

Real-Time Low-Power Anti-Sleep and Alcohol Detection System for Safer Driving

Mohamed Khudhair Al-Gburi^{1*}, Ameer Sameer Hamood Mohammed Ali²

¹Information Networks Department, College of Information Technology, University of Babylon, Hillah, Iraq

²Presidency of the University of Babylon, University of Babylon, TOEFL Center, Babylon, Iraq

* Email: mohamed.algburi@uobabylon.edu.iq

Article Info	Abstract
Received 23/08/2024	Alcohol reduces the level of awareness a driver needs to drive safely. The vision of a drunk driver is blurry or even double vision, and this leads to many problems. This paper presents the development of an IoT-based Anti-Sleep and Alcohol detection algorithm, Low Power Detection Time Operation (LPDTO), to enhance road safety by preventing accidents caused by impaired driving. The proposed method integrates advanced sensors to monitor the driver's alcohol consumption and signs of drowsiness in real time; it uses a microcontroller to set specific Blood Alcohol Content (BAC) thresholds and triggers alerts when these limits are exceeded. Additionally, it employs facial recognition technology to assess driver fatigue by analyzing eye movement patterns and facial expressions; it contributes to low power consumption and real-time monitoring. The results showed the LPDTO algorithm decreased the total average detection response time to 16.242 milliseconds, the total average alert response time to 12.93 milliseconds, and sleep detection accuracy to 98.66%, reducing the incidence of drunk driving-related road accidents by reducing accidents occurring in the city's crowded streets by early detection of drowsiness and alcohol in drivers, and also enhancing the accountability of drivers by providing a traceable record of their behavior.
Revised 18/10/2026	
Accepted 24/10/2026	

Keywords: Anti-Sleep, Alcohol Detection, IoT, Safety Technology, Wireless Network

1. Introduction

One of the dangerous behaviors while driving is driving under the influence of alcohol, because excessive alcohol consumption causes distortions in the driver's thinking pattern, which leads to loss of focus while driving. An investigation conducted by the World Health Organization in 2007 showed that traffic accidents are related to driving under the influence of alcohol [1]. At present, the number of accidents resulting from driving under the influence of alcohol has increased significantly, and it has become very clear that driving under the influence of alcohol causes harm to the public safety of all drivers [2]. Various techniques and methods have been adopted to reduce alcohol-related driving accidents, and drivers have used these techniques, which have increased awareness among drivers [3].

Many methods detect alcohol, including an alcohol detector based on a sensor, an AC power source, an LM 358 Operational Amplifier (Op-Amp), and a Liquid Crystal Display (LCD). These devices display the presence of alcohol molecules in the surrounding air, and warning text appears when the operational amplifier's fixed threshold is exceeded [4]. One of the disadvantages of this system is that the person is very close to the AC power outlet due to the sensor system operating on AC

power [5]. This system also requires two people: one to conduct the test and note when the threshold is exceeded, and the other as the person being tested, comparing both cases and finding the difference between them in relation to the specified threshold value, as well as the actual implementation of sending a warning notice to the driver's fluids or to the relevant authorities to deal with alcohol detection cases [6].

The driver's sleep or if the driver is drunk while driving poses a great danger to his life and the lives of others on the road [7]. This condition may cause serious traffic accidents and even death. For several reasons, including:

- 1- Loss of consciousness and inability to respond properly to road factors such as barriers, directional signs, and weather changes [8].
- 2- The effect of external factors such as boredom, loud music, mobile phone use, and smoke on the driver's health and concentration [9].
- 3- Increasing the possibility of errors in driving, as the driver is unable to think correctly and make the right decisions due to being affected by drowsiness and confusion [10].

Recent advancements in sensing and communication technologies have led to the rapid emergence of low-cost wearable devices, which are increasingly becoming essential tools for applications based on biosensors [11]. These devices are being utilized across various sectors, including industry, transportation, healthcare, daily life, and sports. Many shift-work industries are exploring the use of these innovative technologies to monitor human cognitive states, as they offer a more objective approach compared to traditional measurement methods [12]. By leveraging biosignal technologies, it becomes possible to alert drivers to the early signs of drowsiness, thereby preventing serious accidents and addressing the issue of driver fatigue effectively [13]. Extensive research has been conducted on driver fatigue, exploring various measurement technologies. These approaches can be broadly classified based on the monitoring instruments used: (i) vehicle-based sensors, as shown in Fig. 1 video-based sensors, and physiological signal sensors. The latter category includes techniques such as electrooculography (EOG), electromyography (EMG), electrocardiography (ECG), and electroencephalography (EEG) signals, with the latter being the most widely utilized method in driver fatigue detection [14], [15].

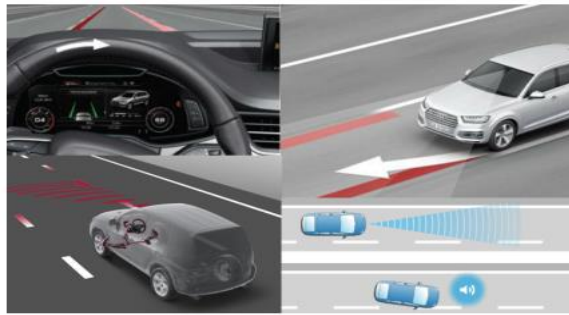


Figure 1. Illustration of vehicle behavioral sensors for fatigue and drowsiness detection.

Fig. 2 monitors and analyzes various indicators of driver alertness.

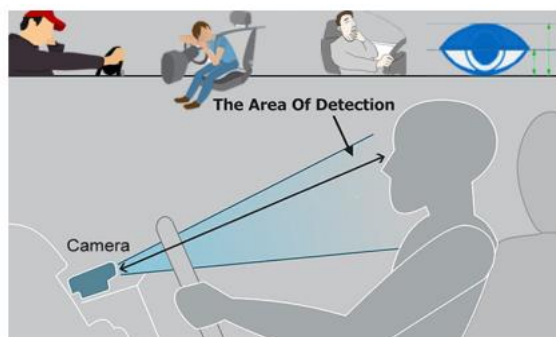


Figure 2. Driver behavioral sensors for fatigue and drowsiness detection.

Fig. 3 shows how to monitor various biological indicators to assess a driver's alertness levels and provide real-time monitoring of driver alertness. When drowsiness is detected, the system can issue alerts, such as auditory signals or visual

warnings, prompting the driver to take corrective actions like resting or pulling over



Figure 3. Physiological signals during the process of detecting driver fatigue and drowsiness.

In-vehicle measurement: a set of sensors is deployed inside the car to measure and collect several indicators used that contribute to determining the level of alertness or drowsiness of the driver, depending on his behavior while driving [16], as shown in Fig. 2 and Fig.3, where the behavior scale focuses on the movement of the steering wheel, the deviation of the car, its location, and the speed of the car. The two most common methods for measuring steering wheel movement (SWM) and standard deviation of lane position (SDLP) are used in industrial products [17].

In addition, the proposed system contributes low power consumption by reducing energy usage is critical for continuous vehicle monitoring devices by using advanced energy management technologies of the proposed system that allow the host system to operate without draining the device battery. Real-time monitoring of driver conditions, specifically targeting drowsiness and alcohol use, enables rapid and timely responses that contribute significantly to enhancing road safety by providing immediate alerts to drivers, thus preventing accidents resulting from unsafe driving under the influence of alcohol. Enhancing road safety by focusing on sleep disorders and alcohol directly contributes to enhancing road safety measures according to the standard criteria to reduce traffic disasters related to driver impairment.

Furthermore, several challenges and limitations affect the ideal functioning of the proposed system, such as sensitivity to environmental conditions, such as changing lighting conditions, which affect the accuracy of sensor detection systems. As well as detecting undefined and unclear behaviors that are not defined and observed during the standard measures of the proposed system training phase and may lead to false negative results in detecting some behaviors related to driver fatigue or distraction.

2. Related Works

There are different research directions dealing with anti-sleeping and alcohol detection as follows: Uzairue et al. [18] developed an alcohol detection system for the safety of land transportation in the smart city, relying on the Internet of Things technology, where two thresholds are used to measure the

alcohol content in the blood and monitor these two thresholds using a microcontroller. When the detection reaches the first threshold, the system transmits the level of alcohol content in the driver's blood and the coordinates of the car's location to the central monitoring unit. When the second threshold of the alcohol content in the blood is reached, the alcohol detection system turns off the car's engine and operates a warning alarm system via the warning light indicator in the car. The results showed that this system contributed to reducing road accidents related to driving under the influence of alcohol in smart cities.

Doudou and Bouabdallah [19] proposed a biosensor-based driver drowsiness detection system to meet the requirements for accurate drowsiness detection. The proposed method is used to detect driver drowsiness efficiently. The results contributed to providing a methodology to facilitate the selection of devices that are suitable for an effective and low-cost system for drowsiness detection using devices specifically designed to sense the driver's physiology while driving.

Kumar et al. [20] proposed a model that was based on detecting drowsiness and alcohol using the MQ3 alcohol sensor by detecting the percentage of alcohol in the driver's breath, which leads to the car slowing down while driving. The method of connecting the system to the Arduino UNO LED sensors depends on special lights that glow when alcohol is detected, a sound notification bell rings when drowsiness is detected, and the car speed varies when both cases are detected.

Perkins et al. [21] proposed a vehicle-based method for successfully addressing the identification of driver drowsiness. The modern method is based on the physiology and behavior of the driver in the vehicle during the detection of drowsiness. The physiological method used monitors the electroencephalogram (EEG), while behavioral monitoring is less robust and accurate during detection and is affected by external factors such as lighting and privacy concerns. In addition, the proposed model is based on sleep detection scales such as the Karolinska Sleepiness Scale. The results showed a set of challenges to detecting drowsiness, including a lack of on-road data and inconsistent protocols for collecting data while driving.

Rozali et al. [22] developed a system that contributes to monitoring the driver's drowsiness. It aims to reduce fatal accidents resulting from the driver's drowsiness and distraction, as the system works by analyzing the driver's eye blinks and repeated yawning as evidence of drowsiness, while distraction is based on estimating the head position and eye tracking, where an alarm system is activated in the event of any of the mentioned cases. The system was implemented in Python using a Raspberry Pi to design a unique system in the form of a platform for alerting while driving. The results showed that the system provides efficient monitoring of the driver's drowsiness and avoids accidents in real time.

Sekhar [23] proposed an alerting driver and sleeping model by alerting the person who is sleeping while driving to avoid accidents and save lives. It is considered very important for people who travel long distances or people who drive cars late at night. It was built using an Arduino Nano circuit, a switch, a bell, a micro-vibration motor, and a Le Amir eye sensor. The results showed that when the driver feels sleepy, the sensor

detects the eye blink and lights the bell with a medium beep sound. When the driver returns to his normal state, the bell turns off.

Yadav and Raju [24] proposed a novel system to detect driver alertness to avoid accidents while driving in order to reduce the levels of driver driving activities by waking him up to maintain transportation safety, based on an Arduino controller connected to many sensors to increase transportation safety and prevent accidents resulting from driver drowsiness, intoxication, and obstacles by estimating the state of alertness. The system relied on integrating data from multiple sources of driver fatigue and alcohol to reduce accidents. The results showed proof of correct verification and provided snapshots of the driver's condition to distinguish his obstacle from other echoes.

Detecting the level of drowsiness in the driver is very important to determine the driver's condition and reduce road accidents due to drowsiness. Dalui et al. [2] proposed a system based on identifying information about potential signs of drowsiness for the driver to make the appropriate decision according to the two conditions and relied on vehicle, leg behavior, and physiology to design a smart real-time alert system that contributes to preventing accidents and turning off vehicles to avoid losing the driver during his sleep by developing an anti-sleep alarm device based on the Internet of Things that activates an automatic alarm in less than 2 seconds to alert the driver and stop the vehicle engine within 5 seconds and install an automatic fire system to prevent accidents inside the vehicle. The results showed the efficiency of the system in sending messages to emergency numbers to detect the fire and contributed to quickly taking the necessary measures in this regard.

Unlike many related systems that prioritize performance over energy consumption, the proposed LPDTO system emphasizes low-power operation and extends sensor lifetime, enabling extended monitoring without battery replacement or recharging. This is useful for devices that require continuous use in the vehicle to monitor the driver with maximum accuracy in detecting behavior. In addition, the proposed LPDTO system offers a new approach to reduce drowsiness and alcohol impairment detection time by generating alerts faster than previous studies. This rapid response is essential in preventing accidents caused by driver fatigue. It also detects both sleep and alcohol states simultaneously, which allows comprehensive monitoring of driver fitness.

3. Methodology

The implementation of the proposed system requires an integrated software environment for programming, based on the Python programming language, to develop code for the Arduino IDE microcontroller for building and uploading the code. In addition, the Blynk IoT platform contributes to the remote monitoring and control of the readings recorded by the sensors, as it contributes to the transfer of real data and the management of instant alerts through the mobile phone interface or the web. In addition, the hardware requirements consist of a microcontroller, sensors, and a set of other components that are explained in Table 1, which contains the required implementation tools and the used system devices. In addition,

the system design architecture shown in Fig. 4 contributes to the detection of alcohol levels or signs of drowsiness, as it issues an alert via an alarm bell, LED indicators, and a vibration PIR motion device. At the same time, the data is transferred to a central monitoring system that allows the competent authority to take the necessary measures to enhance road safety through accurate detection and rapid response to these cases.

Besides, the proposed system is designed for easy installation in vehicles and features IoT connectivity, allowing for real-time data transmission to a central monitoring unit. This enables law enforcement to track and respond to potential incidents effectively. By implementing this technology, the aim is to significantly reduce the incidence of alcohol-related and drowsy driving accidents, thereby promoting safer driving conditions in urban environments. The effectiveness of the system is evaluated through various performance metrics, ensuring reliability and user acceptance. The proposed system aims to determine driver drowsiness and detect anti-sleep and alcohol impairment, creating a safer driving environment by providing timely alerts and interventions to drivers exhibiting signs of fatigue or impairment.

In addition, the proposed Low Power Detection Time Operation (LPDTO) methodology is based on NodeMCU (ESP8266/ESP32), which optimizes for low-power operation while decreasing detection time, and involves several key steps. This includes setting up the device to wake up periodically, check a sensor, and then go back to sleep. The pseudocode of the LPDTO algorithm to decrease detection time for low-power operation is explained as follows:

Pseudocode of Low Power Detection Time Operation (LPDTO) methodology
1. Setup configuration devices Initialize sensor() and WiFi() Configure deep sleep mode() Set wake-up interval (300 seconds) 2. Main Loop while True do Wake up from deep sleep data = Read sensor data() if data meets condition then Perform actions(data) Go back to deep sleep() End if End while 3. Initialize WiFi(): Set WiFi SSID and password Connect to WiFi network Wait for connection to establish 4. Configure deep sleep mode() Set deep sleep duration to wake-up interval Set wake-up source (timer or GPIO pin) 5. Read sensor data(): Delay for sensor to stabilize data = Read data from sensor Power off sensor return data 6. Perform actions of (data):

```

if not WiFi connected then
    Connect to WiFi()
    Send data to server (data)
    Go back to deep sleep():
    Set wake-up timer to wake-up interval
    Enter deep sleep mode
End if
End

```

Besides, the proposed system architecture consists of the WIFI notification section, which is responsible for sending alerts as text messages to the police station or traffic light station or any other alarm notification node; the microcontroller: the NodeMCU, which used to support wireless connection of nodes and is based on Arduino to manage and control all other system components; and the main sensors used as Sensors: EOG sensor and MQ-3 gas sensor to record and sense alcohol and sleeping states, as shown in Fig. 4.

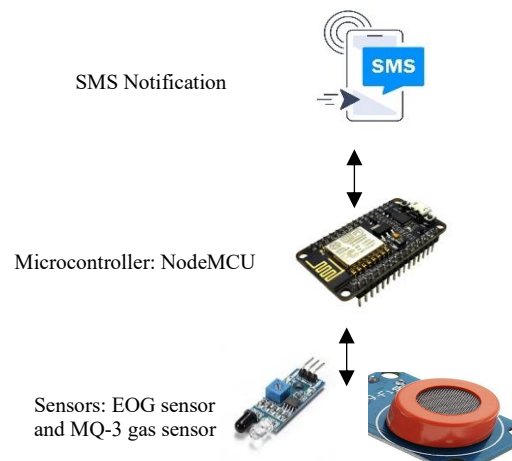


Figure 4. The proposed system architecture.

The main steps are explained as follows:

- 1- Setup
 - Initialize the sensor and configure it to ensure it is ready for operation.
 - Initialize the WiFi if the sensor data needs to be sent to a server.
 - Configure the deep sleep mode and set the wake-up interval.
- 2- Main Loop
 - The device wakes up from deep sleep.
 - The sensor data is read and processed.
 - If the sensor data meets certain conditions, the necessary action (like sending data to a server) is performed.
 - The device then goes back to deep sleep to save power.
- 3- Functions
 - Initialize sensor: Set up and test the sensor.
 - Initialize WiFi: Set up and connect to a WiFi network.
 - Configure deep sleep mode: Set up deep sleep with a specified interval and wake-up source.
 - Read sensor data: Power on the sensor, read data, and power off the sensor.
 - Perform necessary action: Connect to WiFi if not already connected, send data, and optionally disconnect.

-Go back to deep sleep: Set the wake-up timer and enter deep sleep mode.

The proposed approach ensures that the NodeMCU operates in a low-power mode by sleeping between sensor checks and only waking up for short periods to perform necessary tasks, as shown in Fig. 5.

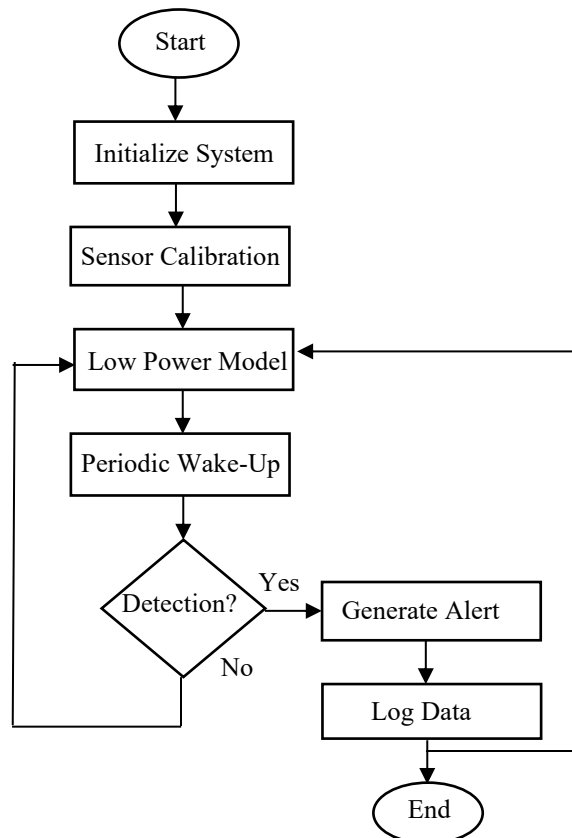


Figure 5. Flowchart of the proposed LPDTP method.

The main steps in Fig. 4 are explained as follows:

- 1- Start: Initialize the system configurations and settings.
- 2- Initialize NodeMCU (ESP8266/ESP32)
Set up sensors (alcohol sensor, sleep detection sensor)
Connect to the power supply
- 3- Sensor Calibration
Calibrate alcohol sensor
Calibrate sleep detection sensor
- 4- Enter Low Power Mode
Put ESP8266/ESP32 in deep sleep mode
- 5- Periodic Wake-Up
Set timer to wake up ESP8266/ESP32 periodically (every 10 seconds)
- 6- Read Sensor Data
Read alcohol sensor data
Read sleep detection sensor data
- 7- Data Analysis
Analyze alcohol sensor data to detect alcohol levels
Analyze sleep detection data for signs of drowsiness
- 8- Decision Making
If the alcohol level exceeds the threshold or drowsiness is detected, proceed to alert
If no detection, return to low-power mode

9- Generate Alert

Activate a buzzer or vibration motor to alert the driver
Optionally send an alert to a connected device (e.g., smartphone)

10- Log Data (Optional)

Log detection data for further analysis

11- Repeat Process

Return to low power mode and repeat the cycle

12- End

In addition, Algorithm 1 includes simulation of the detection system using low power. The structure includes classes to represent the detection system and power states, and methods to simulate detection operations based on power consumption levels using a detection function that manages the current system state. It includes methods to switch the state and detect drowsiness and alcohol conditions through driver behaviors using the sleep state and the system function that is based on the low power concept. The proposed LPDTP system was trained and tested by running different scenarios to ensure that the transitions between states work correctly and that the alcohol and drowsiness detection processes behave as expected during the test. The total power consumption during the different operating states was measured, and the critical state of the total power consumption was estimated, with the state transitions occurring rapidly during the detection phase in low-power modes.

Algorithm 1 formal verification of the Low Power model within Low Power Detection Time Operation (LPDTP) methodology

- 1- Initialization PowerState class.
object name, power_consumption in watts
- 2- Building Detection System:
Select Threshold values from self-power-states pool
 - A- Active state consumes 1 watt
PowerThresholdState('ACTIVE', 1.0)
 - B- Low power state consumes 0.1 watt
PowerThresholdState('LOW_POWER', 0.1)
 - C- Sleep state consumes 0.01 watt
PowerThresholdState('SLEEP', 0.01)
self.current_state = self.power_states['ACTIVE']
self.detection_time = 0
- 3- Switching low power states
if new_state in self.power_states **then**
current= new
Switched to new → power consumption
Endif
- 4- Detect sleepiness(method)
if current selected = ACTIVE **then**
Simulate detection logic (sleepiness)
#Facial expressions and eye closures
(electrooculography (EOG) sensor)
detection time Increment += 1
return True detection is successful

	else
	return False
	End if
5-	Detect alcohol(method)
	if current state name = ACTIVE then
	Simulate detection logic (alcohol)
	#Concentration of alcohol in a driver's breath
	(MQ-3 gas sensor detects alcohol vapor)
	detection time Increment += 1
	return True detection is successful
	else
	return False
	End if
6-	Report status (Evaluation)
	Detection Response Time in ms
	Behavioral Type (state-name: Sleep or Alcohol)
	Alert Response Time in ms
	Detection Accuracy %
	Reliability
	Durability
	End of Algorithm

The proposed system LPDTO methodology consists of the following:

A. Main Design of the proposed system

A small box was used to hold the contents of the system and was placed in the mailbox on a board. A NodeMCU was installed on top of the main board. Long wires were extended for the infrared sensor and a shorter wire for the alcohol sensor to be flexible in examination.

B. Components of the proposed system

Fig. 6 shows the proposed system hardware components, which are Arduino IDE/NodeMCU-based, Electrooculography (EOG) sensor, MQ-3 gas sensor, Jumper Wires, DC motor, Buzzer, PIR motion sensor, ESP8266 Wi-Fi, and breadboard, labeled and explained as follows:

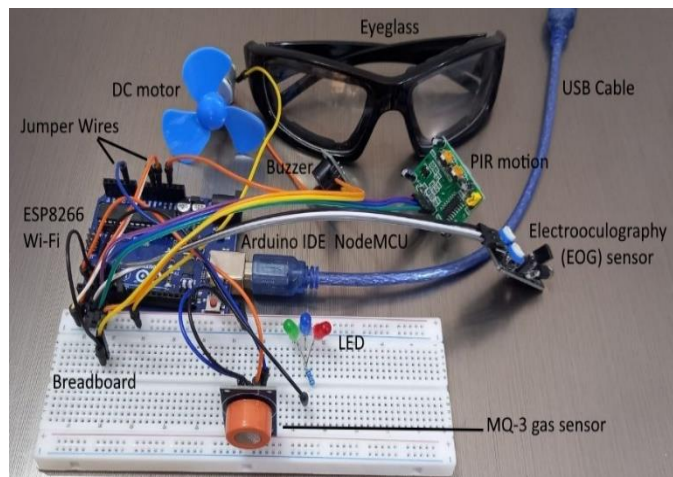


Figure 6. The proposed system components

The explanation of the proposed system components is as follows:

1- NodeMCU

The NodeMCU is an integrated Internet of Things (IoT) system that uses Lua-based programming. The device is based on Arduino-based C/C++ programming language, but it provides direct internet connectivity, making it easy to connect many devices to the internet. The hardware consists of an ESP8266 Wi-Fi CPU and internal flash memory for storing files and programs. NodeMCU is useful for both IoT beginners and professionals. It can be used to analyze sensor data, control devices remotely, and perform many different projects. The USB port makes it simple to load programs, and the NodeMCU offers basic functions like displaying program output on the board, monitoring memory consumption, unloading the program when necessary, and viewing additional NodeMCU information. It can also extend the platform's capabilities by developing Lua programs or using APIs provided by different providers, manufacturers, and framework sites, as shown in Fig. 7.



Figure 7. Nodemcu Device.

The steps in the Arduino IDE to blink an LED connected to one of the GPIO pins are as follows:

- 1- Define the GPIO pin where the LED is connected
- 2- Initialize the digital pin as an output.
- 3- Turn the LED on (HIGH is the voltage level)
- 4- Wait for a second
- 5- Apply the time management approach
- 6- Turn the LED off by making the voltage LOW
- 7- Wait for a second
- 8- Recall the Time management approach

NodeMC's integrated Wi-Fi capabilities and easy-to-use programming environment: the main options, features, and applications are as follows. It consists of a Tensilica 32-bit RISC CPU operating at 80 MHz, 64 KB of RAM, and 4 MB of data storage and program execution. The wireless connection ensures ease of connecting to the network locally within the coverage area provided by the controller. Its benefits include reducing energy consumption, as it is designed efficiently to suit Internet of Things applications with low power, as well as ease of use through Arduino IDE programming and its interaction with many sensors and motors. Its application in the

proposed system is for remote monitoring as well as local alerting of the driver for drowsiness and alcohol conditions.

In addition, the nature of the wireless network plays an important role in the IoT-based sleep and alcohol detection system, which enhances safety methods in data transfer while collecting it from different sensor devices such as the drowsiness advisor and the alcohol sensor and transferring it to the police station in real time when a dangerous condition affecting the driver and road is detected through continuous monitoring and sending the necessary alerts wirelessly using SMS technology or alerts to the driver himself inside the vehicle through an alarming sound, which enables a quick response to potentially dangerous situations and provides the authorities with very important information about the driver's behavior.

C. Sensor MQ-3

Designed to detect flammable gases like alcohol, ethanol, methanol, and others, the MQ-3 sensor is a type of chemical sensor. Several fields, including biomedicine, industry, electronics, and robotics, use this sensor. The sensor operates by exposing the gas for detection to the positive and negative ions in the surrounding air. As soon as the gas interacts with these ions, the sensor emits an electrical signal that changes in level. An electronic circuit reads this signal and converts it into a digital value.

One of the most important uses of this sensor is to detect the level of alcohol in the breath, which makes it useful in vehicles, medical centers, and public places. We also use this sensor to monitor the gas depletion in fuel tanks and other high-risk locations, as shown in Fig. 8.



Figure 8. Sensor MQ-3.

D. Infrared sensor

The infrared sensor is one of the most common ground sensors due to its technology, which is based on infrared rays, as it sends messages between control units or detects objects, as well as detects fires and changes in behavior resulting from excessive movement and others, as this sensor depends on sending and receiving invisible rays to detect objects within its field of operation. What makes this technology easy to use is that both the sender and receiver are on the sensor at the same time, as shown in Fig. 9.



Figure 9. Infrared sensor.

E. buzzer

The loudspeaker primarily emits an audio signal. The buzzer comprises a metal solenoid and a magnet. When an electric current flows through the solenoid, it generates a magnetic effect on the magnet, causing it to oscillate and strike the outside of the vertical bell, which generates the sound.

Many applications, including alarms, alerts, games, robotics, and other electronic products, utilize buzzers. The frequency and sound produced by the buzzer can be controlled by changing the voltage applied to it and making it produce multiple and varied sounds.

F. Motor dc

A DC motor is a device driven by direct current, mainly used in automatic, hydraulic, and other electrical systems. The voltage determines the current available to the motor, speed, and torque, and all DC motors contain two main parts, which are the first fixed part known as the stator, and the free-moving part known as the rotor. Parts are connected by electrodes located in the stator of the motor.

G. Female / male connection wires

Jumper wires (female/male) connect network components, as shown in Fig. 10.

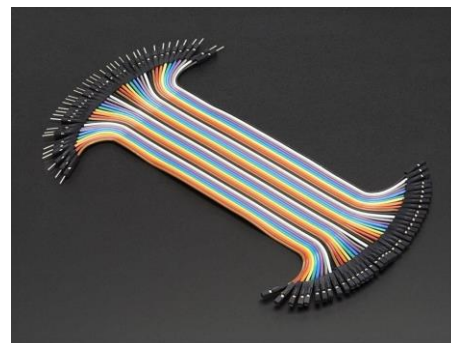


Figure 10. Connection Wires.

H. Breadboard

Use a breadboard or prototype board as a basis for building prototypes of semi-permanent electronic circuits. These boards do not require soldering or destroying the tracks and can therefore be reused again. They contribute to creating prototypes for a range of electronic systems, from small analog and digital circuits to full-fledged central processing units (CPUs). They have high parasitic capacitance, less reliable

connections, relatively high resistance, and are more susceptible to shocks and physical degradation. The signal is limited to about 10 MHz. The circuit does not work when the signal frequency is less than this limit, as shown in Fig. 11.

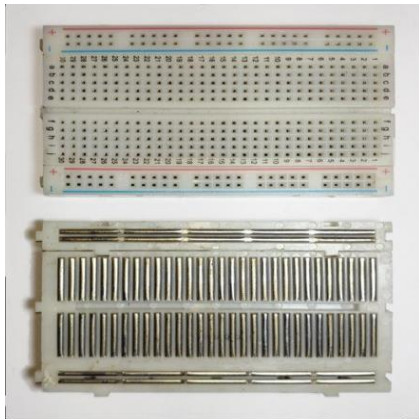


Figure 11. The used Breadboard.

I. Establishing Smart Guard IoT System

The following method connects the proposed system components with the main steps:

- A. Connect the alcohol sensor to pin A0 and the buzzer to pin D2, as shown in Fig. 12.

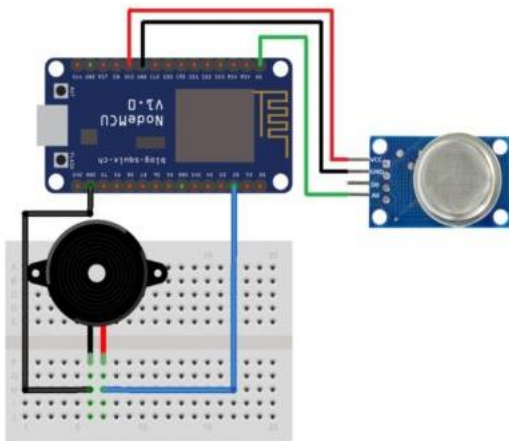


Figure 12. The circuit used to connect the alcohol sensor.

- B. Connect the infrared sensor to pin D1, as shown in Fig 13.

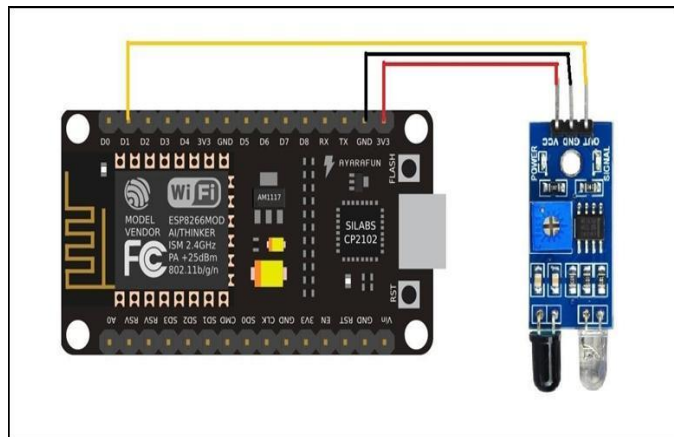


Figure 13. The circuit used to connect the infrared sensor.

- C. Connect the motor to pin D4, as shown in Fig. 14.

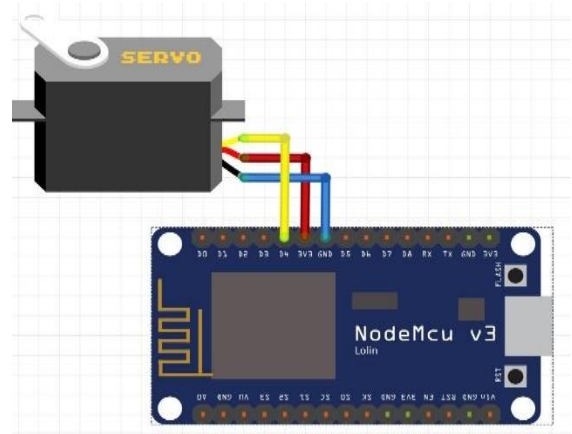


Figure 14. The circuit used to connect the Motor.

1. Arduino IDE

The Arduino IDE is the software used to program and upload code to the Arduino board. Arduino IDE allows users to write programs for Arduino boards more easily and faster. The Arduino IDE has many features, most notably:

- 1- Code Editor: Allows users to write code easily and simply.
- 2- Demo Controller: Allows users to easily test and download code.
- 3- Symbol Library: It has a large number of symbols that are useful for programming various panels.
- 4- Graphical interface: It allows you to interact with the Arduino board easily and simply.
- 5- Virtual Emulator: It allows users to test code on the simulated board before connecting the actual board.

Ultimately, the Arduino IDE is a great tool for both beginners and professionals in the Arduino world. It offers an intuitive and interactive programming interface that makes programming and uploading code to Arduino boards easier and faster.

K. Blynk IoT

Blynk is a user-friendly IoT platform that facilitates the rapid development of IoT applications. It is powered by a mobile application available for smartphones and tablets, which allows users to manage IoT devices and address related challenges effectively. The platform employs an integrated software suite that enables seamless communication between devices and applications. Users have the flexibility to either enhance existing Blynk applications with their own code or create entirely new applications from the ground up using Blynk Server technology. It offers a wide range of features, including access to various variables such as sensors, maps, and control widgets. Additionally, Blynk boasts an extensive library of pre-built systems and innovative applications that users can easily utilize.

Since Blynk operates through mobile devices like smartphones and tablets, it allows users to connect to and manage their

electronic devices from virtually anywhere in the world. This capability ensures that obtaining data and controlling devices is both straightforward and convenient.

The proposed system construction steps as follows:

1. Download and install Blynk.
2. Create an account on Blynk
3. Add alcohol measuring icons.
4. Using a computer, log in to the Blynk IoT website

In addition, Table 1 presents the hardware and software requirements for implementing the proposed Internet of Things-based sleep and alcohol detection system.

Table 1. Implementation tool and frameworks.

Implementation Parameters	Considered Value
Arduino Type	Arduino IDE
IoT platforms	Blynk IoT, NodeMCU-based Lua firmware
Sleepiness detection sensor type	Electrooculography (EOG) sensor
Alcohol detection sensor type	MQ-3 gas sensor
Connection wires	Jumper Wires
Actuation Device	DC motor
Audible alerts	Buzzer
Motion	PIR motion
Wi-Fi CPU type	ESP8266 Wi-Fi
Breadboard Type	Breadboard 8.5 x 5.5cm (400 Holes)
IR sensor type	Modulated IR Sensor
Programming Language	Python, C/C++
RAM size	16 GB
CPU	Core i 7
Operating System	Windows 10

In addition, the feature of sending notifications via SMS was built to link the integration of the sensor system alarm notification and the Police Station (verified, authorized number).

This feature was implemented in the Python programming language, and the implementation steps were based on creating an account on the Twilio website to obtain the Account SID and the event notification token number as the Auth Token, which is necessary to authenticate API requests for the account creation process on Twilio.

The main steps are as follows:

- 1- The private library Twilio is installed in Python using pip install Twilio.
2. The function for sending SMS notifications is configured as follows in Algorithm 2:

Algorithm 2 implementing SMS notifications Sending of Twilio

1. Configure Twilio API sending SMS messages client
2. Setting Twilio account credentials

Assign Twilio account SID and Auth Token
client = Client(account_sid, auth_token)

3. Building send message method as

```
- send_sms(00964xxxxxxxxxx, alert_message):
- alert_message = client.messages.create(message_content,
Sender_Trial User, recipient police station number)
```

4- Sent alert_message created with SID when drowsy and alcohol features existis

```
- send_sms('00964xxxxxxxxxx', 'Alert: Driver
appears drowsy! Please take necessary action.')
```

End of algorithm

3-Integration of the sensor system with the messaging feature

This is done by integrating the SMS function into the Internet of Things system to monitor driver behavior using:

- Sleepiness detection sensor type using Electrooculography (EOG) sensor
- Alcohol detection sensor type using MQ-3 gas sensor

sensors that helped detect drowsiness and then redirect the sensor data as a message object to the competent authority's phone number.

A trial Twilio account was used to send messages only to verified numbers, which is one of the limitations and restrictions of the trial Twilio account used, which contributed to detecting the driver's drowsiness and checking his breathing to greatly enhance road safety requirements. Fig. 15 shows the proposed system implementation in the car.



Figure 15. The proposed system implementation.

Fig. 16 shows the system running and EOG sensing based on IR obstacles when worn in the eyeglass.



Figure 16. Running the used system design in the car.

4. Results

The proposed system utilized NodeMCU as its primary controller, programming it with the Arduino IDE program and connecting the sensors and motors to the Arduino. During the connection process, several issues arose, including a connection error that can lead to further complications. Microcontrollers are an important component of electronic and robotic systems, as well as other applications that control processes, electrical signals, and multiple inputs and outputs. The following common problems are faced in microcontrollers:

- **Unresponsive:** Microcontrollers can exhibit unresponsiveness or incorrect responses to inputs or outputs.
- **Software compatibility:** It can be difficult to develop software that works properly on microcontrollers, and it can be difficult to match different software to communicate with each other.
- **Security risks:** Microcontrollers can have security problems, which can cause the system to be vulnerable to attacks.
- **Software bugs:** There may be bugs in the software running on the microcontrollers, which can lead to unexpected or dangerous behavior when running.
- **Electromagnetic Noise:** The signals that the microcontrollers emit can contain errors or incorrect readings due to electromagnetic noise.
- **Managing environmental conditions:** External factors like dust, humidity, or heat can expose microcontrollers and affect their performance.

Fig. 17 and Fig. 18 show the Alcohol detection readings through sensing the used car environment.



Figure 17. Alcohol Detection Readings.



Figure 18. Live Alcohol Detection Readings.

Fig. 19 shows motion reads for 6 hours, as it sends 1 for (motion) or 0 for (no motion) to the Blynk app.

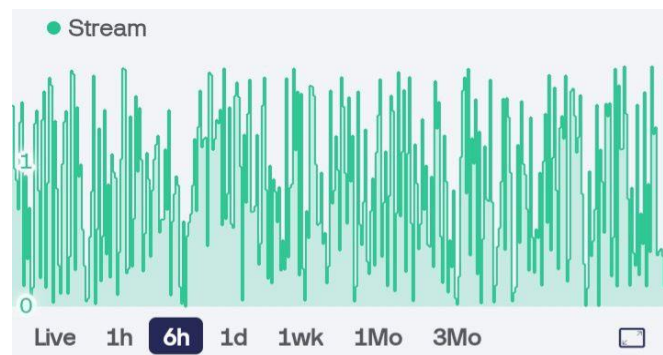


Figure 19. Motion/no Motion reads register from the used sensor.

Fig. 20 shows the EOG sensor reads 6 hours based on IR technology to register sleeping cases, as it sends 1 for (Eyes Closed (Drowsiness detected)) or 0 (Eyes Open (Awake)) to Blynk.

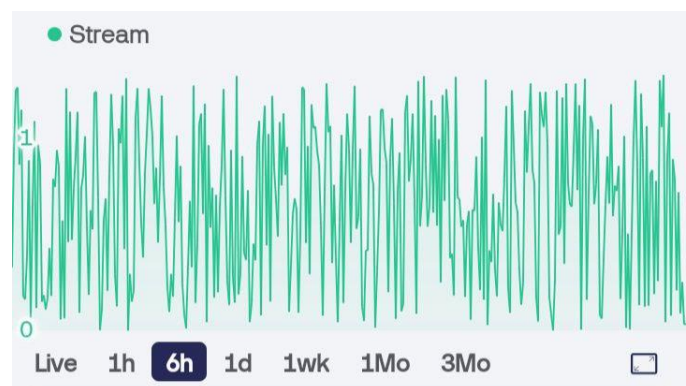


Figure 20. EOG sensor reads to Drowsiness/Awake detected.

The system used a fan as a car engine nozzle that shuts off when the driver's eye closes or becomes intoxicated.

We have prepared the system's components, which include the nodemcu for project control, a fan, a small buzzer box, a main board, a slack, an infrared sensor, and an alcohol sensor. We have installed the infrared sensor on the glasses, extended a long wire for the system, and connected the alcohol sensor to the nodemcu. The project box hosts both the fan and the buzzer.

We installed the fan on the project and connected the NodeMCU to the computer for programming.

Many factors may lead to cars colliding with each other on the highways or cars colliding with the sides of the road, and perhaps the most prominent of them is sleep or drowsiness while driving. According to many statistics, sleeping while driving causes up to 50% of car accidents on some roads; therefore, many companies have issued a driver alert feature for drowsiness.

As mentioned, alcohol reduces the level of alertness, awareness, and coordination a driver needs to drive safely. A drunk driver's vision becomes blurry or even double-visioned, and they are unable to discern the depth and dimensions of what they see in front of them. This makes it difficult for them to judge whether the cars or passersby in front of them are far or near, which can lead to numerous problems. One of the biggest problems that a drunk driver may face is his excessive self-confidence and his lack of realization that his driving skills are not at the level required for safe driving.

In some cases, driving at high speeds, dangerously overtaking cars and trucks, and making clumsy movements far from all safety assets. Tranquilizers, some pain relievers, decongestants, and allergy medications, along with alcohol, can suppress brain and body activity and lead to the same problems as drunk driving. When these drugs combine with alcohol, the problems intensify. The work aims to deter intoxicated individuals from operating a vehicle and encourage the driver to rest.

In the future, there are several ways to develop the proposed system: a smart camera replaces the infrared sensor and determines whether the driver is awake or asleep. Linking the car to an existing traffic database to receive a notification when the driver is drunk and using a strong alarm sound to alert the driver when sleeping.

Therefore, we designed this system to alert the drunk person and prevent accidents caused by drowsiness, so the proposed system is evaluated based on:

- Detection Response Time: The time it takes for the device to detect drowsiness or alcohol presence and alert the driver.
- Alert Response Time: The time it takes for the device to trigger an alert after detecting a potential hazard.
- Sleep Detection Accuracy: Measures the device's ability to accurately detect signs of driver drowsiness, such as eyelid movement, blink rate, and head nodding.
- Reliability: The consistency of sensor performance over time.
- Durability: The device's ability to function effectively under various environmental conditions, such as temperature changes, humidity, and vibrations.

Evaluation metrics are shown in Fig. 21.

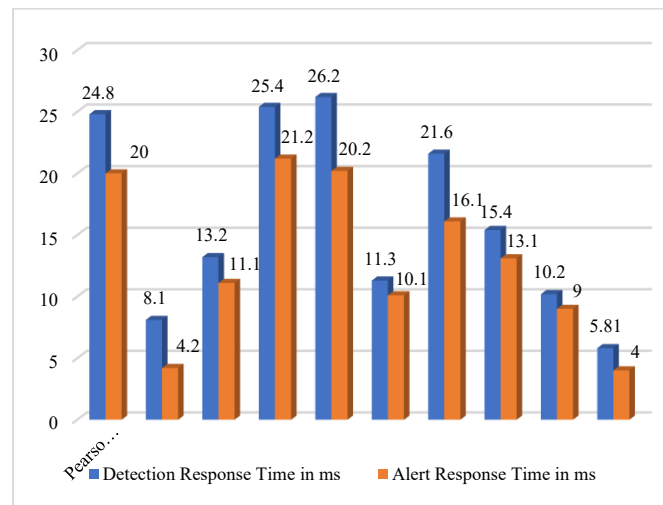


Figure 21. Network Evaluation of the proposed system.

Table 2 shows the response time for detecting misbehavioral sleep or alcohol.

Table 2. The detection response time for each testing case.

Testing Cases	Detection Response Time in ms	Behavioral Type
Pearson 1	24.8248	Sleep
Pearson 2	8.1728	Alcohol
Pearson 3	13.2209	Sleep
Pearson 4	25.452	Sleep
Pearson 5	26.26	Sleep
Pearson 6	11.312	Alcohol
Pearson 7	21.6544	Sleep
Pearson 8	15.4934	Alcohol
Pearson 9	10.21716	Alcohol
Pearson 10	5.8176	Alcohol
Total Average	16.242506	

Table 3 shows the alert response time of misbehavioral sleep or alcohol for all testing cases.

Table 3. Alert response time for each testing case.

Testing Cases	Alert Response Time in ms	Behavioral Type
Pearson 1	20.02	Sleep
Pearson 2	4.24	Alcohol
Pearson 3	11.11	Sleep
Pearson 4	21.21	Sleep
Pearson 5	20.2	Sleep
Pearson 6	10.1	Alcohol
Pearson 7	16.16	Sleep
Pearson 8	13.13	Alcohol
Pearson 9	9.09	Alcohol
Pearson 10	4.04	Alcohol
Total Average	12.93	

Table 4 shows the detection accuracy of sleep and alcohol states.

Table 4. Detection accuracy for each testing case.

Testing Cases	Detection Accuracy %	Behavioral Type
Pearson 1	99.11 %	Sleep
Pearson 2	98.03 %	Alcohol
Pearson 3	97.9 %	Sleep
Pearson 4	98.19 %	Sleep
Pearson 5	98.22 %	Sleep
Pearson 6	98.67 %	Alcohol
Pearson 7	99.29 %	Sleep
Pearson 8	98.36 %	Alcohol
Pearson 9	99.98 %	Alcohol
Pearson 10	98.89 %	Alcohol
Total Average	98.66 %	

Table 5 shows the high reliability and durability of the LPDTo-IoT Anti-Sleep and Alcohol detection device, making it an excellent choice for enhancing driving safety. By ensuring consistent performance and robust construction, the LPDTo method provides drivers with the confidence they need to stay alert and safe on the road. Investing in such a device not only promotes personal safety but also contributes to the overall well-being of all road users. Table 6 shows the proposed system LPDTo methodology compared with other related works.

Table 5. Reliability and durability for each testing case.

Testing Cases	Reliability	Durability	Behavioral Type
Pearson 1	High	High	Sleep
Pearson 2	High	High	Alcohol
Pearson 3	High	High	Sleep
Pearson 4	High	High	Sleep
Pearson 5	High	High	Sleep
Pearson 6	High	High	Alcohol
Pearson 7	High	High	Sleep
Pearson 8	High	High	Alcohol
Pearson 9	High	High	Alcohol
Pearson 10	High	High	Alcohol

Table 6. The proposed methodology comparisons.

Ref. No	Tools	The aim	Method	Max Accuracy
[22]	Raspberry Pi	Drowsiness Monitoring	Driver Drowsiness Detection and Monitoring System (DDMS)	96.3%
[25]	Raspberry Pi	Drowsiness Detection	Facial Landmark and Drowsiness Detection Models	81.0 %
[26]	Raspberry Pi3	Eye accuracy detection and drowsiness accuracy detection	Face landmark algorithm Eye Aspect Ratio (EAR) and Euclidean distance	97.1% 97.7%
[27]	Arduino board	Determining the drowsiness of drivers	Random forest	84 %
The proposed System	Arduino Board	Anti-Sleep and Alcohol Detection	Low Power Detection Time Operation (LPDTo)	98.66 %

5. Conclusion

An alternative perspective is to use the camera to determine the driver's drowsiness based on the areas of the driver's face that fall within the sensor technology to detect drowsiness or alcohol. It is considered one of the technological tests during movement under different lighting conditions that contribute to recognizing the face and detecting alcohol through the driver's breath. Therefore, the entire system is responsible for preventing accidents. However, the IoT Anti-Sleep and Alcohol Detection device represents a significant advancement in road safety technology, addressing two major causes of vehicular accidents: drowsiness and alcohol impairment. By integrating advanced sensors and IoT connectivity, this device enables real-time monitoring of driver behavior, ensuring timely interventions to prevent dangerous driving conditions. Implementing this technology is expected to substantially reduce alcohol-related and fatigue-induced accidents, contributing to safer road environments. In addition, the IoT Anti-Sleep and Alcohol Detection LPDTo method is a promising solution for enhancing road safety and fostering responsible driving habits. The future directions of the proposed system focus on refining detection algorithms in several different fields such as machine learning, deep learning, signal processing, and computer vision; improving user experience; integrating seamlessly with wearable technologies like smartwatches or fitness trackers; and addressing privacy concerns associated with data collection.

Conflict of Interest

The authors confirm that publishing this paper does not produce any conflicting interests.

Author Contribution Statement

Mohamed Khudhair Al-Gburi formulated the theory and delineated the key concepts, composed the manuscript and evidence and supervising this work. Ameer Sameer Hamood Mohammed Ali implemented the experimental data, provided assistance in analyzing the results and contributions made to the manuscript.

Use of LLM and AI

None declared.

Research funding

The authors received no external financial funding for the research, authorship, or publication of this article.

Data Availability

The data supporting the findings of this study were obtained through experimental tests conducted using the proposed in-vehicle alcohol and driver drowsiness detection system. The data were collected during practical tests involving participants inside the vehicle and were not obtained from external datasets.

References

- [1] Global Road Safety Partnership, *Drinking and Driving: A Road Safety Manual for Decision-Makers and Practitioners*. Geneva, Switzerland: Global Road Safety Partnership, 2007. Available:

- <https://www.who.int/publications/m/item/drinking-and-driving--a-road-safety-manual-for-decision-makers-and-practitioners>.
- [2] I. Dalui, D. Jana, P. Ghosh, S. Patra, A. Kundu, and P. D. Sarkar, "Real-time smart alert system for prevention of vehicle accident and fire: An IoT-based alarm system," in *Innovations in Computational Intelligence and Computer Vision*, Lecture Notes in Networks and Systems. Singapore: Springer, 2024, pp. 313–324. doi: https://doi.org/10.1007/978-981-97-3466-5_23.
 - [3] H. R. Ansari, Z. Kordrostami, and A. Mirzaei, "In-vehicle wireless driver breath alcohol detection system using a microheater integrated gas sensor based on Sn-doped CuO nanostructures," *Scientific Reports*, vol. 13, Art. no. 7136, 2023. doi: <https://doi.org/10.1038/s41598-023-34313-6>.
 - [4] M. Doudou, A. Bouabdallah, and V. Berge-Cherfaoui, "Driver drowsiness measurement technologies: Current research, market solutions, and challenges," *International Journal of Intelligent Transportation Systems Research*, vol. 18, no. 2, pp. 297–319, 2020. doi: <https://doi.org/10.1007/s13177-019-00199-w>.
 - [5] P. Sugantha Priyadharshini, N. Jayakiruba, A. D. Janani, and A. R. Harini, "Driver's drowsiness detection using SpO₂," in *Artificial Intelligence and Technologies*, EAI/Springer Innovations in Communication and Computing. Cham, Switzerland: Springer, 2023, pp. 207–215. doi: https://doi.org/10.1007/978-3-031-28324-6_17.
 - [6] Y. Y. Tan, S. T. Lin, and F. Tey, "Development of fatigue-associated measurement to determine fitness for duty and monitor driving performance," in *Virtual, Augmented and Mixed Reality. Systems and Applications*, Lecture Notes in Computer Science, vol. 8027. Berlin, Germany: Springer, 2013, pp. 608–617. doi: https://doi.org/10.1007/978-3-642-39454-6_65.
 - [7] Y. Koo, J. Kim, and W. Han, "A method for driving control authority transition for cooperative autonomous vehicle," in *Proc. 2015 IEEE Intelligent Vehicles Symposium (IV)*, Seoul, South Korea, 2015, pp. 394–399. doi: <https://doi.org/10.1109/IVS.2015.7225717>.
 - [8] R. Vishnu, S. Vishvaragul, P. Srihari, R. Nithiavathy, and R. Asmitha Shree, "Driver drowsiness detection system with OpenCV and Keras," *Journal of Physics: Conference Series*, vol. 1916, no. 1, Art. no. 012172, 2021. doi: <https://doi.org/10.1088/1742-6596/1916/1/012172>.
 - [9] H. Han, K. Li, and Y. Li, "Monitoring Driving in a Monotonous Environment: Classification and Recognition of Driving Fatigue Based on Long Short-Term Memory Network," *Journal of Advanced Transportation*, vol. 2022, pp. 1–14, Mar. 2022. doi: <https://doi.org/10.1155/2022/6897781>.
 - [10] J. S. K. Ooi, S. A. Ahmad, Y. Z. Chong, S. H. Md Ali, G. Ai, and H. Wagatsuma, "Driver emotion recognition framework based on electrodermal activity measurements during simulated driving conditions," in *Proc. 2016 IEEE EMBS Conference on Biomedical Engineering and Sciences (IECBES)*, Kuala Lumpur, Malaysia, 2016, pp. 365–369. doi: <https://doi.org/10.1109/IECBES.2016.7843475>.
 - [11] J. Shi, S. A. Ahmad, H. R. Harun, Y. Z. Chong, and S. H. Md Ali, "A conceptual emotion recognition framework: Stress and anger analysis for car accidents," *International Journal of Vehicle Safety*, vol. 9, no. 3, pp. 181–195, 2017. doi: <https://doi.org/10.1504/IJVS.2017.085188>.
 - [12] L. Oliveira, J. S. Cardoso, A. Lourenço, and C. Ahlström, "Driver drowsiness detection: A comparison between intrusive and non-intrusive signal acquisition methods," in *Proc. 7th European Workshop on Visual Information Processing (EUVIP)*, Tampere, Finland, 2018, pp. 1–6. doi: <https://doi.org/10.1109/EUVIP.2018.8611704>.
 - [13] D. Parashar and A. Jadaun, "Driver drowsiness detection system using machine learning," *YMER Digital*, vol. 21, no. 05, pp. 962–965, May 2022. doi: <https://doi.org/10.37896/ymer21.05/a8>.
 - [14] R. M. Hussein, F. S. Miften, and L. E. George, "Driver drowsiness detection methods using EEG signals: A systematic review," *Computer Methods in Biomechanics and Biomedical Engineering*, vol. 26, no. 11, pp. 1237–1249, Aug. 2022. doi: [10.1080/10255842.2022.2112574](https://doi.org/10.1080/10255842.2022.2112574).
 - [15] A. Chowdhury, R. Shankaran, M. Kavakli, and M. M. Haque, "Sensor applications and physiological features in drivers' drowsiness detection: A review," *IEEE Sensors Journal*, vol. 18, no. 8, pp. 3055–3067, Apr. 2018. doi: <https://doi.org/10.1109/JSEN.2018.2807245>.
 - [16] C. M. Farmer, "Potential lives saved by in-vehicle alcohol detection systems," *Traffic Injury Prevention*, vol. 22, no. 1, pp. 7–12, 2021. doi: <https://doi.org/10.1080/15389588.2020.1836366>.
 - [17] C. V. Vani, A. J. Vijithra, M. K. Vasan, B. Kavimani, V. K. Prasath, and J. Hariharan, "Alcohol detection using automation," *ECS Transactions*, vol. 107, no. 1, pp. 17563–17570, 2022. doi: <https://doi.org/10.1149/10701.17563ecst>.
 - [18] S. Uzairue, J. Ighalo, V. O. Matthews, F. Nwukor, and S. I. Popoola, "IoT-enabled alcohol detection system for road transportation safety in smart city," in *Computational Science and Its Applications – ICCSA 2018*, Lecture Notes in Computer Science, vol. 10963. Cham, Switzerland: Springer, 2018, pp. 695–704. doi: https://doi.org/10.1007/978-3-319-95171-3_55.
 - [19] M. Doudou and A. Bouabdallah, "Performance specifications of market physiological sensors for efficient driver drowsiness detection system," in *Proc. 4th International Conference on Vehicle Technology and Intelligent Transport Systems (VEHITS)*, 2018, vol. 1, pp. 99–106. doi: <https://doi.org/10.5220/0006607800990106>.
 - [20] N. S. Kumar, N. P. Devi, N. M. Singh, and N. M. Rani, "Driver drowsiness detection system," *International Journal of Science and Research Archive*, vol. 12, no. 1, pp. 1017–1022, May 2024. doi: <https://doi.org/10.30574/ijrsra.2024.12.1.0935>.
 - [21] E. Perkins, C. Sitaula, M. Burke, and F. Marzbanrad, "Challenges of driver drowsiness prediction: The remaining steps to implementation," *IEEE Transactions on Intelligent Vehicles*, vol. 8, no. 2, pp. 1319–1338, Feb. 2023. doi: <https://doi.org/10.1109/TIV.2022.3224690>.
 - [22] R. A. F. Rozali et al., "Driver Drowsiness Detection and Monitoring System (DDMS)," *International Journal of Advanced Computer Science and Applications*, vol. 13, no. 6, 2022. doi: <https://doi.org/10.14569/IJACSA.2022.0130691>.
 - [23] C. Sekhar, "Anti-sleep alarm for drivers," *International Journal for Research in Applied Science and Engineering Technology*, vol. 11, no. 11, pp. 580–584, Nov. 2023. doi: <https://doi.org/10.22214/ijraset.2023.56505>.
 - [24] B. P. Yadav and C. Raju, "Multisource data fusion-based driver vigilance state estimation using Arduino Mega and Node MCU," in *Proc. 2023 7th International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC)*, Kirtipur, Nepal, 2023, pp. 1139–1147. doi: <https://doi.org/10.1109/I-SMAC58438.2023.10290686>.
 - [25] K. N. Lam, V. P. Mai, G.-B. Q. Dang, Q.-B. H. Ngo, N.-H. Q. Huynh, M. P. Lieu, and J. Kalita, "A drowsiness detection system based on eye landmarks using IoT," in *Proceedings of the 12th International Symposium on Information and Communication Technology*, Communications in Computer and Information Science, vol. 1688. Singapore: Springer, 2022, pp. 714–722. doi: https://doi.org/10.1007/978-981-19-8069-5_52.
 - [26] A. K. Biswal, D. Singh, B. K. Pattanayak, D. Samanta, and M.-H. Yang, "IoT-based smart alert system for drowsy driver detection," *Wireless Communications and Mobile Computing*, vol. 2021, Art. no. 6627217, 2021. doi: <https://doi.org/10.1155/2021/6627217>.
 - [27] N. Ashlin, D. Sai, K. Milind, Y. Vijayalata, and K. Rahul, "Drowsiness detection using IoT and facial expression," in *Proceedings of the International Conference on Cognitive and Intelligent Computing*, Cognitive Science and Technology. Singapore: Springer, 2023, pp. 679–692. doi: https://doi.org/10.1007/978-981-19-2358-6_61.