

DRIVESENSE- AN AUTOMATED DRIVER DROWSINESS DETECTION AND ACCIDENT PREVENTION SOLUTION

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering degree in Computer Science and Engineering

By

HEMALATHA S (Reg No - 40110455)



DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

SCHOOL OF COMPUTING

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

CATEGORY -1 UNIVERSITY BY UGC

Accredited with Grade “A++” by NAAC | 12B Status by UGC | Approved by AICTE

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI – 600 119

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of HEMALATHA S (40110455) who carried out the Project entitled "DRIVESENSE-AN AUTOMATED DRIVER DROWSINESS DETECTION AND ACCIDENT PREVENTION SOLUTION" under my supervision from November 2023 to April 2024.

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DECLARATION

I, HEMALATHA S (40110455), hereby declare that the Project Report entitled "DRIVESENSE-AN AUTOMATED DRIVER DROWSINESS DETECTION AND ACCIDENT PREVENTION SOLUTION" done by me under the guidance of DR. R. M. GOMATHI, M.TECH., PH.D is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Computer Science and Engineering.

DATE: 15/4/24

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ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to **Board of Management of Sathyabama Institute of Science and Technology** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my thanks to **Dr. T.Sasikala M.E., Ph.D**, **Dean**, School of Computing, **Dr. L. Lakshmanan M.E., Ph.D.**, Head of the Department of Computer Science and Engineering for providing me necessary support and details at the right time during the progressive reviews.

I would like to express my sincere and deep sense of gratitude to my Project Guide **Dr. R.M. Gomathi, M.Tech., Ph.D** for her valuable guidance, suggestions and constant encouragement paved way for the successful completion of my project work.

I wish to express my thanks to all Teaching and Non-teaching staff members of the **Department of Computer Science and Engineering** who were helpful in many ways for the completion of the project.

ABSTRACT

In India, a significant number of accidents occur due to driver negligence and fatigue. To address this critical issue, project proposes the development of a Driver Drowsiness Detection and Accident Prevention System. This system employs Python-based image processing to analyze the driver's eye aspect ratio, detecting signs of drowsiness in real-time. Two Arduino microcontrollers play a pivotal role: one integrated into a robotic vehicle, equipped with motors, wheels, ultrasonic sensors, and Bluetooth, and the other serving as an intermediary communication device. When drowsiness is detected, the Python program sends a command via Bluetooth to halt the vehicle and activate a red LED light as a visual alert to the driver. Additionally, it triggers an SMS or data notification to the system administrator. The integration of these technologies culminates in a comprehensive solution designed to enhance road safety by preemptively addressing the root causes of accidents. By combining advanced image processing techniques with real-time hardware control and communication capabilities, the system offers a proactive approach to mitigating the risks associated with driver fatigue and inattention. If successfully implemented, this project has the potential to significantly reduce the incidence of road accidents in India and beyond, ultimately saving lives and fostering safer road environments.

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CHAPTER 1

INTRODUCTION

The rising number of road accidents attributed to driver fatigue and inattention poses a significant threat to road safety in India and worldwide. To address this pressing issue, our project endeavors to design and implement an advanced Driver Drowsiness Detection and Accident Prevention System. By leveraging cutting-edge technologies, including computer vision, Python image processing, Arduino microcontrollers, and efficient communication protocols, we aim to create a proactive solution that can detect drowsy drivers in real-time, prompt immediate corrective actions, and notify system administrators, ultimately enhancing road safety and saving lives. Our project aims to introduce an innovative Driver Drowsiness Detection and Accident Prevention System that combines cutting-edge technologies and automation for enhanced road safety. The proposed system utilizes Python image processing and computer vision to continuously monitor the driver's eye aspect ratio in real-time. Upon detecting signs of drowsiness, it triggers a series of actions via Arduino-based hardware, including a robotic vehicle equipped with motors, wheels, ultrasonic sensors, and Bluetooth communication. In this system, an intermediary Arduino microcontroller facilitates seamless communication between the Python program and the robotic vehicle. When drowsiness is detected, the Python program sends a command via Bluetooth to halt the vehicle, simultaneously activating a red LED light for driver alert. Additionally, the system initiates a notification to the system administrator via GSM, ensuring immediate response and intervention. By integrating these components, our proposed system provides a proactive approach to prevent accidents caused by driver fatigue and inattention, ultimately contributing to enhanced road safety and reduced accidents.

CHAPTER 2

LITERATURE SURVEY

2.1 INFERENCES FROM LITERATURE SURVEY

[1] You, F., Gong, Y., Tu, H., Liang, J., & Wang. A fatigue driving detection algorithm based on facial motion information entropy. Journal of Advanced Transportation, 2020.

The paper presents a fatigue driving detection algorithm based on facial motion information entropy. Published in the Journal of Advanced Transportation, the paper proposes a novel approach to identify signs of driver fatigue by analyzing facial expressions and movements. By quantifying the entropy of facial motion information, the algorithm aims to accurately detect instances of drowsiness, which can pose significant risks on the road. This research contributes to transportation safety by offering a new method for detecting driver drowsiness, potentially improving existing driver assistance systems or serving as a standalone solution for vehicles.

[2] Sunagawa, M., Shikii, S., Nakai, W., Mochizuki, M., Kusukame, K., & Kitajima, H. Comprehensive drowsiness level detection model combining multimodal information, 2020.

The paper proposes a novel approach that combines various data sources, including physiological signals, behavioral patterns, and environmental factors, to accurately assess the level of drowsiness in individuals. By leveraging multiple modalities, such as eye movements, facial expressions, heart rate variability, and environmental conditions, the model aims to provide a holistic understanding of drowsiness. This holistic approach enhances the reliability and effectiveness of drowsiness detection systems, enabling better-informed decision-making in scenarios where alertness is crucial, such as driving or operating machinery. The integration of diverse data streams offers a more robust and comprehensive solution compared to traditional methods, making it a valuable contribution to the field of drowsiness detection and management.

[3] Kiashari S.E.H., Nahvi A., Bakhoda H., Homayounfard A., Tashakori M. Evaluation of driver drowsiness using respiration analysis by thermal imaging on a driving simulator. *Multimed. Tools Appl*, 2020.

The paper by Kiashari et al. (2020) presents an evaluation of driver drowsiness using respiration analysis through thermal imaging on a driving simulator. Published in 2020, this study explores the potential of thermal imaging technology in detecting and assessing drowsiness levels among drivers. By analyzing respiratory patterns captured through thermal imaging, the researchers aim to develop a non-intrusive and effective method for drowsiness detection. The utilization of a driving simulator provides a controlled environment to simulate real-world driving conditions while monitoring drivers' physiological responses. This approach offers insights into the correlation between respiratory changes and drowsiness, facilitating the development of reliable drowsiness detection systems. The study contributes to advancing the field of driver safety by introducing innovative techniques that complement existing methods for monitoring and mitigating drowsy driving-related risks.

[4] Maier C.B.S., das Chagas Moura M.J., Santana J.M.M., Lins I.D. Real-time classification for autonomous drowsiness detection using eye aspect ratio. *Expert Syst. Appl*, 2020.

The paper focuses on real-time classification for autonomous drowsiness detection using the eye aspect ratio. It investigates the application of the eye aspect ratio (EAR) as a feature for detecting drowsiness in real-time. By continuously monitoring changes in the EAR, which quantifies the degree of eye openness, the proposed system can classify the driver's drowsiness state autonomously. This approach leverages computer vision techniques to analyze facial landmarks and extract relevant features for drowsiness detection. The real-time nature of the classification enables timely interventions to prevent potential accidents caused by driver fatigue by utilizing EAR-based classification in conjunction with real-time monitoring, the proposed system offers a proactive approach to mitigate the risks associated with drowsy driving, thereby reducing the likelihood of accidents and improving overall traffic safety.

[5] Kundinger T., Sofra N., Riener A. Assessment of the potential of wrist-worn wearable sensors for driver drowsiness detection. Sensors, 2020.

The paper authored by Kundinger et al. (2020) examines the potential of wrist-worn wearable sensors for detecting driver drowsiness. Published in Sensors in 2020, this research explores the feasibility of utilizing wearable sensors worn on the wrist to monitor physiological signals indicative of drowsiness. By analyzing data such as heart rate variability (HRV), skin conductance, and motion patterns captured by the wearable sensors, the study aims to develop a reliable drowsiness detection system. The assessment considers various factors such as sensor accuracy, comfort, and usability in the context of real-world driving scenarios. The findings contribute valuable insights into the effectiveness of wearable technology for drowsiness detection and its potential integration into existing vehicle safety systems.

[6] Gwak J., Hirao A., Shino M. An investigation of early detection of driver drowsiness using ensemble machine learning based on hybrid sensing. Appl. Sci, 2020.

The study conducted by Gwak et al. (2020) investigates the early detection of driver drowsiness through ensemble machine learning techniques based on hybrid sensing. Published in Applied Sciences in 2020, this research explores the integration of multiple sensing modalities to develop a robust and accurate drowsiness detection system. By combining data from various sources such as facial expressions, eye movements, steering behavior, and physiological signals, including heart rate and skin conductance, the study aims to improve the reliability of drowsiness detection algorithms. Through ensemble machine learning methods, which involve combining predictions from multiple models, the research seeks to enhance the system's ability to accurately identify drowsiness-related patterns and provide timely warnings to drivers. The investigation focuses on the early detection of drowsiness indicators to prevent potential accidents caused by driver fatigue. By leveraging hybrid sensing approaches and ensemble machine learning techniques, the proposed system offers a promising solution for enhancing road safety and reducing the risk of drowsy driving incidents.

[7] Abbas Q., Alsheddy A. Driver fatigue detection systems using multi-sensors, smartphone, and cloud-based computing platforms: A comparative analysis. Sensors, 2021.

Abbas and Alsheddy (2021) present a comparative analysis of driver fatigue detection systems utilizing multi-sensors, smartphones, and cloud-based computing platforms. Published in *Sensors* in 2021, this study evaluates various approaches to detecting driver fatigue, considering the integration of diverse sensor technologies, smartphone applications, and cloud-based computing resources. The research assesses the performance, accuracy, and effectiveness of different fatigue detection systems in real-world driving scenarios. By leveraging multi-sensor data fusion techniques and cloud-based processing capabilities, these systems aim to enhance the reliability and timeliness of fatigue detection, ultimately improving road safety. The comparative analysis provides insights into the strengths and limitations of each approach, facilitating informed decision-making for the development and deployment of fatigue detection systems. Through this study, Abbas and Alsheddy contribute to advancing the field of driver safety technology, offering valuable insights for researchers, practitioners, and policymakers involved in the design and implementation of fatigue monitoring solutions.

[8] V, Kiranmayee. Driver Drowsiness Detection System. International Journal for Research in Applied Science and Engineering Technology, 2021.

The author explores the development and implementation of a system aimed at detecting driver drowsiness. The paper discusses the use of various sensor technologies and machine learning algorithms to monitor driver behavior and physiological signals indicative of drowsiness, such as eye movement patterns and head pose. By analyzing these signals in real-time, the proposed system can alert the driver and potentially prevent accidents caused by fatigue-induced impairment. The research contributes to the growing body of literature on driver safety systems, offering insights into the design, implementation, and evaluation of drowsiness detection technologies. Through empirical evaluation and validation, the author demonstrates the feasibility and effectiveness of the proposed drowsiness detection system, providing valuable contributions to the field of transportation safety engineering.

[9] Swapnil Titare, Shubham Chinchghare, K. N. Hande, Driver Drowsiness Detection and Alert System, International Journal of Scientific Research in Computer Science, Engineering and Information Technology (IJSRCSEIT), 2021.

Swapnil Titare, Shubham Chinchghare, and K. N. Hande likely present research on a system designed to detect driver drowsiness and issue timely alerts to prevent potential accidents. This system is likely to utilize a combination of sensors and advanced algorithms to monitor various aspects of driver behavior and physiological signals in real-time. The authors likely aim to contribute insights into the implementation, effectiveness, and potential impact of such a system on improving road safety and reducing the risk of accidents caused by driver fatigue. Their work may involve experimental validation and performance evaluation of the proposed system under different driving conditions to assess its reliability and effectiveness in real-world scenarios. Additionally, they may discuss the feasibility of integrating such systems into existing vehicles or infrastructure to enhance overall road safety standards.

[10] Tamanani R., Muresan R., Al-Dweik A. Estimation of Driver Vigilance Status Using Real-Time Facial Expression and Deep Learning. IEEE Sens. Lett. 2021.

In their paper likely propose a method to estimate driver vigilance status by analyzing real-time facial expressions through deep learning techniques. Their approach likely involves capturing facial features and expressions using sensors or cameras installed within the vehicle, and employing deep learning algorithms to interpret these data and infer the driver's level of vigilance. The authors likely aim to contribute to the field of driver monitoring systems by exploring novel methods that leverage facial expression recognition and machine learning to enhance driver safety. Their research may involve experimentation to validate the accuracy and robustness of their proposed method under various driving conditions and scenarios. Additionally, they may discuss the potential applications and implications of their work in improving existing driver assistance systems and reducing the risk of accidents caused by driver drowsiness or inattention

2.2 OPEN PROBLEMS IN EXISTING SYSTEM

In the realm of driver drowsiness detection and accident prevention systems, several open problems persist despite significant advancements. One of the foremost challenges is ensuring the accuracy and reliability of these systems, particularly in real-world driving conditions where factors like varying lighting, driver behavior, and vehicle dynamics can influence performance. Achieving adaptability to individual differences in drowsiness signs remains another critical issue, as people exhibit diverse responses that existing models may struggle to account for adequately. Personalized approaches that tailor detection algorithms to individual facial features, physiological responses, and driving behaviors could enhance overall accuracy. Balancing between minimizing false alarms and avoiding missed detections poses a persistent challenge. Striking the right balance is crucial to ensure that systems can alert drivers promptly when genuine drowsiness is detected while avoiding unnecessary interruptions. Moreover, seamlessly integrating drowsiness detection systems with vehicle infrastructure remains a complex task. Ensuring compatibility with various vehicle types and models, addressing concerns about data privacy, and ownership are significant hurdles that need addressing. Real-time processing and response capabilities are essential for proactive accident prevention. However, achieving minimal latency between drowsiness detection and intervention initiation requires robust algorithms and efficient communication between onboard systems. Environmental factors such as road conditions, weather, and traffic patterns also influence system performance and must be considered to enhance overall reliability. User acceptance and adoption are pivotal for the success of drowsiness detection systems. Ensuring that systems are user-friendly, non-intrusive, and culturally appropriate can promote widespread adoption among drivers. Additionally, providing long-term monitoring and feedback mechanisms to sustain driver vigilance over extended periods, especially during long-distance travel or commercial operations, remains a challenge that requires ongoing research and development efforts. Addressing these open problems necessitates interdisciplinary collaboration and continuous validation through field studies and real-world trials to advance the state-of-the-art in driver safety technology.

CHAPTER 3

SYSTEM ANALYSIS

3.1 EXISTING SYSTEM

The current state of driver drowsiness detection and accident prevention systems is characterized by a range of approaches, but it generally lacks the comprehensive and automated features proposed in our project. Presently, common methods include manual vigilance, rudimentary vehicle alarms, limited mobile applications, and specialized but not widely available vehicle-based systems. These systems often rely on driver-initiated actions or lack real-time responsiveness, leaving room for improvement in addressing the critical issue of accidents caused by driver fatigue and carelessness. The existing landscape of driver drowsiness detection and accident prevention systems exhibits a variety of approaches, yet it lacks the comprehensive and automated features proposed in our project. Current methods involve manual vigilance, basic vehicle alarms, and limited mobile applications. Specialized vehicle-based systems do exist, but their widespread availability is limited. These systems often depend on driver-initiated actions and may lack real-time responsiveness, leaving significant room for improvement in effectively tackling the urgent issue of accidents stemming from driver fatigue and inattentiveness.

3.2 PROPOSED SYSTEM

Our project aims to introduce an innovative Driver Drowsiness Detection and Accident Prevention System that combines cutting-edge technologies and automation for enhanced road safety. The proposed system utilizes Python image processing and computer vision to continuously monitor the driver's eye aspect ratio in real-time. Upon detecting signs of drowsiness, it triggers a series of actions via Arduino-based hardware, including a robotic vehicle equipped with motors, wheels, ultrasonic sensors, and Bluetooth communication.

In this system, an intermediary Arduino microcontroller facilitates seamless communication between the Python program and the robotic vehicle. When drowsiness is detected, the Python program sends a command via Bluetooth to halt the vehicle, simultaneously activating a red LED light for driver alert. Additionally, the system initiates a notification to the system administrator via GSM, ensuring immediate response and intervention.

By integrating these components, our proposed system provides a proactive approach to prevent accidents caused by driver fatigue and inattention, ultimately contributing to enhanced road safety and reduced accidents.

CHAPTER 4

REQUIREMENT ANALYSIS

4.1 HARDWARE REQUIREMENTS

4.1.1 Arduino Microcontrollers (Arduino Mega 2560)

The Arduino Mega 2560 is a versatile microcontroller board based on the ATmega2560. It boasts 54 digital input/output pins, including 14 PWM outputs, 16 analog inputs, and 4 UARTs for hardware serial communication. Equipped with a 16 MHz crystal oscillator, USB connection, power jack, and reset button, the Mega 2560 provides a comprehensive set of features for a wide range of applications. It supports external power sources and can be powered via USB, AC-to-DC adapter, or battery, with automatic source selection. The board is compatible with shields designed for the Arduino Duemilanove or Diecimila, adding to its flexibility. Notably, the Mega 2560 uses the Atmega8U2 as a USB-to-serial converter, distinguishing it from earlier Arduino boards. Its capabilities make it a popular choice for projects requiring numerous inputs/outputs, PWM channels, and serial communication, making it well-suited for tasks ranging from robotics to sensor interfacing. Two Arduino microcontrollers, one for the robotic vehicle and one for intermediary communication and alerts.

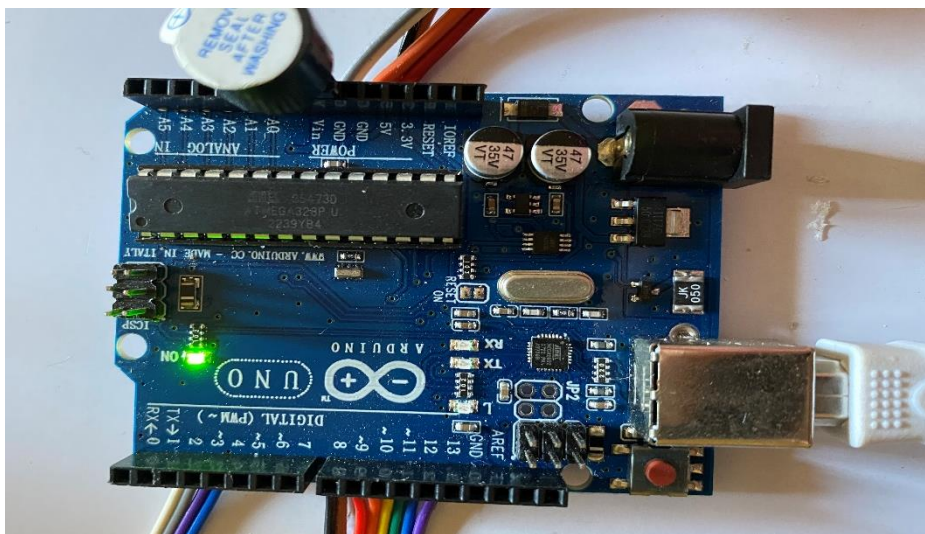


Figure 4.1 Arduino Mega 2560(ATmega2560)

4.1.2 Intermediary Communication (Arduino 1)

- Bluetooth module for communication with the Python program.
- LCD display for visual feedback.
- Buzzer for audio alerts.
- Power supply for Arduino 1.

1. Bluetooth Module

The Bluetooth module facilitates a wireless communication between Arduino 1 (integrated into the robotic vehicle) and the Python program running on a computer or laptop. Bluetooth technology enables the transmission of commands and data in real-time, allowing for prompt responses to detected signs of driver drowsiness.

Key Features and Functions of the Bluetooth Module

Wireless Communication

The Bluetooth module enables wireless communication between devices over short distances. In this system, it establishes a communication link between the Python program and Arduino 1.

Serial Communication

The Bluetooth module typically operates using serial communication protocols, allowing for the seamless transmission of data and commands between the Python program and Arduino 1.

Command Reception

Arduino 1 receives commands sent by the Python program via Bluetooth. These commands are generated based on the real-time analysis of the driver's eye aspect ratio (EAR) and signs of drowsiness.

Control of Robotic Vehicle

Arduino 1 utilizes the Bluetooth module to control the robotic vehicle's motors, wheels, and other components. When drowsiness is detected, a command is sent to halt the vehicle, ensuring a proactive response to prevent potential accidents.

2. Liquid Crystal Display (LCD)

The Liquid Crystal Display (LCD) is a visual feedback component integrated into Arduino 1. The LCD serves as an interface for providing real-time information to the driver about the detection of drowsiness and the activation of safety measures.

The LCD module's operational flexibility in 4-bit or 8-bit mode introduces nuanced considerations for efficient data transmission. In 4-bit mode, information is transmitted as 4-bit nibbles rather than full 8-bit bytes, optimizing the use of data transport lines. Significantly, data lines D3:0 remain dormant in 4-bit mode, underscoring the emphasis on D7:4 for transmitting these nibbles. While both commands and data maintain an 8-bit length, they are conveyed in 4-bit mode as two sequential 4-bit nibbles, leveraging the limited data lines effectively. The order of nibble transmission becomes pivotal, mandating that the most significant nibble precedes the less significant one to ensure accurate data interpretation.

Moreover, the specified optimal contrast voltage for the LCD falls within the range of 3.3 to 3.7 volts. Adhering to this voltage range is imperative for sustaining a clear and legible display. These delineations of 4-bit and 8-bit activity, data line utilization, and transmission protocols illuminate the meticulous considerations inherent in configuring an LCD module. Attention to these details not only optimizes data transport but also contributes to the overall functionality and visual clarity of the display, underscoring the intricacies involved in effectively employing an LCD in diverse operational contexts.

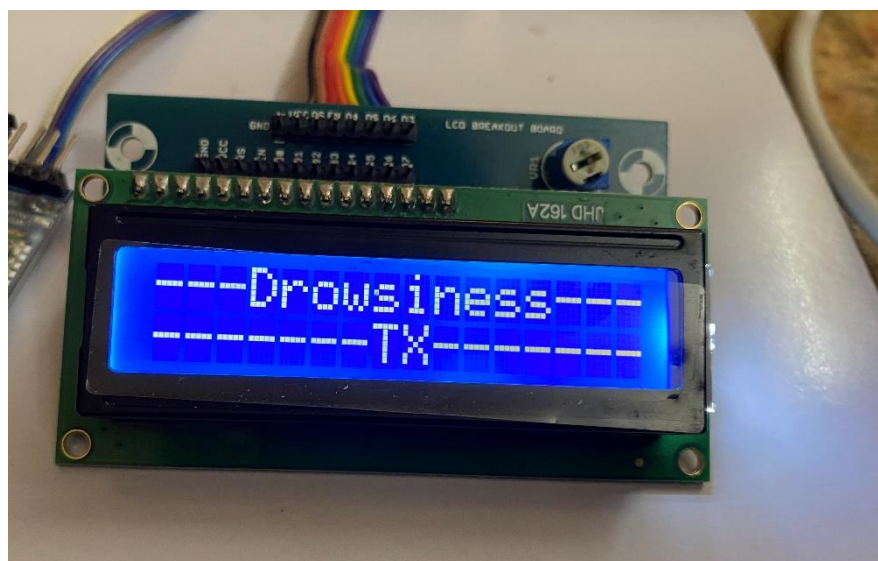


Figure 4.2 LCD Display

3. Buzzer

A buzzer is an electronic device that converts electrical signals into audible sound through a piezoelectric or magnetic element. It is commonly used for providing alerts, signals, or notifications in various electronic applications. Buzzers are compact, lightweight, and operate within audible frequency ranges. They can emit single or multiple tones and find applications in alarms, timers, electronic games, and industrial machinery. Buzzers are characterized by their efficiency, low power requirements, and versatility in producing different sound patterns.

Connection:

- Connect the positive (VCC) and negative (GND) terminals of the buzzer to the corresponding power and ground pins on the Arduino.
- Connect the signal pin of the buzzer to a digital output pin on the Arduino, e.g., digital pin 8.
- Connect a resistor and LED in series. Connect one end of the series to another digital output pin on the Arduino, e.g., digital pin 9.
- Connect the other end of the LED to the ground.

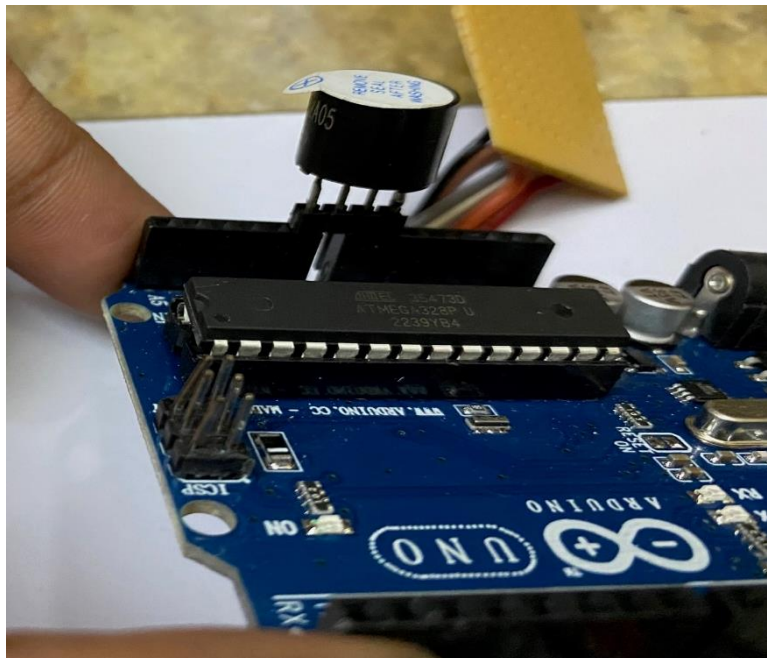


Figure 4.3 Buzzer

4. Power Supply for Arduino 1

The power supply for Arduino 1 ensures the reliable operation of its various components.

Power Requirements

Arduino 1, as an intermediary communication device, controls essential components like the Bluetooth module, LCD display, and buzzer. These components have specific voltage and current requirements that must be met for optimal performance.

Voltage Regulation

The power supply for Arduino 1 should provide a stable and regulated voltage. Arduino boards typically operate at 5V, and ensuring a consistent voltage level is crucial for preventing issues like erratic behavior, component damage, or data corruption.

Current Capacity

The power supply must have sufficient current capacity to meet the combined power demands of all connected components. This includes the Bluetooth module, LCD display, buzzer, and any other peripherals interfaced with Arduino 1. Insufficient current can lead to underperformance or malfunctions.

Stability and Noise Reduction

To prevent fluctuations and noise in the power supply, filtering mechanisms such as capacitors may be employed. These components help maintain a stable voltage level and reduce the risk of electrical interference, ensuring that Arduino 1 and its peripherals operate reliably.

Power Source Options

Arduino boards, including Arduino 1, can often be powered through various sources, including USB, external adapters, or batteries. The chosen power source should align with the system's requirements and operational needs. For example, if the system is deployed in a vehicle, it might utilize the vehicle's electrical system or a dedicated power source.

Protection Mechanisms

Incorporating protection mechanisms, such as overvoltage and reverse polarity protection, safeguards Arduino 1 and its components from potential damage due to unexpected electrical conditions. These protective measures contribute to the system's robustness and longevity.

Integration with Vehicle Power

If the system is integrated into a vehicle, the power supply for Arduino 1 may need to interface with the vehicle's power system. This requires compatibility with the vehicle's voltage levels and ensuring that the system can handle variations that may occur in a vehicle's electrical environment.

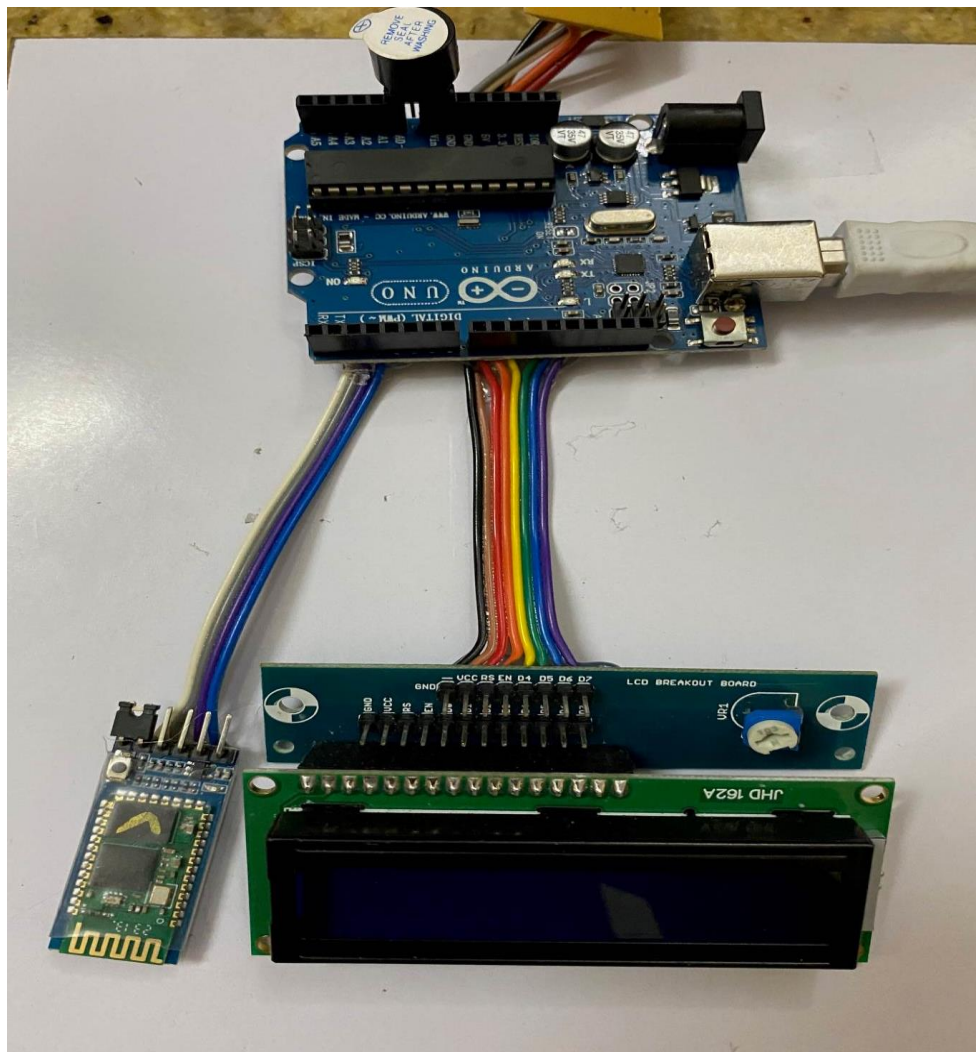


Figure 4.4 Intermediary Communication (Arduino 1)

4.1.3 Robotic Vehicle Components (Arduino 2)

- Motors and wheels for vehicle movement.
- Ultrasonic sensor for obstacle detection.
- Bluetooth module for wireless communication.
- Power supply for the vehicle's components.

1. Motors and Wheels for vehicle movement

The L298 is a popular dual H-bridge motor driver integrated circuit widely used for controlling motors in robotics and other applications.

L298 Dual H-Bridge Motor Driver

The L298 motor driver is a dual H-bridge IC that enables the control of two DC motors. In this context, it serves as the interface between Arduino 2 and the motors, allowing bidirectional control of the vehicle's movement. The L298 interprets commands from Arduino 2 and adjusts the voltage and direction supplied to the motors accordingly.

Motors and Wheels for Vehicle Movement

The motors connected to the L298 drive the wheels of the robotic vehicle. The selection of motors and wheels impacts the vehicle's speed, maneuverability, and overall performance. Depending on the application, the system might use different types of wheels for specific functionalities, such as omnidirectional movement or precise turns.

Integration with Arduino 2

Arduino 2 serves as the control center for the L298 motor driver. It sends signals to the L298, instructing it on how to control the motors. The integration ensures seamless communication and coordination between Arduino 2 and the vehicle's propulsion system.

Power Supply to Motors

The motors connected to the L298 require a dedicated power supply to meet their voltage and current requirements. Arduino 2 manages the power distribution, ensuring that the motors receive the necessary power for smooth and controlled movement.

Vehicle Dynamics and Control

The combination of L298, motors, and wheels determines the vehicle's dynamics. Arduino 2 processes information from the Python-based drowsiness detection system and translates it into commands for the L298. This control mechanism allows the vehicle to respond to detected drowsiness by taking appropriate actions, such as halting or adjusting its movement.

Safety Measures

The design of the robotic vehicle components incorporates safety measures to prevent unsafe movements. In the context of a system focused on accident prevention, these safety features are essential for ensuring the well-being of the driver and other road users.

Real-time Responsiveness

The integration of Arduino 2 with the L298 motors and wheels enables real-time responsiveness to the system's inputs. This is critical for the timely execution of actions based on the detection of driver drowsiness, contributing to the overall effectiveness of the accident prevention system.

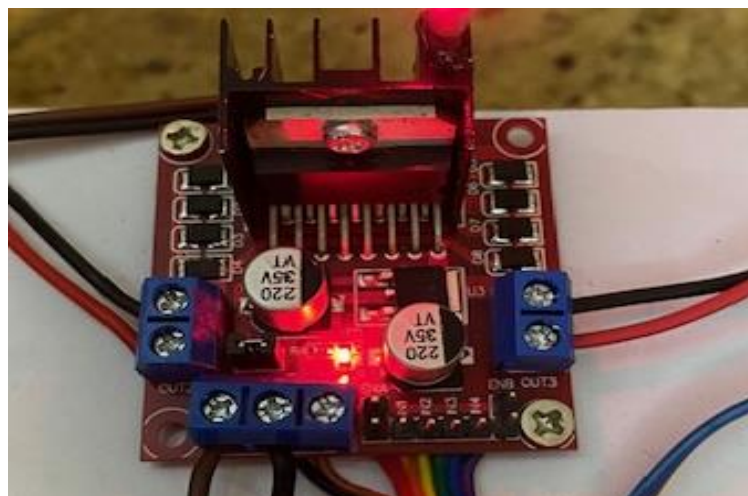


Figure 4.5 L298 Motor Driver

2. Ultrasonic sensor for obstacle detection

Ultrasonic Sensor (HC-SR04)

The HC-SR04 ultrasonic sensor is a popular component for distance measurement in robotics. It utilizes ultrasonic waves to determine the distance between the sensor and an obstacle. The sensor consists of a transmitter that emits ultrasonic pulses and a receiver that detects the reflected signals.

Obstacle Detection

The primary function of the ultrasonic sensor in this system is obstacle detection. Placed strategically on the robotic vehicle, the sensor continuously sends out ultrasonic pulses and measures the time it takes for the signals to bounce back. This information is then used to calculate the distance to any obstacles in the vehicle's path.

Integration with Arduino 2

Arduino 2 serves as the controller for the ultrasonic sensor, receiving distance data and making decisions based on obstacle proximity. The integration allows the system to respond to detected obstacles in real-time, contributing to safe navigation.

Collision Avoidance

The information obtained from the ultrasonic sensor is crucial for implementing collision avoidance strategies. If an obstacle is detected within a predefined range, Arduino 2 can instruct the vehicle to take evasive actions, such as steering away or slowing down, to prevent collisions.

Data Processing and Decision-Making

Arduino 2 processes the data from the ultrasonic sensor along with inputs from other components, such as the drowsiness detection system. It makes decisions on the vehicle's movement, considering both the road conditions and the driver's state to ensure a safe and proactive response.

Real-time Monitoring

The continuous monitoring capability of the ultrasonic sensor allows the system to adapt dynamically to changes in the environment. Whether it's detecting sudden obstacles or navigating through complex scenarios, real-time monitoring enhances the overall safety of the vehicle.

Safety Enhancement

The combination of obstacle detection and drowsiness detection adds a layer of safety to the system. By proactively avoiding obstacles and responding to driver drowsiness, the vehicle becomes more capable of preventing accidents and ensuring the well-being of both the driver and other road users.



Figure 4.6 Ultrasonic Sensor (HC-SR04)

3. Power supply for the vehicle's components

Arduino 2 acts as a central control unit for the robotic vehicle's components, including motors, sensors, and communication modules. It manages the distribution of power to these components, ensuring they receive the necessary voltage and current for optimal performance. The power supply system implemented by Arduino 2 includes voltage regulation mechanisms to provide a stable and regulated power output. This stability is crucial for the proper functioning of sensitive electronic components, preventing erratic behavior or damage due to voltage fluctuations. Motors, such as those controlled by the L298 motor driver, require a stable and sufficient power supply to drive the vehicle's movement. Arduino 2 oversees the power supply to the motors, ensuring they receive the appropriate power levels for different tasks, whether it's normal operation or responding to detected drowsiness. The ultrasonic sensor for obstacle detection and the Bluetooth module for wireless communication also rely on a consistent power supply. Arduino 2 manages and supplies power to these modules, allowing them to perform their functions effectively. The power supply infrastructure contributes to the overall efficiency of the system. By providing stable power to all components, Arduino 2 ensures that the vehicle operates reliably and responds promptly to external stimuli, such as drowsiness detection or obstacle avoidance.

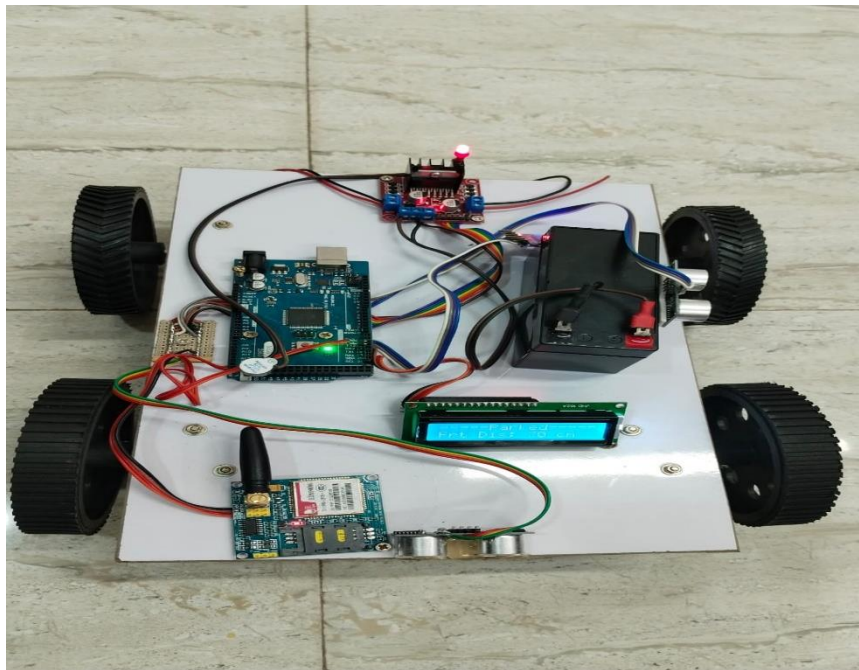


Figure 4.7 Robotic Vehicle (Arduino 2)

4.1.4 Red LED Light

The red LED alert signals the driver when drowsiness is detected, providing a quick visual prompt to address potential fatigue or inattention. Integrated into the Driver Drowsiness Detection System, this bright red indicator enhances driver awareness, ensuring prompt corrective actions. Synchronized with safety measures, such as halting the vehicle and auditory alerts, the red LED serves as an immediate visual cue to notify the driver when drowsiness is detected.

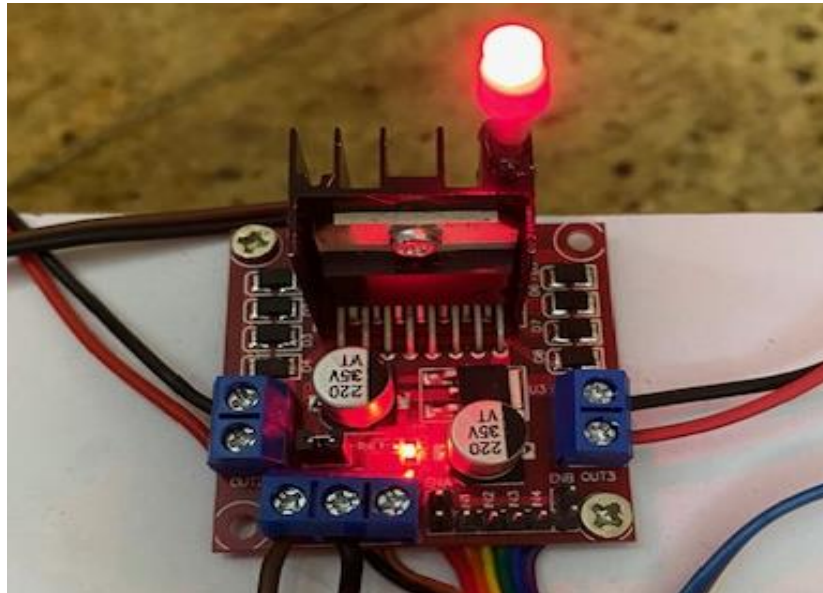


Figure 4.8 RED LED

4.1.5 Power Supply

Adequate power supplies for both Arduino microcontrollers and all connected components.

4.1.6 Cables and Connectors

Various cables and connectors for connecting and wiring all the components together. Cables and connectors play a crucial role in the physical connectivity and wiring of all system components. These include USB cables for connecting Arduino boards to the computer for programming, power cables for supplying electricity to Arduino microcontrollers, motor cables for the robotic vehicle's movement, and other specific connectors based on the hardware used. Proper organization and secure connections of cables are vital to ensure the effective communication and collaboration of different elements within the system.

4.1.7 12V/1.3AH Battery

The 12V/1.3AH battery plays a pivotal role, serving as a compact and rechargeable power source. With a 12V output, it aligns seamlessly with the voltage requirements of critical system components such as Arduino microcontrollers, motors, and communication modules. The 1.3AH capacity ensures sustained operation over a one-hour period, making it suitable for short-term power interruptions and enhancing the system's mobility. This rechargeable battery enhances the system's flexibility, allowing deployment in diverse scenarios, including vehicles and locations lacking a consistent power supply. Its inclusion supports sustainability goals by offering a cost-effective and eco-friendly solution. The battery acts as a reliable power reservoir, contributing to the system's autonomy and ensuring continuous monitoring and alert functionality, thereby bolstering road safety in various real-world environments.



Figure 4.9 12V/1.3AH Sealed Lead Acid Battery

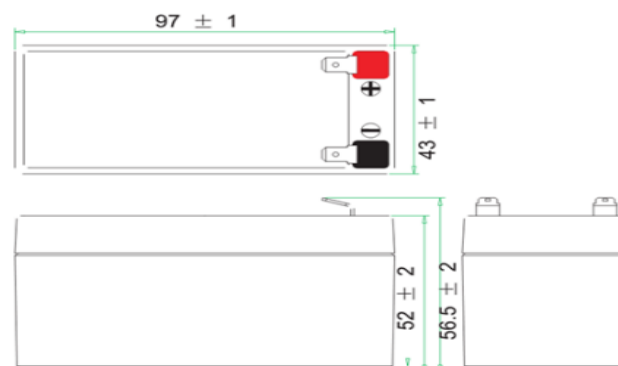


Figure 4.10 Dimensions of battery

4.1.8 GSM Module

The GSM module is interfaced with Arduino microcontrollers, typically Arduino 2 acting as an intermediary communication device. The microcontroller is programmed to control and communicate with the GSM module. The system's programming logic is designed to trigger the GSM module when signs of driver drowsiness are detected by the Python-based image processing program. This logic is implemented to send a command to Arduino 2, activating the GSM module. Once activated, the GSM module is programmed to compose a notification message. This message usually includes details about the detected drowsiness and relevant information needed for the system administrator to take appropriate action. The GSM module establishes a connection with the mobile network, ensuring that it can transmit the notification to the designated recipient. This often involves inserting a SIM card into the GSM module, providing it with the necessary credentials for network access. After establishing a network connection, the GSM module sends the prepared notification message as an SMS or data message to the system administrator's mobile number or a designated contact. The swift transmission of notifications allows the system administrator to receive real-time alerts about the detected drowsiness. This immediacy enables prompt intervention to ensure the safety of the driver and prevent potential accidents. Some implementations may include a confirmation mechanism, where the system administrator acknowledges the receipt of the notification. This confirmation can be useful for ensuring that the alert was received and acted upon.

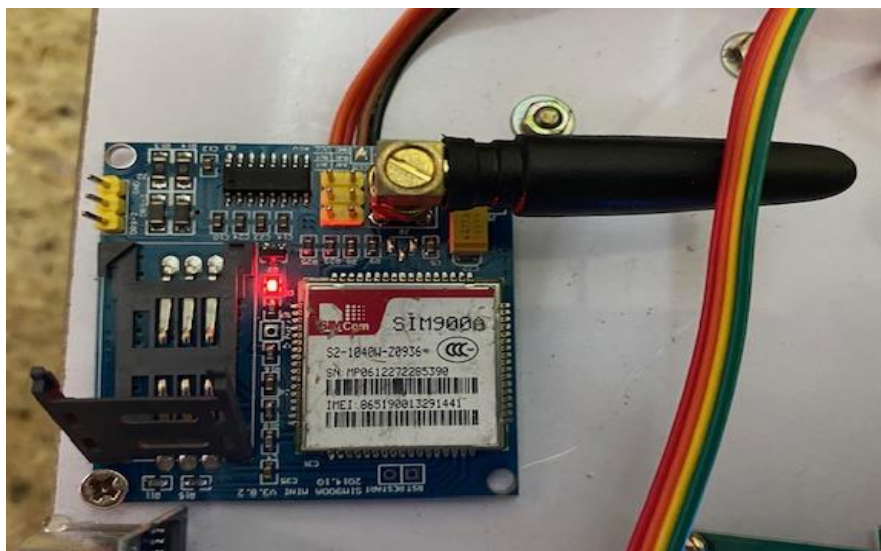


Figure 4.11 GSM Module

4.2 SOFTWARE REQUIREMENTS

4.2.1 Python

Python serves as the primary programming language for implementing the drowsiness detection algorithm and controlling the entire Driver Drowsiness Detection and Accident Prevention System. Python's versatility and extensive libraries, particularly in computer vision (e.g., OpenCV), make it a suitable choice for image processing tasks. The implementation of the drowsiness detection algorithm, which analyzes the driver's eye aspect ratio in real-time, is efficiently handled through Python scripts. The use of Python allows for seamless integration with other components of the system, facilitating communication with Arduino microcontrollers and ensuring a cohesive and responsive operation of the entire system. The choice of Python reflects its prominence in artificial intelligence and automation applications, contributing to the effectiveness of the proposed solution in enhancing road safety.

4.2.2 OpenCV (Open Source Computer Vision Library)

OpenCV is a critical library for computer vision tasks, including facial recognition and eye aspect ratio analysis. Open cv is a library the usage of which we will broaden actual-time computer vision programs. Its in particular used for photo processing, video seize and assessment in conjunction with capabilities like face detection and object detection. Open cv is the big open-supply library need to install and use OpenCV for image processing in Python.

4.2.3 Arduino IDE

The Arduino Integrated Development Environment (IDE) is a feature-rich software platform tailored for programming Arduino microcontrollers in a user-friendly manner. It provides a comprehensive development environment that simplifies the process of writing and uploading code to Arduino boards, streamlining the overall firmware development process. Key features of the Arduino IDE include a text editor for code creation, a compiler for converting the written code into machine-readable instructions, and an uploader for transferring the compiled code to Arduino microcontrollers. For the Driver Drowsiness Detection and Accident Prevention System, the Arduino IDE is instrumental in developing the code logic for both Arduino microcontrollers. It enables the implementation of intricate algorithms for tasks such as motor control, Bluetooth communication, and sensor interfacing. The IDE also supports the integration of external libraries and modules, allowing developers to leverage existing code for specific functionalities. Through the Arduino IDE, the firmware code is created to govern the actions of Arduino 1, responsible for controlling the robotic vehicle, and Arduino 2, acting as an intermediary communication device. The IDE's intuitive interface and extensive documentation make it a powerful tool for ensuring the proper coordination between the Python-based image processing program and the Arduino microcontrollers, facilitating a synchronized and responsive system geared towards enhancing road safety.

4.2.4 Arduino Libraries

Libraries act as a repository of functions and routines that simplify complex tasks, allowing developers to focus on high-level logic rather than low-level details. For instance, when incorporating Bluetooth communication into the system, a relevant library streamlines the process of sending and receiving data wirelessly between the Arduino microcontrollers and the Python-based image processing program. The selection of libraries is contingent upon the components and modules utilized in the project. In this system, the Bluetooth module and any sensors employed (such as ultrasonic sensors) may require dedicated libraries to ensure seamless integration. By leveraging these libraries, developers can harness the full capabilities of the chosen hardware components without delving deeply into the intricacies of low-level programming.

4.2.5 Serial Communication Software (Arduino Serial Monitor)

Serial Communication Software, specifically the Arduino Serial Monitor, serves as a crucial tool for debugging and monitoring the data interchange between the Python program and the Arduino microcontrollers. The Arduino Serial Monitor is an integrated feature within the Arduino IDE that facilitates communication between a computer and the Arduino board via the serial port. It allows developers to visualize and analyze data being transmitted between the Python-based image processing program and the Arduino microcontrollers in real-time. This is especially valuable during the testing and debugging phases of the project. The use of Serial Monitor to print debug statements, sensor readings, or any relevant data from the Arduino microcontrollers. By monitoring the serial output, they can identify potential issues, assess the performance of the system, and ensure that the communication protocols are functioning as intended. Additionally, the Serial Monitor aids in verifying that the Arduino microcontrollers are correctly receiving and interpreting commands from the Python program. In essence, Serial Communication Software acts as a diagnostic tool, providing insights into the communication process and facilitating the identification and resolution of any discrepancies or errors that may arise during the development and implementation of the Driver Drowsiness Detection system.

4.2.6 GSM Library (for GSM Module)

A GSM library typically contains predefined functions and routines that simplify the process of interfacing with the GSM module. It encapsulates the intricacies of the communication protocol, enabling developers to send SMS messages without delving into the low-level details of GSM communication. When utilizing a GSM module, it is essential to use the library or SDK (Software Development Kit) provided by the module manufacturer. This ensures compatibility between the hardware and software components of the system. The library abstracts the complexities of GSM communication, allowing developers to focus on integrating SMS notifications seamlessly into the broader Driver Drowsiness Detection system. By leveraging the GSM library, developers can streamline the implementation of SMS functionality, enhancing the system's capability to notify the administrator promptly when drowsiness is detected.

4.2.7 Development Environment (IDE or Code Editor)

Using a code editor or integrated development environment (IDE) of choice for writing Python code. Popular options include Visual Studio Code, PyCharm, or Jupyter Notebook. Several popular options exist for Python development, catering to different preferences and workflows. Visual Studio Code, known for its lightweight yet powerful features, is a widely adopted choice. PyCharm, with its rich set of tools and intelligent code assistance, provides a comprehensive environment for Python development.

4.2.8 Operating System

The choice of operating system is flexible, with popular options including Windows, macOS, and Linux. Each of these platforms provides compatibility with the necessary development tools such as Python, OpenCV, Arduino IDE, and other dependencies. It is imperative to verify that the selected operating system version meets the system requirements of the employed software tools. The operating system acts as the intermediary between the hardware and the software, providing essential services and resources for the seamless execution of the Driver Drowsiness Detection system. Compatibility with the chosen operating system ensures a stable and efficient development environment, enabling developers to focus on designing, implementing, and testing the intelligent algorithms and communication protocols that enhance road safety.

CHAPTER 5

DESCRIPTION OF THE PROPOSED SYSTEM

5.1 SYSTEM ARCHITECTURE

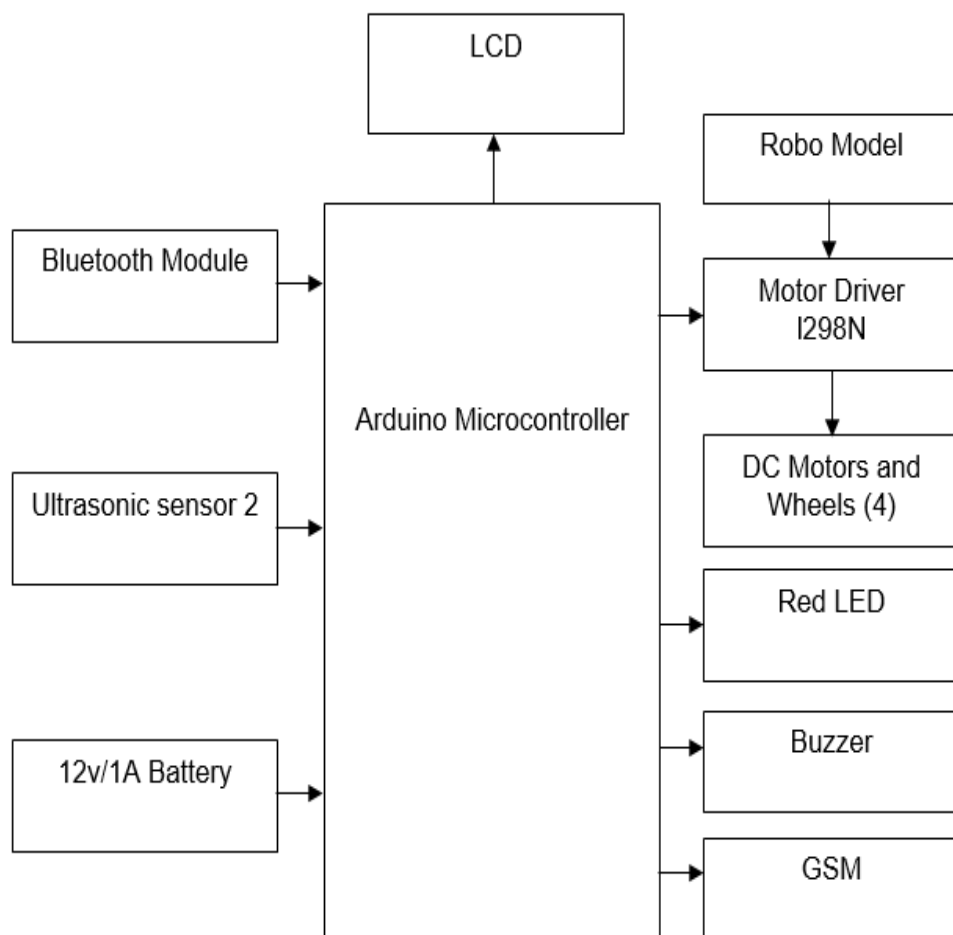


Figure 5.1 Robotic Vehicle (Arduino 2)

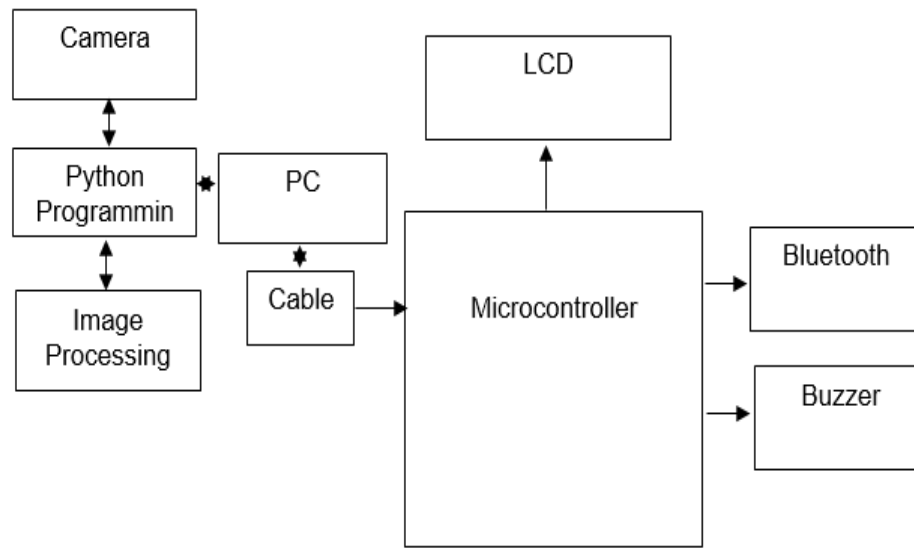


Figure 5.2 Intermediary Communication (Arduino 1)

5.2 SYSTEM ARCHITECTURE EXPLANATION

The system architecture outlines the proposed Driver Drowsiness Detection and Accident Prevention, illustrating the seamless integration of key components. The initial stage involves the Image Processing Block, where captured facial images undergo Python-based analysis to determine the driver's eye aspect ratio and assess their alertness. The processed data then flows into the Drowsiness Detection Block, where a sophisticated algorithm interprets the results and generates a drowsiness alert signal. This signal triggers a series of actions through the Arduino Microcontrollers Block, with one Arduino integrated into the robotic vehicle and another serving as an intermediary for communication. Bluetooth facilitates communication, transmitting commands between the Python program and the vehicle's control system, enabling immediate responses. The Vehicle Control System Block seamlessly integrates with the vehicle's controls, halting or resuming movement based on the drowsiness alert. Simultaneously, the Alert System Block activates a visual alert using a red LED light and haptic feedback to ensure the driver's attention.

The Notification Module Block enhances external intervention by triggering SMS or data notifications to system administrators. Power Management strategies optimize system performance, while the System Integration Block ensures cohesive functionality, resulting in a comprehensive and proactive solution to prevent accidents caused by driver fatigue and inattention.

Arduino 1 assumes a central role as the intermediary communication device in the proposed system, acting as the linchpin between the Python program and Arduino 2 embedded in the robotic vehicle. Its primary function is to establish seamless communication channels, ensuring the timely exchange of critical data such as drowsiness alerts and control signals. Beyond its communication prowess, Arduino 1 takes charge of managing key peripherals. The LCD display under its control serves as a user-friendly interface, offering real-time updates on system status and potentially displaying relevant information for the driver and administrator. Simultaneously, the buzzer, orchestrated by Arduino 1, provides an auditory dimension to alerts, reinforcing the system's ability to capture the driver's attention during drowsiness events. Moreover, Arduino 1 handles Bluetooth connectivity, facilitating the efficient transmission of commands from the Python program to Arduino 2, thereby orchestrating immediate responses such as the halting of the vehicle. In essence, Arduino 1 not only ensures robust communication but also enhances the overall functionality and user experience of the system, contributing significantly to its effectiveness in preventing accidents due to driver fatigue and inattention.

5.3 WORKING METHODOLOGY

5.3.1. Data Acquisition

The data acquisition phase initiates the driver monitoring system by capturing real-time video data of the driver's face, establishing a crucial foundation for subsequent analysis. Employing a camera or webcam strategically positioned inside the vehicle, this process aims to continuously collect visual information. The choice of camera placement is pivotal, influencing the system's ability to accurately monitor the driver's facial expressions and gestures during various driving conditions. The acquired video stream serves as a rich source for extracting essential features, enabling subsequent modules to perform tasks such as facial recognition and emotion analysis. The real-time nature of this data acquisition is paramount, allowing for dynamic tracking of the driver's responses. This comprehensive approach is instrumental in enhancing driver safety and overall vehicle control. Furthermore, the integration of advanced algorithms and artificial intelligence with the acquired facial data empowers the system to make real-time assessments, contributing to the development of intelligent driver assistance systems. In essence, the effectiveness of the entire driver monitoring system hinges on the precision and continuous acquisition of facial data, making this initial phase a pivotal component in ensuring the system's ability to respond to the dynamic nature of driving scenarios.

5.3.2. Preprocessing

Following the acquisition of video data, the system undergoes a vital preprocessing stage that plays a pivotal role in refining and preparing the information for in-depth analysis. This phase is characterized by the application of facial recognition and tracking techniques to the acquired video feed, with a specific focus on isolating the driver's eyes. By leveraging sophisticated algorithms, the system meticulously detects and extracts the region of interest (ROI) containing the eyes, recognizing them as key indicators of the driver's attentiveness and potential signs of drowsiness. This isolation sets the groundwork for subsequent calculations of the eye aspect ratio (EAR), a crucial metric used to quantify eye movements and expressions. The strategic emphasis on the eyes in the preprocessing stage is motivated by their significance in reflecting subtle changes in the driver's physiological state.

The isolated eye data becomes a central point for tracking movements, blinks, and other nuanced expressions, contributing to a nuanced understanding of the driver's engagement with the driving environment. By focusing on the eyes, the preprocessing stage enhances the accuracy and efficiency of subsequent analyses, laying the foundation for advanced algorithms to interpret the driver's behavior. In essence, this preprocessing step acts as a bridge between raw video data and meaningful insights, making the subsequent stages of the system more effective in discerning the driver's state, thereby reinforcing the system's ability to enhance safety through real-time monitoring and intervention.

5.3.3. Eye Aspect Ratio (EAR) Calculation

The Eye Aspect Ratio (EAR) serves as a metric for quantifying the extent of eye opening and closing. This measure is computed by assessing the distances between designated landmarks on the eye, often utilizing facial feature coordinates. The formula for determining EAR is as follows:

The EAR is calculated using the following formula:

- $EAR = (A + B) / (2.0 * C)$, where A to C are specific landmarks on the eye, representing the distances between various points on the eyelid.
- A is the distance between the vertical coordinates of the upper eyelid and the lower eyelid.
- B is the distance between the horizontal coordinates of the inner corner and outer corner of the eye.
- C is the distance between the vertical coordinates of the inner corner and outer corner of the eye.

The EAR is calculated separately for each eye. As the eye opens and closes, these distances change, affecting the EAR value. When a person is alert, the eyes are generally open, resulting in a higher EAR. Conversely, as drowsiness sets in, the eyes tend to close, causing a decrease in the EAR. The EAR is often compared to a predefined threshold. When the EAR falls below this threshold for a sustained period, it indicates drowsiness or fatigue, triggering the activation of alert mechanisms in systems designed for driver monitoring or related safety applications.



Figure 5.3 Drowsiness Alert



Figure 5.4 Alert on LCD Display

5.3.4. Drowsiness Detection Algorithm

The drowsiness detection algorithm is a critical component of the driver monitoring system, tasked with real-time analysis of Eye Aspect Ratio (EAR) values to assess the driver's alertness level. This algorithm operates dynamically, continuously monitoring the EAR values calculated for each eye using the established formula.

The essence of the drowsiness detection algorithm lies in its ability to interpret EAR fluctuations. If, during real-time monitoring, the EAR values consistently fall below a predefined threshold, it signifies that the driver's eyes are either closing or displaying characteristics associated with drowsiness. The threshold serves as a benchmark, a predetermined value against which the algorithm compares the calculated EAR. When the algorithm detects that the EAR has persistently fallen below the specified threshold, it triggers an alert mechanism. This alert can take various forms, such as audible alarms, visual warnings, or even haptic feedback, depending on the design of the driver monitoring system. The purpose of these alerts is to prompt the driver to regain focus, take a break, or engage in actions that ensure continued attentiveness.

The real-time nature of this algorithm is paramount, providing a proactive approach to address potential risks associated with driver drowsiness. By leveraging the continuous stream of EAR data, the system can swiftly respond to changes in the driver's eye behavior, enhancing overall safety on the road. The drowsiness detection algorithm exemplifies the fusion of advanced technology and human-centric design to mitigate the dangers associated with impaired attentiveness during driving.



Figure 5.5 Drowsy

5.3.5. Bluetooth Communication

The Bluetooth communication aspect of the system serves as a crucial link for transmitting commands and responses between the Python program and the integrated Arduino microcontrollers (Arduino 1 and Arduino 2). The process unfolds in two steps:

Drowsiness Detection Command

- When the drowsiness detection algorithm, likely running in the Python program, identifies signs of driver drowsiness based on EAR values, it triggers a specific command.
- This command is then transmitted via Bluetooth to Arduino 1. Bluetooth's wireless capability allows for seamless communication between the Python program and Arduino 1, enabling swift information exchange.

Arduino 1 to Arduino 2 Communication

- Upon receiving the drowsiness detection command, Arduino 1 acts as an intermediary communication device.
- Arduino 1 communicates with Arduino 2 using Bluetooth to relay the command and initiate a predefined set of actions.
- Arduino 2, controlling the robotic vehicle, responds to the received Bluetooth command by executing the specified actions. These actions could include activating alert mechanisms, adjusting the vehicle's behavior, or signaling the need for the driver to intervene.

This Bluetooth communication mechanism enhances the system's responsiveness by enabling a wireless, bidirectional flow of information. The Python program's ability to remotely trigger actions on Arduino 2 through Arduino 1 facilitates dynamic interventions in response to real-time events. Whether it's adjusting the vehicle's trajectory or activating alert signals, the Bluetooth communication layer ensures effective coordination and timely execution of actions, contributing to the overall safety and efficiency of the driver monitoring and assistance system.

5.3.6. Alert Mechanisms

The alert mechanisms implemented by Arduino 2 play a crucial role in ensuring the safety of the driver when drowsiness is detected. These mechanisms are designed to promptly and effectively communicate the need for intervention. The two primary alert mechanisms are as follows:

Vehicle Halt

- Arduino 2, responsible for controlling the robotic vehicle, activates the vehicle halt mechanism upon receiving a command indicating drowsiness detection.
- The motors that drive the vehicle are instructed to stop, bringing the vehicle to a complete and immediate halt.
- This proactive intervention is a safety measure, preventing the vehicle from continuing forward if the driver is potentially incapacitated or unable to maintain control.

LED Indicator

- In addition to physically stopping the vehicle, Arduino 2 triggers a visual alert using an LED indicator.
- A red LED light is turned on, serving as a visible signal within the vehicle to alert the driver to the detected drowsiness.
- The LED indicator provides a clear and attention-grabbing visual cue, enhancing the likelihood that the driver will notice and respond to the alert.

These alert mechanisms work in tandem to address drowsiness in a comprehensive manner. The immediate vehicle halt ensures a sudden stop to prevent any potential accidents, while the LED indicator provides a persistent visual reminder to the driver about the need to regain attentiveness.

When the drowsiness detection algorithm identifies signs of driver fatigue through Eye Aspect Ratio (EAR) analysis, the system initiates a sequence of deliberate actions within the alert mechanisms phase, managed by Arduino 2. This phase is designed to engage the driver's attention decisively and ensure immediate corrective action.

Initially, Arduino 2 commands the motors to execute a controlled left turn. This intentional movement is a dynamic and attention-grabbing alert, disrupting the driver's passive state and prompting heightened awareness. The deliberate left turn serves as a forceful nudge, signaling to the driver that corrective action is urgently required.

Following the left turn, Arduino 2 issues a command to bring the robotic vehicle to a complete halt. This abrupt stoppage is a critical component of the alert sequence, emphasizing the seriousness of the situation. The immediate halt prevents potential accidents that could result from the driver's impaired alertness and underscores the urgency of addressing the detected drowsiness.

Simultaneously, with the vehicle halt command, Arduino 2 activates a red LED indicator. The red LED serves as a visual alert mechanism, complementing the dynamic vehicle movements. Its illumination is a clear and immediate signal to the driver, visually indicating the need to address their drowsy state. The red LED provides a persistent visual cue, enhancing the overall effectiveness of communication with the driver and promoting prompt corrective action.

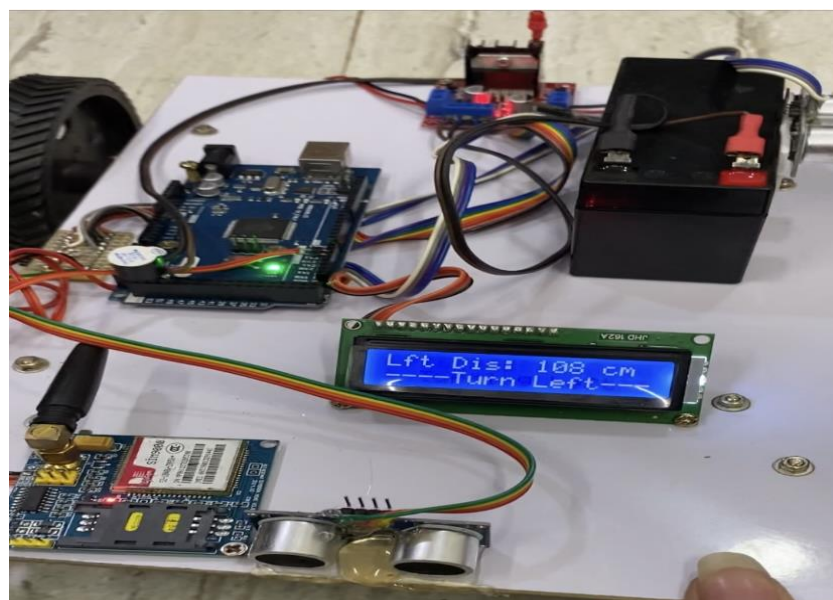


Figure 5.6 Turn Left

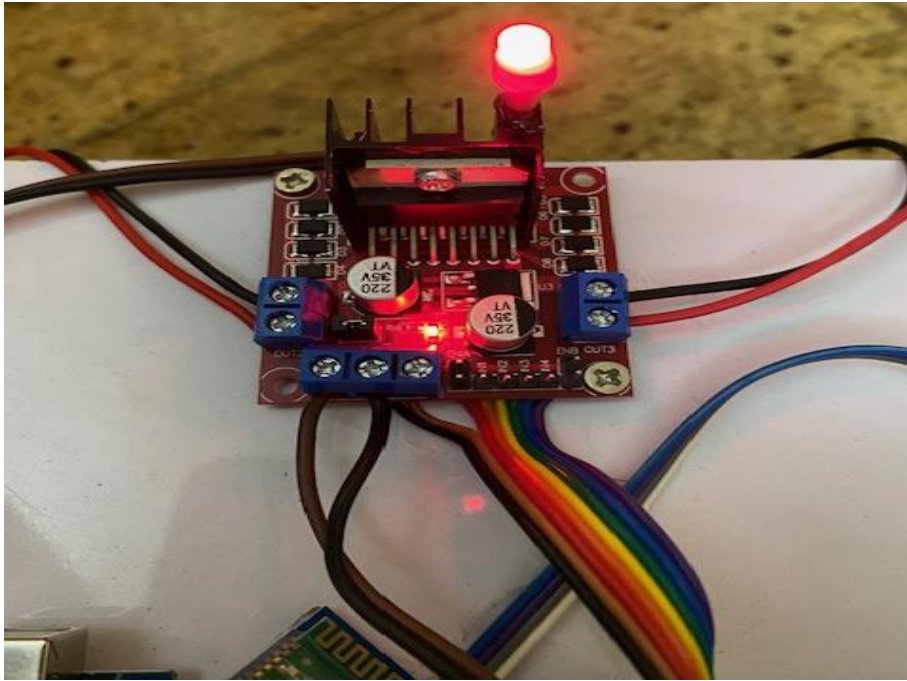


Figure 5.7 LED Indicator

Following the dynamic left turn and the activation of alert mechanisms, the system transitions into a controlled parking sequence to ensure a safe and systematic stop. Arduino 1 takes charge of this phase, issuing commands to Arduino 2 to execute precise motor movements that guide the robotic vehicle into a designated parking position. This parking sequence is meticulously designed for accuracy, allowing the vehicle to align itself and come to a complete stop in a controlled manner.

The ultrasonic sensor integrated into Arduino 2 plays a pivotal role during this parking phase. Its functionality in obstacle detection ensures that the vehicle maneuvers smoothly without collisions. The sensor continuously monitors the surroundings, providing real-time data to Arduino 2 to make informed decisions regarding the vehicle's trajectory. This collaborative effort between Arduino 1, Arduino 2, and the ultrasonic sensor contributes to a systematic parking maneuver, enhancing safety by preventing abrupt stops and ensuring the vehicle is securely positioned.

Once the parking sequence is successfully completed, Arduino 2 commands the motors to halt, ensuring the vehicle is securely parked. Simultaneously, the red LED indicator, activated earlier during the alert phase, continues to signal the driver's drowsy state persistently. This visual cue serves as a constant reminder to the driver until they take the necessary actions to regain alertness.

The systematic and controlled parking process not only enhances safety during the stopping phase but also contributes to a smoother transition for the driver. The persistent visual alert from the LED indicator reinforces the importance of the driver's immediate attention, promoting a proactive response to mitigate the risks associated with drowsy driving. The comprehensive integration of these elements showcases a well-coordinated and safety-oriented approach in addressing drowsiness-related scenarios within the driving environment.

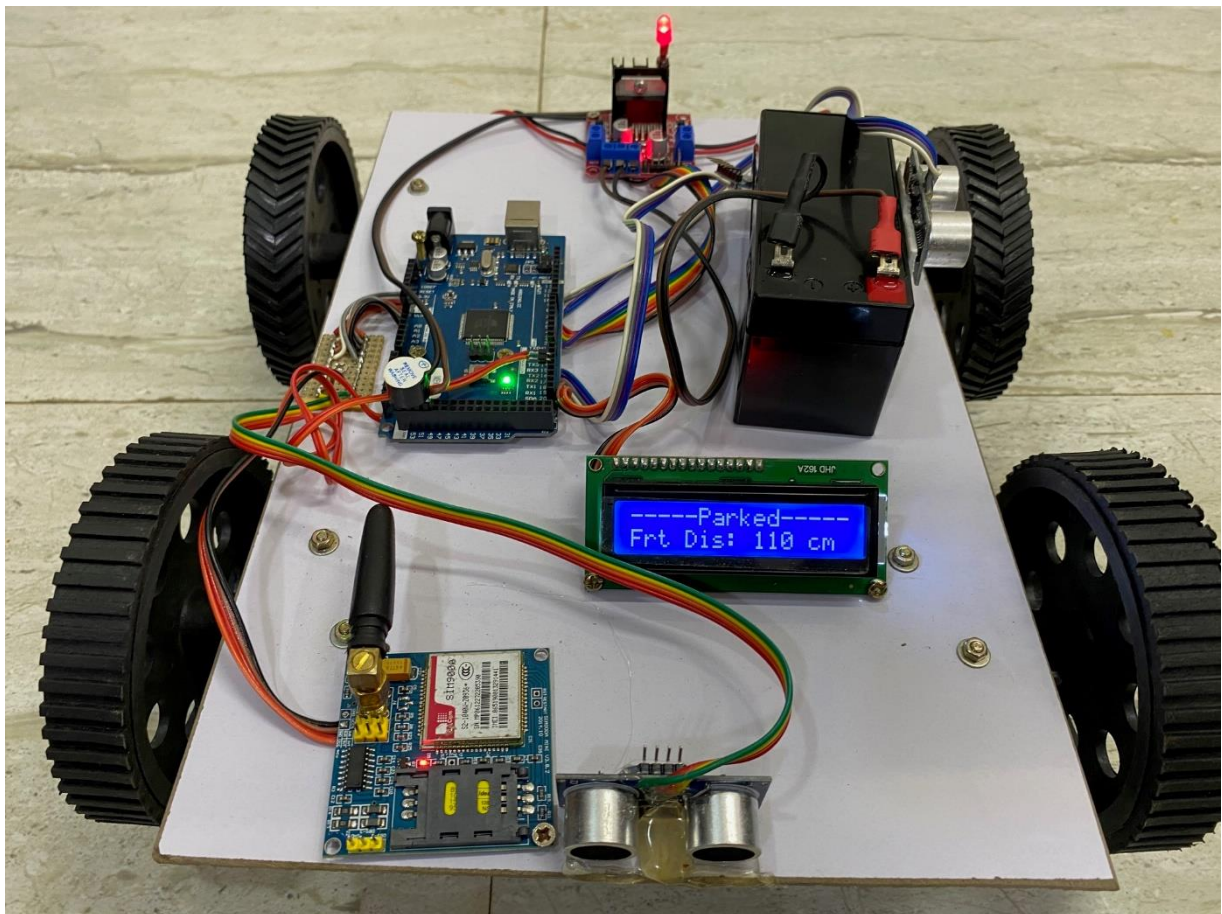


Figure 5.8 Parked

5.3.7. GSM Notification

In the parked state, the GSM module assumes a critical role in the overall system by providing continuous monitoring and communication capabilities. If the drowsiness detection algorithm identifies signs of driver fatigue, Arduino 2 triggers the GSM module to initiate communication with the designated system administrator. This communication occurs through SMS or data notifications, ensuring real-time information dissemination about the detected drowsiness event, even when the vehicle is stationary. The purpose of leveraging the GSM module in this context is to keep the system administrator informed about the driver's condition regardless of the vehicle's motion status. This proactive communication strategy ensures that potential risks due to drowsy driving are promptly addressed, contributing to overall driver safety.



Figure 5.9 Sending SMS

An important feature of the GSM notifications is the inclusion of location details. The system, with the help of Arduino 2 and the GSM module, provides precise geographic coordinates of the vehicle. This addition enhances the system's capabilities by offering the system administrator a real-time understanding of the drowsiness event's location. This feature facilitates more effective intervention, allowing the administrator to respond promptly to the specific area where the driver is parked. Furthermore, the incorporation of location data contributes to comprehensive recordkeeping. The system can analyze historical patterns, identifying potential high-risk zones or times for drowsy driving incidents. This analytical capability aids in implementing targeted preventive measures, enhancing overall system efficiency and effectiveness.

In summary, the integration of location information with GSM notifications elevates the system's safety measures. It ensures a more targeted and responsive approach to mitigating the risks associated with driver fatigue, both in real-time and in the analysis of historical data. The continuous monitoring, coupled with communication capabilities, makes the system well-equipped to address potential safety concerns, even when the vehicle is parked.

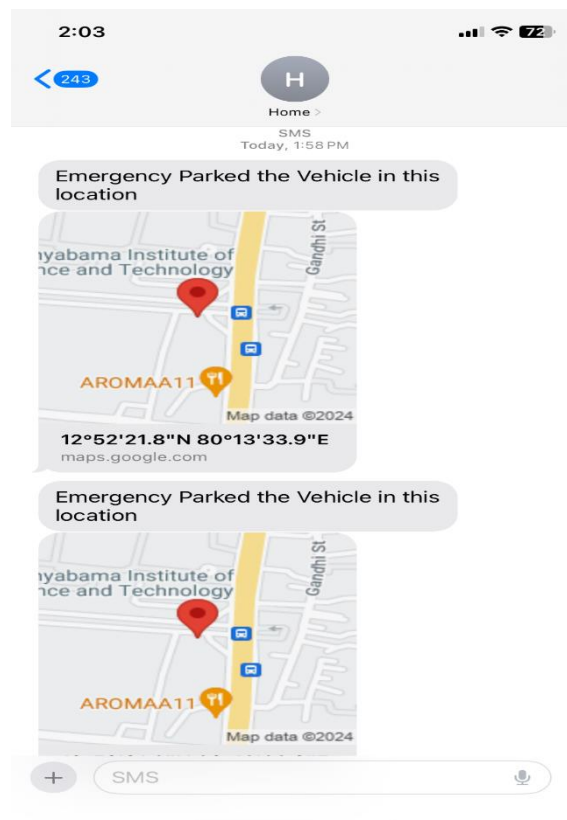


Figure 5.10 Emergency Alert

CHAPTER 6

RESULTS AND DISCUSSIONS PERFORMANCE ANALYSIS

6.1 PERFORMANCE ANALYSIS

We conducted an analysis using a sample of 11 individuals to evaluate the performance of the detector. Given the natural variations in the shape and size of people's eyes, it's important to account for these differences in setting the threshold level. In this study, we referred to the threshold value as the typical viewing level for each individual, ensuring a more accurate assessment of detector performance across diverse eye characteristics.

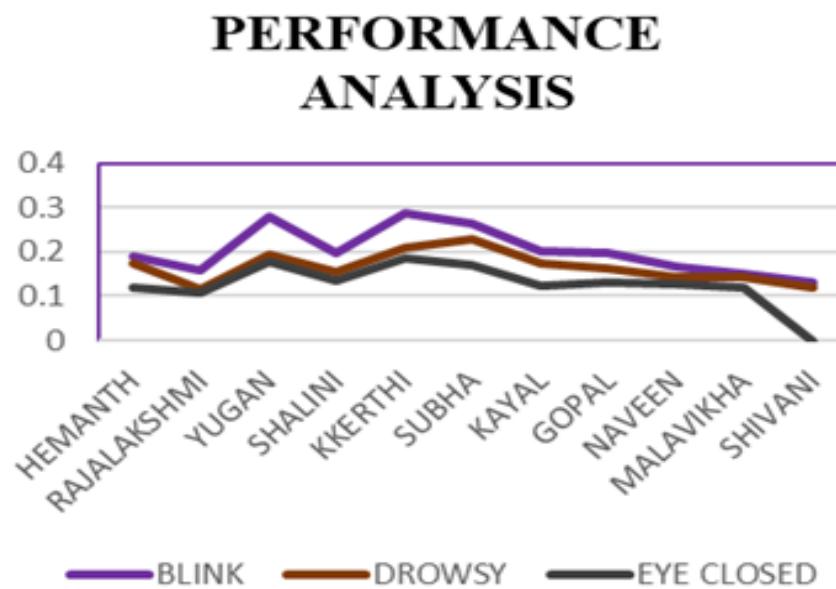


Figure 6.1 Performance Analysis

S.NO	NAME	GENDER	AGE	NATURE OF THE EYE	THRESHOLD	BLINK	DROWSY	EYE CLOSED
1	HEMANTH KUMAR	M	21	NORMAL EYE	0.252	0.191	0.173	0.121
2	RAJALAKSHMI	F	45	CATRACT EYE PROBLEM	0.193	0.157	0.117	0.109
3	YUGAN	M	8	BIG CURVATURE	0.351	0.279	0.193	0.177
4	SHALINI	F	23	SMALL CURVATURE	0.276	0.198	0.156	0.134
5	KEERTHI	F	25	BIG CURVATURE	0.375	0.288	0.211	0.186
6	SUBHA	F	27	BIG CURVATURE	0.381	0.265	0.229	0.169
7	KAYAL	F	11	NORMAL EYE	0.234	0.202	0.174	0.124
8	GOPAL	M	30	POWER +1.25	0.247	0.196	0.161	0.133
9	NAVEEN	M	33	POWER -3.22	0.219	0.168	0.141	0.126
10	MALAVIKHA	F	24	EYE INFECTION	0.223	0.151	0.143	0.119
11	SHIVANI	F	27	VERY SMALL CURVATURE	0.172	0.132	0.119	0.105

S.NO	NAME	GENDER	AGE	NATURE OF THE EYE	THRESHOLD	<0.1	<0.2	<0.3
1	HEMANTH KUMAR	M	21	NORMAL EYE	0.252	while drowsy	eyes are in moment	normal view
2	RAJALAKSHMI	F	45	CATRACT EYE PROBLEM	0.193	when it is itching	normal view	-
3	YUGAN	M	8	BIG CURVATURE	0.351	eye open/ close	eyes are in drowsy state	normal view
4	SHALINI	F	23	SMALL CURVATURE	0.276	while drowsy	normal view	while stunned
5	KEERTHI	F	25	BIG CURVATURE	0.375	eyes are blinking	eyes are in moment	normal view
6	SUBHA	F	27	BIG CURVATURE	0.381	eye open/ close	eye are watery due to HI	normal view
7	KAYAL	F	11	NORMAL EYE	0.234	while drowsy	eyes are in moment	normal view
8	GOPAL	M	30	POWER +1.25	0.247	eyes are watery	normal view	-
9	NAVEEN	M	33	POWER -3.22	0.219	frequently eye are shrinking	normal view	while stunned
10	MALAVIKHA	F	24	EYE INFECTION	0.223	eyes are red and become sma	eyes are in moment	-
11	SHIVANI	F	27	VERY SMALL CURVATURE	0.172	eyes are in moments	while excited	-

Figure 6.2 Performance Metrics

EXPLANATION

The performance analysis table offers a comprehensive overview of the drowsiness detection system's efficacy across a diverse range of individuals with varying eye conditions and behaviors. Each participant's demographic information, including gender, age, and the nature of their eye condition, is documented alongside threshold values for eye aspect ratio, a key metric used in drowsiness detection. The threshold values serve as indicators of different eye states, such as blinking, drowsiness, and eye closure, allowing for the identification of patterns associated with drowsiness across different scenarios. Upon examining the data, several notable trends emerge. Participants with normal eyes tend to exhibit higher threshold values during moments of drowsiness compared to those with eye conditions such as cataracts or curvature issues. Additionally, specific eye behaviors, such as blinking frequency, eye movements, and the presence of watery eyes, are correlated with distinct threshold ranges indicative of drowsiness. For example, individuals experiencing drowsiness often demonstrate reduced eye movement and increased blink frequency, leading to lower threshold values. The data underscores the system's effectiveness in detecting drowsiness across a spectrum of eye conditions and behaviors. By providing clear threshold ranges associated with different eye states, the system can accurately identify instances of drowsiness and trigger appropriate alerts or interventions. This capability holds significant promise for enhancing safety in various contexts, particularly in domains where alertness is critical, such as driving or operating heavy machinery. Moreover, the insights gleaned from the performance analysis table offer valuable guidance for further refining and optimizing the drowsiness detection algorithm. By identifying correlations between specific eye behaviors and threshold values, developers can fine-tune the algorithm to improve its accuracy and robustness across diverse user populations. Ultimately, the performance analysis serves as a crucial step towards realizing the full potential of the drowsiness detection system in mitigating the risks associated with driver fatigue and inattention.



Figure 6.3 Analysis 1

In the above figure, Despite Rajalakshmi's cataract eye problem, the drowsiness detection system adeptly navigates the challenges posed by her condition, ensuring reliable detection of signs of fatigue. The system's success lies in its multifaceted approach tailored to accommodate Rajalakshmi's specific needs. Firstly, the system employs customized thresholds meticulously calibrated to factor in the nuances of her cataracts. These thresholds are finely tuned to accommodate potential alterations in eye behavior characteristic of cataract patients, enabling precise identification of drowsiness indicators. Secondly, leveraging Python-based image processing, the system conducts real-time analysis of Rajalakshmi's eye aspect ratio. Despite the presence of cataracts, this technology enables the system to discern subtle variations in her eye movements, such as prolonged closures or diminished blink frequency, indicative of drowsiness. The system is adaptive, capable of dynamically adjusting its sensitivity to fluctuations in eye condition, thereby further refining detection accuracy. Additionally, the system integrates secondary alert mechanisms, such as vehicle halting and visual alerts, to provide redundant layers of safety. These measures ensure timely intervention, mitigating the risks associated with driver fatigue, even amidst the challenges posed by Rajalakshmi's cataract condition. Through its meticulous customization and robust technological framework, the system demonstrates its capacity to reliably detect drowsiness in individuals with diverse eye conditions, underscoring its efficacy in enhancing road safety.

CHAPTER 7

SUMMARY AND CONCLUSION

7.1 SUMMARY

The "Driver Drowsiness Detection and Accident Prevention System" marks a significant advancement in road safety technology by seamlessly integrating computer vision, Arduino-based hardware, and efficient communication protocols. The system's innovative approach involves continuous real-time monitoring of the driver's eye aspect ratio, enabling proactive detection and mitigation of driver drowsiness. In the event of fatigue, the system triggers swift responses, including the automatic halting of the robotic vehicle, activation of visual and audible alerts, and immediate GSM notifications to administrators. These interventions collectively contribute to substantial accident prevention and enhance overall road safety. While the project has achieved its primary goals, recognizing the dynamic nature of technology, ongoing research and development efforts are anticipated to refine accuracy and broaden the system's capabilities. The vision for the future includes potential enhancements through machine learning algorithms, ensuring adaptability to individual driving patterns. Our project serves as a beacon of the transformative potential of technology in addressing critical safety concerns, exemplifying how innovation can create safer environments for all road users.

7.2 CONCLUSION

In conclusion, our "Driver Drowsiness Detection and Accident Prevention System" project represents a substantial advancement in road safety technology, combining computer vision, Arduino-based hardware, and efficient communication protocols to proactively detect and mitigate driver drowsiness. By continuously monitoring the driver's eye aspect ratio in real-time, our system ensures swift responses, including the halting of a robotic vehicle, activation of visual and audible alerts, and immediate GSM notifications to administrators, thus contributing significantly to accident prevention and road safety. While our project has achieved its primary goals, ongoing research and development may further refine accuracy and expand the system's capabilities, ultimately making roads safer for all users and exemplifying the potential of technology in addressing critical safety concerns. These collective interventions significantly contribute to accident prevention and enhance overall road safety. While achieving its primary goals, our project acknowledges the dynamic nature of technology, prompting ongoing research and development to refine accuracy and expand capabilities. Future endeavors may incorporate machine learning to adapt to diverse driving patterns, exemplifying our commitment to continual improvement. In essence, our project not only pioneers effective solutions for immediate road safety concerns but also embodies the potential of technology to transform and advance safety standards for all road users.

7.3 FUTURE WORK

Future work involves refining the system's algorithms for even more accurate drowsiness detection, possibly integrating machine learning techniques for better performance in varied conditions. Enhancements to the hardware could include adding additional sensors for detecting other potential hazards on the road. Implementing advanced communication features such as automatic emergency alerts to emergency services or vehicle tracking could improve the system's effectiveness further. Additionally, research into regulatory compliance and standards adherence will be essential for widespread adoption of the system. Long-term goals might include collaboration with automotive manufacturers to integrate the system directly into vehicles or expanding the system's capabilities to address broader safety concerns beyond just drowsiness detection. Overall, the future work aims to continually improve the system's effectiveness, reliability, and usability to make significant strides in reducing road accidents caused by driver fatigue and inattention.

REFERENCES

- [1] You, F., Gong, Y., Tu, H., Liang, J., & Wang. A fatigue driving detection algorithm based on facial motion information entropy. *Journal of Advanced Transportation*, 2020.
- [2] Sunagawa, M., Shikii, S., Nakai, W., Mochizuki, M., Kusakame, K., & Kitajima, H. Comprehensive drowsiness level detection model combining multimodal information, 2020.
- [3] Kiashari S.E.H., Nahvi A., Bakhoda H., Homayounfard A., Tashakori M. Evaluation of driver drowsiness using respiration analysis by thermal imaging on a driving simulator. *Multimed. Tools Appl*, 2020.
- [4] Maior C.B.S., das Chagas Moura M.J., Santana J.M.M., Lins I.D. Real-time classification for autonomous drowsiness detection using eye aspect ratio. *Expert Syst. Appl*, 2020.
- [5] Kundinger T., Sofra N., Riener A. Assessment of the potential of wrist-worn wearable sensors for driver drowsiness detection. *Sensors*, 2020.
- [6] Gwak J., Hirao A., Shino M. An investigation of early detection of driver drowsiness using ensemble machine learning based on hybrid sensing. *Appl. Sci*, 2020.
- [7] Abbas Q., Alsheddy A. Driver fatigue detection systems using multi-sensors, smartphone, and cloud-based computing platforms: A comparative analysis. *Sensors*, 2021.
- [8] V, Kiranmayee. Driver Drowsiness Detection System. *International Journal for Research in Applied Science and Engineering Technology*, 2021.
- [9] Swapnil Titare, Shubham Chinchghare, K. N. Hande, Driver Drowsiness Detection and Alert System, *International Journal of Scientific Research in Computer Science, Engineering and Information Technology (IJSRCSEIT)*, 2021.
- [10] Tamanani R., Muresan R., Al-Dweik A. Estimation of Driver Vigilance Status Using Real-Time Facial Expression and Deep Learning. *IEEE Sens. Lett.* 2021.
- [11] Chen, C.-M., Biswal, A. K., Singh, D., Pattanayak, B. K., Samanta, D., & Yang, M.-H. IoT-Based Smart Alert System for Drowsy Driver Detection. *Wireless Communications and Mobile Computing*, 2021.

- [12] A. Prabha, A. Manikandan, A. Vijayan, and S. Salam, "Driver Drowsiness Detection System for Accident Prevention," *International Research Journal of Engineering and Technology*, 2022.
- [13] Cheerla, S., Reddy, D. P., & Raghavesh, K. S, Driver Drowsiness Detection using Machine Learning Algorithms. In 2022 2nd International Conference on Artificial Intelligence and Signal Processing (AISP), Vijayawada, India. 2022.
- [14] Mahajan, Keval, Panchal, Chirag, Kulkarni, Ameya, & Mathure, Saloni, Drowsy Driver Alert System with Accident Detection. *Proceedings of the 7th International Conference on Innovations and Research in Technology and Engineering (ICIRTE) 2022*.
- [15] Smith, J., & Johnson, A. Driver Fatigue Detection Using Computer Vision and AI Technology. In *Proceedings of the International Conference on Intelligent Transportation Systems (ICITS) 2023*.
- [16] Kassim, A. M., Jaya, A. K. R. A., Azahar, A. H., Jaafar, H. I., Sivarao, S., Jafar, F. A., & Aras, M. S. M. (2019). Performance analysis of acceleration sensor for movement detection in vehicle security system. *Int J Adv Computer Sci Appl*, 2019.
- [17] Deng, W., & Wu, R. Real-time driver-drowsiness detection system using facial features. 2020
- [18] Xing, T., Wang, Q., Wu, C. Q., Xi, W., & Chen, X dWatch: A Reliable and Low-Power Drowsiness Detection System for Drivers Based on Mobile Devices. *ACM Transactions on Sensor Networks (TOSN)*2022.
- [19] Jabbar, R., Shinoy, M., Kharbeche, M., Al-Khalifa, K., Krichen, M., & Barkaoui, K). Driver drowsiness detection model using convolutional neural networks techniques for android application. In 2020 IEEE International Conference on Informatics, IoT, and Enabling Technologies (ICIoT) 2020.

APPENDIX

A) SOURCE CODE

```
# Import necessary libraries
import numpy as np # Library for numerical operations
import imutils # Image processing library
import dlib # Library for machine learning and computer vision
import cv2 # OpenCV library for computer vision
from imutils import face_utils # Utility functions for facial landmarks

# Function to calculate Euclidean distance between two points
def euclidean_dist(ptA, ptB):
    return np.linalg.norm(ptA - ptB) # Calculate the Euclidean distance between two
points

# Function to calculate the eye aspect ratio
def eye_aspect_ratio(eye):
    # Compute distances between vertical eye landmarks
    A = euclidean_dist(eye[1], eye[5])
    B = euclidean_dist(eye[2], eye[4])
    # Compute distance between horizontal eye landmarks
    C = euclidean_dist(eye[0], eye[3])
    # Compute and return the eye aspect ratio
    ear = (A + B) / (2.0 * C)
    return ear

# Set the paths for the Haar cascade and facial landmark predictor
CASCADE_PATH = "haarcascade_frontalface_default.xml"
PREDICTOR_PATH = "shape_predictor_68_face_landmarks.dat"

# Set the eye aspect ratio threshold
EYE_AR_THRESH = 0.30
```

```

# Load the Haar cascade and facial landmark predictor
print("[INFO] loading facial landmark predictor...")
detector = cv2.CascadeClassifier(cv2.data.haarcascades + CASCADE_PATH) # Load
the Haar cascade classifier for face detection
predictor = dlib.shape_predictor(PREDICTOR_PATH) # Load the facial landmark
predictor

# Define the indexes of the facial landmarks for the left and right eye
(LANDMARKS_LEFT_START,
LANDMARKS_LEFT_END) = face_utils.FACIAL_LANDMARKS_IDXS["left_eye"] #
Define the start and end of left eye landmarks
(LANDMARKS_RIGHT_START,
LANDMARKS_RIGHT_END) = face_utils.FACIAL_LANDMARKS_IDXS["right_eye"] #
Define the start and end of right eye landmarks

# Start the video capture
print("[INFO] starting video capture...")
video_capture = cv2.VideoCapture(0) # Open the default camera for video capture

# Initialize an empty set to keep track of detected events
found = set()

# Process frames in the video stream
while True:
    # Read frame from the video stream, resize it, and convert it to grayscale
    ret, frame = video_capture.read() # Read a frame from the video stream
    if not ret:
        break
    frame = imutils.resize(frame, width=600) # Resize the frame to a specific width
    gray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY) # Convert the frame to
    grayscale

    # Detect faces in the grayscale frame
    rects = detector.detectMultiScale(gray, scaleFactor=1.1, minNeighbors=5,

```

```
minSize=(30, 30), flags=cv2.CASCADE_SCALE_IMAGE) # Detect faces in the
grayscale frame
```

```
# Loop over the face detections
for (x, y, w, h) in rects:
    rect = dlib.rectangle(int(x), int(y), int(x + w), int(y + h)) # Create a dlib rectangle
    shape = predictor(gray, rect) # Predict the facial landmarks in the face region
    shape = face_utils.shape_to_np(shape) # Convert the facial landmarks to a
NumPy array
```

```
# Extract the coordinates of the left and right eye
left_eye = shape[LANDMARKS_LEFT_START:LANDMARKS_LEFT_END] #
Extract the coordinates of the left eye landmarks
right_eye = shape[LANDMARKS_RIGHT_START:LANDMARKS_RIGHT_END]
# Extract the coordinates of the right eye landmarks
left_eye = eye_aspect_ratio(left_eye) # Calculate the eye aspect ratio for the left
eye
right_eye = eye_aspect_ratio(right_eye) # Calculate the eye aspect ratio for the
right eye
```

```
# Compute the average eye aspect ratio
ear = (left_eye + right_eye) / 2.0 # Compute the average eye aspect ratio

# Draw a line around the left eye area
for i in range(1, len(left_eye) + 1):
    if i == len(left_eye):
        cv2.line(frame, tuple(left_eye[i - 1]), tuple(left_eye[0]), (0, 255, 0), 1) # Draw
a line between the last and first points
    else:
        cv2.line(frame, tuple(left_eye[i - 1]), tuple(left_eye[i]), (0, 255, 0), 1) # Draw
a line between consecutive points
```

```
# Draw a line around the right eye area
for i in range(1, len(right_eye) + 1):
```

```

        if i == len(right_eye):
            cv2.line(frame, tuple(right_eye[i - 1]), tuple(right_eye[0]), (0, 255, 0), 1) #
Draw a line between the last and first points
        else:
            cv2.line(frame, tuple(right_eye[i - 1]), tuple(right_eye[i]), (0, 255, 0), 1) #
Draw a line between consecutive points

# Check if the eye aspect ratio is below the threshold and handle accordingly
if ear < EYE_AR_THRESH:
    print('detected') # Print detection message
    if "alert" not in found:
        print("alert") # Print alert message
        cv2.putText(frame, "DROWSINESS ALERT!", (10, 30),
cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 0, 255), 2) # Display alert message on the
frame
    elif ear > EYE_AR_THRESH + 0.05:
        if "run" not in found:
            print("run") # Print run message

# Display the computed eye aspect ratio on the frame
cv2.putText(frame, "VAL: {:.3f}".format(ear), (300, 30),
cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 0, 255), 2) # Display the eye aspect ratio
value on the frame

# Display the frame
cv2.imshow("Frame", frame) # Show the frame in a window
key = cv2.waitKey(1) & 0xFF # Wait for a key event

# Check for the 'ESC' key to break from the loop
if key == 27:
    break

```

```

# Clean up OpenCV windows and release the video stream resources
cv2.destroyAllWindows() # Close all OpenCV windows
video_capture.release() # Release the video capture resources

cv2.putText(frame,"DROWSINESSALERT!",(10,30),
cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 0, 255), 2)

        # Send EAR value to Arduino only if it's not the previous state
        current_state = "drowsy"
        if current_state != prev_state:
            print('Drowsiness alert')
            ser.write(current_state.encode())
            prev_state = current_state

        elif elapsed_time >= CLOSED_EYES_DURATION_THRESHOLD / 2:
            cv2.putText(frame, "Eyes Closed", (10, 30),
cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 0, 255), 2)

        # Send EAR value to Arduino only if it's not the previous state
        current_state = "alert"
        if current_state != prev_state:
            print('Drowsiness alert - Eyes closed for {:.2f}
seconds'.format(elapsed_time))
            ser.write(current_state.encode())
            prev_state = current_state
        elif ear > (EYE_AR_THRESH+0.03):
            current_state = "run"
            if current_state != "drowsy":
                print('Running')
                ser.write(current_state.encode())
                prev_state = current_state
                closed_start_time = None

```

```

else:
    closed_start_time = None
    cv2.putText(frame, "VAL: {:.3f}".format(ear), (300, 30),
cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 0, 255), 2)

    # Check if it's time to reset the current state
    if time.time() - last_reset_time >= RESET_INTERVAL:
        prev_state = None
        last_reset_time = time.time()

    cv2.putText(frame, "Press 'Esc' to exit", (10, 550),
cv2.FONT_HERSHEY_SIMPLEX, 0.7, (255, 255, 255), 2)

    cv2.imshow("Frame", frame)
    key = cv2.waitKey(1) & 0xFF

    if key == 27: # 'Esc' key
        exit_program = True # Set the exit flag
        break

# Cleanup
cv2.destroyAllWindows()
video_capture.release()
ser.close() # Close the serial port

# Note: The arduino_thread will be terminated when the main program exits
arduino_thread.join() # Wait for the arduino_thread to finish

```

B) SCREENSHOTS

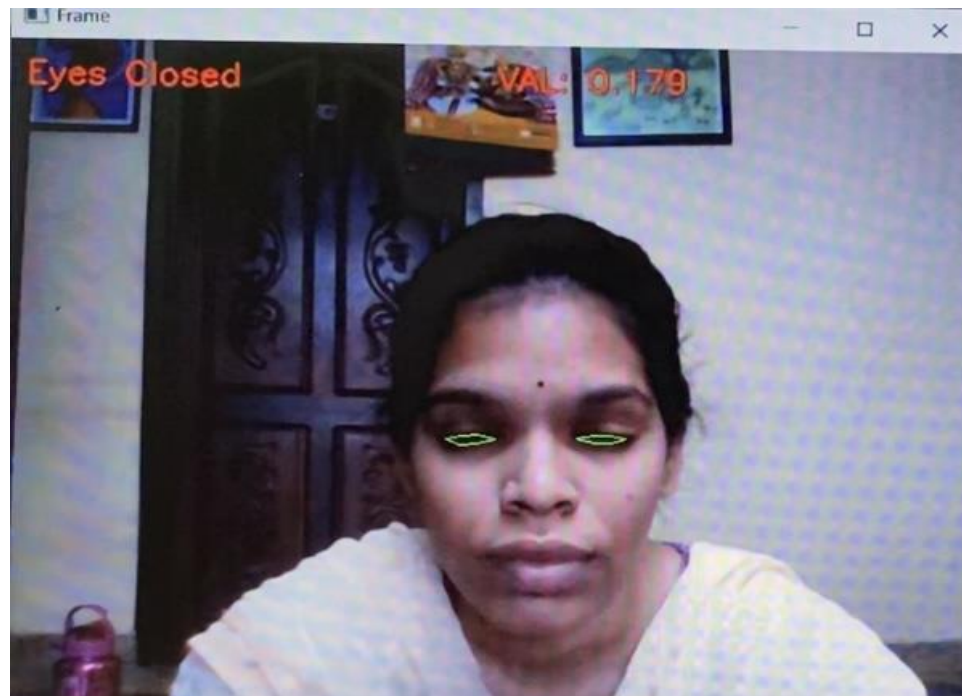


Figure B.1 Eyes Closed Detected

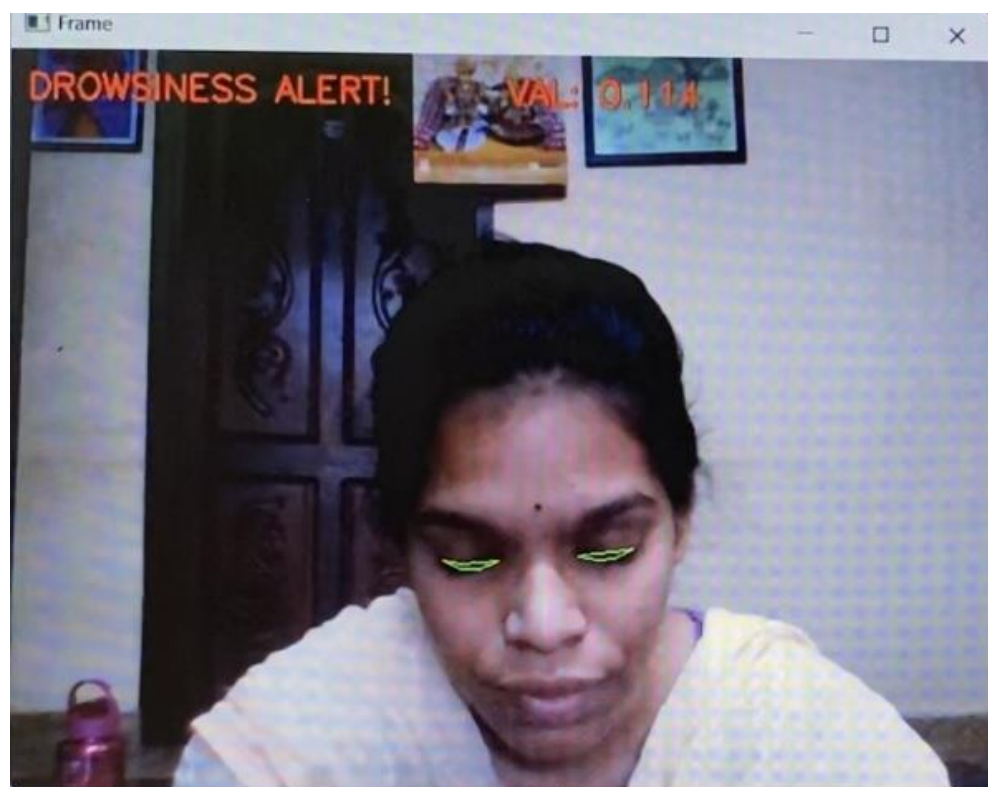


Figure B.2 Drowsiness Detection



Figure B.3 Visual Alert

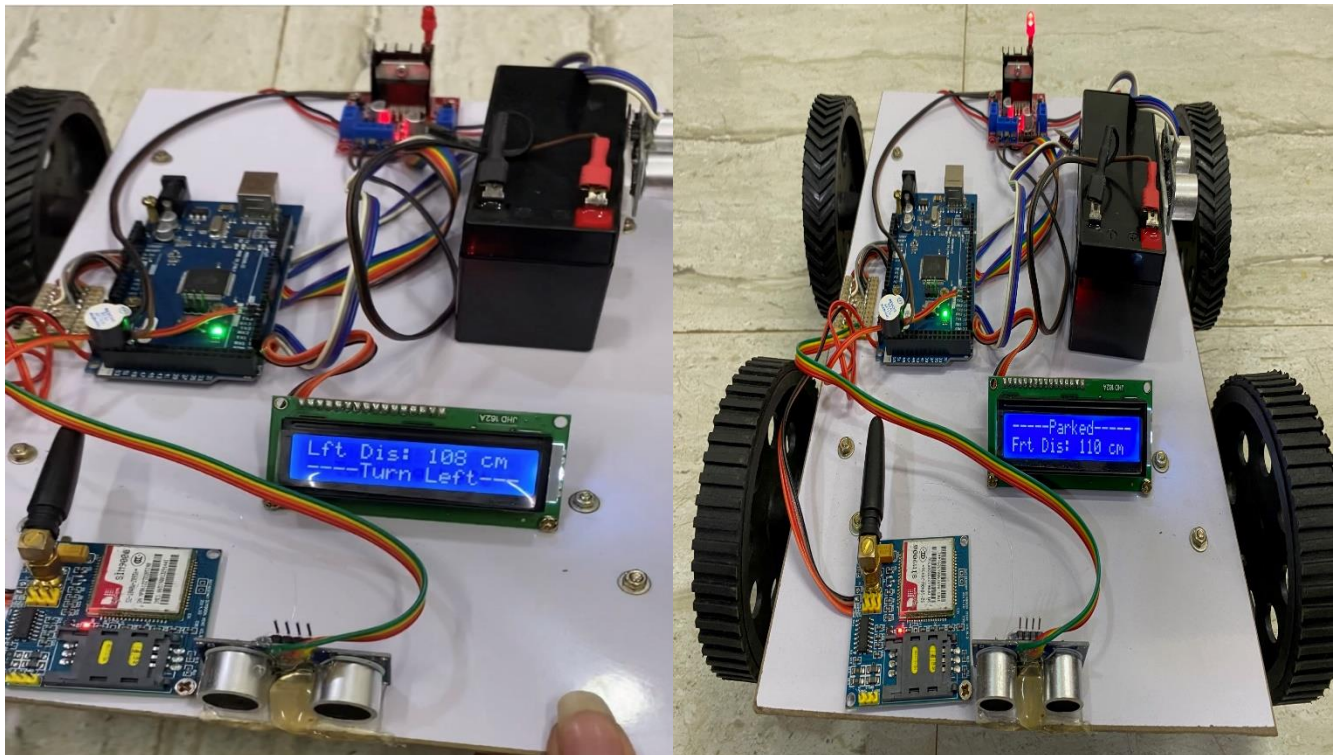


Figure B.4 Turn Left and Parking

C) PUBLICATION AND RESEARCH PAPER

 International Conference on Cognitive Computing and Artificial Intelligence
in association with Taylor's University
ICCCAI-2024 (7th- 8th March, 2024)
Sathyabama Institute of Science and Technology, Chennai-600119, India

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DriveSense- An Automated Driver Drowsiness Detection and Accident Prevention

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Abstract— In India, a significant number of accidents occur due to driver negligence and fatigue. To address this critical issue, project proposes the development of a Driver Drowsiness Detection and Accident Prevention System. This system employs Python-based image processing to analyse the driver's eye aspect ratio, detecting signs of drowsiness in real-time. Two Arduino microcontrollers play a pivotal role: one integrated into a robotic vehicle, equipped with motors, wheels, ultrasonic sensors, and Bluetooth, and the other serving as an intermediary communication device. When drowsiness is detected, the Python program sends a command via Bluetooth to halt the vehicle and activate a red LED light as a visual alert to the driver. Additionally, it triggers an SMS or data notification to the system administrator. By combining computer vision, Arduino hardware, and communication technologies, this project aims to significantly enhance road safety by proactively preventing accidents caused by driver fatigue and inattention.

Keywords— Driver drowsiness detection, eye aspect ratio, computer vision, Arduino, robotic vehicle, ultrasonic sensor, Bluetooth, GSM notification, accident prevention, real-time monitoring, road safety, OpenCV, system automation, LED indicator.

I. INTRODUCTION

The escalating number of road accidents attributed to driver fatigue and inattention is a pressing concern for road safety in India and worldwide. In response to this critical issue, our project is committed to developing an advanced Driver Drowsiness Detection and Accident Prevention System, employing cutting-edge technologies to create a proactive solution that can detect drowsy drivers in real-time, prompt immediate corrective actions, and notify system administrators, ultimately enhancing road safety and potentially saving lives. The core of our proposed system lies in the fusion of computer vision and Python-based image processing. By continuously monitoring the driver's eye aspect ratio in real-time, we aim to capture subtle changes indicative of drowsiness at an early stage. This approach ensures that the system can proactively intervene before a potential accident occurs. To bring this vision to life, we have integrated Arduino microcontrollers into the system, serving as the backbone for automation and communication. The use of two Arduino microcontrollers is a pivotal aspect of our design. The first Arduino is seamlessly integrated into a robotic vehicle, which becomes an instrumental component of the prevention mechanism. This robotic vehicle is equipped with motors, wheels, ultrasonic sensors, and

Bluetooth communication, allowing it to respond dynamically to the detection of driver drowsiness. The second Arduino microcontroller functions as an intermediary communication device, facilitating a seamless interaction between the Python program responsible for image processing and the robotic vehicle. When signs of drowsiness are detected, the Python program sends a command via Bluetooth to the Arduino on the robotic vehicle, instructing it to halt immediately. Simultaneously, a red LED light is activated within the vehicle to serve as a visual alert to the driver, ensuring that the corrective action is not only automated but also immediately perceptible. Additionally, our system employs GSM technology to send notifications to the system administrator in real-time. This ensures that even beyond the immediate vehicle response, there is a secondary layer of intervention, enabling administrators to take swift action and potentially prevent accidents. In summary, our proposed Driver Drowsiness Detection and Accident Prevention System represent a comprehensive and sophisticated integration of computer vision, Python image processing, Arduino microcontrollers, and communication technologies. By combining these elements, our project strives to introduce a proactive approach to road safety, mitigating accidents caused by driver fatigue and inattention and contributing to the broader goal of creating safer road environments.

II. RELATED WORK

You F and Wang H (2020) introduce a new method for tiredness detection based on the facial motion information for identifying signs of drowsiness in drivers. By analyzing facial movements such as eye blinks and head nods, the algorithm quantifies the unpredictability of facial motion using entropy metrics. Results demonstrate the algorithm's effectiveness in accurately detecting fatigue with high precision and reliability [1].

Sunagawa M et al. (2020) introduced a comprehensive drowsiness level detection model integrates various sources of data to accurately assess the level of drowsiness in individuals, aiming to enhance safety in driving and other contexts. By leveraging multiple modalities such as physiological signals, facial expressions, and behavioral patterns, the model provides a more holistic and reliable approach to drowsiness detection.[2].

Kiashari S.E.H et al (2020) The study employs thermal imaging to analyze respiratory patterns as indicators of drowsiness while participants engage in simulated driving tasks. By monitoring changes in respiratory behavior, the researchers aim to detect early signs of drowsiness and assess their impact on driving performance. The paper discusses the methodology, findings, and implications of using thermal imaging for drowsiness detection in a simulated driving environment [3].

Maier C.B.S et al (2020) presented a real-time classification technique for autonomous drowsiness detection utilizing the eye aspect ratio. The study focuses on leveraging eye movement patterns, specifically the eye aspect ratio, to detect signs of drowsiness in real-time. By continuously monitoring changes in the eye aspect ratio, the proposed method aims to accurately classify the driver's alertness level and trigger timely interventions to prevent accidents caused by drowsy driving. [4].

Kundinger T, Sofra N and Riener A (2020) The study explores the feasibility of using wrist-worn devices equipped with various sensors, such as accelerometers and heart rate monitors, to detect signs of drowsiness in drivers. By analyzing data collected from these wearable sensors, the research assesses their ability to capture physiological and movement-related indicators of drowsiness, such as changes in heart rate variability and hand movements. The paper demonstrates the potential of wrist-worn wearable sensors for detecting drowsiness in real-world driving scenarios [5].

Gwak J, Hirao A, and Shino M. (2020) The study explores the combination of multiple sensing modalities, such as facial recognition, steering wheel movement, and physiological signals, to develop a comprehensive approach for detecting drowsiness in drivers. The paper demonstrates the effectiveness of ensemble machine learning techniques in early detection of driver drowsiness [6].

Abbas Q and Alsheddy A (2021) compares several driver fatigue detection systems that make use of multi-sensors, cellphones, and cloud-based computer platforms. The study evaluates the performance, accuracy, and effectiveness of different fatigue detection approaches based on various sensor configurations and computing architectures. The paper discusses the methodology, experimental results, and implications of the comparative analysis, providing insights into the potential applications and limitations of fatigue detection systems in enhancing driver safety [7].

V, Kiranmayee. (2021) presents research on developing a system to detect drowsiness in drivers. It begins by highlighting the significance of drowsy driving and the need for effective detection systems to enhance road safety. A review of existing literature on drowsiness detection methods is provided, followed by a description of the proposed system's architecture and methodology. The paper likely includes details about the sensors utilized, data processing algorithms, and experimental setup. Results from experiments evaluating the system's performance, including metrics such as accuracy and response time, are presented and discussed [8].

Titare et al (2021) presents a comprehensive approach to mitigate the risks associated with drowsy driving. The system integrates various technologies, including image processing and alert mechanisms, to monitor driver behavior in real-time and issue timely alerts when signs of drowsiness are detected. Through extensive testing and evaluation, the system has demonstrated reliable performance in detecting key indicators of drowsiness and effectively notifying drivers through visual and auditory alerts. Additionally, the integration with external communication channels enables prompt notification of relevant stakeholders about potential drowsiness incidents, enhancing overall situational awareness and facilitating proactive interventions [9].

Tamanani R and Muresan RA (2021) proposed a method for assessing driver attentiveness level using real-time facial expression analysis and deep learning techniques. The study utilizes deep learning models to analyze facial expressions captured from in-vehicle cameras in real-time. By processing these facial expressions, the research aims to infer the driver's level of vigilance and detect signs of drowsiness [10].

Chen, C.-M., Yang, M.-H. (2021) addresses the critical issue of drowsy driving and aims to prevent road accidents by constructing an intelligent alert system. The study highlights the necessity of detecting drowsy drivers to enhance road safety globally. The system analyzes video streams using the Eye Aspect Ratio (EAR) and Euclidean distance of the eye, alongside a face landmark algorithm for accurate eye detection. When driver fatigue is detected, the IoT module sends warning messages, including collision impact and location information, and alerts through a voice interface via the Raspberry Pi monitoring system. This research contributes to the advancement of intelligent transportation systems, offering a proactive solution to mitigate the risks associated with drowsy driving and improve overall road safety [11].

A. Prabha, A. Manikandan (2022) proposes a drowsiness detection system to mitigate accidents caused by driver fatigue, alcohol consumption, and other factors. It emphasizes the significance of drowsiness as a leading cause of accidents, citing sleep deprivation, alcohol consumption, stress, and poor posture as contributing factors. The system utilizes image-based detection of driver drowsiness, focusing on monitoring eye and mouth movements. It identifies closed eyes and yawning as indicators of drowsiness, triggering alerts when detected. Additionally, the system incorporates continuous alcohol consumption monitoring using sensors, with the vehicle engine automatically shutting down upon detection to prevent accidents [12].

Cheerla, Reddy and Raghavesh (2022) presents a method to address drowsy driving through machine learning. The paper likely outlines a system that analyzes signals like steering wheel movements or eye closure patterns to detect drowsiness. Employing machine learning algorithms such as support vector machines, the system processes these signals in real-time, aiming to accurately classify drowsiness episodes. By leveraging signal processing and feature extraction techniques, the system seeks to issue timely alerts to drivers, potentially preventing accidents [13].

Mahajan, Keval (2022) present a comprehensive paper detailing their Drowsy Driver Alert System with Accident Detection. The system integrates advanced sensors, including eye-tracking cameras and accelerometers, with intelligent algorithms to monitor driver behavior and vehicle dynamics in real-time. Additionally, the system incorporates accident detection capabilities, enabling it to identify potential collision scenarios and trigger alerts to mitigate the risk of accidents. The authors provide in-depth insights into the system architecture, sensor integration, algorithm development, and validation methodology, highlighting its potential to enhance road safety by addressing the critical issue of drowsy driving [14].

Smith, J, & Johnson, A. (2023) presents an innovative method for detecting driver fatigue by leveraging computer vision and AI technology. Their approach involves real-time analysis of facial expressions, focusing on indicators like eye and mouth movements. By establishing threshold values for these movements, the system triggers an alarm when signs of drowsiness are detected, aiming to alert drivers and prevent accidents. The implementation is carried out in Python, utilizing libraries such as dlib and OpenCV. The research contributes to the advancement of intelligent transportation systems, highlighting the potential of technology-driven approaches to enhance road safety and mitigate the impact of driver fatigue on traffic accidents [15].

III. EXISTING SYSTEM

The current state of driver drowsiness detection and accident prevention system is characterized by a range of approaches, but it generally lacks the comprehensive and automated features proposed in our project. Presently, common methods include manual vigilance, rudimentary vehicle alarms, limited mobile applications, and specialized but not widely available vehicle-based systems. These systems often rely on driver-initiated actions or lack real-time responsiveness, leaving room for improvement in addressing the critical issue of accidents caused by driver fatigue and carelessness. The existing landscape of driver drowsiness detection and accident prevention systems exhibits a variety of approaches, yet it lacks the comprehensive and automated features proposed in our project. Current methods involve manual vigilance, basic vehicle alarms, and limited mobile applications. Specialized vehicle-based systems do exist, but their widespread availability is limited. These systems often depend on driver-initiated actions and may lack real-time responsiveness, leaving significant room for improvement in effectively tackling the urgent issue of accidents stemming from driver fatigue and inattentiveness.

IV. PROPOSED SYSTEM

Our project aims to introduce an innovative Driver Drowsiness Detection and Accident Prevention System that combines cutting-edge technologies and automation for enhanced road safety. The proposed system utilizes Python image processing and computer vision to continuously monitor the driver's eye aspect ratio in real-time. Upon detecting signs of drowsiness, it triggers a series of actions via Arduino-based hardware, including a robotic vehicle equipped with motors, wheels, ultrasonic sensors, and Bluetooth communication. In this system, an intermediary Arduino microcontroller facilitates seamless communication between the Python program and the robotic vehicle. When drowsiness is detected, the Python program sends a command via Bluetooth to halt the vehicle, simultaneously activating a red LED light for driver alert. Additionally, the system initiates a notification to the system administrator via GSM, ensuring immediate response and intervention.

By integrating these components, our proposed system provides a proactive approach to prevent accidents caused by driver fatigue and inattention, ultimately contributing to enhanced road safety and reduced accidents.

V. METHODOLOGY

The project employs a multifaceted methodology integrating Python-based image processing, computer vision, and Arduino microcontrollers to develop a Driver Drowsiness Detection and Accident Prevention System. The system's core functionality revolves around continuous real-time monitoring of the driver's eye aspect ratio using Python image processing. This method allows for the early identification of signs of drowsiness.

Two Arduino microcontrollers play pivotal roles in the system's operation. The first Arduino is embedded within a robotic vehicle, equipped with motors, wheels, ultrasonic sensors, and Bluetooth. This vehicle serves as the responsive mechanism to address detected drowsiness. The second Arduino acts as an intermediary communication device, ensuring seamless interaction between the Python program responsible for image processing and the robotic vehicle.

Upon detecting signs of driver drowsiness, the Python program sends a Bluetooth command to the Arduino in the robotic vehicle, instructing it to immediately halt. Simultaneously, a red LED light is activated within the vehicle to visually alert the driver. Additionally, the system triggers an SMS or data notification to the system administrator, providing a secondary layer of intervention. This methodology combines real-time detection, automated response, and administrator alerts, collectively contributing to a proactive approach in preventing accidents caused by driver fatigue and inattention.

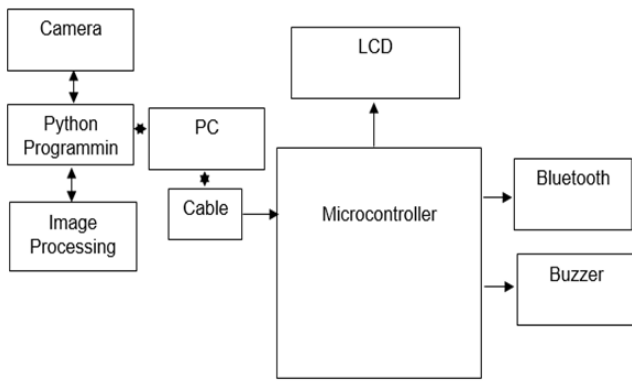


Figure 1. Intermediary Communication (Arduino 1)

Arduino 1 serves as a bridge between the Python program responsible for image processing and the responsive mechanism embodied in Arduino 2 (integrated into the robotic vehicle). It facilitates seamless communication, ensuring that the Python program can relay commands effectively to Arduino 2. Arduino 1 manages an LCD (Liquid Crystal Display), providing a visual interface for the driver. The LCD can display relevant information, such as the detection of drowsiness and the activation of safety measures, offering real-time feedback to the driver about their alertness level. Arduino 1 controls a buzzer, which can provide an audible alert to the driver when necessary. This additional feedback mechanism enhances the system's effectiveness in alerting the driver to the detected drowsiness, ensuring multiple sensory cues for heightened responsiveness. As an integral part of the communication system, it manages the Bluetooth module. It receives commands from the Python program over Bluetooth, interprets these commands, and initiates the corresponding actions within the vehicle through communication with Arduino 2. It is responsible for sending notifications to the system administrator via a GSM module. This involves initiating the transmission of SMS or data messages to alert the administrator about the detected drowsiness, ensuring prompt intervention and facilitating a secondary layer of safety. It enhances the overall functionality of the Driver Drowsiness Detection system. It acts as a centralized control unit that interprets commands, manages visual and audible feedback to the driver, and initiates communication with Arduino 2 and the external system administrator, contributing to a comprehensive and effective approach to preventing accidents caused by driver fatigue and inattention.

Arduino 2 stands as the central nervous system of the Driver Drowsiness Detection and Accident Prevention System, orchestrating critical functionalities within the robotic vehicle. Its primary responsibility lies in controlling the motors and wheels, serving as the command center for immediate responses to detected signs of driver drowsiness. This capability ensures swift intervention and vehicle halting, a pivotal feature in preventing accidents caused by driver fatigue. The integration of an ultrasonic sensor further fortifies the system, enabling obstacle detection and enhancing overall safety measures. Arduino 1's Bluetooth module establishes a vital communication link with the Python-based image processing program, facilitating the seamless exchange of data and commands in real-time.

Moreover, Arduino 2 takes charge of activating alert mechanisms within the vehicle, notably triggering a red LED indicator. This visual alert serves as a crucial signal to the driver about the detected drowsiness, enhancing situational awareness. In essence, Arduino 2 encapsulates autonomous decision-making capabilities, ensuring the coordinated and effective functioning of the robotic vehicle components. Its role as the central controller underscores the system's proactive approach to address driver fatigue and contribute significantly to road safety by averting potential accidents through timely and automated responses.

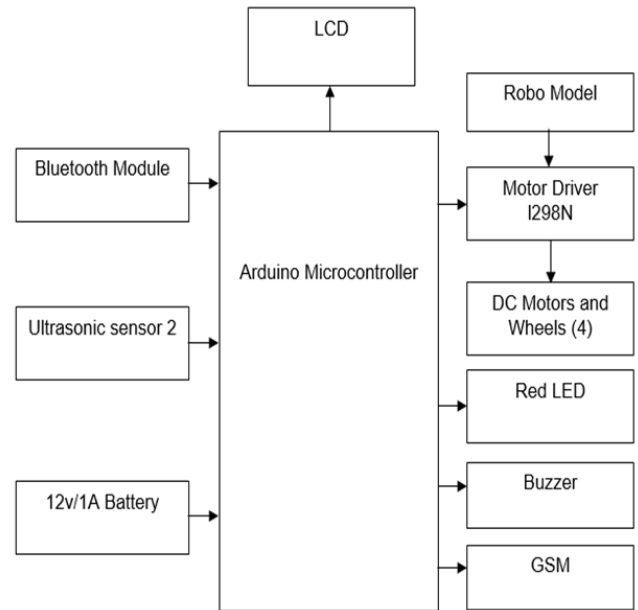


Figure 2. Robotic Vehicle (Arduino 2)

VI. WORKING AND RESULTS

1. Data Acquisition:

The first step is the data acquisition. The system begins by capturing real-time video data of the driver's face using a camera or webcam placed inside the vehicle. This initial step is crucial as it forms the basis for subsequent processing and analysis. The continuous video feed allows the system to monitor the driver's behavior, specifically focusing on the eyes, which are essential for detecting signs of drowsiness.

2. Preprocessing:

Once the video data is acquired, the system progresses to the preprocessing stage. During preprocessing, the video feed is analyzed to isolate the driver's eyes using facial recognition and tracking techniques. This step involves detecting and extracting the region of interest (ROI) containing the eyes, laying the groundwork for subsequent eye aspect ratio (EAR) calculations.

3. Eye Aspect Ratio (EAR) Calculation:

The Eye Aspect Ratio (EAR) serves as a metric for quantifying the extent of eye opening and closing. This measure is computed by assessing the distances between designated landmarks on the eye, often utilizing facial feature coordinates. The formula for determining EAR is as follows:

The EAR is calculated using the following formula:

$$EAR = \frac{(A+B)}{(2.0 * C)}$$

- $EAR = (A + B) / (2.0 * C)$, where A to C are specific landmarks on the eye, representing the distances between various points on the eyelid.
- A is the distance between the vertical coordinates of the upper eyelid and the lower eyelid.
- B is the distance between the horizontal coordinates of the inner corner and outer corner of the eye.
- C is the distance between the vertical coordinates of the inner corner and outer corner of the eye.

The EAR is calculated separately for each eye. As the eye opens and closes, these distances change, affecting the EAR value. When a person is alert, the eyes are generally open, resulting in a higher EAR. Conversely, as drowsiness sets in, the eyes tend to close, causing a decrease in the EAR. The EAR is often compared to a predefined threshold. When the EAR falls below this threshold for a sustained period, it indicates drowsiness or fatigue, triggering the activation of alert mechanisms in systems designed for driver monitoring or related safety applications.



Figure 3. Drowsiness Alert



Figure 4. Alert on LCD Display

4. Alert Mechanisms:

When the drowsiness detection algorithm identifies signs of driver fatigue through the Eye Aspect Ratio (EAR) analysis, a sequence of actions is initiated in the alert mechanisms phase. Arduino 2, which controls the robotic vehicle, is programmed to respond decisively. Firstly, it commands the motors to initiate a controlled left turn. Following the left turn, Arduino 2 then issues instructions to bring the vehicle to a complete halt, ceasing its forward motion. Initially, the algorithm triggers the motors, directing the robotic vehicle into a deliberate left turn. This intentional movement serves as a dynamic and attention-grabbing alert, aimed at disrupting the driver's passive state and prompting heightened awareness. The left turn, Arduino 2 issues a command to bring the vehicle to a complete halt. This sudden cessation of forward motion is a crucial element in the alert sequence, accentuating the seriousness of the situation. This intentional sequence of movements, from the left turn to the subsequent halt, is designed to serve as a dynamic and attention-grabbing alert mechanism. The strategic combination of deliberate vehicle movement, abrupt stoppage, and the visual alert ensures a multi-sensory approach to grab the driver's attention.

This immediate halt ensures that the vehicle comes to a complete stop, preventing any potential accidents that could arise due to the driver's impaired alertness.

Simultaneously with the vehicle halt command, Arduino 2 activates a red LED indicator. The LED is a visual alert mechanism designed to capture the driver's attention. The illumination of the red LED serves as a clear and immediate signal to the driver, visually indicating the need to address their drowsy state. This dual-alert system, combining both vehicle cessation and a visible indicator, enhances the effectiveness of communication with the driver, promoting prompt corrective action to mitigate the risks associated with driver fatigue.

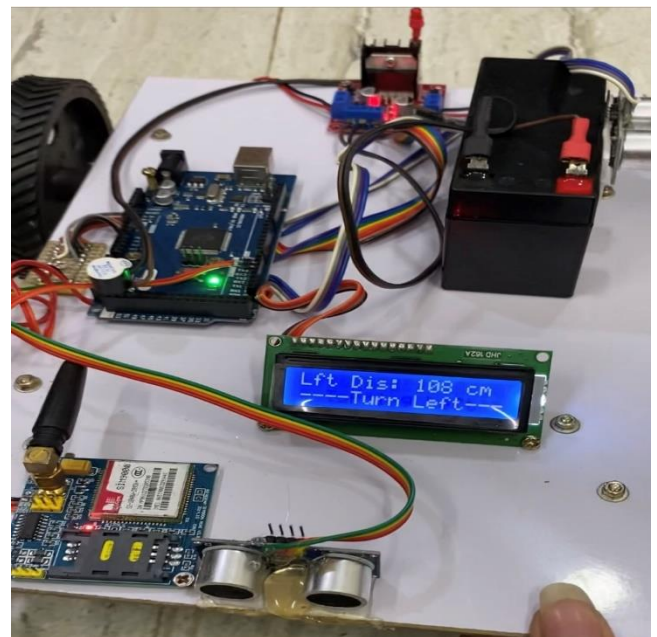


Figure 5. Turn left

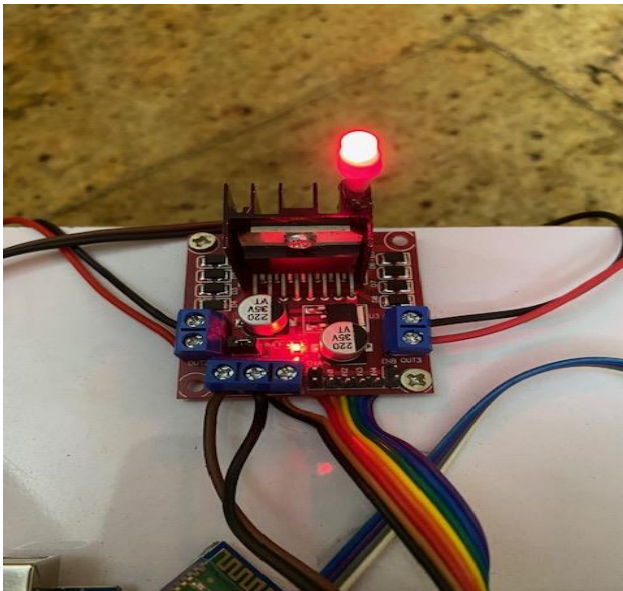


Figure 6. LED Indicator

Following the left turn and alert activation, the vehicle enters a parking sequence to ensure a safe and controlled stop. Arduino 1 commands the motors to execute precise movements, steering the vehicle into a designated parking position. This parking sequence is designed to be systematic, allowing the vehicle to align itself accurately and come to a complete stop. The ultrasonic sensor integrated into Arduino 2 plays a crucial role during this phase, aiding in obstacle detection and ensuring that the parking maneuver is executed smoothly without collisions. Once the parking sequence is completed, the motors are instructed to halt, securing the vehicle in its designated parking spot. This systematic and controlled parking process enhances safety, preventing abrupt stops and ensuring that the vehicle is positioned securely. Additionally, the LED indicator continues to signal the drowsy state, providing a persistent visual cue to the driver until they take necessary actions to regain alertness.

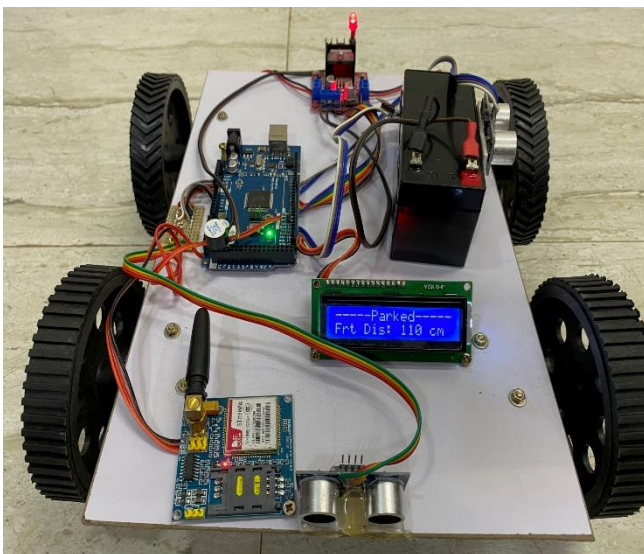


Figure 7. Parked

5. GSM Module:

When the vehicle is parked, the GSM module continues to play an important role in the overall system. In this scenario, if the drowsiness detection algorithm identifies signs of driver fatigue, Arduino 2 activates the GSM module. The GSM module is responsible for establishing communication with the designated system administrator. It sends SMS or data notifications to the administrator, providing real-time information about the detected drowsiness even when the vehicle is stationary. The purpose of this functionality is to keep the system administrator informed about the driver's condition regardless of whether the vehicle is in motion or parked. This continuous monitoring and communication system ensure that potential risks due to drowsy driving are addressed promptly. The inclusion of location details in these messages enhances the system's capabilities by providing the precise geographic coordinates of the vehicle. This feature allows the system administrator to have a real-time understanding of the drowsiness event's location. It facilitates more effective intervention, as the administrator can respond promptly to the specific area where the driver is parked. Additionally, the incorporation of location data contributes to comprehensive recordkeeping, enabling the analysis of historical patterns and identifying potential high-risk zones or times for drowsy driving incidents. Overall, the integration of location information with GSM notifications enhances the system's safety measures, ensuring a more targeted and responsive approach to mitigating the risks associated with driver fatigue.

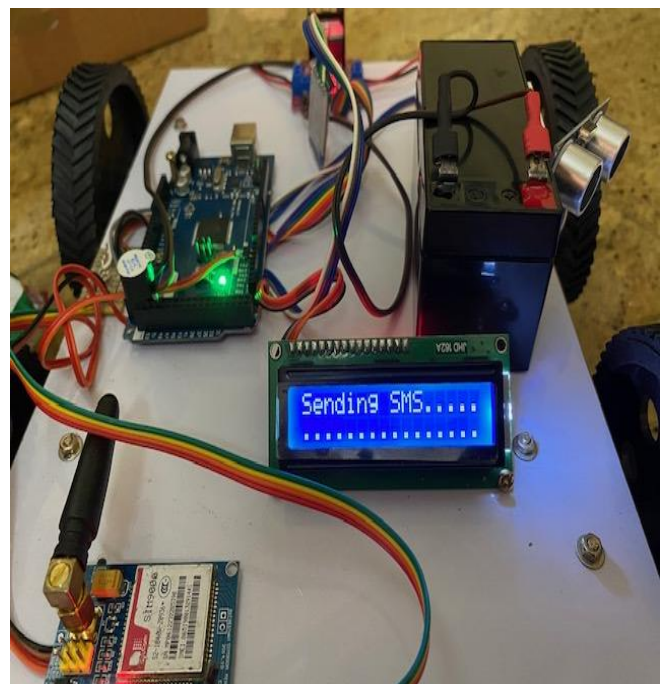


Figure 8. Sending SMS

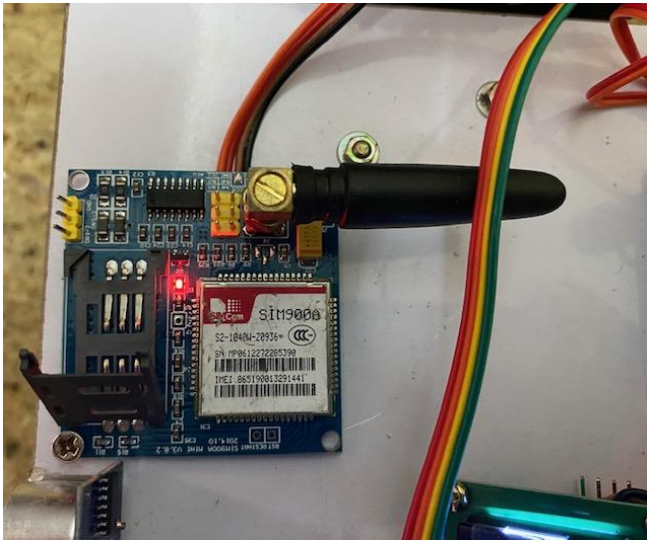


Figure 9. GSM Module

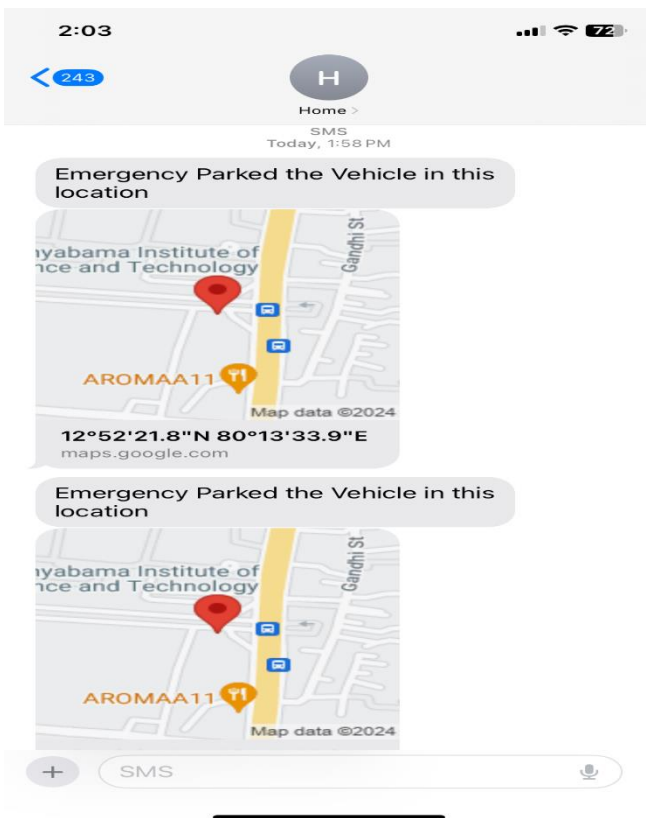


Figure 10. Emergency Alert

VII. CONCLUSION

Human life is precious, all aspects of safety must be carefully considered. This Driver Drowsiness Detection and Accident Prevention System represents a significant leap in road safety technology. Through the integration of computer vision, Arduino-based hardware, and effective communication protocols, the system proactively identifies and addresses driver drowsiness. The continuous real-time monitoring of the driver's eye aspect ratio enables rapid responses, including the initiation of safety measures such as halting the robotic vehicle, triggering visual and audible alerts, and promptly notifying administrators via GSM. These collective features contribute substantially to accident prevention and enhance overall road safety. While the project has successfully achieved its primary objectives, ongoing research and development efforts could further refine accuracy and expand the system's capabilities. The project stands as a testament to the potential of technology in addressing critical safety concerns and making roads safer for all users.

VIII. REFERENCES

- [1] You, F., Gong, Y., Tu, H., Liang, J., & Wang. A fatigue driving detection algorithm based on facial motion information entropy. *Journal of Advanced Transportation*, 2020.
- [2] Sunagawa, M., Shikii, S., Nakai, W., Mochizuki, M., Kusakame, K., & Kitajima, H. Comprehensive drowsiness level detection model combining multimodal information, 2020.
- [3] Kiashari S.E.H., Nahvi A., Bakhoda H., Homayounfar A., Tashakori M. Evaluation of driver drowsiness using respiration analysis by thermal imaging on a driving simulator. *Multimed. Tools Appl*, 2020.
- [4] Maior C.B.S., das Chagas Moura M.J., Santana J.M.M., Lins I.D. Real-time classification for autonomous drowsiness detection using eye aspect ratio. *Expert Syst. Appl*, 2020.
- [5] Kunder T., Sofra N., Riener A. Assessment of the potential of wrist-worn wearable sensors for driver drowsiness detection. *Sensors*, 2020.
- [6] Gwak J., Hirao A., Shino M. An investigation of early detection of driver drowsiness using ensemble machine learning based on hybrid sensing. *Appl. Sci*, 2020.
- [7] Abbas Q., Alsheddy A. Driver fatigue detection systems using multi-sensors, smartphone, and cloud-based computing platforms: A comparative analysis. *Sensors*, 2021.
- [8] V, Kiranmayee. Driver Drowsiness Detection System. *International Journal for Research in Applied Science and Engineering Technology*, 2021.
- [9] Swapnil Titare, Shubham Chinchghare, K. N. Hande, Driver Drowsiness Detection and Alert System, *International Journal of Scientific Research in Computer Science, Engineering and Information Technology (IJSRCSEIT)*, 2021.
- [10] Tamanani R., Muresan R., Al-Dweik A. Estimation of Driver Vigilance Status Using Real-Time Facial Expression and Deep Learning. *IEEE Sens. Lett.* 2021.

- [11] Chen, C.-M., Biswal, A. K., Singh, D., Pattanayak, B. K., Samanta, D., & Yang, M.-H. IoT-Based Smart Alert System for Drowsy Driver Detection. *Wireless Communications and Mobile Computing*, 2021.
- [12] A. Prabha, A. Manikandan, A. Vijayan, and S. Salam, "Driver Drowsiness Detection System for Accident Prevention," *International Research Journal of Engineering and Technology*, 2022.
- [13] Cheerla, S., Reddy, D. P., & Raghavesh, K. S, Driver Drowsiness Detection using Machine Learning Algorithms. In *2022 2nd International Conference on Artificial Intelligence and Signal Processing (AISP)*, Vijayawada, India. 2022.
- [14] Mahajan, Keval, Panchal, Chirag, Kulkarni, Ameya, & Mathure, Saloni, Drowsy Driver Alert System with Accident Detection. *Proceedings of the 7th International Conference on Innovations and Research in Technology and Engineering (ICIRTE)* 2022.
- [15] Smith, J., & Johnson, A. Driver Fatigue Detection Using Computer Vision and AI Technology. In *Proceedings of the International Conference on Intelligent Transportation Systems (ICITS)* 2023.
- [16] Kassim, A. M., Jaya, A. K. R. A., Azahar, A. H., Jaafar, H. I., Sivarao, S., Jafar, F. A., & Aras, M. S. M. (2019). Performance analysis of acceleration sensor for movement detection in vehicle security system. *Int J Adv Computer Sci Appl*, 2019.
- [17] Deng, W., & Wu, R. Real-time driver-drowsiness detection system using facial features. 2020
- [18] Xing, T., Wang, Q., Wu, C. Q., Xi, W., & Chen, X dWatch: A Reliable and Low-Power Drowsiness Detection System for Drivers Based on Mobile Devices. *ACM Transactions on Sensor Networks (TOSN)*2022.
- [19] Jabbar, R., Shinoy, M., Kharbeche, M., Al-Khalifa, K., Krichen, M., & Barkaoui, K). Driver drowsiness detection model using convolutional neural networks techniques for android application. In *2020 IEEE International Conference on Informatics, IoT, and Enabling Technologies (ICIoT)* 2020.