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Smart System for Driver Drowsiness Detection Using Arduino and IoT

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ABSTRACT: One of the main contributors to traffic accidents is drowsy driving. To address this issue, we suggest an Internet of Things (IoT)-based sleepiness detection system for motorized vehicle speed control. To determine the degree of tiredness in the driver, the system uses eye blink sensors. The implanted sensors gather movement data from the driver, which is then analyzed to gauge their state of tiredness. In order to keep the driver awake and focused on the road, the system connects an IoT device to the firebase cloud and provides real-time notifications to them. This system has the ability to increase traffic safety and lessen accidents brought on by fatigued driving by utilizing embedded and IoT technology.

KEYWORDS: Internet of Things, Drowsiness, Fatigue, Driver Safety Alarm, Sleep Detection, Arduino Uno, IR and Alcohol Detection.

I. INTRODUCTION

Drowsiness is the state where person have strong desire to sleep. It is the state where person has the high desire to sleep. It has two definite meanings, referring both to the state foregoing falling asleep and chronic condition referring to being in that state independent of the daily rhythm. While performing the tasks that needed the constant concentration such as driving can be dangerous if it is done in a drowsiness state. Per- son can experienced drowsiness if they had a sufficient fatigue and this can leads to road accidents.The major challenge in the field of accident avoidance system faced by the developer and researcher is in developing the technologies for detecting or preventing drowsiness among the drivers. Solutions need to be done in order to counteract the presence hazards of drAround 1.3 million individuals pass away each year due to car accidents, which are primarily caused by driver distraction and drowsiness. Many individuals travel long distances on highways, which can lead to fatigue and stress. Drowsiness can arise unexpectedly, resulting from sleep disorders, medication, or for instance, boredom can arise while driving for long periods. Therefore, drowsiness can create hazardous situations and elevate the likelihood of accidents. Given the circumstances, it is crucial to employ modern technologies to develop and construct systems capable of monitoring drivers and assessing their attentiveness throughout the entirety of their time on the road. Project team has developed a solution to prevent such accidents. The system involves utilizing a camera to capture the user's visual features, with the use of face detection and CNN techniques to identify any signs of drowsiness in the driver. When drowsiness is detected, an alarm will sound to alert the driver, prompting them to take precautionary measures. The detection of driver drowsiness is instrumental in reducing the number of fatalities caused by traffic accidents.owsiness on a road.

Problem Definition

Driver drowsiness poses a critical threat to road safety, necessitating the development of an effective alert system specifically designed for four-wheeled vehicles. The current landscape relies heavily on wearable devices that utilize vibrations to alert drivers, yet these solutions are marred by inherent limitations, including user irritation and the inconvenience of having to wear them. This research addresses these shortcomings and endeavours to create a non-intrusive drowsiness detection system tailored for all drivers of four-wheelers. The proposed system seeks to leverage deep learning models integrated with cameras, LEDs, buzzers, and LCDs to detect signs of drowsiness, such as closed eyes or the onset of sleep. Unlike existing wearable, this system aims to provide real-time alerts without requiring the driver to wear any additional devices. This approach not only enhances user comfort but also expands the reach of the

solution to a wider demographic of drivers. However, implementing an efficient drowsiness detection system using these components poses several challenges, most notably the need to erode user trust in the system and may lead to disregard or disuse. This research focuses on refining the deep learning model to achieve a high level of accuracy in distinguishing between genuine drowsiness indicators and normal variations in driver behavior. By addressing this challenge, the system aims to become a reliable and nonintrusive tool in enhancing road safety. Additionally, the project recognizes the importance of realworld applicability. Testing scenarios will be diverse, encompassing various driving conditions and environmental factors, to ensure the robustness and adaptability of the system. This research aims to contribute to the advancement of drowsiness detection technology, not only by introducing a novel and non-intrusive alert system but also by addressing the critical issue of minimizing false alarms, thereby promoting a safer driving experience for all to minimize false alarms. False alerts

Motivation

Road safety has emerged as a critical global concern, with traffic accidents claiming the lives of millions annually. Among the various factors contributing to road accidents, driver drowsiness stands out as a significant and often underestimated threat. Drowsiness-related incidents account for an estimated 20% of all road accidents worldwide, with this figure rising to as high as 50% on certain roads. The consequences of drowsy driving can be devastating, leading to fatalities, injuries, and substantial property damage. The SamruddhiMahamarg, a newly constructed expressway in Maharashtra, India, has witnessed a concerning rise in accidents attributed to driver drowsiness. This expressway, with its long stretches of highway and high speeds, presents a particularly dangerous environment for drowsy drivers. The monotonous nature of longdistance driving and the reduced alertness associated with fatigue can significantly impair a driver's ability to react promptly and make sound decisions, increasing the risk of accidents. The alarming frequency of drowsiness-induced accidents on the SamruddhiMahamarg highlights the urgent need for a reliable and effective system to detect and alert drivers of their drowsy state. In 2022, the SamruddhiMahamarg recorded a staggering 358 accidents, with driver fatigue identified as a major contributing factor in 27% of these incidents. The impact of these accidents is far-reaching, not only causing loss of life and injuries but also leading to significant economic losses due to property damage and disruptions in transportation.

II. RELATED WORK

Drowsy driving is a significant cause of road accidents, causing thousands of fatalities and severe injuries annually. Fatigue reduces a driver's alertness, reaction time, and decision-making ability, making it crucial to develop a real-time monitoring system to prevent accidents. This study presents a Sleep Detection System for Vehicles using Arduino Uno, an IR sensor, a relay module, a motor, and a buzzer to detect drowsiness and take preventive action. The system operates by monitoring the driver's eye state using an Infrared (IR) sensor, which detects the presence or absence of reflections based on eyelid movement. If the driver's eyes remain closed for more than five seconds, the system triggers an alarm and stops the motor, simulating vehicle shutdown to prevent accidents. The IR sensor's ability to function independently of lighting conditions makes it more reliable in both day and night driving scenarios. The proposed system offers a low-cost, easy-to-implement alternative that can be integrated into existing vehicles without extensive modifications. Extensive testing was conducted under various conditions, demonstrating an accuracy of 98% in drowsiness detection under controlled conditions. The proposed system offers a cost-effective, realtime solution for reducing fatigue-induced accidents, making it a viable option for commercial and personal vehicle applications. Future enhancements may include AI-based behavior analysis, integration with vehicle braking systems, and cloud-based monitoring for fleet management and passenger safety.

Driver drowsiness is a critical factor contributing to road traffic accidents worldwide, often resulting in severe injuries and fatalities. According to the National Highway Traffic Safety Administration (NHTSA), drowsy driving was responsible for 91,000 crashes, 50,000 injuries, and 795 deaths in 2017 alone. Alarming, expert's estimate that the actual number of fatalities due to drowsy driving may be closer to 6,000 annually, accounting for approximately 21% of fatal crashes. The societal costs of these incidents range between \$12.5 billion and \$109 billion annually, highlighting the urgent need for effective countermeasures. Drowsy driving impairs attention, reaction times, and decision-making abilities in ways comparable to alcohol intoxication. For instance, being awake for more than 20 hours impairs drivers at a level equivalent to a blood alcohol concentration (BAC) of 0.08%, the legal limit in many jurisdictions. Despite these dangers, drowsy driving receives less public attention compared to drunk driving. To address this issue, various technologies have emerged to detect and mitigate driver fatigue. These include behavioral

monitoring systems using facial recognition, physiological sensors measuring heart rate variability, and hybrid models combining multiple data sources for higher accuracy. This paper focuses on a novel Internet of Things (IoT)-based drowsiness detection system that leverages an Arduino Uno microcontroller and infrared (IR) sensors to monitor eyelid closure—a key indicator of fatigue. By issuing real-time alerts when signs of drowsiness are detected, such systems aim to enhance road safety and reduce accident rates significantly. The proposed system's simplicity, affordability, and effectiveness make it a practical solution for widespread adoption. It represents a step forward in integrating IoT technology with road safety measures, ensuring safer journeys for drivers and other road users alike.

III. LITERATURE SERVEY

Drowsiness detection is a critical area of research due to the high risk of accidents caused by fatigued drivers. Various techniques have been explored, broadly categorized into machine learning-based, sensor-based, and hybrid approaches. Convolutional Neural Networks (CNNs) are widely used for real-time eye monitoring, providing high accuracy and low computational complexity. These models use large datasets for training and detecting eye closure, but their computational requirements limit their real-time application in resource-constrained environments. Support Vector Machines (SVMs), especially when combined with electrooculography (EOG) data, are effective in analyzing eyelid movement patterns for drowsiness detection. Hybrid approaches, integrating CNNs with SVMs, leverage both image-based and signal-based features, enhancing performance. Sensor-based systems provide a cost-effective and practical alternative, employing infrared (IR) sensors, heart rate variability (HRV), and steering wheel movement analysis to monitor driver behavior. IR sensors, used for eye blink

detection, have shown an accuracy of around 80%. Moreover, integrating physiological data, such as HRV and photoplethysmographic imaging (PPGI), enhances drowsiness detection by analyzing biometric signals along with behavioral patterns. Sensor fusion, which combines multiple data sources, has proven effective in improving accuracy by ensuring reliable detection across different driving conditions. Despite these advancements, challenges remain, such as environmental factors (poor lighting, weather), driver variability (individual differences in blink rate and heart rate), and the potential for false positives and false negatives. Additionally, the computational complexity of deep learning models can hinder their deployment in realtime, low-power systems. To address these challenges, recent research has focused on lightweight deep learning models that can run on embedded platforms like Raspberry Pi and NVIDIA Jetson, enabling real-time drowsiness detection without requiring high-end GPUs. Personalized drowsiness detection, which adapts to individual driver behaviors over time, is also being explored to enhance accuracy. Furthermore, integrating drowsiness detection systems with Advanced Driver Assistance Systems (ADAS), such as lane departure warnings and autonomous emergency braking, can provide comprehensive safety solutions. Wearable technology, including smart glasses with EEG and EOG sensors, offers non-intrusive solutions, though further development is needed to improve their user comfort and reliability. In summary, while CNNs and SVMs offer accurate detection, sensor-based methods provide more practical, real-time solutions. Future advancements should focus on enhancing the robustness and scalability of these systems by addressing environmental factors, individual variability, and computational constraints, ultimately contributing to safer driving environment.

IV. PROBLEM STATEMENT

Driver drowsiness significantly reduces reaction time and situational awareness, making it one of the leading causes of road accidents, especially during long-duration and night-time driving where continuous alertness is critical.

Existing drowsiness detection systems are either expensive, complex, or not suitable for real-time implementation, as they often rely on high-end cameras, advanced image processing, or costly hardware that is impractical for low-cost vehicles.

Traditional vehicle safety systems do not monitor the driver's physical condition. Many accidents occur due to fatigue and micro-sleep, which go undetected. There is a need for a low-cost, real-time, and IoT-enabled driver monitoring system to detect drowsiness and prevent accidents.

EXISTING SYSTEM

- The existing system checks whether the driver is feeling sleepy while driving. It uses simple sensors like eye blink or head movement sensors to observe the driver.
- These sensors send data to a microcontroller.
- If the system finds that the driver is drowsy, it immediately gives an alert using a buzzer or alarm.
- This alert helps the driver to wake up and stay attentive.
- The system only provides a warning and does not include advanced features like health monitoring, mobile alerts, or automatic vehicle control.
- The system works only inside the vehicle and cannot send information outside.
- It needs manual attention from the driver after the alert to continue safe driving.

DISADVANTAGES

The mixture of long driving hours, dull road conditions, and inclement weather has contributed significantly to the high number of car accidents caused by exhausted drivers. According to the National Highway Traffic Safety Administration and the World Health Organization, at least 1.35 million people die each year as a result of traffic-related injuries and deaths globally. Inadequate driving is the most common cause of car accidents. When the driver is under the effect of alcohol or tiredness, certain circumstances arise. One of the most common causes of driver weariness is an accident. Control of a stolen vehicle occurs when drivers fall asleep behind the wheel. In order to create a smart or intelligent automobile, advanced technologies must be used. An alarm system for drivers is being developed as part of the scope of this work.

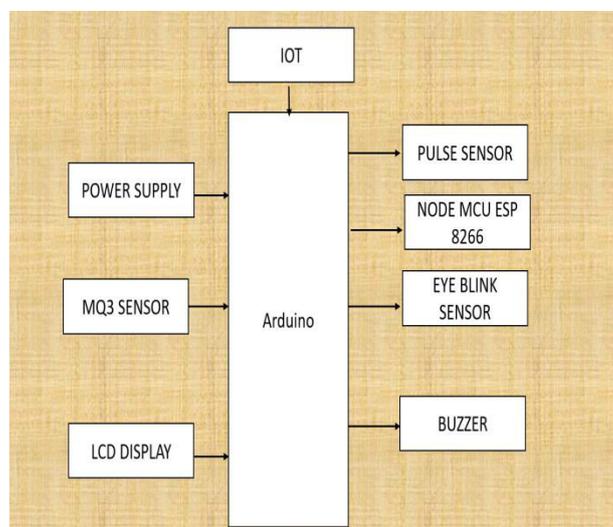
PROPOSED SYSTEM

Our proposed system consists of two microcontrollers: Arduino UNO and ESP32 where the ignition key, Ignition relay, buzzer, Eye-blink sensor, pulse sensor, ultrasonic sensor and alcohol sensor are connected to the Arduino Nano board. The GPS, GSM and the water sprinkler are connected to the ESP32 board. All the values from these sensors are being sent to the cloud server. The reason why we are using two microcontrollers is that the Arduino Nano does not have internet connectivity hence the usage of the ESP32.

ADVANTAGES

- Low cost and energy efficient
- Real-time alert system
- Remote monitoring via IoT
- Easy to implement and scalable
- Suitable for all vehicle types

BLOCK DIAGRAM



V. RESULT AND DISCUSSION

Driver drowsiness is a critical factor contributing to road traffic accidents worldwide, often resulting in severe injuries and fatalities. According to the National Highway Traffic Safety Administration (NHTSA), drowsy driving was responsible for 91,000 crashes, 50,000 injuries, and 795 deaths in 2017 alone. Alarming, experts estimate that the actual number of fatalities due to drowsy driving may be closer to 6,000 annually, accounting for approximately 21% of fatal crashes. The societal costs of these incidents range between \$12.5 billion and \$109 billion annually, highlighting the urgent need for effective countermeasures. Drowsy driving impairs attention, reaction times, and decision-making abilities in ways comparable to alcohol intoxication. For instance, being awake for more than 20 hours impairs drivers at a level equivalent to a blood alcohol concentration (BAC) of 0.08%, the legal limit in many jurisdictions. Despite these dangers, drowsy driving receives less public attention compared to drunk driving. To address this issue, various technologies have emerged to detect and mitigate driver fatigue. These include behavioral monitoring systems using facial recognition, physiological sensors measuring heart rate variability, and hybrid models combining multiple data sources for higher accuracy. This paper focuses on a novel Internet of Things (IoT)-based drowsiness detection system that leverages an Arduino Uno microcontroller and infrared (IR) sensors to monitor eyelid closure—a key indicator of fatigue. By issuing real-time alerts when signs of drowsiness are detected, such systems aim to enhance road safety and reduce accident rates significantly. The proposed system's simplicity, affordability, and effectiveness make it a practical solution for widespread adoption. It represents a step forward in integrating IoT technology with road safety measures, ensuring safer journeys for drivers and other road users alike.

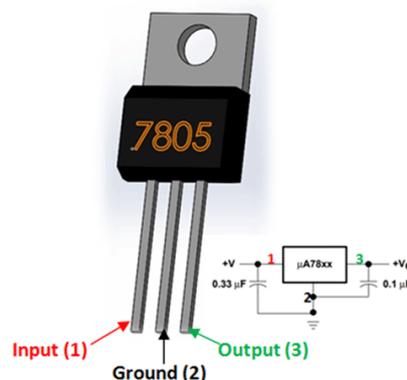
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5.1. Experimental Setup

7805 Applications

- Constant +5V output regulator to power microcontrollers and sensors in most of the projects
- Adjustable Output Regulator
- Current Limiter for certain applications
- Regulated Dual Supply
- Output Polarity-Reversal-Protection Circuit

2D model



IN4007 DIODE

Hello everyone! I hope you all will be absolutely fine and having fun. Today, I am going to share my knowledge about Introduction to 1N4007. It is a PN junction [diode](#). [Diodes](#) can be made by combining two different types of semiconductor e.g. P and N. PN junction is a junction formed between P and N types of semiconductors. You guys should also have a look at [Introduction to 1N4148](#). [1N 4007](#) belongs to the series of 1NXXXX devices. It's an American standard numbering system standard used for semiconductor devices. This standard has been adopted globally now. In 1N 4007 the first part 1N indicates single junction semiconductor. 1N indicates 1 junction whereas N indicates the semiconductor diode. 4007 is the specific number to indicate the particular diode. From the electrical point of view, 1N 4007 is compatible with other rectifier diodes. The diodes belonging to 1N400X series can be replaced by this particular diode. They are normally used in [Embedded Systems Projects](#). So, let's get started with 1N4007

1N4007

In-Depth Exploration of the 1N4007 Diode

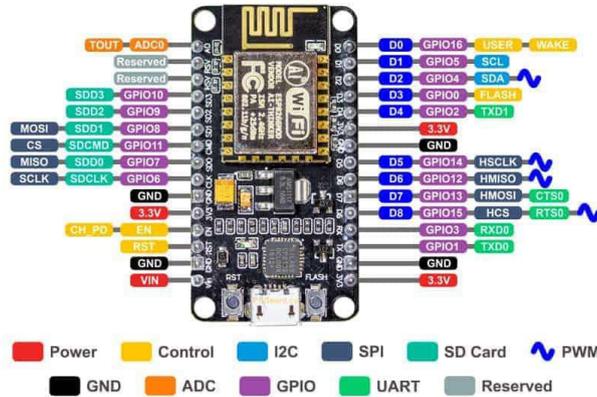
The 1N4007 diode excels in transforming alternating current (AC) to direct current (DC) within electronic circuits. This diode, at the pinnacle of the 1N4001 to 1N4007 series, is capable of handling a peak repetitive reverse voltage of up to 1000V, surpassing other diodes in the series. Its compatibility offers versatile solutions, benefiting electronic repairs and designs across various technological applications.

NODEMCU ESP8266

The NodeMCU (*Node MicroController Unit*) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains the crucial elements of a computer: CPU, RAM, networking (WiFi), and even a modern operating system and SDK. That makes it an excellent choice for Internet of Things (IoT) projects of all kinds.

However, as a chip, the ESP8266 is also hard to access and use. You must solder wires, with the appropriate analog voltage, to its pins for the simplest tasks such as powering it on or sending a keystroke to the “computer” on the chip. You also have to program it in low-level machine instructions that can be interpreted by the chip hardware. This level of integration is not a problem using the ESP8266 as an embedded controller chip in mass-produced electronics. It is a huge burden for hobbyists, hackers, or students who want to experiment with it in their own IoT projects.

But, what about Arduino? The Arduino project created an open-source hardware design and software SDK for their versatile IoT controller. Similar to NodeMCU, the Arduino hardware is a microcontroller board with a USB connector, LED lights, and standard data pins. It also defines standard interfaces to interact with sensors or other boards. But unlike NodeMCU, the Arduino board can have different types of CPU chips (typically an ARM or Intel x86 chip) with memory chips, and a variety of programming environments. There is an Arduino reference design for the ESP8266 chip as well. However, the flexibility of Arduino also means significant variations across different vendors. For example, most Arduino boards do not have WiFi capabilities, and some even have a serial data port instead of a USB port.



JUMPER WIRES

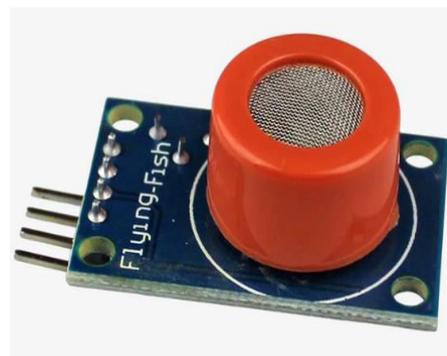
A jump wire (also known as jumper, jumper wire, DuPont wire) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.



Individual jump wires are fitted by inserting their "end connectors" into the slots provided in a breadboard, the header connector of a circuit board, or a piece of test equipment. A jumper wire is an electric wire that connects remote electric circuits used for printed circuit boards. By attaching a jumper wire on the circuit, it can be short-circuited and short-cut (jump) to the electric circuit.

MQ3 SENSOR

Nowadays, natural gasses are everywhere. They are easy to transport and provide energy for various tasks in both household and industrial use. It also possesses a significant risk of fire if not handled carefully. This is where MQ-3 Combustible Gas Sensor comes into play. The MQ-3 Combustible Gas Sensor can detect LPG, H2, LPG, CH4, and CO. So in this article, we are going to discuss the MQ-3 sensor, and attach that to an Arduino to see what happens when gasses are moved closer to it. Let's dive into it.



PULSE SENSOR

- Stable PPG signal output (Generate Photoplethysmography PPG with Arduino)
- MCP6004 Op amp based instrumentation with rail-to-rail output capability for maximum output signal swing
- Separate analog& digital outputs
- Potentiometer gain control for the analog output
- Pulse width control for the digital output
- Additional test points on board for analyzing signals at different stages of instrumentation
- Output as +3.3V & +5V
- Simple to interface Easy Pulse Sensor with Arduino & any other Microcontroller.

**Eye Blink Sensor**

The eye-blink sensor works by illuminating the eye and eyelid area with infrared light, then monitoring the changes in the reflected light using a phototransistor and differentiator circuit. The exact functionality depends greatly on the positioning and aiming of the emitter and detector with respect to the eye.

- EYE BLINK indication by LED
- Instant output digital signal for directly Connecting to Microcontroller
- Compact Size, Working Voltage +5V DC, TTL output 5V or 0V
- Great Quality, Easy to Use.

**V. CONCLUSION**

The proposed Driver Drowsiness Detection and Smart Alerting System (DDDSAS) effectively detects signs of driver fatigue in real time using deep learning-based facial analysis. Experimental validation demonstrated high accuracy in identifying drowsiness indicators such as prolonged eye closure and head tilting. The Arduino- controlled buzzer provided immediate alerts, significantly reducing response time and enhancing driver awareness. Additionally, GPS tracking improved situational awareness by monitoring vehicle movement. The system proved to be a cost-effective, non-intrusive solution, making it suitable for private vehicles and commercial fleets to enhance road safety.

The Driver Drowsiness Detection and Smart Alerting System effectively integrates Arduino, GPS, a camera, and deep learning-based image recognition to monitor driver fatigue and enhance road safety. By continuously analyzing facial features such as eye closure, yawning, and head tilt, the system accurately detects signs of drowsiness and triggers an immediate alert through a buzzer. Additionally, GPS tracking provides further insights into vehicle movement patterns. This real-time system serves as a proactive solution to reduce accidents caused by drowsy driving, ensuring safer transportation and improved driver awareness. Future enhancements may include automatic vehicle control mechanisms and cloud-based monitoring for further reliability.

FUTURESCOPE

Future advancements in the Driver Drowsiness Detection and Smart Alerting System will focus on improving accuracy and expanding functionalities. Integrating real-time IoT connectivity can enable remote monitoring by fleet operators or emergency services. Enhancing the deep learning model with larger datasets and advanced architectures like transformers or hybrid CNN-LSTM networks can further refine detection accuracy. Additionally, implementing automated vehicle control, such as speed reduction or lane correction, could enhance safety measures. Future versions may also incorporate wearable sensors for physiological monitoring (heart rate, EEG) to complement visual detection, ensuring a multi-modal and more robust drowsiness detection system.

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