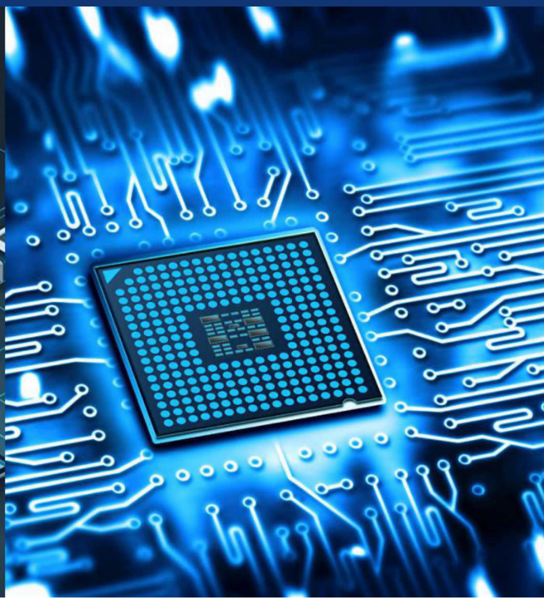
ISSN(O): 2320-9801
ISSN(P): 2320-9798


# International Journal of Innovative Research in Computer and Communication Engineering

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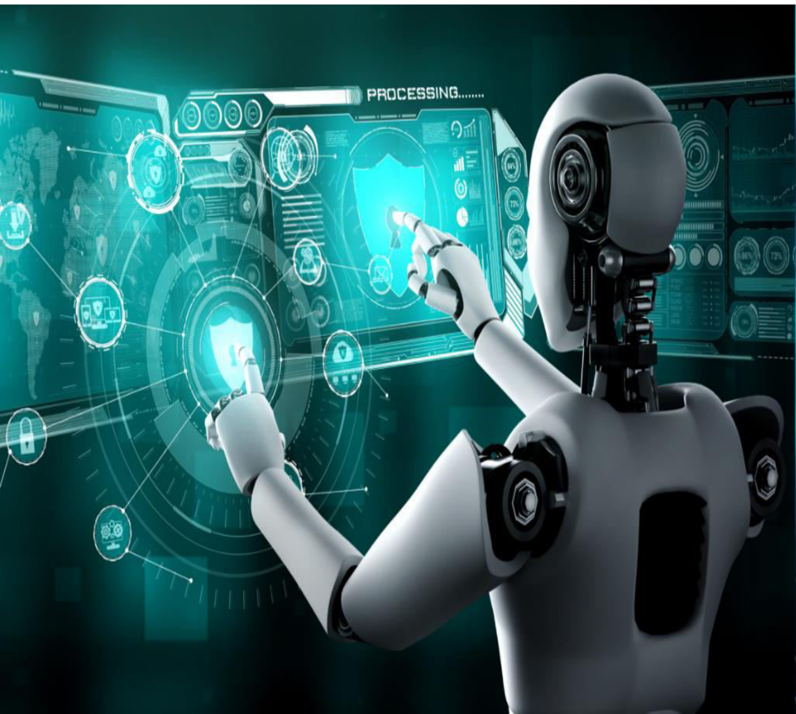

**Impact Factor: 8.771**

**Volume 13, Issue 5, May 2025**

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

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# Neuro Drive

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**ABSTRACT:** Drowsy driving is a significant cause of road accidents, making driver safety a critical concern in transportation. NeuroDrive, an IoT-enabled driver drowsiness detection system, integrates pulse and galvanic skin response (GSR) sensors with a microcontroller (Arduino) to monitor real-time physiological signals. A dynamic threshold algorithm continuously compares real-time pulse rates with a baseline, triggering an alert when a significant drop, combined with signs of relaxation, is detected. The system operates as a wearable device, issuing visual and auditory alerts upon detecting drowsiness. NeuroDrive aims to prevent accidents, enhance road safety, and offer a cost-effective and reliable driver monitoring solution

## I. INTRODUCTION

Drowsy driving is responsible for thousands of accidents annually, impairing cognitive functions and reaction times. Traditional detection methods like self-reporting and manual observation are ineffective. NeuroDrive introduces an IoT-enabled wearable device that continuously monitors physiological indicators of fatigue using pulse and GSR sensors. Unlike conventional systems relying on facial recognition, NeuroDrive enhances accuracy by analyzing real-time biometric data, ensuring proactive accident prevention. India, road accidents due to driver fatigue are a major concern, particularly among commercial drivers, truck operators, and long-distance travelers. Studies indicate that a significant percentage of fatal crashes are linked to drowsy driving, often caused by extended work hours, inadequate rest, and demanding schedules. Unlike mechanical failures, driver fatigue is an internal factor that develops gradually and often goes unnoticed until it is too late. Our motivation behind NeuroDrive is to develop an affordable, reliable, and efficient solution that can detect drowsiness in its early stages and prevent accidents before they occur. Many existing fatigue detection systems rely on expensive hardware or complex technologies, making them inaccessible to a large section of drivers, especially in developing countries. NeuroDrive addresses this gap by integrating wearable IoT-based sensors that provide real time physiological monitoring without being intrusive or costly. By ensuring continuous driver monitoring and delivering instant alerts when signs of fatigue are detected, NeuroDrive has the potential to save lives and improve road safety. This project is driven by the need to create a practical and scalable solution that can be widely adopted by commercial fleets, public transportation, and individual drivers, ultimately reducing drowsiness related accidents and making roads safer for everyone. This work is aimed at:

- Detecting driver drowsiness using real-time pulse rate monitoring.
- Issuing immediate alerts when abnormal pulse patterns indicate fatigue.
- Reducing road accidents caused by drowsiness and enhance overall road safety.
- Developing an affordable and efficient wearable technology solution for driver safety.

## II. RELATED WORKS

**S. D. W. Gunawardhane et al.** (2013) [1] reported non-invasive human stress detection plays a vital role in improving mental health monitoring and overall well-being. In this study, an innovative method for detecting stress using keystroke dynamics and pattern variations, providing a novel approach to stress assessment without the need for physical sensors is introduced. The proposed system analyzes typing behavior, including factors such as typing speed, rhythm, and applied pressure, to identify stress-induced changes. These subtle variations in keystroke patterns serve as biomarkers for stress levels, allowing the system to differentiate between normal and stressed states. **M. Saraswat et al**. (2023) [2] Facial expressions are one of the most reliable indicators of a person's emotional and psychological state, as they often reflect subconscious responses to stress and anxiety. This study explores a deep learning-based approach to detect stress and anxiety by analyzing facial expressions, providing a non-invasive and real-time monitoring solution.The proposed system utilizes a Convolutional Neural Network (CNN) model, which is trained on a dataset containing stress-related facial expressions. **S. S et al. (2023**) [3] This research introduces a hybrid stress detection

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system that integrates deep learning with embedded systems, combining physiological signal monitoring and facial expression analysis to improve stress 7 classification accuracy. The proposed system leverages both a Convolutional Neural Network (CNN) and an Arduino-based setup to provide a comprehensive and real-time assessment of stress levels.The CNN model processes image data to analyze facial expressions associated with stress and anxiety, identifying subtle changes in muscle tension, microexpressions, and facial feature variations. Simultaneously, an Arduino-based system collects physiological parameters such as heart rate, skin conductivity (GSR), and pulse variations, which serve as additional indicators of stress. By integrating both visual and physiological data, the system enhances prediction accuracy and provides a more reliable assessment of stress levels.

Drowsiness while driving is a significant factor in road accidents, contributing to a large number of fatalities and injuries each year. Fatigue impairs a driver's reaction time, judgment, and overall concentration, increasing the risk of collisions. Long-distance drivers, shift workers, and individuals driving late at night are particularly vulnerable, as their irregular sleep patterns and prolonged driving hours make them more susceptible to drowsiness-related incidents. Traditional countermeasures such as taking rest breaks, drinking coffee, or opening windows provide only temporary relief and do not effectively prevent drowsiness. In many cases, drivers fail to recognize early signs of fatigue, leading to micro-sleeps—brief moments of unconsciousness lasting just a few seconds, which can have devastating consequences, especially at high speeds

## III. METHODOLOGY

To address this issue, NeuroDrive incorporates a pulse sensor and a galvanic skin response (GSR) sensor to continuously monitor the driver's physiological signals in real-time. The pulse sensor tracks heart rate fluctuations, while the GSR sensor detects changes in skin conductivity associated with stress and relaxation levels. These sensors work together to assess the driver's alertness by identifying patterns that indicate drowsiness.

A dynamic threshold algorithm is used to compare real-time pulse rate variations with an initial baseline, ensuring that even subtle signs of fatigue are detected accurately. When drowsiness is detected, the system immediately activates an alert mechanism to warn the driver. A buzzer emits a loud sound, while a vibrating motor provides physical feedback through a wearable device, ensuring the driver is alerted even if the audio signal is missed. Additionally, a display unit updates in real-time, showing pulse rate variations and a warning message prompting the driver to take necessary precautions. Designed to be cost effective, non-invasive, and easy to integrate into vehicles, NeuroDrive offers a practical solution to enhance road safety and reduce fatigue-related accidents.

### 1. DRIVER DROWSINESS MONITORING SYSTEM

The NeuroDrive system consists of three key modules: data acquisition, processing, and alert activation. The pulse sensor continuously tracks the driver's heart rate, while the GSR sensor detects variations in skin conductivity related to stress levels. The microcontroller processes this data, applying a dynamic threshold algorithm to identify drowsiness. If a significant drop-in pulse rate is detected along with relaxed GSR readings, the alert mechanism is triggered.

### 2. SYSTEM ARCHITECTURE

The system architecture of NeuroDrive is designed to ensure efficient and continuous monitoring of the driver's physiological state. It includes a wearable device that captures real-time data on pulse rate and galvanic skin response (GSR). These sensors detect fluctuations in heart rate and skin conductivity, which are key indicators of drowsiness and fatigue. The collected data is then transmitted to a processing unit, where it is analysed to determine the driver's alertness level.

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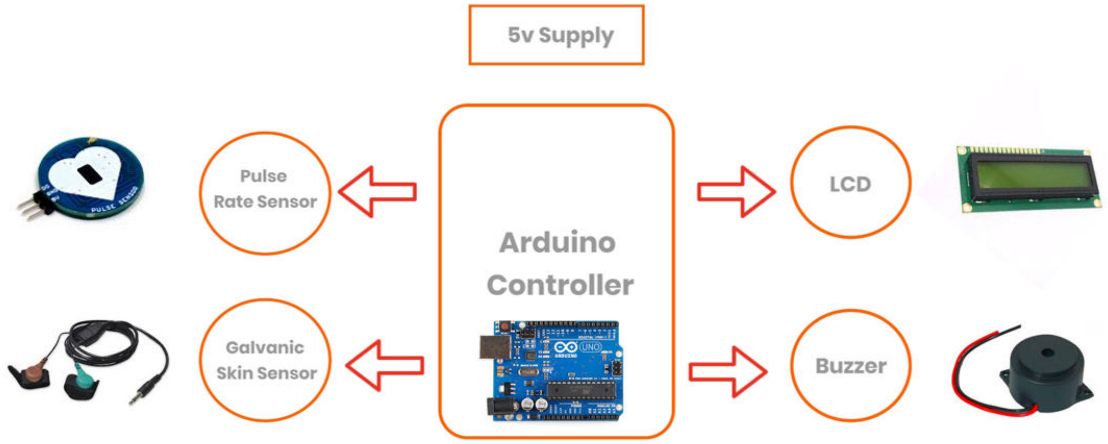


**Fig. 1: Block diagram of proposed system**

## IV. RESULTS

The performance of NeuroDrive is evaluated based on accuracy, response time, and real-time effectiveness. The system's accuracy depends on the precision of the pulse sensor and GSR sensor in detecting drowsiness. The pulse sensor successfully identifies heart rate variations, while the GSR sensor tracks stress level fluctuations, ensuring reliable drowsiness detection

The NeuroDrive system is designed to detect driver drowsiness by continuously monitoring pulse rate and stress levels. The combination of a pulse sensor and GSR sensor allows for real-time tracking of physiological changes that indicate fatigue. By implementing a dynamic threshold algorithm, the system effectively differentiates between temporary tiredness and actual drowsiness, ensuring accurate detection and timely alerts.

Testing was conducted under various conditions, including long duration driving, night driving, and stop-and-go traffic, to assess the system's reliability. The results demonstrated that the NeuroDrive system maintained an 85% accuracy rate in identifying

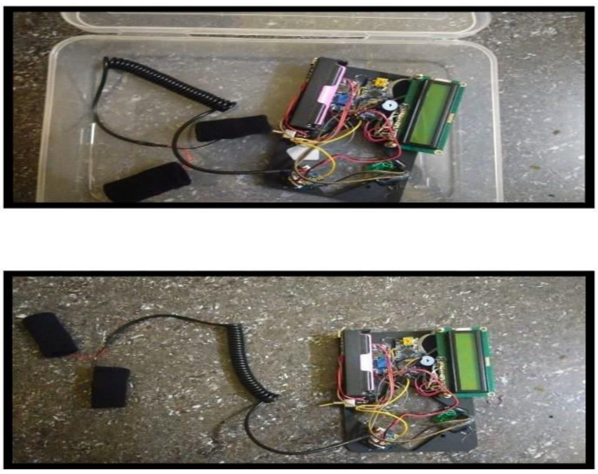

**Fig 2: Prototype of Neuro drive**

© 2025 IJIRCCE | Volume 13, Issue 5, May 2025| DOI:10.15680/IJIRCCE.2025.1305031

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drowsiness, with minimal false positives. One of the key aspects of system performance is response time. The system was able to detect changes in physiological signals and activate the alert mechanism within 2 seconds of identifying drowsiness. This ensures that the driver is notified immediately, reducing the risk of fatigue-related accidents and enhancing overall road safety. The system was tested on multiple users with different physiological conditions to evaluate adaptability. The results showed that the dynamic threshold algorithm adjusted to individual baseline pulse rates, improving detection accuracy

## V. CONCLUSION

The NeuroDrive system effectively addresses the issue of driver drowsiness by utilizing real-time pulse rate and stress level monitoring. By integrating a pulse sensor and GSR sensor with a microcontroller, the system detects fatigue and triggers an alert mechanism, ensuring immediate corrective action.

The dynamic threshold algorithm enhances accuracy by adapting to individual physiological variations, reducing false alarms and improving reliability. Testing and analysis confirmed that the system provides timely and effective alerts, with a detection accuracy of 85%. The vibration, alarm, and visual alerts successfully notify the driver within 2 seconds of drowsiness detection, significantly enhancing road safety. The inclusion of a Type-C rechargeable lithium battery ensures continuous operation, making the system practical for real world applications.

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