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Emergency Vehicle Detection in Heavy Traffic Using Computer Vision

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A B S T R A C T

Recent advances in Computer Vision technology have revolutionized the field of Intelligent Transportation Systems. Applications range widely, from self-driving vehicles to traffic monitoring systems. Most applications entail at least simple, if not advanced image or video analytics at a fundamental level. This paper is an attempt to examine the use of object detection and instance segmentation for emergency vehicle detection, which is indispensable to any Intelligent Transportation System. More particularly, emergency vehicle detection can be programmed into autonomous vehicles as well as traffic signal controllers for preferential signal switching upon encountering emergency vehicles. The architectures implemented are Faster RCNN for object detection and Mask RCNN for instance segmentation. These implementations' computational outcomes, accuracy, andmost importantlysuitability for emergency vehicle recognition under chaotic traffic settings are discussed. Again, using the example of emergency vehicle identification, the object detection approach is compared to instance segmentation and the benefits and drawbacks of each are discussed.

Keywords: Emergency Vehicle Detection, Computer Vision, Object Detection, Instance Segmentation, Convolutional Neural Network, Faster RCNN, Mask RCNN.

1. Introduction

The development of artificial intelligence and computer vision technologies has given research in a number of domains a new direction. As a result, the automotive sectors have seen remarkable, continuous technical advancements over the past ten years. These technological developments have given rise to autonomous and intelligent vehicle systems.

However, the road traffic deaths pose significant challenge to it. World Health Organization (WHO) estimates the road traffic death in India to be 22.6 per 1,00,000 population. Several factors like lousy drivers, appalling road conditions, ignorance of the traffic rules, inability to understand the present road situation and making correct decision instantly, may contribute to the road crashes and the eventual deaths. Thus, an Intelligent Vehicle System has become inexorable in the today's world which will provide an aid to the driver for dealing with road classification recognising difficult driving conditions and warning the driver of the likely collision. Similar to a human, an autonomous vehicle must have an effective method for analyzing its environment and making judgements. a system for effective vehicle identification and segmentation, as well as one that can recognise lane-filled road scenarios pedestrians, traffic divider, potholes and speed bumps forms the basis of the realizing an intelligent vehicle system.

Vehicle detection and road scene tracking also marks its significance in Intelligent Transport Systems (ITS), It seeks to make use of the transportation networks intelligently. Several tasks associated with ITS like traffic analysis, detecting an emergency vehicle, surveillance, automatic toll collection, and generating e-challan, are realized with the help of vehicle detectionSuch significant applications have motivated the researchers to explore proficient methods of vehicle detection using various deep learning models for computer vision and feature based analysis. Despite the fact that there are several cutting-edge approaches for object detection, segmentation for detection improves the training process, detection effectiveness, and object boundary specification. Also, it has the benefit of not including any additional background information, which is a significant disadvantage of bounding box-based object recognition.
Thus, use of segmentation has been explored for numerous applications of object detection, for instance in the segmentation technique is employed to detect various layers of cornea, similarly and provide segment-based target detection approaches for detecting robots and people, respectively.

2. Literature Review

2.1. Emergency Vehicle Detection on Heavy Traffic Road from CCTV Footage Using Deep Convolutional Neural Network.

According to the paper, it proposes a method for detecting emergency vehicles in heavy traffic from CCTV footage using a deep convolutional neural network (CNN). The authors argue that detecting emergency vehicles in heavy traffic is challenging due to occlusion, changing lighting conditions, and the presence of other vehicles. The authors suggest a deep CNN architecture to overcome these difficulties and reliably identify emergency vehicles in real-time. The suggested method was tested against existing state-of-the-art techniques using a publicly accessible dataset, and the findings indicated that it performed better. The authors conclude that their method has the potential to improve emergency vehicle response times in heavy traffic and can be used for traffic management and emergency services. Overall, the research exhibits the potential of deep learning approaches and emphasises the significance of creating effective solutions for emergency vehicle recognition in dense traffic [1].

2.2. Adaptive and Optimized Emergency Vehicle Dispatching Algorithm for Intelligent Traffic Management System.

In this paper, it proposes an emergency vehicle dispatching algorithm for intelligent traffic management systems. The authors contend that the real-time traffic circumstances are not taken into account by the present emergency vehicle dispatching systems, which causes response times to be delayed and places emergency responders at greater danger. The authors suggest an adaptive and optimal dispatching algorithm that takes into consideration current traffic circumstances and the priority of emergency response in order to overcome these issues.A simulation model was used to test the suggested method, and the findings revealed that it surpassed current attempting to cut dispatching algorithms in terms of reaction time and emergency vehicle usage.The authors conclude that their method can improve the efficiency and effectiveness of emergency vehicle dispatching, reduce response times, and ultimately save lives. Overall, the paper highlights the importance of integrating real-time traffic information and emergency response priorities into dispatching algorithms for intelligent traffic management systems. The proposed algorithm has the potential to revolutionize emergency response systems and enhance public safety [2].

2.3. Emergency Vehicle Recognition and Classification Method Using HSV Color Segmentation.

The base paper proposes a method for recognizing and classifying emergency vehicles using HSV color segmentation.The authors contend that lighting circumstances and aesthetic differences impose restrictions on conventional approaches to emergency vehicle detection, such as template matching and feature-based techniques. To address these challenges, the authors propose a method based on HSV color segmentation, which is less affected by variations in lighting conditions. Using a dataset of photos of emergency vehicles, the suggested technique was tested, and the results revealed that it performed better than previous methods in terms of accuracy and robustness to lighting conditions. The authors conclude that their method has the potential to improve emergency vehicle recognition and classification for applications such as traffic management, emergency response, and public safety. Overall, the paper highlights the importance of developing efficient and robust methods for emergency vehicle recognition and classification, and demonstrates the potential of color segmentation techniques [3].

2.4. Implementing Intelligent Traffic Control System for Congestion Control, Ambulance Clearance and Stolen Vehicle Detection.

The objective of this paper proposes an intelligent traffic control system (ITCS) that integrates three key functionalities: congestion control, ambulance clearance, and stolen vehicle detection.The authors argue that current traffic control systems do not effectively address these three critical issues, resulting in increased traffic congestion, delayed ambulance response times, and increased risks of vehicle theft. To address these challenges, the authors propose an ITCS that uses a combination of sensor networks, image processing, and machine learning algorithms to monitor traffic flow, detect emergency vehicles, and identify stolen vehicles. A simulation model was used to test the suggested system, and the findings revealed that it surpassed current snipping traffic control systems in terms of reducing congestion, ambulance clearance times, and rates of stolen car identification. The authors conclude that their ITCS has the potential to revolutionize traffic management and enhance public safety. Overall, the study illustrates the potential of intelligent systems and emphasises the value of incorporating diverse features into traffic management systems [4].

2.5. Leveraging Computer Vision for Emergency Vehicle Detection Implementation and Analysis.

The base paper proposes a computer vision-based method for detecting emergency vehicles on the road.According to the authors, conventional techniques of identifying emergency vehicles, such as radio transmission and sirens, have limits and can be inaccurate in some circumstances.To address these challenges, the authors propose a computer vision-based method that uses a combination of image processing techniques and machine learning algorithms to detect emergency vehicles in real-time. The suggested technique was tested and assessed using a dataset of traffic films, and the findings revealed that it performed better in terms of detection accuracy and speed than current state-of-the-art methods. The authors conclude that their method has the potential to improve emergency response times and enhance public safety by providing more accurate and reliable detection of emergency vehicles. Overall, the paper highlights the importance of leveraging computer vision techniques in emergency vehicle detection and demonstrates the potential of these methods [5].

2.6. Traffic Management for Emergency Vehicle Priority Based on Visual Sensing.

The base paper proposes a method for managing traffic and prioritizing emergency vehicles using visual sensing techniques.The authors argue that current methods of emergency vehicle prioritization, such as audible alarms and radio communication, can be unreliable in heavy traffic or noisy environments. To address these challenges, the authors propose a method that uses visual sensing techniques to detect emergency vehicles and communicate their presence to a centralized traffic management system. The suggested method's effectiveness in prioritizing emergency vehicles and reducing their response times was determined by testing it in a simulated urban traffic situation. The authors conclude that their method has the potential to improve emergencyresponse times and reduce the risks associated with emergency vehicle travel in heavy traffic. Overall, the research illustrates the potential of visual sensing techniques in tackling significant difficulties in emergency services and significant figure of incorporating these approaches into traffic management systems [6].

2.7. Density Based Smart Traffic Light Control System and Emergency Vehicle Detection Based on Image Processing.

This paper proposes a method for smart traffic light control and emergency vehicle detection using image processing techniques. According to the authors, conventional traffic signal control systems are ineffective, which can worsen traffic congestion and cause delays for emergency vehicles.The authors suggest a method that employs density-based traffic light regulation and image processing-based emergency vehicle recognition to overcome these difficulties. The proposed system was evaluated on a simulated traffic environment, and the results showed that it effectively reduced traffic congestion and improved emergency vehicle response times. The authors conclude that their system has the potential to revolutionize traffic management and emergency response by providing more efficient and reliable control of traffic flow. Overall, the study emphasises the need of creating intelligent traffic control systems and shows how image processing techniques may be used to handle difficult problems in traffic management and emergency services. the research reflects the need of creating intelligent traffic control systems and shows how image processing techniques may be used to handle complicated issues in traffic management and emergency services [7].

2.8. Intelligent Traffic Management System for Prioritizing Emergency Vehicles in a Smart City.

This base paper proposes an intelligent traffic management system that prioritizes emergency vehicles in a smart city.The authors contend that the way in which present traffic management systems prioritise emergency vehicles causes response times to be delayed and the hazards to public safety to grow.To solve these issues, the authors suggest a system that employs a mix of sensors, communication networks, and machine learning algorithms to recognize emergency vehicles and prioritise their passage through traffic. The proposed system was evaluated on a simulated smart city environment, and the results showed that it effectively reduced emergency vehicle response times and improved public safety. The authors draw the conclusion that their approach has the potential to completely transform emergency response and traffic management in smart cities.Overall, the article exhibits the potential of intelligent systems in tackling important difficulties and emphasises the significance of incorporating cutting-edge technologies into traffic management systems[8].

2.9. PLC Based Traffic Control System with Emergency Vehicle Detection and Management.

This paper proposes a traffic control system that incorporates emergency vehicle detection and management using Programmable Logic Controllers (PLCs). The authors argue that traditional traffic control systems are inefficient and cannot effectively manage emergency vehicle passage through traffic. The authors suggest a system that employs PLCs to detect emergency cars and adjust traffic lights in order to overcome these issues. The proposed system was evaluated on a simulated traffic environment, and the outcomes demonstrated that it significantly lowered traffic congestion and enhanced the response times of emergency vehicles.The authors come to the conclusion that their technology has the potential to change traffic management and emergency response by making it possible for more reliable and effective regulation of traffic flow. The article illustrates the possibilities of PLC-based systems and emphasises the significance of integrating cutting-edge technology into traffic control systems.Overall, the article exhibits the potential of intelligent systems in tackling important difficulties and emphasises the significance of incorporating cutting-edge technologies into traffic management systems [9].

2.10. Vehicle Detection through Instance Segmentation using Mask R-CNN for Intelligent Vehicle System

In recent years, there has been a lot of interest in the application of vehicle detection for intelligent vehicle systems using instance segmentation utilizing Mask R-CNN. In this method, automobiles are detected and segmented in real-time from video or picture data using a deep learning algorithm. The Mask R-CNN algorithm has been found to be particularly effective in this area, as it provides both object detection and instance segmentation capabilities. The MaskR-CNN technique for vehicle recognition in intelligent vehicle systems has been implemented in a variety of ways, according to several research projects and articles published on the subject. These publications examine the efficacy of this method in enhancing the precision and effectiveness of vehicle recognition, as well as its prospective applications in domains including traffic monitoring and autonomous driving. This research serves as an example of the potential benefits of instance segmentation-based vehicle recognition for intelligent vehicle systems, including increased safety, better traffic flow, and reduced congestion [10].

3. Conclusion

Two different algorithms in computer vision, object detection and instance segmentation, have been described for emergency vehicle detection and localization. Both algorithms can be used for applications in intelligent transportation systems, such as the deployment of smart traffic signals and autonomous cars, as they are effective at distinguishing an emergency vehicle from a group of vehicles.The application uses the design that was created in order to separate the emergency vehicles from most other vehicles. When the computer determined the detained automobile was an emergency vehicle and "a notification made to the traffic controller," we were able to successfully convince the computer to change one traffic light to green while other traffic lights were set to red.

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