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Autonomous Braking System for Automobile Powered by Artificial Intelligence and Reinforcement Learning

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Abstract- The rising number of accidents and injuries on the roads has created a pressing need for systems that can provide safety and protection to passengers while ensuring high performance in adverse conditions. Traditional braking systems may not always respond in time to prevent collisions, particularly in adverse conditions or emergencies. These systems rely on the driver to apply the brakes manually, which can result in delayed response times or even complete failure to apply the brakes in time. Additionally, these systems do not take into account factors such as road conditions, vehicle speed, and driver reaction time. To overcome these limitations and meet the needs, the Autonomous Braking System has been introduced in commercial vehicles, providing rapid brake response according to the driver's need and safety. This system employs an intelligent control strategy that uses image processing technology based on object detection with the help of haarcascading object detection technique. Computer vision, a crucial component of this system, allows for the detection of path which is being followed by vehicle using Canny's lane detection technique, obstacles and objects in the vehicle's path. This information is then used to make decisions about when and how to apply the brakes, ensuring quick and safe stops. Reinforcement learning is also a key element of the system, allowing it to learn from its experiences and make better decisions over time. This involves providing feedback on the system's performance and using it to adjust its behavior and improve its performance over a period of time. The haarcascading technique here recognizes captured objects as potential obstacles, feeding this information into the algorithm to take appropriate decisions. Overall, the Intelligent Braking System promises to significantly improve safety and performance in commercial vehicles.

Index Terms- autonomous braking system, reinforcement learning, autonomous

I. INTRODUCTION

Our everyday lives are significantly impacted by automobiles, and they are crucial to mobility. Road safety has grown to be a big worry as the number of vehicles on the road keeps increasing. Over 1.35 million people worldwide pass away as a consequence of traffic accidents each year, according to the World Health Organization (WHO) . In 2020, there were more than 38,000 traffic fatalities in only the United States. The chance of accidents rises along with the number of vehicles on the road.

Numerous automobile manufacturers have created safety measures like seat belts, airbags, and anti-lock braking systems in order to solve this problem. However, accidents do still happen, thus further safety precautions must be implemented. One approach that may help to lower the number of accidents on the road is autonomous driving technology. Vehicles, capable of operating without human input using sensors and other technology to traverse roadways and prevent crashes, are referred to as autonomous vehicles.

The creation of an autonomous braking system (ABS) is a critical component of autonomous driving technology. An ABS makes use of sensors and cameras to see possible collisions and activate the brakes to stop or lessen the effect of one. Artificial intelligence (AI) and reinforcement learning (RL) have been important technologies in the development of intelligent braking systems in recent years. AI is a type of computer programme that simulates aspects of human intellect, such the capacity for learning and judgement. RL is a branch of AI that emphasises optimization and decision-making through trial and error. An ABS can be developed that can make better judgements than a human driver by combining RL and AI.

This work aims to create an ABS for vehicles powered by RL and AI. The resulting ABS will develop the ability to anticipate the possibility of an accident and respond appropriately. The system is trained to recognise possible risks

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and make wise judgements to avoid or lessen the effect of a collision by using real-world data. Through the implementation of an intelligent braking system that can make judgements better than a human driver, the initiative seeks to improve traffic safety and decrease the incidence of accidents. This section provides the basic introduction to the domain and proposed system. The literature review covering related work from various researchers is covered in next section. It will be followed by implementation of proposed system. Finally, concluding remarks and future scope of the work is discussed in last section.

II. LITERATURE REVIEW

Himanshu Singh et al. [1] provided a step-by-step approach for implementing machine learning algorithms for image recognition with practical examples that can be easily replicated. It also discussed the challenges associated with implementing machine learning algorithms for image recognition and provided solutions to address these challenges. The author's expertise in the field of machine learning and image processing is reflected in the detailed explanations and examples provided.

Richard Szeliskiet al. [2] elaborated an in-depth understanding of computer vision algorithms and their applications. It covers a wide range of topics, including image formation, image filtering, feature detection and matching, stereo and motionanalysis, and object recognition. A handson approach is used to explain complex algorithms with practical examples. The challenges associated with implemention of computer vision algorithms and solutions to address these challenges are also discussed. Jesús Martinezet al. [3] discussed practical solutions to overcome various computer vision challenges using machine learning. The book covers a wide range of topics, including image classification, object detection, semantic segmentation, and image generation. The authors provide step-by-step instructions for implementing machine learning algorithms using TensorFlow 2.0, which is a popular machine learning framework. It also discusses the challenges associated with implementing computer vision applications and provides solutions to address these challenges.

Li Yinet al. [4] gave an overview of the applications of computer vision in various fields. It explains how computer vision techniques are used for face recognition, object detection, motion tracking, and autonomous vehicles. The article also discusses the challenges associated with implementing computer vision applications and provides examples of real-world applications. The author's expertise in the field of computer vision is evident in the detailed explanations and examples provided throughout the article. The article provides valuable insights into the potential of computer vision applications and highlights the importance of this field in the current technological landscape.

L. L. Lacatanet al. [5] discussed the existing methods for collision warning systems and highlights the limitations of these systems. The authors also provide a detailed description of their proposed system, which uses computer vision techniques to detect vehicle braking accurately. The authors evaluated their system using a dataset of real-world braking scenarios and achieved an accuracy of 95.3%. The results demonstrate the effectiveness of their proposed approach and highlight its potential for improving the safety of vehicles. Overall, the paper makes a valuable contribution to the field of collision warning systems, and the proposed approach can be further developed to enhance the safety of vehicles.

III. PROPOSED AUTONOMOUS BRAKING SYSTEM

The proposed system aims to address the problem of high number of road accidents caused by human errors. [5] Despite advances in automobile safety technology, such as anti-lock braking systems (ABS), accidents caused by driver error continue to occur. Safety of oneself on road after taking all the precautionary measures (by following driving discipline) will guarantee only 50% of success; other 50% depends on the drivers-driving habits of opposite vehicle. The higher number rate of traffic accidents shows that the dominant cause of accidents is due to the human factor. The physical condition such as tiredness or feeling sleepy during driving is the primary problem according to the survey . It is observed that drivers due to nervousness don’t apply brake when they come to know that the vehicle is going to collide. To avoid such incidents there is a need for a system which can detect and respond accordingly. The proposed system aims to address the problem of the high number of road accidents caused by human errors. Despite advances in automobile safety technology, accidents caused by driver error continue to occur. While drivers can take precautionary measures and follow driving discipline to ensure their safety on the road, it is essential to recognize that other drivers' behavior and habits also play a significant role. Therefore, relying solely on individual driving habits and discipline guarantees only 50% of success, with the remaining 50% dependent on the actions of other drivers.

One prominent factor contributing to accidents is the human factor, which includes physical conditions such as tiredness or feeling sleepy while driving. According to surveys, these conditions significantly increase the risk of accidents. Additionally, nervousness or panic during critical situations can lead to drivers failing to apply brakes when they realize that a collision is imminent. To mitigate such incidents, there is a pressing need for a system that can detect potential

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collisions and respond accordingly, independent of human factors.

The system takes in the input as frames from the sensors, The frames are then transformed into required data by performing Gaussian blur and adjusting the contrast and contour of the frame. The transformed data is then sent to the lane detection module where the frames are used as input to draw the lane borders that are to be followed by the vehicle. The Canny's edge detection here plays an important role in determining the correct borders for the lane that is being followed by the vehicle. The previously transformed data is also sent to the object detection module where haar cascading helps in determining the crucial obstacles that are in front of the vehicle. Finally, both the modules are merged to determine the speed and brake percentage to be applied by the vehicle to be in a safe zone by determining the distance of the object from the vehicle by its increase in size in the frame. The brake percentage is also used to alert the driver regarding sudden braking.

The proposed system, which integrates an autonomous braking system using artificial intelligence and reinforcement learning, addresses these challenges. By leveraging AI algorithms and sensors such as radar, lidar, and cameras, the system can collect and process real-time data about the surrounding environment. This data is then analyzed to accurately identify potential collision risks, even in situations where drivers may be unable to react appropriately due to fatigue, panic, or other human limitations.

To overcome the problem of high number of road accidents due to human error, an Autonomous Braking System (ABS) for vehicles is proposed and implemented. The system primarily uses AI and RL technologies to replicate human intelligence with efficient decision making through continuous feedback and analytics. The block diagram of the proposed system with its various key components is shown in Fig. 1.

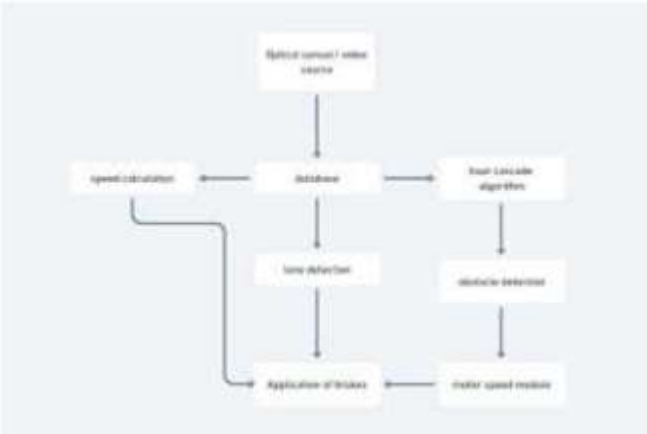

Figure 1: Proposed Autonomous Braking System

The step-by-step development of proposed system involves several stages, including hardware design, software development, data collection, training, and evaluation. The following methodology is followed in this project:

Hardware Design: A sensor and camera system are designed and implemented to gather data about the environment and the behaviour of other vehicles on the road. The system is designed to be compatible with the existing infrastructure of automobiles.

Software Development: A machine learning algorithm is developed to process the data from the sensors and cameras in real-time and make informed decisions about braking. The algorithm is designed using Python and TensorFlow, a popular open-source machine learning library.

Data Collection: Real-world data is collected using the sensor and camera system. The data includes information about the environment, the behavior of other vehicles on the road, and the performance of the ABS.

Training: The machine learning algorithm is trained using the real-world data to identify potential hazards and make decisions to prevent or minimize the impact of a collision. The training involves reinforcement learning, where the algorithm learns from its interactions with the environment.

Evaluation: The performance of the ABS is evaluated in simulated and real-world scenarios to assess its effectiveness in preventing accidents. The evaluation involves testing the ABS under different driving conditions and scenarios.

Optimization: The ABS is optimized for maximum efficiency and effectiveness in different driving conditions and scenarios. The optimization involves fine-tuning the machine learning algorithm and hardware design to improve the performance of the ABS.

IV. CONCLUSION AND FUTURE SCOPE

The Autonomous Braking System for Automobile powered by Artificial Intelligence and Reinforcement Learning is an innovative advancement with the potential to revolutionize the automobile industry. By utilizing machine learning algorithms, this system can accurately predict potential collisions and autonomously apply the brakes to prevent accidents. This development carries significant implications for both driver safety and convenience. As the number of vehicles on the road continues to increase, so does the risk of collisions and accidents. Implementing the autonomous braking system can help mitigate these risks and enhance road safety for everyone.

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One of the key advantages of using artificial intelligence and reinforcement learning in this system is the ability to continuously improve and adapt. The system can learn from its experiences, making it capable of enhancing its performance over time. This continuous learning and adaptation feature further enhances the safety and reliability of the system. It represents a remarkable example of how technology can be harnessed to improve our lives, and it marks a significant stride forward in the field of autonomous driving.

To ensure the system's effectiveness, ongoing research and development efforts will focus on improving the accuracy and reliability of collision detection algorithms. This will involve refining sensor technology, optimizing data processing algorithms, and minimizing false positives or false negatives. Additionally, future systems may incorporate more sophisticated AI models that better comprehend complex driving environments, including diverse weather conditions, road signs, traffic signals, and pedestrian behavior.

Integrating the autonomous braking system with Vehicle-to-Everything (V2X) communication technology can provide real-time updates about potential collision risks by enabling vehicles to exchange information with other vehicles, infrastructure, and pedestrians. This integration enhances the system's effectiveness and responsiveness to dynamic driving situations.

Reinforcement learning algorithms can be designed to facilitate continuous learning and adaptation to new scenarios and driving conditions. This adaptive capability enables the autonomous braking system to become more robust and effective over time, further enhancing safety on the roads.

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