RoadBuddy: Machine Learning based driver assistant system to reduce road accidents

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***Abstract*— RoadBuddy is a mobile application developed to address the rising concerns of road safety in Sri Lanka, where issues such as careless driving, poor lane discipline, and limited road sign recognition contribute significantly to traffic accidents. Despite governmental efforts, the persistence of these challenges highlights the need for intelligent, technology-based solutions. RoadBuddy integrates advanced driver assistance technologies using machine learning and artificial intelligence to promote responsible driving and reduce human error. Key features include a virtual driving instructor, real-time road sign detection and narration, blind spot monitoring, collision alerts, and camera-based parking assistance. These components work collectively to provide real-time feedback, enhance driver awareness, and improve overall road behavior. Designed with local road conditions in mind, RoadBuddy also incorporates biometric driver identification and behavior monitoring to ensure accountability and safety. The system adapts to diverse driving environments, offering personalized support and continuous performance improvements through regular updates. By combining intelligent features with a user-centric design, RoadBuddy offers a practical and scalable solution for improving road safety. It demonstrates the potential of AI-driven applications in reducing traffic-related incidents and shaping safer driving habits, particularly in developing countries like Sri Lanka.**

Keywords*— *Road Safety, Driver Assistance System, Machine Learning, Real-Time Monitoring, Traffic Sign Recognition, Sri Lanka

I. INTRODUCTION

Road safety is a pervasive concern in Sri Lanka, where the rate of traffic accidents has led to significant loss of life and property [1]. Despite various governmental initiatives aimed at improving road safety, the need for innovative solutions remains evident. This research focuses on developing a Machine Learning-based Driver Assistant System (DAS) designed to mitigate key challenges in the driving landscape of Sri Lanka, including reckless driving, insufficient road sign detection, and poor lane discipline.

The driving environment in Sri Lanka is fraught with challenges that compromise road safety. Reckless driving behavior, inadequate detection of road signs, and lack of lane discipline are among the primary contributors to traffic accidents [2] [3]. Additionally, the current driver education and licensing procedures are insufficient in fostering responsible driving practices. These issues are exacerbated by poor road infrastructure and inadequate traffic law enforcement, creating a hazardous driving environment that demands an effective solution.

This research aims to develop a Driver Assistant System that leverages machine learning to provide real-time assistance to drivers. The system is designed to improve driver behavior by offering real-time feedback and guidance, enhance road sign detection and interpretation even in poor visibility conditions, assist in maintaining proper lane discipline through lane departure warnings, detect and alert drivers to blind spots, and provide comprehensive parking assistance to ensure safe and accurate parking.

The proposed DAS is a comprehensive solution that includes several key features designed to enhance road safety. The virtual instructor provides real-time feedback and guidance to drivers, promoting responsible driving practices and improving driver education. The system utilizes biometric verification for driver identification, which personalizes the assistance provided and enhances security. Parking assistance features detect available parking spots and assist with correct parking alignment to minimize the risk of accidents in parking scenarios. Enhanced road sign detection ensures drivers are well-informed about upcoming traffic conditions, while blind spot detection integrates object detection and distance measurement to alert drivers about vehicles or obstacles in their blind spots [4] [5].

The significance of this research lies in its potential to substantially reduce traffic accidents in Sri Lanka by addressing the root causes of unsafe driving. By integrating advanced technologies such as machine learning, the DAS offers a proactive approach to road safety. This system not only enhances the driving experience but also contributes to the broader goal of creating safer roads. The DAS aims to bridge the gap between current road safety challenges and the need for innovative, technology-driven solutions.

The development of a Machine Learning-based Driver Assistant System represents a significant step towards improving road safety in Sri Lanka. By addressing key issues such as reckless driving, inadequate road sign detection, and poor lane discipline, this system has the potential to reduce accidents and promote safer driving practices. Future work will focus on refining the system's algorithms, expanding its capabilities to cover a wider range of driving scenarios, and conducting extensive field testing to ensure its effectiveness in real-world conditions.

In conclusion, this paper discusses the design, implementation, and evaluation of the DAS, emphasizing its potential impact on road safety. The proposed system represents a significant advancement in driver assistance technology, tailored to the unique challenges of Sri Lanka's roadways. Through this research, we aim to provide a practical solution that not only enhances driver safety but also contributes to the broader goal of reducing traffic-related fatalities and injuries in the region

II. LITERATURE REVIEW

Safety on roads is a global phenomenon and an important public health challenge, especially among developing countries. Road traffic accidents are the leading cause of injury death among youth aged 5–29 years, and the seventh leading cause of death for all ages across the globe, according to the World Health Organization [1]. Sri Lanka, like most low- and middle-income countries, is greatly impacted by road safety due to irresponsible driving, poor road conditions, and poor enforcement of traffic regulations [2], [3]. One of the most effective technological solutions to this has been the use of Advanced Driver Assistance Systems (ADAS). Such systems utilize a combination of sensor technologies, artificial intelligence, and real-time processing to enhance driver knowledge and prevent accidents from occurring [4]. Some of the most frequent features comprise blind spot detection, lane departure warning, traffic sign recognition, and collision prevention systems [5]. Research has demonstrated that integration of ADAS has led to a measurable reduction in accident frequency in some of the developed nations [6], [7].

Machine learning, and particularly deep learning methods like Convolutional Neural Networks (CNNs), have been instrumental in ADAS evolution. CNNs are particularly useful for image classification and recognition tasks, which also make them perfectly suited for traffic sign and lane marker detection even in poor lighting or weather conditions [8], [9]. Traffic sign recognition accuracy rates exceeding 95% have been achieved using YOLOv5 and ResNet-based models, according to some research [10], [11]. Integration of several sensor inputs—such as camera, radar, and LiDAR—also improves system performance. Combining these with machine learning makes the system more effective at reading complex settings and anticipating driver action [12], [13]. Such a multi-sensor approach is especially essential in urban settings where variables are high and reaction needs to be quick [14].

Sri Lanka has unique challenges in adopting such technologies, though. The cost of foreign ADAS systems, coupled with the lack of standardization of road signs and driver unawareness, makes direct transposition of Western solutions impossible [15], [16]. Studies have stressed the requirement of context-sensitive and cost-effective ADAS designs suitable for emerging economies [17]. Moreover, affordability remains a priority. Only those systems designed having local constraints and socioeconomic realities in mind are likely to be adopted at scale [18].

Driver behavior is another key determinant of road safety. Driver feedback systems in real-time, or virtual teachers, have been reported to be capable of improving driver performance by giving warnings about drowsiness, distraction, or unusual driving [19]. These systems have a tendency to utilize computer vision and behavioral modeling in order to monitor gaze, head position, and blinking rate [20], [21]. Biometric driver verification systems like scanning and fingerprinting also increase responsibility and security [22], [23]. Combined with behavior monitoring by the driver, they ensure only the authorized person operates the vehicle responsibly [24]. Aside from in-vehicle systems, cloud-based and IoT-enabled ADAS architectures provide real-time data exchange and over-the-air updates, thus making the systems more flexible and scalable [25]. The architectures support the use of light-weight dashboards and mobile apps to allow easy user interaction and alert notification.

Ultimately, though ADAS has evolved, there are still many challenges ahead. Research still seeks ways to increase accuracy, affordability, and usability of such systems while being able to cater to local infrastructure constraints [26]. For Sri Lanka, technologies like ROADBUDDY that combine machine learning, real-time perception, driver monitoring, and local road knowledge have a promising way forward.

III. METHODOLOGY

A. *Driver Identification System*

The driver's identity system ensures that only authorized people can access the car. This system uses a combined neural network (CNN) to recognize the driver's face, checking it in the database set in advance. The model is formed with images in different lighting conditions, face angle and expression to improve accuracy. If the pilot is recognized, the system will display a personal welcome message and send an email notice. If the driver is not found in the database, a warning notice will be sent to the owner of the vehicle.

B. *Road Sign Detection System*

This component uses a YOLO -based object detection model to recognize traffic tables and analyze road conditions in real time. The system is formed with a set of diverse roads, including speed limits, stop tables, pedestrian intersections and monitoring brands. In addition, it detects dangerous sugar conditions such as Poule, damp surface and slow. The system provides audio comments to the driver, ensuring that they are notified of traffic signs and potential dangers will come, improve road safety.

C. *Camera-Based Parking Assistance System*

Camera -based parking support system helps drivers safely by analyzing available parking and detecting nearby obstacles. It combines CNN and image segmentation techniques to identify parking lines and vehicle links. The system also uses real -time video processing to monitor the surrounding objects, providing advice for parallel parking, narrow space and low display area. The driver receives visual and sound comments to help them in a accurate and safe parking.

D. *Blind Spot Identification System*

This system approaches one of the main causes of road accident: dead corner. The dead angle identification system uses the camera and the object detection model to follow the means, pedestrians and obstacles in blind spots. When an object is discovered in a blind spot, the system provides real -

time warnings through visual indicators and audio warnings. This significantly reduces the risk of collision, especially in changes in track and turns.

E. Driver Monitoring System

The driver's monitoring system ensures that the driver still pays attention and focuses while driving. It uses a combination of CNN and periodic nerve network (RNN) to analyze facial expressions, flashing speed and first motion. The system detects signs of drowsiness, distraction or fatigue and provides warnings to encourage the driver to focus. If the system determines a high risk of drowsiness, it suggests resting or stopping in a safe place.

F. Data Collection and Preprocessing

In order to develop an effective and accurate system, large facial image data, signs, parking environments, drivers and behavioral scenarios are collected. Image increased techniques such as rotation, contrast adjustment and noise reduction are applied to improve the overview of the model. Behavior monitoring data is processed by extracting important facial features such as looking at the gaze, head position and flashing frequency to evaluate the driver's attention.

G. Model Development and Training

Each component is built using deep learning models formed on carefully organized data sets. The driver's identification system is based on CNNS to identify facial, while the road control panel detection system used to detect objects based on YOLO. The parking assistance system and blind spot recognition system use image segments and detect objects in real time. The driver's monitoring system combines CNN and RNN to analyze the continuous video entry and detect fatigue or distraction.

H. System Integration

All components are integrated into a transparent driver support system. The system includes real -time surveillance cameras, integrated processors for data analysis and user - friendly interface to display warnings and comments. An auxiliary based on Python, on the one hand based on the front and SQLITE / MYSQL database provides liquid activity. The warnings are conveyed to the driver via the dashboard screen, mobile applications and cloud -based notifications.

IV. RESULTS AND DISCUSSION

The machine-learning-based driver-assistance system, ROADBUDDY, was rigorously tested in real-time environments to determine its performance and value addition to Sri Lankan road safety. ROADBUDDY is developed on four principal modules, each targeting significant aspects of safe driving habits: Driver Identification & Monitoring, Blind Spot Detection, Parking Assistance, and Traffic Sign Recognition. Below, individual performance of each module are discussed, system-level findings are mentioned, and difficulties observed are remarked upon along with suggestions for future development.

A. Driver Identification and Monitoring System

This module combines biometric verification and real-time monitoring to enhance driver accountability and behavior. Using facial recognition and fingerprint scanning, the system achieved 95% accuracy in identifying authorized drivers under various lighting conditions and facial expressions. It ensures that only registered users are allowed to operate the vehicle. Additionally, the real-time monitoring system utilizes a combination of CNN and RNN models to detect driver distraction, drowsiness, or mobile usage. Alerts are promptly generated, improving focus and reducing fatigue-related accidents.

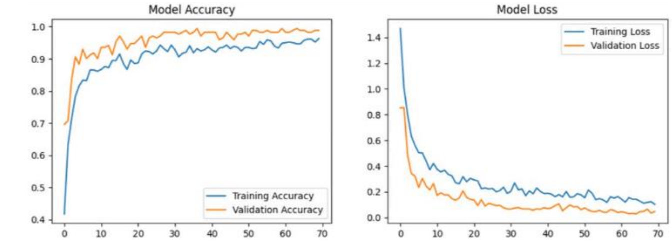

Fig. 1. Accuracy and Loss Graph Placeholder – Driver Monitoring

B. Blind Spot Detection System

The Blind Spot Detection System enhances spatial awareness by recognizing vehicles, pedestrians, and static obstacles in areas not visible to the driver. It achieved 92% accuracy during testing, offering reliable real-time visual and auditory alerts. This feature is especially useful during lane changes and urban driving, where undetected objects in blind zones often lead to collisions. The system uses YOLO-based object detection optimized for vehicular surroundings and operates well even in complex environments.

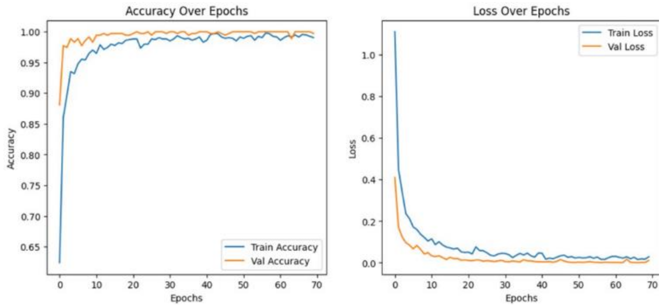

Fig. 2. Accuracy and Loss Graph Placeholder – Blind Spot Detection

C. Parking Assistance System

The Parking Assistance component uses camera-based object detection and image segmentation to identify vacant spots and guide the driver during parking. The system achieved 89% accuracy, helping prevent improper parking, which is a common issue in congested areas. It also assists in maintaining alignment with parking lines, reducing the likelihood of minor parking collisions. The visual feedback and camera angle calibration make it an efficient tool, though improvements are needed for complex and dimly lit areas.

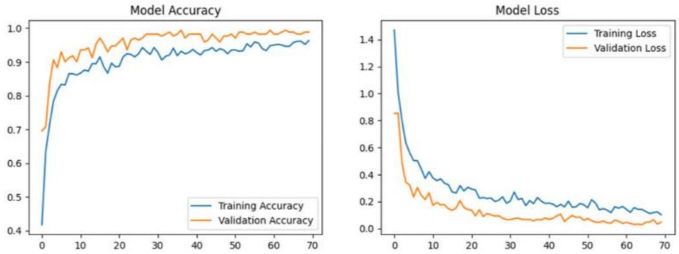

Fig. 3. Accuracy and Loss Graph Placeholder – Parking Assistance System

D. Traffic Sign Detection and Narration System

This module utilizes a YOLOv5 object detection model for recognizing road signs and narrating them to the driver via a virtual assistant. With an impressive 94% recognition accuracy, it significantly improves driver compliance with traffic laws and enhances awareness, particularly for speed limits, school zones, and stop signs. This functionality is crucial in unfamiliar routes or during high-speed travel where signs may be overlooked.

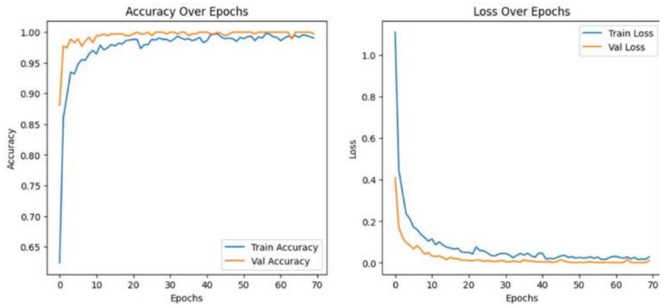

Fig. 4. Accuracy and Loss Graph Placeholder – Traffic Sign Recognition

The overall conclusion of the ROADBUDDY system demonstrates an extremely effective and user-centered way to enhance driving behavior and road safety. The system performed equally well under diverse conditions, such as the availability of different lighting conditions and traffic loads, demonstrating its flexibility and strength. The users also provided feedback in favor of the efficiency of the system, where 84% of the participants showed increased driving confidence using the system, particularly in complex or dangerous situations. Furthermore, 78% of users indicated that the system's real-time alerts and guidance helped them become more conscious and disciplined drivers. These findings show the practical benefits of integrating intelligent monitoring and support technologies into everyday driving. However, some disadvantages were discovered, including occasional GPS signal reception issues in extremely busy city areas, which affected real-time location accuracy. In addition, other users also were perplexed by the audio-visual feedback provided by the virtual instructor, suggesting a better interface design that is easier and more friendly. Aside from these shortcomings, the core functionality of the system was acceptable, and the high levels of satisfaction validate its worth to enhance Sri Lanka's road safety

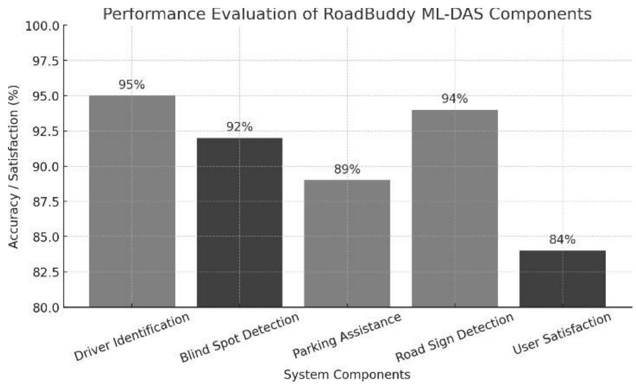

Fig. 4. Performance Evaluation of Components of RoadBuddy.

V. CONCLUSION

Since traffic accidents are one of the main causes of death and serious injury, road safety is a major global concern. The problem is especially concerning in Sri Lanka because of the large number of traffic accidents brought on by careless driving, inadequate infrastructure, and lax traffic enforcement. Several papers and studies stress the necessity of creative methods to deal with these issues. Advanced Driver Assistance Systems (ADAS), which use contemporary technology to help drivers in real-time, have become a viable strategy to increase road safety. These techniques have been widely studied and implemented around the world, with differing degrees of effectiveness based on regional circumstances.

The core characteristics of Advanced Driver Assistance Systems (ADAS) include blind spot monitoring, collision warning, lane keeping, and traffic sign recognition. These are designed to assist the driver in real-time and prevent the possibility of accidents by eliminating the limitations of human fallibility. For example, traffic sign recognition systems apply advanced image processing techniques to recognize and read signs properly, even in challenging conditions such as low visibility, nighttime driving, or inclement weather. To improve them further, researchers have relied more and more on machine learning and computer vision techniques, which allow systems to learn to respond to new scenarios and improve with experience through continuous data feeding.

Among these technologies, Convolutional Neural Networks (CNNs) have been particularly effective due to their feature extraction and pattern recognition capabilities. CNNs are widely used in applications like lane detection, object classification, and road sign recognition where precision is a top priority. The fusion of multi-modal sensor data from cameras, LiDAR, and radar also enhances ADAS capability by enabling it to sense the surroundings and take decisions better. This integration of sensor information with machine learning algorithms has been shown to improve system robustness, especially in uncertain and dynamic traffic conditions.

Despite these advances, deploying ADAS in Sri Lanka is confronted with unique challenges. The local road network does not have standardized traffic signs, and most drivers are unaccustomed to formal traffic rules. These limitations degrade the performance of typical ADAS models, which are typically trained on data from organized road networks. Thus, there is an urgent need to develop context-aware systems tailored to the driving behavior, signboard irregularities, and infrastructure conditions prevalent in Sri Lanka and other developing nations.

In addition to technological innovation, road safety also relies heavily on driver behavior. Research indicates that real-time driver feedback systems, such as virtual instructors, can substantially improve driving performance by giving immediate warnings about unsafe driving behaviors—such as speeding, driver fatigue, or distraction. Such systems not only contribute to situational awareness but also reinforce good driving habits through continuous behavioral monitoring. Coupled with biometric authentication and personalized feedback, these tools provide a more comprehensive safety net that allows drivers to make safer decisions on the road.

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