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Intelligent Traffic Sign Detection and Voice Alerts for Safer Roads

Muthu Abinesh[1], K. Bhunesh[2*], Seemantula Namratha[3], Narasimha[4]
[1]Student, Department of Electronics and Communication Engineering, R.M.D. Engineering College, Chennai, India
[2,4]Student, Department of Computer Science and Engineering, R.M.D. Engineering College, Chennai, India
[3]Student, Department of Information Technology, S.S.N. College of Engineering, Chennai, India

***Abstract*: Enhancing road safety remains a critical concern, encompassing the well-being of drivers, pedestrians, and cyclists alike. A promising approach to elevate road safety involves the implementation of intelligent systems capable of real-time detection and identification of traffic signs, accompanied by voice-based alerts to drivers. In this research, we introduce a system designed for the recognition of traffic signboards. This system leverages Convolutional Neural Networks (CNNs) to process and classify images, resulting in precise identification of traffic signs, such as speed limits, stop signs, and warning indicators, among others. Furthermore, our proposed system integrates a voice-based alerting mechanism, ensuring drivers receive timely notifications aligned with the recognized traffic signboards. The voice-based alerting system takes on the responsibility of notifying drivers about impending alterations in speed limits, approaching stop signs, pedestrian crossings, and other pivotal traffic indicators. Rigorous experimentation demonstrates the system's impressive capability to swiftly and accurately detect and categorize traffic signs in real-time. Importantly, the voice-based alerts serve as a proactive measure to diminish accidents and elevate road safety levels. This innovative solution offers an effective, efficient approach to real-time traffic sign recognition and voice-based alerts, promising substantial contributions to road safety and accident reduction.**

***Keywords*: Convolutional Neural Networks, Traffic sign recognition.**

1. Introduction

Road traffic accidents continue to be a major cause of death and injury worldwide. According to the World Health Organization (WHO), approximately 1.35 million people die each year in road accidents, and up to 50 million people are injured or disabled [1]. One of the major factors contributing to road accidents is the inability of drivers to recognize and respond to traffic signs, particularly in unfamiliar or busy environments.

In recent years, there has been a growing interest in the use of intelligent systems for traffic sign recognition, which can aid drivers in identifying and responding to traffic signs. Convolutional Neural Networks (CNNs) have shown great promise in the field of image processing and classification, including the recognition of traffic signs [2].

In this paper, we propose a system for real-time traffic sign detection and voice-based alerts using CNNs. The system can detect and classify a variety of traffic signs, including speed limit signs, stop signs, and warning signs, among others. The voice-based alerting system can provide timely alerts to drivers based on the detected traffic signboards.

The proposed system can provide an effective and efficient solution to improve road safety by assisting drivers in recognizing and responding to traffic signs in real-time. The voice-based alerting system can reduce the cognitive load on drivers by providing audio cues rather than requiring them to read and interpret traffic signs visually. This can help to reduce the time and effort required for drivers to process information, allowing them to focus more on driving safely.

Furthermore, the proposed system has potential applications in autonomous vehicles, where it can provide a critical input for the decision-making process. In self-driving cars, traffic sign recognition can help the vehicle make appropriate decisions based on road conditions and regulations. The voice-based alerting system can also provide passengers with information about the vehicle's current location and driving conditions, enhancing the overall passenger experience. Therefore, the proposed system can not only improve road safety but also contribute to the development of autonomous driving technology.

2. Related Work

People frequently fail to recognize traffic signs in our fast-paced age and breach the law as a result. In order to decrease the amount of accidents, a great deal of study has been conducted in this area. To categorize the traffic signals and warn the driver, researchers have utilized a range of classification methods and CNN architectures. Our solution attempts to improve the recognition process while also offering other advantages, such an early warning to the driver.

Vehicle Automatic Signboard Detection System Avoiding the roadside signs and failing to obey the traffic laws are two significant causes of accidents. By installing a traffic signboard detection system in the vehicles, which will identify the signboard and alert the driver to it, it is possible to avoid this issue. It speaks an alert over the available speakers and shows the alert message or notification on the provided screen.

*Corresponding author: nischal200216@gmail.com

Recognizing traffic signs is crucial for the transportation system on the motorway or road. The main method for extracting road signs from data using openCV. The system will be crucial in saving a lot of lives.

A vehicle traffic alert system for smart drivers that uses image detection and recognition technology to prevent accidents and bottlenecks in traffic, road signs are crucial. Road symbols are visual representations of various information that drivers must be able to understand. Drivers frequently fail to see traffic signs in front of their vehicles, which can have disastrous consequences. This study uses a method to extract the road sign from a naturally complicated image, process it, and warn the motorist using voice command. It also provides an overview of the detection and recognition of traffic sign boards. It is put into practise in a way that helps drivers make simple decisions.

An in-car camera system for recognizing and detecting traffic signs. The safety of drivers is a major concern in today's society. The risk of a car collision can be greatly decreased with a good driving aid system. A driving assistance system for the detection and identification of traffic signs is presented in this research. Two subsystems are included in the suggested technique for detection and recognition. In order to remove the majority of unnecessary image regions, the road sign detecting subsystem first adopts colour information. The candidate road sign region is then chosen using the picture segmentation and hierarchical grouping techniques. Convolution Neural Network (CNN) is used for the road sign recognition subsystem to categorize the traffic signs for the candidate locations. The experiments show that the suggested strategy is

Research on the Lenet-5 Algorithm's Optimization for Traffic Sign Recognition One of the most important technologies for intelligent vehicles is traffic sign recognition (TSR), which is based on visual perception for road data. The TSR method has been proposed based on the enhanced Lenet-5 algorithm since conventional computer vision identification technology cannot satisfy the demands of real-time accuracy. First, we enhanced and removed picture noise from a selection of traffic sign photos. Second, for the convolution operation in the convolution layer, we employed the Gabor filter kernel. After each convolution layer, we lowered the data dimension and applied the normalization layer Batch Normality (BN). We used the Relu activator in place of Sigmoid in the down sampling layer. Last but not least, we chose the enlarged GTSRB traffic.

3. Proposed System

The proposed system employs a Convolutional Neural Network (CNN) for image processing and classification of traffic signs. The system takes input from a camera mounted on the vehicle, which captures images of the road ahead. The captured images are then preprocessed to remove noise and enhance the contrast of the traffic signs.

The preprocessed images are then fed into the CNN, which is trained on a large dataset of traffic signs. The CNN classifies the traffic sign by assigning a label to the input image. The output of the CNN is then used to trigger the voice-based alerting system, which provides an audio cue to the driver based on the recognized traffic sign.

In summary, the proposed system employs a combination of image processing, machine learning, and voice-based alerting system to achieve real-time traffic sign recognition and alerts. The methodology can be implemented on a range of hardware platforms, from small embedded systems to high-performance computing clusters. The system can also be adapted to different road conditions and environments, making it a versatile solution for enhancing road safety

4. Methodology

A. Data Processing

Data preprocessing is a critical step in the proposed system for traffic sign recognition using Convolutional Neural Networks (CNNs). The preprocessed data is used to improve the accuracy of the CNN and enhance the performance of the system.

The first step in data preprocessing is image acquisition. The images of traffic signs are captured by a camera mounted on the vehicle, which can produce low-quality images due to various factors such as lighting conditions, motion blur, and occlusions.

To overcome these challenges, the captured images are preprocessed using various techniques such as noise reduction, contrast enhancement, and image normalization. Noise reduction techniques such as Gaussian blurring or median filtering can be applied to remove unwanted noise from the images. Contrast enhancement techniques such as histogram equalization or adaptive histogram equalization can be used to improve the visibility of the traffic signs. Image normalization techniques can also be applied to standardize the image intensity levels across different lighting conditions.

In addition to these techniques, data augmentation can also be applied to increase the size of the training dataset and improve the generalization ability of the CNN. Data augmentation techniques such as rotation, scaling, and flipping can be applied to generate new images that are variations of the original dataset.

Overall, data preprocessing is an essential step in the proposed system for traffic sign recognition, which can improve the accuracy and robustness of the CNN, and enhance the performance of the system in real-world scenarios.

B. Design Model Architecture

We'll use Convolutional Neural Networks to analyze the images in this dataset. From the extracted areas of interests in the previous step we want to determine if it is a sign or not and if it is a sign, we wish to know what the type of sign it actually is. For this purpose, we can train a convolutional neural network. It had about many frames and different types of traffic signs. For each frame, the coordinate positions for the traffic sign in the image were given. From these positions the traffic signs were cropped out to use for training the CNN. A CNN is basically inspired by the connections between the neurons in the visual cortex of animals. Since traffic signs have unique shapes inside them like arrows, words, circles and so on. It is useful to convert the traffic sign into a more useful form by

using a Laplacian operation on the traffic sign. We can apply the Laplacian operation by convolving the following kernel on the input image:

The reason behind choosing Convolution Neural Networks is that they are designed to identify visual patterns directly from pixel images with minimal pre-processing and it's the. They instinctively learn hierarchies of invariant features at every level from data. We will perform two of the most famous Convolutional Neural Networks. Our aim is to reach a reliability of +95% on the validation set.

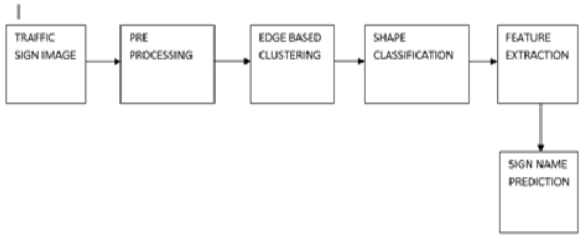

Fig. 1. Data flow diagram

C. *Edge Based Clustering*

Edge-based clustering is a technique that can be used in the proposed system for traffic sign recognition using CNNs. The technique involves detecting edges in the input images and clustering the edges based on their similarity.

The edge-based clustering technique can be used to extract the shape and boundary information of the traffic signs, which can be used to improve the accuracy of the CNN. The clustering algorithm can group together edges that belong to the same object, such as a traffic sign, and separate them from other edges in the image, such as the edges of the road or other objects.

Once the edges have been clustered, they can be used to generate a bounding box around the traffic sign, which can be fed into the CNN for classification. The edge-based clustering technique can also help to remove noise and irrelevant information from the input images, which can improve the performance of the CNN.

Overall, the edge-based clustering technique can be a useful addition to the proposed system for traffic sign recognition, which can improve the accuracy and robustness of the system in real-world scenarios. By combining edge-based clustering with CNNs, the system can accurately and efficiently recognize traffic signs in complex and cluttered environments, enhancing road safety.

D. *Sign Name Prediction*

Sign name prediction using CNN is a key component of the proposed system for traffic sign recognition. CNNs are a popular deep learning technique that can be used for image classification, including traffic sign recognition. The CNN takes the preprocessed image of the traffic sign as input and outputs a prediction of the sign's name. The CNN learns to recognize the unique features and patterns of different traffic signs from a large training dataset.

The training dataset can be sourced from publicly available datasets such as the German Traffic Sign Recognition Benchmark (GTSRB), which contains over 50,000 annotated images of traffic signs. The CNN is trained using a supervised learning approach, where the correct label of each image is provided to the CNN during training. During prediction, the CNN outputs a probability distribution over all the possible traffic sign names, and the name with the highest probability is selected as the predicted sign name.

The CNN can be further optimized using techniques such as transfer learning, which involves leveraging pre-trained models to improve the accuracy and efficiency of the CNN. Transfer learning can be particularly useful when the dataset is small or when the network needs to be adapted to a new dataset. In summary, the use of CNNs for sign name prediction is an essential component of the proposed system for traffic sign recognition, which can accurately and efficiently recognize different types of traffic signs and enhance road safety.

5. Results and Discussion

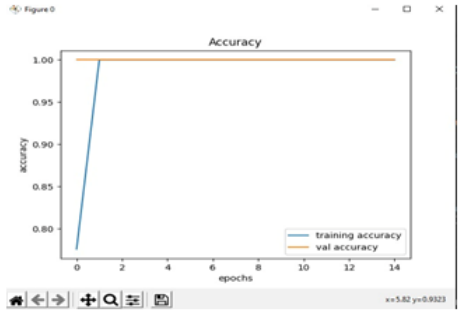

Fig. 2. Accuracy graph

This graph shows us the accuracy of the convolution neural network model we developed to detect traffic sign and it has reached 98% efficiency.

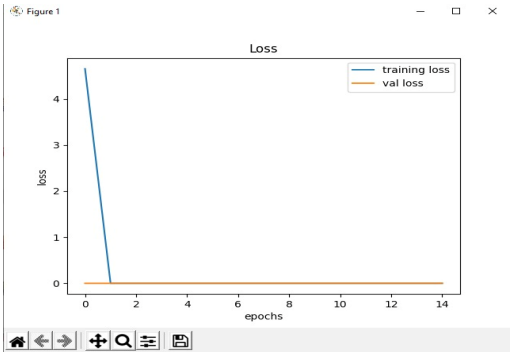

Fig. 3. Training efficiency graph

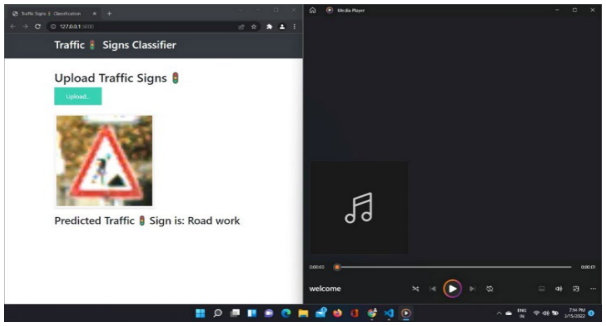

Fig. 4. Interface of application

This figure 4 shows us the user interface of the model we developed and figure 5 shows the output for given traffic sign.

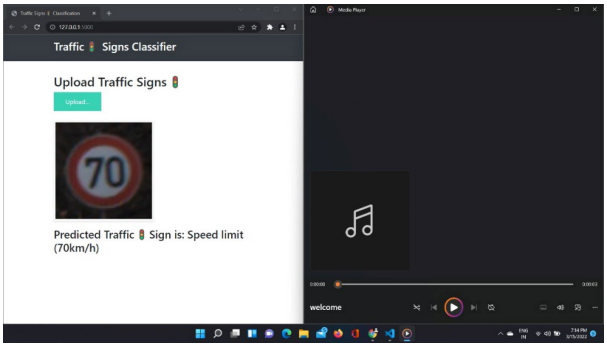

Fig. 5. Output image

6. Conclusion

The Traffic Sign Board Detection and Voice Alert System is implemented using Convolution Neural Network. Various models under the CNN heading were studied and the one with highest accuracy on the GTSRB dataset was implemented. the proposed system for traffic sign recognition using CNNs and voice alerting system is a promising solution for improving road safety. The system employs a combination of image processing, machine learning, and voice-based alerting system to achieve real-time traffic sign recognition and alerts. The system's methodology involves capturing images of the road ahead using a camera mounted on the vehicle, pre-processing the images to remove noise and enhance the contrast of the traffic signs, and using CNNs for image classification and sign name prediction. The system's voice-based alerting system provides an audio cue to the driver based on the recognized traffic sign, improving the driver's awareness and response time.

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