be installed in the vehicle very easily without any modifications although any kind of modifications can be made to the software to work in accordance with the seated driver. Irrespective of the driver wearing spectacles and darkness level inside the vehicle, the system can detect the drowsiness.

TABLE I. LITERATURE REVIEW

Sr. No.	Paper Title	Algorithm Used	Accuracy	Techniques	Advantages	Dataset	Applications
1	Driver Fatigue Monitoring System Based on Eye State Analysis	Viola-Jones Face Cascade of Classifiers Support Vector Machine	93.5%	Face detection for eye state analysis.	Non-invasive: Many drowsiness detection systems use non-invasive sensors These sensors do not require any physical contact with the driver, making them easy and comfortable to use.	5 subjects	Drowsiness detection system
2	Driver Drowsiness Monitoring Based On Yawning Detection	Color segmentation Active contour model Viola-Jones Method	I. 85% 40% 40% II. 95% 85% 60%	I. Camera installed at front mirror: Face detection Mouth detection Yawn detection II. Camera installed on the dash: Face detection Mouth detection Yawn detection	One of the primary benefits is that it improves road safety by alerting the driver when they are getting drowsy.	342 videos	Driver drowsiness detection system
3	Real-Time Nonintrusive Monitoring and Detection of Eye Blinking in view of Accident Prevention due to Drowsiness	Viola-Jones object detection Haar cascade classifier	Not Specified	Face and eye detection Eye blinking detection Warning system design	detects the onset of drowsiness before the driver even realizes it. This early detection helps preventing accidents.	Not Specified	Driver Drowsiness detection system
4	Facial Features Monitoring for Real Time Drowsiness Detection	Viola Jones algorithm K-means algorithm SVM	94.58%	Face detection and skin segmentation Eye detection Yawn detection	easy to install and can be integrated into existing vehicles without any major modifications.	100 templates	Drowsiness detection system

The researchers have found that humans are most reactive when they experience a sense of touch. So, amongst all the different senses, the sense of touch makes the brain most reactive and it makes the body to be woken up involuntarily. And so, our system includes an alert system which uses a sprinkler to make the driver come back to consciousness. This sprinkler is more like a spray of water for just a fraction of seconds, just enough for the driver to regain consciousness.

Thus, through our system we aim at building a more humane and psychologically sound system that detects and alerts the drowsy driver and helps avoid road accidents to the most extent.

A. Working

Figure 1 is the flowchart for the proposed solution to tackle the disadvantages of the existing systems and to add a new idea of alert system which is used to trigger haptic actions that is by using the Sprinkler Alert System.

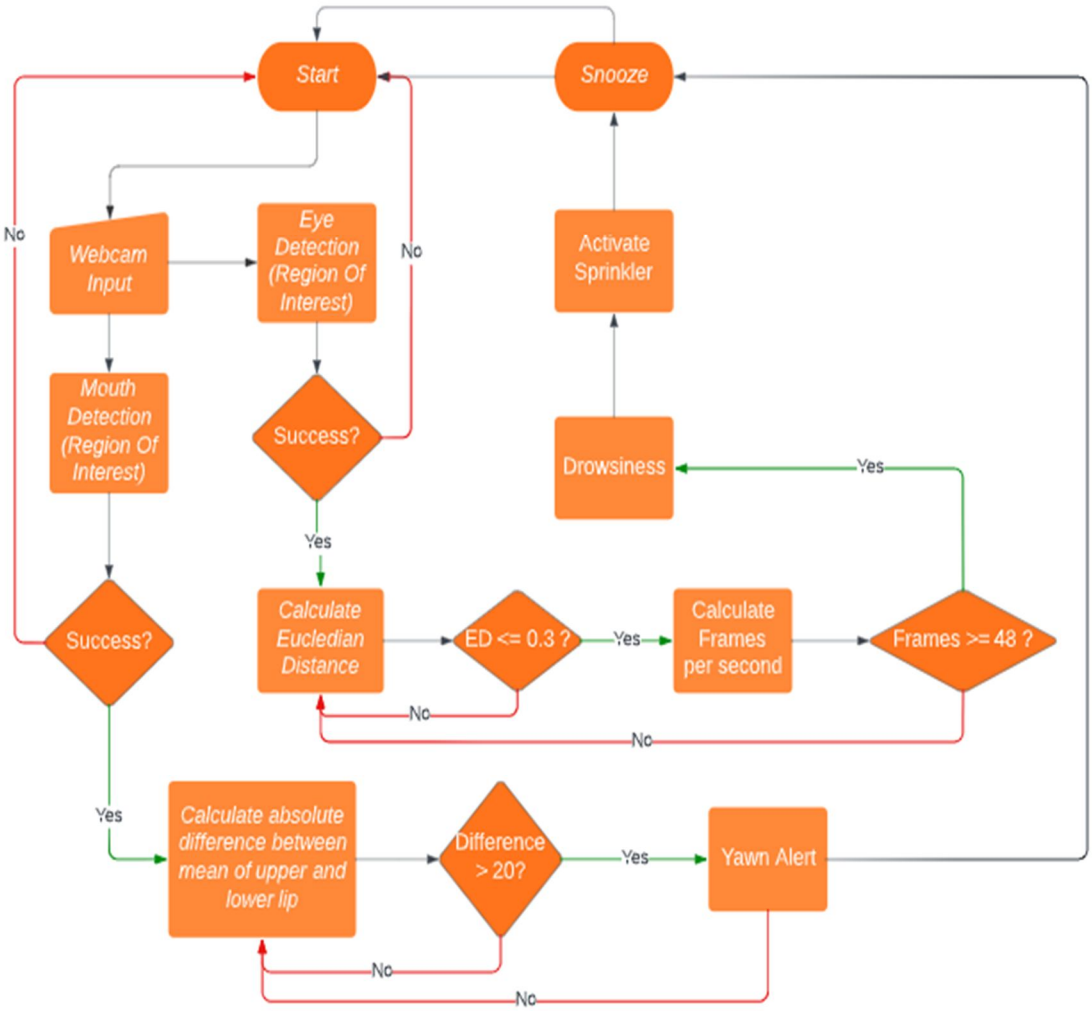

Figure 1. Flowchart of System Design

B. Implementation Details

Software Details: Here, we have used Python as the programming language of choice and are using its libraries which are Open CV, Dlib, Imutils and SciPy. We are using the Open CV and Dlib libraries to detect the region of interest on the face and mark those landmarks. The logic behind the software is the use of experimental thresholds to detect the drowsiness by continuously monitoring the eye and mouth areas. Figures 2 to 5 depicts the capturing and detection and figure 6 shows the calculation of Eye Aspect Ratio (EAR). Eye Aspect Ratio or EAR is the ratio to calculate the euclidean distance of the eye using 6 different points as depicted in figure 6.

A = dist.euclidean(eye[1], eye[5]) (1)

B = dist.euclidean(eye[2], eye[4]) (2)

C = dist.euclidean(eye[0], eye[3]) (3)

Equations (1), (2) and (3) are the euclidean distances between the specified points as shown in figure 6 and the EAR is calculated as (4)

EAR = (A + B) / (2.0 * C) (4)

where A, B and C are the values calculated from (1), (2) and (3) respectively.

Hardware Details: For this system, we built a haptic alert system using Raspberry Pi 3B, raspberry pi 5MP camera, LCD display, LED, buzzer, DC motor, jumper cables, water spray and breadboard. Here, the software was mounted on the raspbianOS and the camera continuously captured the face which was used to detect drowsiness and the buzzer and LED lit up with the spray of water as an alert for the same. Figure

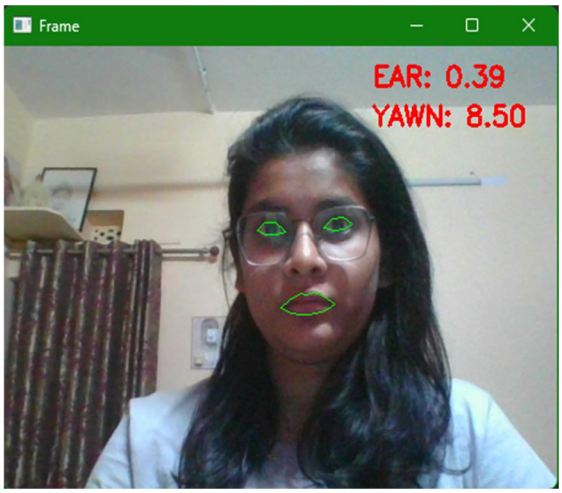

Figure 2. Face Detection

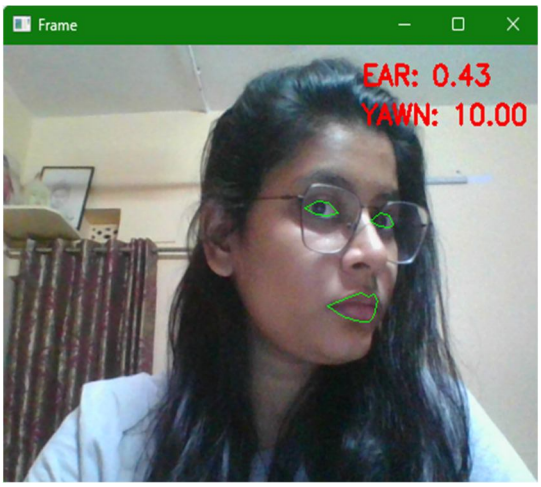

Figure 3. Face Detection from my angle

Figure 4. Yawn Alert

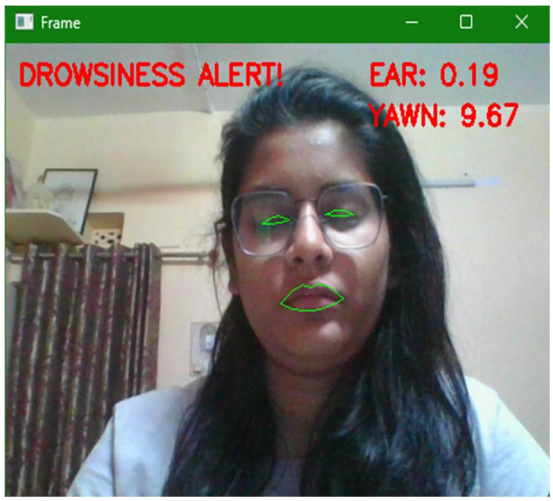

Figure 5. Drowsiness Detection

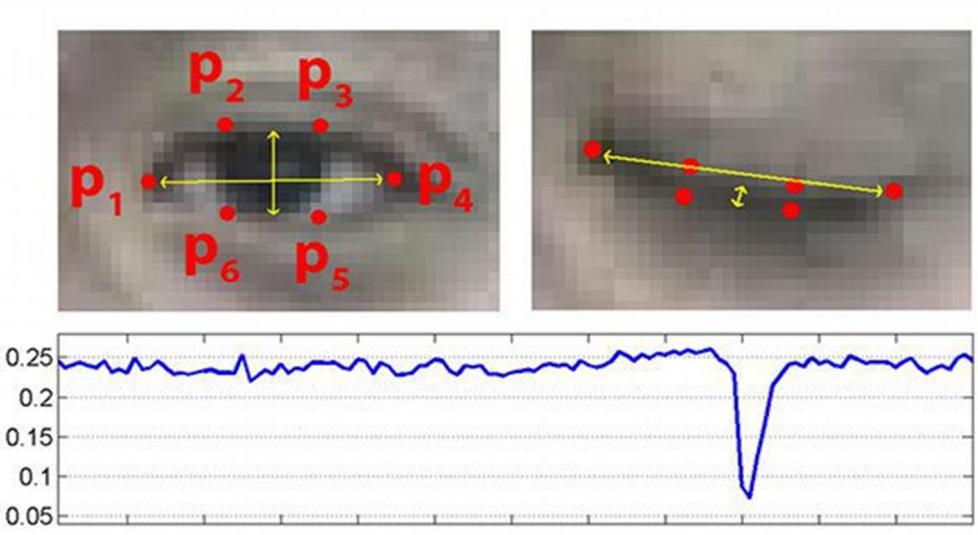

Figure 6. Different aspect points on the eye

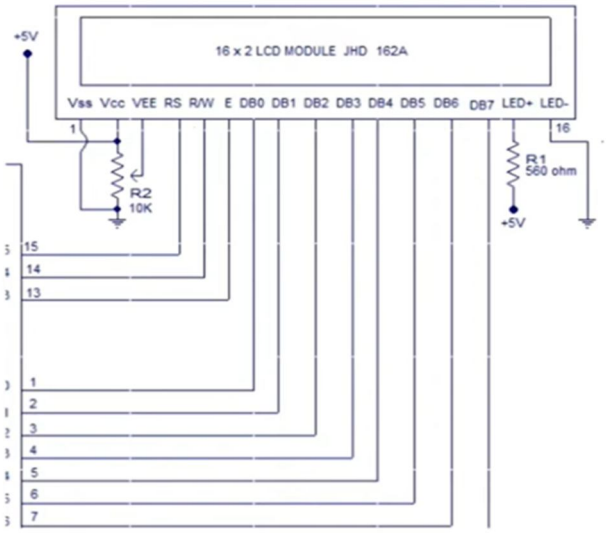

Figure 7. PCB connections for LCD display

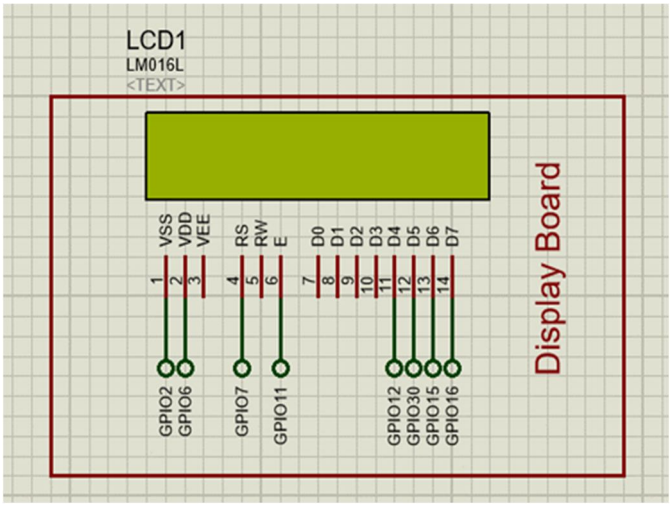

Figure 8 LCD connection with Raspberry Pi

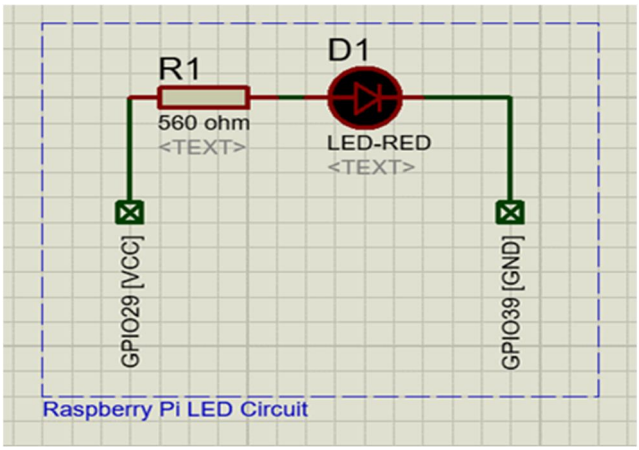

Figure 9. LED connections with Raspberry Pi

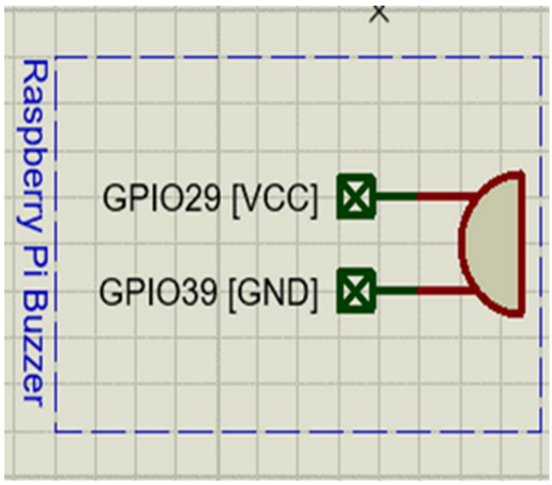

Figure 10. Buzzer connections with Raspberry Pi

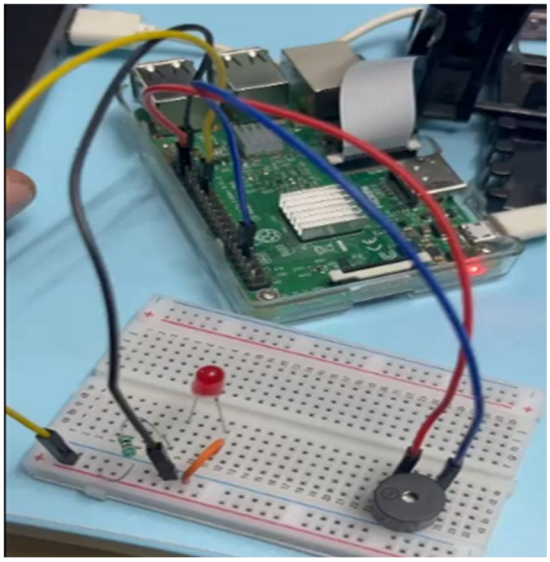

Figure 11. Final Connection

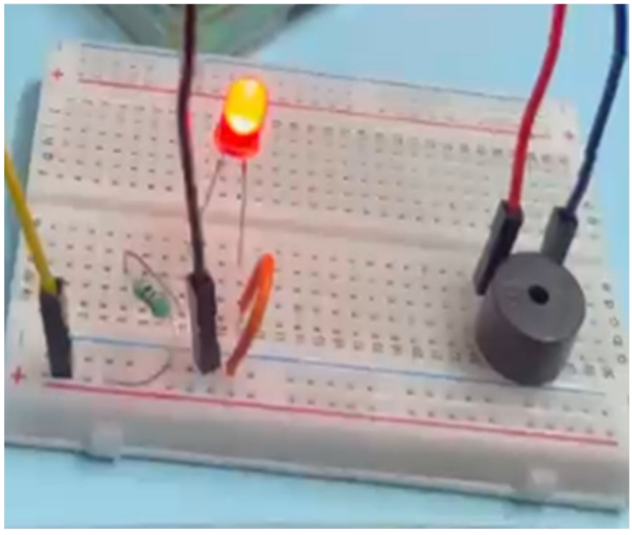

Figure 12. Alert system in Effect

III. Conclusion and Future Work

We had divided the system into two phases, detection phase and alert phase. We implemented both the phases in two different ways, one was software based which was the detection phase and the other was hardware based which was the alert phase, this phase was not fully implemented but the blipping of LED denotes the fraction of a second for which the water will be sprayed. After the implementation, we conclude that our system can have multiple more applications. It can be used to save the data including what time period is extremely prone to drowsiness and what area is mostly traveled in during that period. We are still struggling to decide with a deployment and installation place for our system on the dashboard so that it works as intended and it does not hamper the vision or view port of the driver. Although we have a few areas in mind including the area just behind the steering wheel. Now, as we are only mainly focusing on the truck drivers therefore that place on the dashboard will prove to be a relatively good area for deployment of our system. But we are still researching the same.

References

[1] Swapnil Titare, Shubham Chinchghare, K.N. Hande, “Driver drowsiness detection and alert system”, June 2021

[2] Jyotsna Gabhane, “Drowsiness detection and alert system”, April 2018.

[3] Mahek Jain, Bhavya Bhagearthi, Sowmyarani C N, “Real-time driver drowsiness detection using computer vision”, October 2021.

[4] Bhargava Reddy, Ye-Hoon kim, Sojung Yung, Chanwon Seo, Junik Jang, “ Real-time driver drowsiness detection for embedded systems using model compression of deep neural networks”, May 2017.

[5] V B Navya Kiran, Raksha R, Anisoor Rahman, Varsha K N, Dr. Nagamani N P, “Driver drowsiness detection”, 2020.

[6] Neeta Parmar Instructor: Peter Hiscocks, "Drowsy Driver Detection System" Department of Electrical and Computer Engineering", presented at Ryerson University Â© 2002.

[7] Cyun-Yi Lin, Paul Chang, Alan Wang, Chih-Peng Fan, “Machine Learning and Gradient Statistics Based Real-Time Driver Drowsiness Detection”, 2018 IEEE International Conference on Consumer Electronics-Taiwan (ICCE-TW)

[8] Mkhuseli Ngxande, Jules-Raymond Tapamo, Michael Burke, “Driver drowsiness detection using Behavioral measures and machine learning techniques: A review of state-of-art techniques”, 2017 Pattern Recognition Association of South Africa and Robotics and Mechatronics International Conference (PRASA-RobMe)

[9] Singh, Sarbjit and Papanikolopoulos, N.P., “Monitoring Driver Fatigue Using Facial Analysis Techniques”, IEEE Intelligent Transport System Proceedings (1999), pp 314-318