Computer Vision and AI-Based Driver Behavior Analysis for Smoke and Alcohol Detection

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***Abstract*—The problem of road accidents has recently become very significant due to poor activities like smoking and alcoholism. The effect of these activities influences the focus, response time, and decision-making capability of the driver. In this research paper, an algorithm is presented that detects accident-prone drivers by using methods of computer vision and artificial intelligence. The algorithm makes use of data collected through the image and sensor to detect the presence of alcohol within the driver. The actions of the driver can be detected based on his gestures and facial expressions. When there is any risky activity detected, the system generates a warning message for the driver.**

***Keywords*—Driver Monitoring System, Behavioral Detection Algorithm, Artificial Intelligence Approach, Alcohol Detection Mechanism, Smoke Activity Detection, Road Safety Improvement**

I. INTRODUCTION

Road safety has become a crucial issue because of the rising cases of traffic accidents across the world. A vast majority of the accidents occur as a result of human error caused by distractions and poor habits. Smoking and drinking are some of the habits that lead to driver distraction and compromise driver awareness.

Smoking while driving leads to distraction since a smoker must divide his attention between driving and managing the cigarette. The minor distraction might cause delay when reacting to emergency situations. On the other hand, drinking affects the functioning of the brain, and a driver may be unable to estimate speed, distance, and direction.

Traditional alcohol detection methods such as breath analysis are often employed during traffic inspections and are discontinuous in nature. Moreover, such methods are ineffective in preventing accidents before they occur. There is an urgent need for a continuous and reliable system to monitor driver behavior.

Advancements in technology in recent times have enabled computers to analyze human behavior through cameras. Computer vision techniques enable a computerized system to examine and interpret actions in real-time.

The current study explores a system that integrates the use of cameras and sensors to detect smoking and alcohol behavior in drivers.

II. DATASET DESCRIPTION

As a rule, the performance of any monitoring system is determined by the quality of the employed dataset. For this reason, the current study makes use of a hybrid dataset design for training purposes. Such an approach allows for creating a more powerful vision model resistant to noise. Specifically, the presented approach involves three datasets – a benchmark dataset, a supplementary environmental dataset, and a custom dataset aimed at modeling specific behaviors such as smoking and drinking.

The first dataset involved in the development of the proposed driver monitoring system is a State Farm Distracted Driver Detection Dataset. As mentioned before, this dataset consists of a large number of driver pictures labeled with particular activities. It includes images of drivers driving normally, talking on a phone, texting, and being distracted. Hence, this dataset can be considered reliable for further training.

To train a model tolerant to various lighting conditions, facial positions, and postures of the driver, images chosen from the NTHU Driver Drowsiness Detection Dataset will be used. This dataset is characterized by the presence of numerous videos showing people in dark environments and during the nighttime. Consequently, it can be regarded as a supplementary environment.

Smoking is an important part of the research. However, no publicly available dataset contains enough information on smoking behavior. Thus, the creation of a special custom dataset seems reasonable. The created dataset comprises approximately 5,000 frames obtained after the analysis of recorded videos. These videos show the actions of the driver while driving and smoking.

When it comes to alcohol drinking detection, only sensor data will be used. In particular, it will include numerous records made on the basis of the operation of the MQ-3 alcohol sensor. These records will be acquired in controlled alcohol environments with and without the consumption of alcohol. Based on these records, thresholds will be set.

Table 1: Dataset Summary and Characteristics

Dataset Name	Type	Size	Purpose	Key Features	Limitation
State Farm Dataset	Image	22,000+ images	Driver behavior detection	Diverse driving actions	No smoking class
NTHU Dataset	Video/Image	100+ subjects	Lighting & posture variation	Night & low-light data	Limited alcohol context
Custom Dataset	Video frames	~5000 frames	Smoking detection	Hand-mouth interaction	Small dataset size
MQ-3	Numeric	1000+ readings	Alcohol detection	Real-time sensor values	Sensitive to environment

III. LITERATURE REVIEW

Driver monitoring systems incorporating recent advancements in technologies such as artificial intelligence and computer vision have been developed mainly in pursuit of improving road safety. The existing systems can generally be categorized as vision-based, sensor-based, and hybrid.

Vision-based systems make use of various deep learning algorithms including CNNs to detect driver distractions based on the driver's facial expression, gaze direction, and gestures with their hands. These systems have achieved impressive results in controlled environments but tend to underperform in real-life situations due to varying conditions such as lighting and camera orientation.

The alcohol detection systems that employ MQ-series sensors fall under the category of sensor-based systems. These systems offer accurate measurements of the concentration of alcohol but do not interpret behavioral contexts. They can also be affected by environmental influences such as the presence of perfumes and chemical vapors.

Hybrid systems combining both vision and sensor-based systems have been researched in order to address the shortcomings of the aforementioned systems. Such systems exhibit better reliability but encounter difficulties in computational efficiency.

Table 2: Comparative Analysis of Existing Studies

Study	Approach	Accuracy	Strength	Limitation
Kumar et al. (2022)	CNN	91%	Good visual detection	No alcohol detection
Sharma (2023)	MQ-3 Sensor	88%	Accurate alcohol sensing	No behavior analysis

Study	Approach	Accuracy	Strength	Limitation
Singh et al. (2021)	AI-based	89%	Real-time detection	Limited dataset
Recent Studies (2024–25)	Hybrid Models	93–96%	High accuracy	High computation cost

IV. RESEARCH GAP

Although there have been numerous developments in this area, most of the existing systems adopt either vision or sensor-based techniques independently, which decreases reliability during practical applications. In addition, several hybrid systems are not optimized for real-time operations and cannot be deployed at a lower cost.

V. RELATED WORK

There have been various models created for monitoring the driver's behavior. A vision-based driver monitoring system that recognizes distractions based on facial features was created by Kumar & Patel [1]. Alcohol detection system using the MQ-3 sensor was proposed by Sharma [2] for vehicle safety purposes. Singh & Verma [3] introduced an AI-based model for real-time behavior analysis.
However, most of the current systems use either sensor or vision techniques separately, while the proposed solution will overcome this drawback.

VI. SYSTEM OVERVIEW

The proposed system utilizes two modules, namely, vision-based and sensor-based to monitor the driver's activity. They combine their efforts to improve the accuracy and reliability of the detection process of inappropriate actions.
Vision-based module uses the camera installed within the car interior facing the driver's seat. It records the video stream of the driver's activities. The system analyzes patterns, including the motion of hands, direction of facial view, and the presence of objects nearby. In addition, it detects recurrent movements that indicate the smoking behavior of the driver. Moreover, it detects the distractions, including the absence of eye contact with the road, which means that the driver's attention is directed elsewhere. This information allows assessing whether the driver follows the traffic rules.

Sensor-based module utilizes the alcohol detection sensor, such as MQ-3 sensor, to detect alcohol concentration in the air inside the vehicle. The alcohol sensor constantly monitors the surrounding environment and reports in real-time its findings. When the alcohol concentration surpasses the predetermined limit, it implies the consumption of alcohol by the driver. Therefore, it is essential for determining the condition of the driver's activity, particularly if the vision-based module cannot provide the same information.

The modules are linked to a central decision unit that serves as the system core. It receives the signals transmitted from the camera processing system and the alcohol sensor. The decision-making system compares the data against the set criteria to assess whether the driver's activity is safe or risky. Consequently, it initiates the alarm system whenever necessary. The alarms include the buzzer sound, warning light, and message display, which alert the driver of his actions.

One significant benefit of this system is that it uses the combined approach in detecting inappropriate behavior instead of a single method. As a result, the system increases the likelihood of detecting the appropriate behaviors. Therefore, the system becomes more reliable and useful for practical purposes.

VII.STRENGTHS OF THE PROPOSED SYSTEM

There are several strengths of the proposed system that allow its application in practice. First, it allows for continuous monitoring of driving behavior without any additional interference from the outside. As a result, any violation of traffic rules will be discovered instantly. Second, the integration of computer vision technology with sensor technology increases the reliability of the system and minimizes the risk of erroneous reports.

Another strength of the proposed system is its affordability because it utilizes readily available hardware components such as cameras and MQ-3 sensors. Also, it can be adjusted according to the type of a vehicle where it will be installed. Moreover, the notification mechanism allows avoiding car accidents by promptly informing drivers about their mistakes.

VIII. SYSTEM ARCHITECTURE

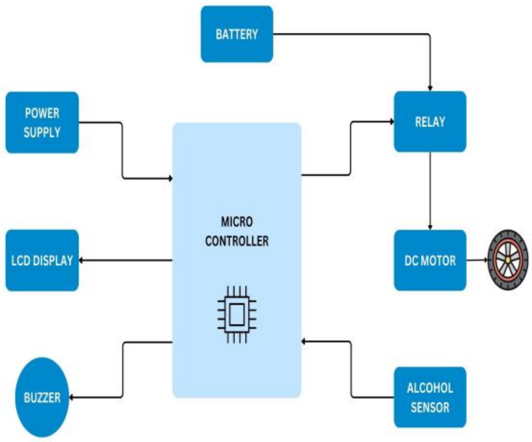

Fig. 1. System Architecture

IX. METHODOLOGY

The technology uses a systematic approach to monitor unsafe driver conduct.
1. Gathering Data – The camera provides real-time footage of the driver while an alcohol sensor provides a continuous reading of the air.
2. Extracting Frames – The video footage is split into individual images with each being examined separately for analysis.
3. Feature Recognition – A number of significant features of importance are identified by the technology such as the location of the driver's hands, the direction of their head, and the presence of any objects located near their mouth.
4. Conduct Recognition – By utilizing predetermined patterns, the technology is able to determine if the identified features correlate to either smoking or distracted conduct.
5. Evaluating the Alcohol Sensor – The reading from the alcohol sensor is then evaluated against a predetermined threshold value. If it exceeds this threshold, it will notify the technology that alcohol is present.
6. Decision Making – After both visual and sensor information have been gathered, the technology will analyse both sources to determine if either or both sources indicate an unsafe conduct. If they do, then the technology determines that it has detected unsafe conduct.
7. Generating Alerts – An alert(s) (visual or audible) will then be created to immediately advise the driver of the unsafe conduct.

Additionally, this proposed system will use an artificial intelligence hybrid framework to combine real-time detection of objects and behaviour classification to provide the capability of detecting unsafe driving behaviours via a lightweight object detection model based on YOLO (You Only Look Once) to identify applicable objects (e.g. cigarettes) and detect hand motion movement toward the driver's mouth area.

X. APPLICATIONS OF THE SYSTEM

The system that has been developed can be used across multiple applications, assisting in both improving safety and making sure monitoring occurs for individuals having the capability and desire to drive. The system can be used within privately owned vehicles to help ensure that a driver is demonstrating safe and healthy driving habits. The system can assist in commercial transportation systems such as buses, taxis, and trucks by being used to monitor driver behavior, which then reduces the potential of accidents.

The system can also assist in the management of fleets (of vehicles) by providing continuous monitoring of the drivers within those fleets. Additionally, the system can be integrated within smart vehicles and advanced driver assistance systems (ADAS) as additional safety measures. Law enforcement agencies will also be able to utilize the system for inspections regarding safety and programs aimed at increasing driver awareness of traffic safety. Based on these examples provided, the system exhibits a large number of potential applications in modern transportation systems.

XI. PERFORMANCE OF THE SYSTEM

Deployment of driver monitoring systems into real-world environments requires efficient processing and low latency. Since the proposed system operates continuously, it must analyze visual and sensor data in real time with no delays in generating alerts based on that information.

To accomplish this, the proposed system utilizes a lightweight implementation of a detection model. Instead of processing input video frames at their original high resolutions, the input video frames are resized to optimize a balance between computational efficiency and detection accuracy. Resizing the frames allows for significantly reducing the time for processing while maintaining reliable performance.

The system also utilizes frame sampling.

Table 3: Optimization Techniques and Impacts

Component	Technique Used	Benefit
Video Input	Resolution reduction	Faster processing
Frame Analysis	Frame sampling	Lower computation
Detection Area	ROI extraction	Improved efficiency
Sensor Data	Moving average filter	Noise reduction
Decision Logic	Threshold tuning	Faster response

XII. PROTOTYPE IMPLEMENTATION OF DRIVER SAFETY SYSTEM

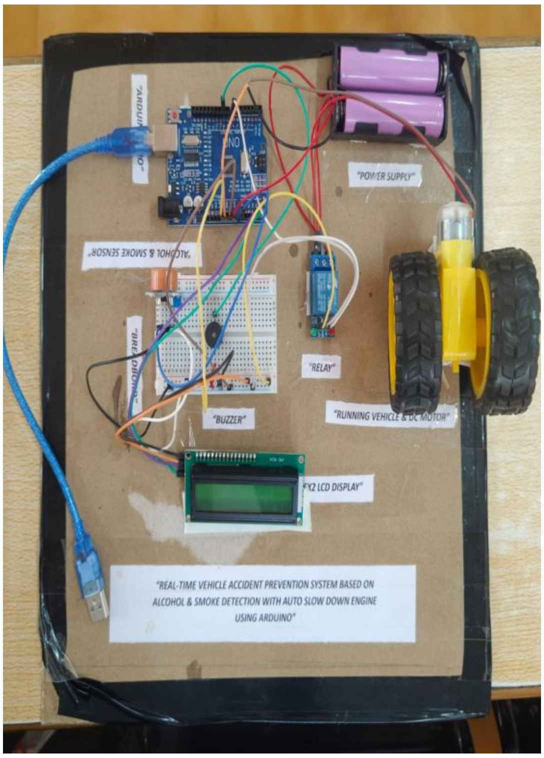

Fig. 2. Prototype Implementation

XIII. ANALYSIS / RESULTS

The system's ability to perform and be dependable under several driving situations was assessed through testing under different environments (i.e., regular driving conditions, simulations of smoking behaviours, and the existence of alcohol in the environment of the vehicle). Testing under diversified driving circumstances aided in identifying the system's capability to identify unsafe actions as well as how fast it would respond.

The system successfully completed all tests without any false positive occurrences while operated in standard driving conditions. This shows the system was stable without having to trigger an alert unnecessarily. Minimising the number of false positive alerts is vital to preserving the level of confidence in the system, as excessive false positive alerts can cause an individual using a system to lose confidence in it.

Using the preceding methods in our smoking behaviour tests and simulations demonstrates the computer vision module's ability to accurately identify smoking behaviours when there are obvious and somewhat repetitive visible patterns to use as visual markers. However, when hand movements were either very rapid/movements were partially blocked from the view of the sensor, some decrease in detection rate was noted.

Alcohol content was detected using an MQ-3 sensor with respect to measuring alcohol levels in the surrounding air. The sensor provided an accurate measure of alcohol presence while in a controlled test environment. As a result, the system was able to calculateт/to estimate alcohol consumption in a controlled test environment.

XIV. PERFORMANCE EVALUATION

The performance evaluation of the proposed system included an analysis of its accuracy, response time, and reliability. The system was able to recognize almost all unsafe behaviors and generate alerts quickly enough to be used in real time. By combining the use of camera and sensor modules, false readings have been minimized and overall system reliability has improved; however, there were some small differences recognized in low-light conditions and/or environments with interference. This indicates that additional improvements may be made.

XV. CHALLENGES

While the system is effective, there are numerous challenges it faces, including:

- Poor illumination conditions may prevent the camera from accurately detecting images.
- Similar items may confuse the detection system by causing image recognition problems.
- Sensor readings may differ based on ambient surroundings.
- Real-time processing requires the use of appropriate hardware.

The aforementioned issues must be resolved to enhance the overall performance of this system.

XVI. FUTURE SCOPE

There are various avenues available to enhance the existing system and provide additional functionality, including:

- Implement a deep learning model in order to achieve better accuracy in detection.
- Upgrade functionality for detection of images in darkness through the use of night vision technology.
- Facilitate interconnection of vehicle control systems with detection systems.
- Provide a means of connectivity between detection systems and mobile applications for remote monitoring.
- Add provide means for identification of the operator driving the vehicle.

Any or all of these improvements would increase the reliability and ability to use the detection system for various applications.

XVII. CONCLUSION

This research study describes an automated system that uses visual representations and AI technology to observe how drivers act while driving and identify behaviours that have the potential to be dangerous, such as drinking and smoking. By using both visual input from a camera and input from another form of sensor, the accuracy and reliability of detecting driver behaviours will be enhanced. This system works by continuously monitoring how drivers behave and the conditions surrounding their environment, allowing the system to evaluate whether or not the driver is exhibiting risky behaviours as they occur.

One benefit of this system is providing alerts almost immediately after a driver may be observed to be behaving unsafely. The driver can then take/implement what they need to prevent an accident from happening – thus reducing their likelihood of being in an accident. Because the camera analysis and sensor detection have both been combined, the reliability of the system is significantly greater than using either method alone.

In a series of tests to evaluate how well the system worked under various conditions – normal driving conditions, driving in a simulated smoke-filled vehicle, and driving with the presence of alcohol - the system has demonstrated that it performs well. While it has been shown to have limitations, including sensitivity to different types of lighting or other types of environmental conditions, the overall performance of the system has remained solid and valuable for practical usage.

The proposed system will be of value in enhancing the safety of drivers and passengers when driving by functioning as a proactive tool versus a reactionary tool. Improvements can be made to both the camera analysis portion and the sensor detection portion.

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