Driver's Drowsiness Detection Using SpO2

P. Sugantha Priyadharshini, N. Jayakiruba, A. D. Janani, and A. R. Harini

1 Introduction

Drowsiness is tiredness that expresses as heavy eyelids, yawning, daydreaming, rubbing of the eyes, and a lack of focus. We primarily focused on oxygen saturation levels in our study. Long-distance drivers who do not even take regular rests may become tired and make mistakes like vehicle accidents and other unfortunate incidents. Accidents and deaths are happening more frequently, which poses a serious threat to everyone in the world. Therefore, it is crucial to develop a driver's drowsiness detection system that really can alert the driver of their drowsiness and inattentiveness.

Driver drowsiness detection is a car safety technology that guards against accidents brought on by drowsy driving. According to numerous studies, drowsiness may be a factor in up to 50% of accidents on such roads, or about 20% of all accidents. Numerous investigations have discovered that driving can be affected by lack of sleep just as much as alcoholism. According to research, driving after 17–18 h of non-stop driving while awake is just as dangerous as doing so when impaired by alcohol legal limit in many European nations is 0.05%. Driving while impaired by blood alcohol content (BAC) is extremely risky than sleep deprivation. It has been established that sleep deprivation harms driving performance, particularly in four areas: coordination, longer reaction times, impaired judgment, memory, and ability to retain information. Human SpO2 levels typically range from 95% to 100%. An individual's oxygen level will be low whenever they feel sleepy. As a result, it is specified in our article that the alarm will sound when a person's oxygen

P. Sugantha Priyadharshini (✉) · N. Jayakiruba · A. D. Janani · A. R. Harini
Sri Ramakrishna Engineering College, Coimbatore, Tamil Nadu, India
e-mail: sugantha.ravee@srec.ac.in; jayakiruba.2001058@srec.ac.in; janani.2001057@srec.ac.in; harini.2001049@srec.ac.in

A. Haldorai et al. (eds.), *5th EAI International Conference on Big Data Innovation for Sustainable Cognitive Computing*, EAI/Springer Innovations in Communication and Computing, https://doi.org/10.1007/978-3-031-28324-6_17

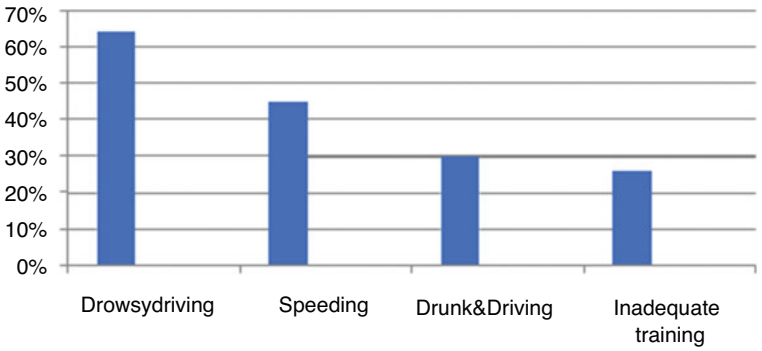

Fig. 1 Major reasons for road accidents

level is less than 96%. In order for the vehicle to quickly regain awareness and drive safely, we developed the concept of a driver drowsiness detection system that alerts the driver when feeling tired to solve this issue. People can fall asleep at any time, so it is imperative to have a real-time drowsiness detection gadget. The integration of the Arduino board in this device is mainly to transmit the input data obtained and process the data to obtain the outcome. It binds the connectivity between input, output, and the sensor SpO2. Technology or system such as detection and monitoring systems for driver fatigue is essential for reducing road accidents. As the drivers face problems and difficulty in detecting fatigue, the vehicle must be installed with a fatigue detection and monitoring system.

Figure 1 depicts the different reasons of occurring road accidents. It is shown in graphical representation with percentile values.

2 Literature Review

A driver who is drowsy and experiencing micro sleep is probably considerably more dangerous on the road than a driver who is driving too fast. Automakers and researchers are working to find technical solutions to this issue to prevent a crisis of this magnitude. In this study, they emphasize neural network-based techniques for the identification of such micro sleep and sleepiness [1]. To detect the same, their earlier research in this area used machine learning and multi-layer perceptrons. In this study, the convolutional neural network (CNN) was used to classify tiredness, and accuracy was improved by using facial landmarks that the camera detects and sends to the network.

Road accidents, which are now nearly a daily issue in the modern world, result in significant loss of life and property and harm the economy. Drunk driving is a major factor in these collisions. To prevent these unwanted events, it is crucial to identify drowsy drivers as soon as possible. In this work, two physiological parameters—

heart rate and eye-blink rate—are continuously analyzed to provide a very reliable and cost-effective method for determining if a driver is sleepy or weary [2]. This system also has a reliable alarm function [3]. The system identifies the driver's tired or sleepy condition and immediately informs him to restore consciousness if the threshold values of the drowsiness checking parameters are surpassed [4].

The driver face monitoring system can identify driver distraction and fatigue in real time using machine vision techniques. This research presents the method for detecting driver hypervigilance (fatigue and distraction) based on symptoms in the face and eye areas [5]. This technique extracts hypervigilance symptoms from the face and eye, respectively, by horizontally projecting the top-half portion of the face image and matching face templates. A distraction that is removed from the facial region can be detected by the head-turning. Eyelid distance alterations relative to the usual eyelid distance, eye closure rate, and proportion of closed eyes are the retrieved symptoms from the eye area.

3 Objective of the Work

The objective of this research is to create a device that can detect drowsiness to lower accident rates in our nation [6]. The tool analyzes a driver's blood saturation level, which assists in identifying the driver's drowsiness and alerting him so that he is awake and aware while driving [7]. This tool will be incredibly useful because it biologically recognizes drowsiness. The goal of the research is to lower the country's fatality rate and to notify the exhausted driver to take a break, which avoids road accidents [8]. It can be achieved by using a SpO2 sensor to detect tiredness because it gives an efficient and stable outcome, and it is also cost-efficient. Figure 2 depicts the workflow of the research [9].

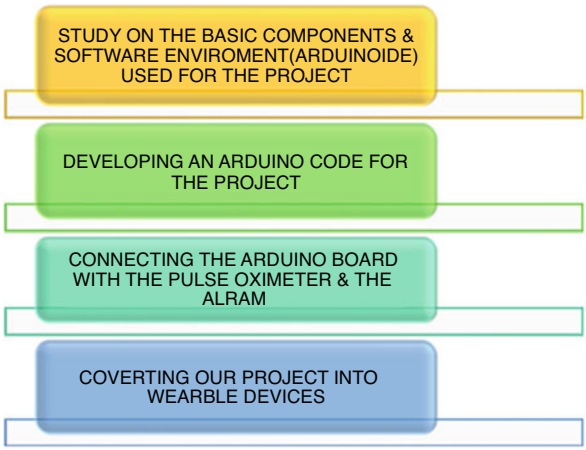

Fig. 2 Workflow

4 System Analysis

4.1 Existing System

The existing system developed for driver drowsiness detection uses image processing for detecting whether the driver was feeling fatigued and sleepy. In this system, they analyze the drowsiness from the eyes of the person [10].

It detects how much time the eyes are closed on the driver. If the eyes are closed for longer than 20 s, the speaker included in the system will sound an alert, thus alerting the driver, waking him up, and preventing an accident.

4.2 Proposed System

The expected outcome of our research will be like the device will be wearable and continuously monitor the blood oxygen level once worn in the hand. When the oxygen level of the person goes below the threshold point, the device will give an alarm to the driver that he/she is drowsy and need to be active. Though there are several methods for measuring drowsiness, this approach is completely non-intrusive and does not affect the driver in anyway.

The existing systems are not accurate and reliable, but this research is very accurate and reliable because of using a biological method for the calculation and also cost affordable and easy to wear. Most of the previous research works, which are related to the driver's drowsiness, are all about sensing the eye blink, and a more complicated heart rate, but in our work, the oxygen level in the blood is sensed. If it is less than 96%, our work will produce an alert to the driver, which will awaken his consciousness.

Figure 3 shows the system architecture of the work. It explains the interconnection of the components and the steps involved in the detection of drowsiness.

5 Hardware and Software Requirements

The hardware requirements include a SpO2 sensor, LCD Display, Alarm buzzer, Resistor, Transistor, Breadboard and also jumper wires, and software requirements like Arduino IDE and some of the libraries to be used for our work.

5.1 SpO2 Sensor

The amount of oxygen-carrying hemoglobin in the blood about the amount of hemoglobin that does not carry oxygen is measured by SpO2, also referred to as oxygen saturation. A specific amount of oxygen must be present in the blood for the

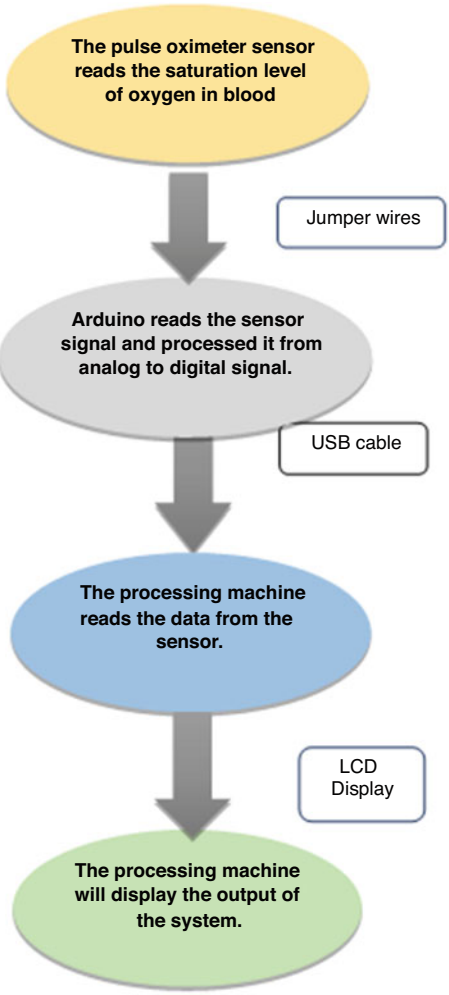

Fig. 3 System architecture

body to function properly. Figure 4 shows the SpO2 sensor, which senses the blood oxygen level.

5.2 LCD Display

LCD (Liquid Crystal Display) is a type of flat panel display which uses liquid crystals in its primary form of operation. LEDs have a large and varying set of use cases for consumers and businesses. Figure 4 depicts the LCD display where the level of the blood oxygen will be displayed.

Fig. 4 SpO2 senso r

5.3 Alarm

Distinctive sound is to help attract attention to the computer or hardware device. A buzzer depicted in Fig. 5 is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, training, and confirmation of user input such as a mouse click or keystroke (Fig. 6).

5.4 ArduinoIDE

The Arduino Integrated Development Environment—or Arduino Software (IDE)—contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions, and a series of menus (Fig. 7). It connects to the Arduino hardware to upload programs and communicate with them.

Fig. 5 LCD display

Fig. 6 Alarm buzzer

Fig. 7 Arduino IDE logo

6 Implementation and Results

The driver's wrist will host the wearable device. To prevent accidents, the driver must wear this drowsiness detection gadget after the vehicle is started in the driveway. The gadget includes an anti-sleep alarm and pulse oximetry, which are connected to an Arduino Uno R3 attached to the device to rouse the sleepy motorist. The sensor for pulse oximetry detects the driver's heart rate and SpO2 level (blood oxygen saturation). If the heart rate falls below a certain level and when SpO2 falls to 96% of oxygen at 60 bpm, the active alarm buzzer emits a few passive internal shocks and sound vibrations, which are used to shake the motorist out of sleep. First, the system's code implementation is completed, and the circuit connection with the necessary parts is created. The code is uploaded to the Arduino board after proper connection, the operation of the sensor has been verified, and the system is now implemented. This research work is certain to provide the best result in comparison to the existing research. Utilizing this device, we can lessen accidents in daily life and preserve valuable life.

7 Experimental Results

The experiment's objectives are to determine the SpO2 level in the body's blood and to determine whether the apparatus is operating correctly. The outcomes will show the driver's condition, and whether or not he or she is active while driving. The states of the driver are identified from the experiment, and if the driver is not active, the alert sounds. These findings are crucial to fulfilling the project's requirements and enhancing the caliber and effectiveness of the research. We propose a novel system for evaluating the driver's level of consciousness based on SpO2 level (blood saturation level) detection in the human body. We use the experimental results to track the drowsiness level of the driver. Therefore, this research work is almost a real-time system as it has a high operation speed. From the experimental results, the driver's drowsiness detection system using SpO2 applies to different circumstances and can offer stable performance.

Figure 8 illustrates the working principle of pulse oximeter sensor, detection of blood level and triggering of an alarm that meets the desired level of SpO2.

The experimental detection of blood oxygen level is depicted in Fig. 9.

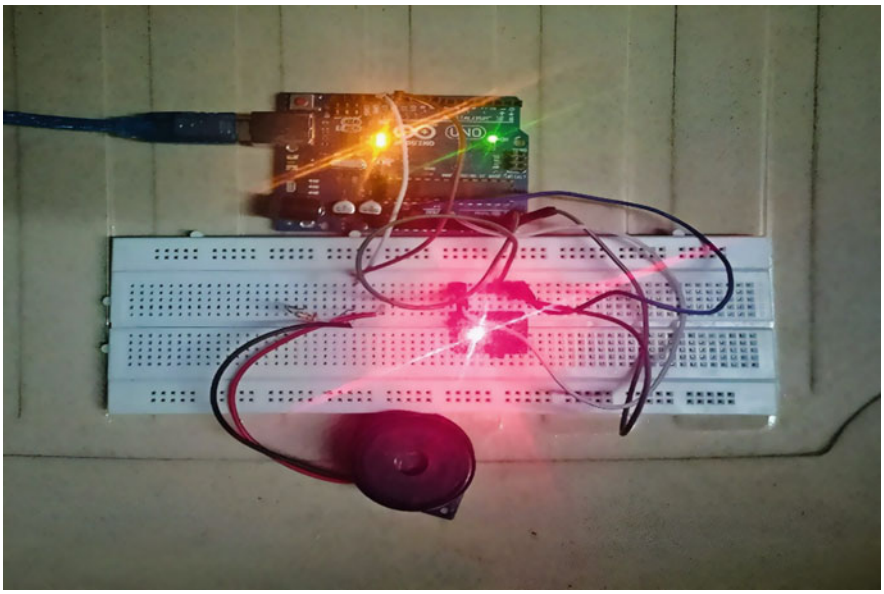

Fig. 8 Working of the pulse oximeter sensor

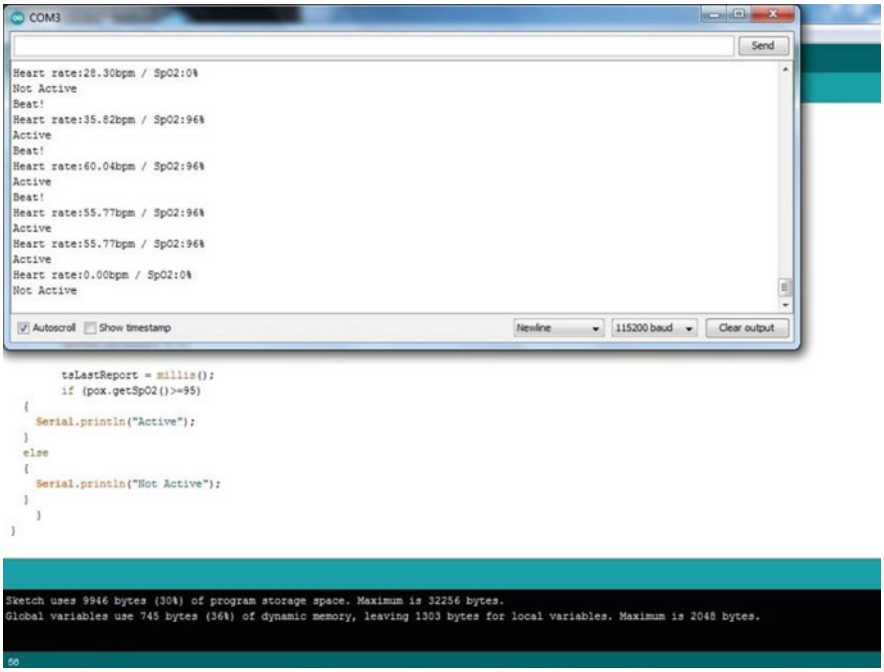

Fig. 9 Console window

8 Conclusion and Future Work

The purpose of this research is to find effective methods for handling situations where a driver's drowsiness is suspected. The analysis leads to the conclusion that in other existing research, they have incorporated the domain, of image processing which was a bit complicated process, and also there are fewer chances to convert their model into wearable devices. Our drowsiness detection system focused on detecting the oxygen saturation level in the blood, which helps to detect the drowsiness of the driver.

Our future work is to convert the prototype into a wearable device that will be useful for commercial purposes. From all the above experiments, it is proven that the developed system using a pulse oximeter sensor can detect the driver's drowsiness condition. The device successfully detects the drowsiness level of the driver and produces good results. However, the implementation of our work can be extended with some more physiological sensors like heart rate and monitors, but still, it is effective research with a success rate. Despite various results from various domains like image processing and hybrid-based systems, this biological method is reliable, affordable, and easy to use and helps us in detecting drowsiness level more accurately.

References

1. R. Jabbar et al., Driver drowsiness detection model using convolutional neural networks techniques for android application. arXiv:2002.03728v1, 1–6 (2020)
2. S.H. Alam et al., A cost-effective driver drowsiness recognition systems, in *2019 IEEE International Conference on Biomedical Engineering, Computer and Information Technology for Health (BECITHCON)*, (IEEE, 2020)
3. A.Y. Avidan, Chapter 101: Sleep and its disorders, in *Bradley and Daroff's Neurology in Clinical Practice*, ed. by J. Jankovic, J.C. Mazziotta, S.L. Pomeroy, N.J. Newman, 8th edn., (Elsevier, Philadelphia, 2022)
4. M. Doudou, A. Bouabdallah, V. Berge-Cherfaoui, Driver drowsiness measurement technologies. Int. J. Intell. Transp. Syst. Res. **18**(2), 297–319 (2020)
5. J. Batista, A drowsiness and point of the attendance monitoring system for driver vigilance, in Proceedings of Intelligent Transportation Systems Conference, Seattle, WA, USA (October 2007), pp. 702–708
6. G. Li, B.-L. Lee, W.-Y. Chung, Smartwatch-based wearable EEG system for driver drowsiness detection. IEEE Sens. J. **15**(12), 7169–7180 (2015)
7. R. Sasikala, S. Suresh, J. Chandramohan, M. Valanrajkumar, Driver drowsiness detection system using image processing technique by the human visual system. Int. J. Emerg. Technol. Eng. Res. **6**(6), 1–11 (2018)
8. J. He, W. Choi, Y. Yang, J. Lu, X. Wu, K. Peng, Detection of driver drowsiness using wearable devices: A feasibility study of the proximity sensor. Appl. Ergon. **65**, 473–480 (2017)
9. J.N. Mindoro, C.D. Casuat, A.S. Alon, M.A.F. Malbog, J.A.B. Susa, Drowsy or not? Early drowsiness detection utilizing Arduino based on electroencephalogram (EEG) neuro-signal. Int. J. Adv. Trends Comput. Sci. Eng. **9**(2), 2221 (2020)
10. B. Warwick, N. Symons, X. Chen, K. Xiong, Detecting driver drowsiness using wireless wearables, in *2015 IEEE 12th International Conference on Mobile Ad Hoc and Sensor Systems*, (IEEE, 2015), pp. 585–588