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Driver Monitoring System

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***Abstract*— This paper presents an innovative approach for addressing the critical issue of road safety. The proposed solution involves the development of a Driver Monitoring System (DMS) leveraging advanced technologies including Python programming, Raspberry Pi, and YOLOv5 (You only look once) for real-time object detection. The Objective is to consistently monitor vital behaviors such as facial expression, signs of drowsiness and yawning, seat belt usage and compliance with safety guidelines regarding use of mobile phone and earphone while driving. The key features of this paper are Drowsiness and yawning detection, Alcohol detection, Accident detection, Seat belt detection, mobile phone detection and earphone detection. Raspberry Pi is a versatile and affordable SoC (System on chip) used to control the chassis for the movement and GPIO (General-purpose input/output) interface enable the integration of sophisticated sensors like the MQ3 gas sensor for alcohol detection and the MPU6050 gyroscope for accident detection. Utilizing Haar Cascade classifiers, this system performs facial analysis to detect signs of drowsiness and yawning, facilitating real-time monitoring of driver alertness. The YOLOv5 model is trained using a diverse dataset of annotated images to improve detection accuracy for these specific behaviors. Once trained, the YOLOv5 model is deployed to detect seat belt usage, mobile phone presence, and earphone usage in live video streams. Immediate auditory and visual alarms are triggered to alert drivers of unsafe behaviors. This article represents a significant contribution to road safety technology, offering an integrated solution to address key aspects of driver behavior and promote safer driving practices.**

***Index Terms*— Driver, Drowsiness, Yawning, Haar Cascade, Alcohol, Accident, Raspberry Pi, YOLOv5, Seat Belt, Mobile Phone, Earphone.**

I. INTRODUCTION

Road accidents are the leading cause of death worldwide among individuals aged 15 to 49. An estimated 1.3 million lives are lost worldwide each year because of road accidents. The number of road accidents has been rising recently, and these incidents are frequently the result of driver carelessness or human mistakes. This illustrates how quickly advanced car safety systems are needed. This study presents a Driver Monitoring System (DMS) that incorporates modern technology. It is intended to go beyond traditional safety measures. Addressing road safety challenges necessitates a holistic strategy, demanding a comprehensive and integrated approach for effective solutions. Through the combination of many essential elements, each aimed at a particular aspect of driving behaviour that leads to accidents and fatalities, the suggested DMS represents an efficient solution. A broad range of modern DMS have been developed in response to growing concerns about road safety. These systems are designed to reduce the dangers associated with driving while distracted or under the influence of alcohol. This work presents a comprehensive driver monitoring system that includes features like alcohol and drowsiness

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detection, accident detection, and accurate recognition of crucial driving behaviour including wearing a seat belt, holding a phone, and using headphones. For object identification, the machine learning model YOLOv5 is utilised by this system, which allows for precise and accurate tracking of the driver's condition and movements in real time.

II. Literature Survey

This paper describes an alert system designed to detect driver drowsiness through image processing. The system aims to enhance road safety by monitoring and alerting drivers to potential drowsiness-related risks [1]. The research aims to contribute to advanced systems that enhance road safety by identifying and addressing potential risks associated with driver fatigue [2]. A system that employs Self Organizing Map (SOM) technology for drowsiness detection [3]. This paper aims to provide decision support for addressing driver drowsiness, contributing to the advancement of technologies for sustainable development, particularly in the context of road safety. This system [4] employs the Internet of Things (IoT) technology for detecting unsafe driving behaviours. The research focuses on developing a system that utilizes IoT to enhance driving safety by identifying and addressing instances of unsafe driving. The integration of alcohol detection technology into cars to enhance safety by preventing operation when the driver's alcohol levels exceed a certain threshold, aiming to mitigate the risks associated with drunk driving [5]. Developing an emergency alert system that utilizes IoT technology [6] to promptly notify relevant authorities or individuals in the event of a motorbike accident, aiming to enhance response times and improve overall safety. This paper [7] focuses on leveraging technology to promptly detect accidents and send alerts, which improves emergency response time and enhance overall road safety. The system integrates alcohol detection capabilities with a seat belt control mechanism using Arduino UNO, providing a comprehensive approach to increase safety measures in vehicles [8]. This paper [9] gives insights on the methods for detecting a driver's mobile phone usage and also aims to address the safety concern of distracted driving by developing techniques capable of identifying instances where a driver is using a mobile phone and tries to mitigate potential risks on the road. A deep learning-based method for detecting driver distraction [11] caused by mobile phone usage. The research explores the application of advanced neural networks to enhance the accuracy of distraction detection, addressing safety concerns in the context of driving.

III. Motivation

The motivation behind this project is driven by a desire to harness technology for social good, addressing a critical public health and safety issue. Through the implementation of sophisticated monitoring and detection techniques, we intend to provide drivers with immediate feedback and interventions that promote safer driving practices.

IV. Problem Statement

The goal of this project is to create a reliable driver monitoring system for detecting and addressing risks related to driver drowsiness, alcohol consumption, accidents, and failure to comply with safety regulations like seat belt usage, mobile phone handling, and earphone use. YOLOv5 for real-time monitoring of seat belt, mobile phone, and earphone usage to enhance road safety by addressing driver impairment and distractions. The objective is to enhance road safety and minimize accidents attributed to driver-related factors.

V. Proposed Project

The proposed system is a versatile robot based on a Raspberry Pi aimed at enhancing road safety 5by integrating multiple functionalities. It incorporates driver drowsiness and yawning detection through real-time analysis of driver behaviour captured by a camera. Additionally, it includes alcohol detection using an MQ3 Sensor, and seat belt, cell phone, and earphone detection using YOLOv5 object identification. Real-time accident detection is facilitated by monitoring changes in the car's X, Y, Z coordinates using an MPU sensor. The Raspberry Pi functions as the central processing unit, managing data from multiple sensors and executing necessary actions in response to identified violations. The system aims to proactively prevent accidents by issuing alerts for alcohol content, unsafe behaviours, and driver fatigue, leveraging sensor data and advanced algorithms for comprehensive safety management on the road.

V. Hardware And Software Architecture

A. Block Diagram

The SoC (system on chip) used is Raspberry Pi. The PMDC motor serves as the actuation component, the L293D Motor Driver controls the motor, the MQ3 gas sensor detects alcohol, the MCP3008 10-bit ADC converts analogue to digital, the UART Module facilitates communication, the MPU6050 Gyroscope sensor detects motion, the GSM Module provides connectivity, the ACCUPLUS rechargeable Lead Acid Battery powers the device, the IR sensor detects proximity, and the buzzer provides audio feedback.

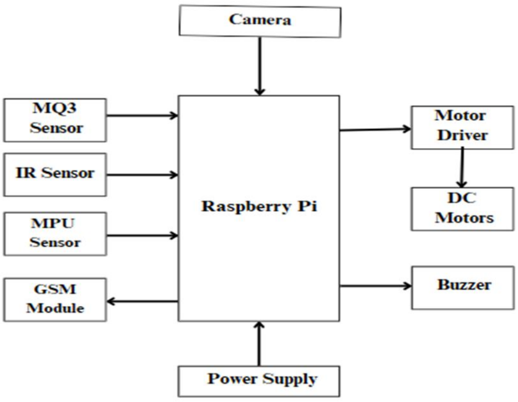

Figure 1. Block Diagram

B. Software Flowchart

The envisioned software architecture for the Driver Monitoring System (DMS) is meticulously crafted to encompass critical functionalities, including drowsiness detection, alcohol detection, accident detection, and the monitoring of seatbelt, mobile phone, and earphone usage. The architecture hinges on the integration of the YOLOv5 model, renowned for its ability in real-time object detection. The Haar Cascade Classifiers, specifically trained for face and eye detection, are employed within the Object Detection Module. This module processes each video frame, identifying and locating facial features, including the eyes. Haar Cascade based eye detection algorithms are employed to track eye movements, focusing on factors such as blink rate and closure duration. These metrics serve as key indicators for drowsiness. The Alerting Module plays a crucial role in conveying real-time information to the driver, using visual alerts on the screen to indicate the system's detection of drowsiness, which is based on the analysis of eye behaviour. Additionally, auditory alerts, such as beeping sounds or voice messages, can be integrated to further capture the driver's attention. The YOLOv5 model, functioning as the central component of the architecture, analyses video frames through the Object Detection Module. Within this module, the YOLOv5 utilizes anchor boxes to predict bounding box coordinates, class probabilities, and objectness scores for each identified object, such as seatbelt, mobile phones, and earphones, within the input image or video frame. This allows the model to accurately recognize and categorize these objects, and visual indicators are then presented on the screen, providing information about the driver's actions, including whether they are wearing a seatbelt, using a cell phone, or wearing earphones while driving.

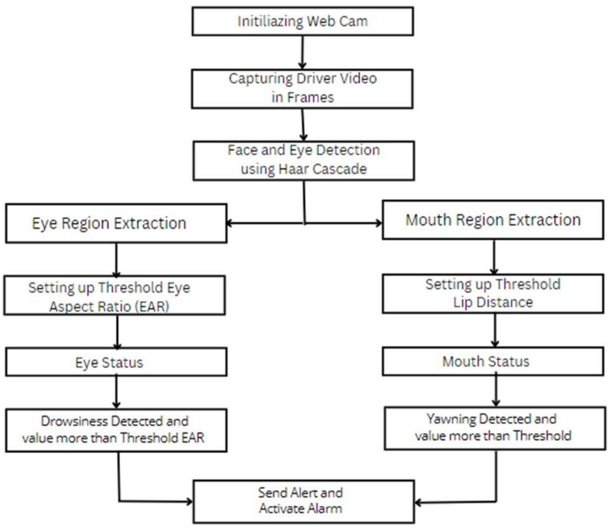

Figure 2. Software Flow Chart for Drowsiness Detection

VI. WORKING

A. Drowsiness Detection

Utilizing Haar Cascade and pre-trained classifiers, machine learning recognizes facial and eye features from images or video frames. The classifiers are trained on large datasets to identify distinctive patterns. The Raspberry Pi executes a code controlling the prototype's movement, accelerating unless signs of driver drowsiness is detected. Computer vision algorithms monitor for extended closed eyelids or slow eye movements as indicators of tiredness. When the driver's drowsiness or yawning is detected, then the UART module is responsible for sending data from the algorithm to the Raspberry Pi. The system issues audible warnings, such as beep sounds, and instructs the prototype to stop from moving forward, providing a better solution for monitoring drivers and promoting safer driving experiences.

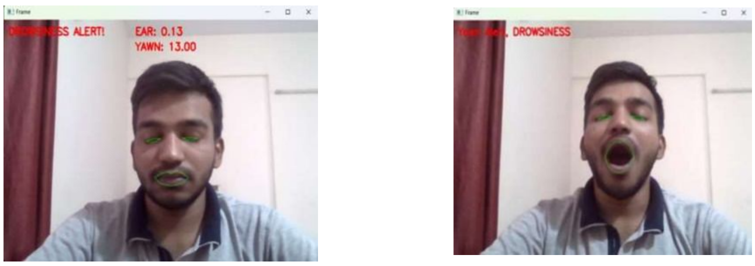

Figure 3. Drowsiness and Yawning Detection

B. Alcohol Detection

Alcohol detection using a smoke sensor such as the MQ3 gas sensor typically relies on the principle of gas sensing. The code associated with the sensor includes a predefined threshold or percentage value that serves as a reference for determining the concentration of alcohol in the air. The MQ3 gas sensor's detecting material undergoes an electrical property change when alcohol vapour comes into touch with it. The conductivity of the sensitive layer of the sensor changes, and this change is directly related to the amount of alcohol present in the surrounding air. Overall, the utilization of the MQ3 gas sensor in alcohol detection shows how well gas detecting technology is effective. Using the sensor's ability to respond to alcohol vapours, it provides a reliable method of identifying and measuring alcohol levels.

C. Accident Detection

The MPU6050 sensor plays a crucial role in modern automobile safety systems for accident detection, monitoring angular velocity, acceleration, and deceleration. In normal driving situations, it captures and analyzes motion-related data within expected ranges. However, in the event of a collision or sudden deviation from typical motion patterns, the sensor quickly identifies abnormalities. The gyroscope readings are utilized to identify notable changes suggestive of an accident. Upon identification, the system activates the GSM Module for notifying designated emergency contacts via phone and SMS. This integrated system enables rapid sharing of critical information, facilitating swift assistance and potentially minimizing the consequences of car accidents.

D. Seatbelt and Mobile phone Detection

The YOLOv5 model undergoes rigorous training, utilizing a diverse dataset with annotated images of drivers to enhance detection of seatbelt usage and mobile phone presence. Configuration of the model architecture, specification of dataset paths, and setting hyperparameters are done in the training pipeline, with continuous evaluation on a validation set for generalization to unseen data. Once trained, the YOLOv5 model is deployed in real-world driver monitoring systems, focusing on detecting seatbelt usage and mobile phone presence in real-time. Immediate alarms are triggered for the absence of a seatbelt or use of a cell phone, accompanied by both auditory warnings and visual messages. This approach, leveraging YOLOv5, contributes significantly to driving safety by emphasizing seatbelt use and preventing distractions from cell phones through a comprehensive system of visual and auditory alerts.

E. Earphone Detection

The driver monitoring system incorporates earphone detection with YOLOv5 to improve safe driving habits. The process begins by creating an extensive dataset of annotated images featuring drivers wearing earphones, partitioned into training and validation sets for comprehensive scenario coverage. Regular evaluations on the validation set guides adjustments to hyperparameters, ensuring optimal precision, recall, and overall accuracy during the training phase. Once trained, the YOLOv5 model analyses video frames from the webcam, identifying instances where the driver is using Earphones, Air pods, or a Neckband. Visual alerts prompt the driver to remove their earphones while driving, and voice alerts enhance this approach for a well-rounded notification system. This dual notification system effectively reminds drivers to prioritize safety by refraining from using earbuds while operating a vehicle. In essence, the YOLOv5-equipped driver monitoring system acts as a crucial tool in promoting responsible and secure driving practices by efficiently detecting and addressing earphone usage.

Figure 4. Seatbelt and Cell phone Detection

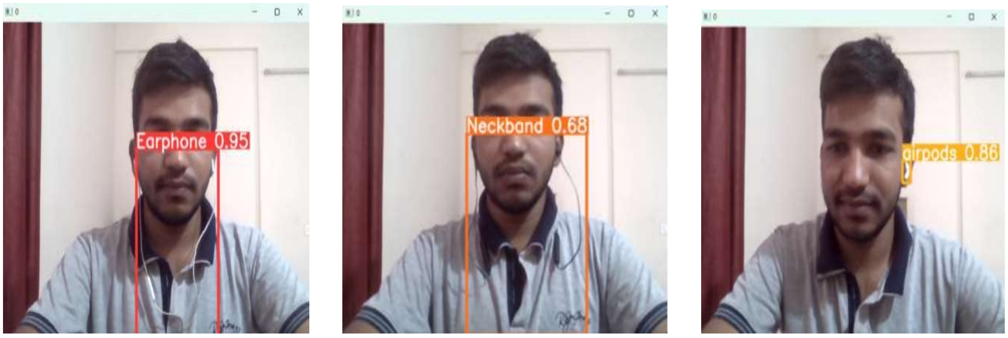

Figure 5. Earphone, Neckband and Air pods Detection

VII. Future Scope

In future developments, expanding the capabilities of the Driver Monitoring System (DMS) could involve enhancing contextual awareness through advanced machine learning models to better interpret driver behaviour and emotional states. Integrating seat belt, mobile phone, and earphone detection using the YOLO algorithm with hardware. Furthermore, incorporating biometric sensors for health monitoring could offer a more comprehensive approach to promoting driver’s well-being. The utilization of more sophisticated algorithms has the potential to further improve the accuracy of the system, ensuring enhanced road safety measures in the long term.

VIII. Conclusions

To summarize up, this article showcases the development of a Driver Monitoring System (DMS) leveraging advanced technologies that ensures driver safety. Through real-time analysis of facial expressions, detection of drowsiness and yawning, monitoring of seat belt and cell phone usage, among other features, this project encourages safe driving practices and compliance with traffic regulations. The integration of hardware components such as Raspberry Pi as the central processing unit ensures efficient data management and execution of necessary operations. The sophisticated software architecture, utilizing Haar Cascade Classifiers for facial and eye detection, allows the system to effectively monitor critical aspects of driver behaviour, including drowsiness, alcohol detection, seat belt usage, and adherence to mobile phone and earphone usage. Overall, this project provides a holistic approach to improving driver behaviour and enhancing road safety. By implementing advanced monitoring and detection methods, the system aims to create a safer driving environment and reduce accidents caused by driver-related factors.

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