Traffic Sign Detection Under Foggy Environment Using Machine Learning

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Abstract –

Road signs are important to ensure smooth traffic flow without bottle necks or mishaps. Road symbols are the pictorial representations having different necessary information required to be understood by driver. Road signs in front of the vehicle are ignored by the drivers and this can lead to catastrophic accidents. This paper presents an overview of the traffic sign board detection and recognition and implements a procedure to extract the road sign from a natural complex image, processes it and alerts the driver using voice command It is implemented in such a way that it acts as a boon to drivers to make easy decisions. Traffic sign recognition is a critical component of modern intelligent transportation systems, contributing to road safety and efficient traffic management. This paper presents a novel approach to traffic sign recognition based on Convolutional Neural Networks (CNNs).

Key Words*: *CNN, Pre-processing, Feature Extraction.

1.INTRODUCTION

In foggy environments, detecting traffic signs becomes a critical challenge due to reduced visibility and degraded image quality. To address this issue, a combination of dehazing techniques and convolutional neural networks (CNNs) offers a promising solution. By leveraging advanced algorithms to remove haze from images and training CNN models to detect traffic signs, we can enhance visibility and accurately identify crucial road signs even in adverse weather conditions. This integrated approach not only improves road safety but also enables efficient traffic management systems in foggy environments, ultimately contributing to safer and more reliable transportation networks.

Visibility is greatly reduced in foggy situations, which presents a considerable challenge to traffic sign detection systems. Fog causes images to have blurry edges, low contrast, and general quality degradation, which makes it difficult for conventional computer vision algorithms to recognise and locate traffic signs. However, there are hopeful answers to this issue thanks to developments in machine learning and image processing techniques.

A. Traffic Sign Detection

It is quite difficult to detect traffic signs in foggy circumstances since vision is diminished and visual elements are distorted. Under such circumstances, the light scattering caused by airborne water droplets reduces contrast and sharpness in photographs, making object differentiation challenging. Furthermore, objects' colours and shapes get warped, making detection much more difficult. These difficulties make it difficult for traditional computer vision techniques, such as edge detection and colour segmentation, to function well in foggy settings. Recent developments in deep learning, however, have demonstrated encouraging outcomes in reducing these problems. Fog is one of the many meteorological situations that can be found in datasets used to train Convolutional Neural Networks (CNNs). Even under minimal visibility, these networks are able to learn to extract relevant information. Overall, while detecting traffic signs in foggy environments remains a challenging task, advancements in deep learning and sensor fusion techniques offer promising solutions for improving the accuracy and reliability of such systems.

B. Eliminating haze from the image

Getting rid of haze from photos is essential for increasing clarity and improving the quality of the image, notably in computer vision, remote sensing, and photography applications. Numerous techniques have been devised for this objective. A popular method is the black Channel Prior, which takes advantage of the statistical finding that there are black pixels in outdoor photos even when there is haze. The dark channel is obtained by finding the least intensity in a local window for each colour channel. This allows assessment of the thickness and strength of the haze layer. Estimating the ambient light, or the hue and intensity of light scattered by the haze, is another crucial factor. Removing the haze layer accurately requires knowledge of this information.

In addition, haze removal heavily relies on transmission map estimation. The percentage of light that reaches the camera unbroken by haze is shown on the transmission map. It is possible to efficiently eliminate the haze layer by estimating this map. A number of techniques, such as assessing the scene depth and employing the dark channel prior, can be used to construct transmission maps.

Additionally, methods based on deep learning have demonstrated encouraging outcomes in the dehazing of images. To discover the mapping between two sets of hazy and haze-free photos, convolutional neural networks (CNNs) are trained on these pairs of images. Generative Adversarial Networks (GANs), a CNN variant, have also been used for dehazing. These techniques frequently work better, especially in intricate scenes with a range of haze and scene information.

C. Using computer vision feature extraction methods

This is an early approach in which many algorithms and methodologies were proposed by computer vision scientists prior to the advent of machine learning. Methods such as Histogram Oriented Gradients (HOG) were first developed for the detection of pedestrians; gradients of colour images are computed along with various normalised, weighted histograms. Scale Invariant Feature Transform (SIFT) was employed for classification, and a sliding window approach was used to accomplish both detection and classification tasks concurrently

In the area of computer vision and computer graphics, a simplified atmospheric scattering model is widely used to explain the cause of formation of a hazy image.

$$I(x) = J(x)t(x) + A(1-t(x)) \quad (1)$$

where I (x) is the image which need store move haze, J (x) is the image which has been dehazed A is the global atmospheric light, and t(x) is the transmission. J (x) t (x) describes the scene radiance and its decay in the medium, called direct attenuation, A(1 − t (x)) is called air light which results from previously scattered light and leads to the shift to the scene color. Here I (x) is the only known condition, and the purpose of haze removal Is to recover J (x) by calculating A and t(x) from I (x).

C. Convolutional Neural Network (CNN)

Convolutional Neural Networks (CNNs) play a key role in providing dependable performance in the field of traffic sign detection in foggy situations, even in the face of obstacles including reduced visibility and distorted visual features. To replicate foggy situations, first datasets consisting of pictures of traffic signs in different weather conditions—including fog—are gathered and enhanced. Preprocessing methods such as atmospheric scattering models or dark channel prior are then used to reduce haze and improve visibility. Next, a mixture of clear and foggy weather photos are used to choose and train CNN architectures specifically designed for object recognition, such as You Only Look Once (YOLO), Single Shot Detectors (SSD), and Region-Based CNNs (R-CNN). The CNN can now learn discriminative characteristics even in cloudy conditions thanks to this

training.

2. BODY OF PAPER

Due to the substantial research efforts and the use of diverse datasets, comparing past research in traffic sign detection poses challenges. Researchers have tackled various tasks such as detection, classification, and tracking, each using different datasets. This diversity makes it difficult to directly compare the effectiveness and performance of different approaches.

Md Tarequl Islam [3] introduces a system for detecting and categorizing various traffic signs from images, using a broad range of globally recognized signs. Unlike previous approaches, this system employs two distinct neural networks—one for sign classification and another for shape recognition. Training datasets are constructed through image augmentation techniques, with 40,000 images used for training. The first classifier is trained with 28,000 positive images featuring signs and 12,000 negative images without signs, while the second classifier utilizes 2,400 positive and 1,200 negative images. Image processing methods identify regions of interest, which are then analyzed by the CNN classifiers for classification.

A.D. Kumar and colleagues presents an innovative approach to traffic sign detection, employing capsule networks. These networks utilize capsules, which are groups of neurons representing object instantiation parameters such as pose and orientation, along with dynamic routing and route by agreement algorithms[1].

The above study's primary focus is to eliminates the need for manual feature extraction and addresses the issue of deep neural networks' susceptibility to spatial variances and adversarial attacks. Capsule networks offer increased reliability in traffic sign detection for autonomous vehicles by providing resistance to such attacks. The model proposed in the paper achieved a remarkable accuracy of 97.6% on the German Traffic Sign Recognition Benchmark dataset (GTSRB), establishing it as a state-of-the-art solution in the field.

By incorporating a vehicle's viewing distance and accounting for the effects of haze, the research proposes a practical method for identifying traffic signs in real-world scenarios. These findings carry significant implications for the advancement of autonomous driving systems and the overall enhancement of road safety, underscoring the importance of effectively identifying traffic signs, especially in challenging environmental conditions like haze. Dr. Ashok T. Gaikwad conducted and offers valuable insights into enhancing traffic sign recognition in hazy environments, which could significantly improve road safety[2].

Chao Fengbe worked on method for detecting speed limit signs under hazy conditions. Their approach involves three primary stages: haze removal, localization of speed limit signs, and sign recognition. They employ the dark channel prior technique for haze removal, while sign localization is achieved through Histogram of Oriented Gradient (HOG) feature extraction and Support Vector Machine (SVM) classification. Sign recognition is carried out using a seven-layer Convolutional Neural Network (CNN)[3][4]. Experimental outcomes indicate improved performance compared to existing dehazing techniques, with a reduction in processing time. The method achieves a recognition rate of 98.51% for speed limit signs, surpassing human performance, and demonstrates robustness against distortions like rotation, shift, and scale[4].

Jiawei Xing present an improved framework in this work for traffic sign recognition (TSR) using the YOLOvS and Faster R-CNN algorithms. With extra assistance from satellite data, the method focuses on identifying road signs from the driver's point of view. Using guided image filtering, the technique preprocesses input images to reduce noise. Then, the suggested networks are used for model training and testing on the processed images. TSR system's results show encouraging results, indicating that it can be used in real-world circumstances with reasonable success[7].

A Practical Approach of Recognizing and Detecting Traffic Signs using Deep Neural Network Model presents an effective strategy for traffic sign recognition and detection through deep neural networks. It focuses on developing a reliable solution for real-world scenarios by utilizing advanced learning techniques. The study likely outlines the methodology, including data preprocessing, model design, training, and evaluation. It may also discuss experimental results to validate the approach's effectiveness compared to existing methods. Overall, the paper provides valuable insights into applying deep neural networks to address challenges in transportation and road safety[6].

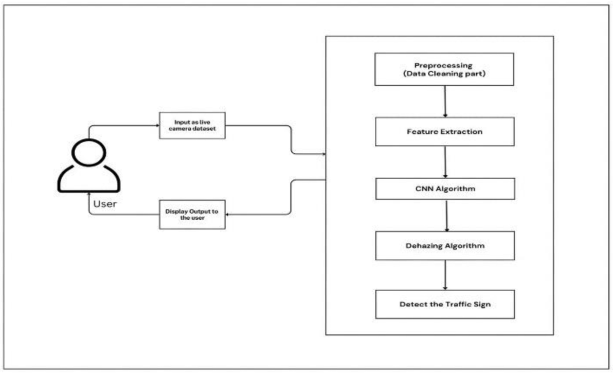

Figure 1. System Architecture

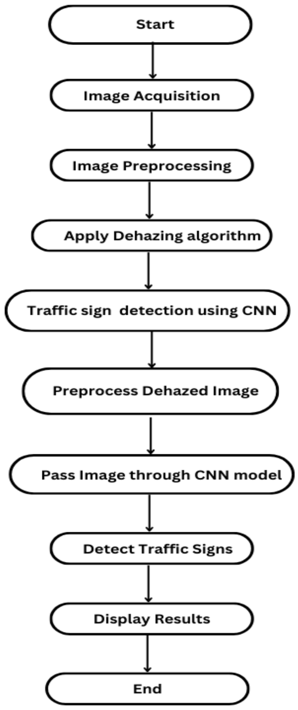

Figure 2: Flowchart

3. CONCLUSIONS

We suggest a smart driver warning system that speaks to the driver after identifying and detecting traffic signs from video stream input. We can safely control traffic and lower the number of traffic accidents by utilizing this technology. a system with the ability to recognize and categorize a variety of traffic signs in various settings. The results are mediocre, and they could be better by experimenting with other neural network configurations. Since a neural network is frequently referred to as a "black box," there is no assurance that the specified set will yield the optimal results. In the future, real-time detection and recognition may potentially be used. The part on future work describes potential avenues for expansion or study that could expand on your work.

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5. REFERENCES

[1]Amara Dinesh Kumar, R.Karthika, Latha Parameswaran " Novel Deep Learning Model for Traffic Sign Detection Using Capsule Networks"

[2]Ali Mansour Al-Madani, Dr. Asha Gaikwad, Vivek Mahale , and Dr. Ashok T. Gaikwad "Identifying traffic signs in a hazy environment using a vehicle's viewing distance"

[3]Md Tarequl Islam " Traffic sign detection and recognition based on convolutional neural networks"

[4]Gang Yana,b, Ming Yub, Shuo Shib and Chao Feng "The recognition of traffic speed limit sign in hazy weather"

[5]Uday Kamal, Thamidul Islam, Sowmitra Das, and, Md. Kamrul Hasan. "Automatic Traffic Sign Detection and Recognition Using SegU-Net and a Modified Tversky Loss Function with L1-Constraint".

[6]Geetha Rani E, Tanuep Bellam, Mounika E, Bhuvaneswari P. "A Practical Approach of Recognizing and Detecting Traffic Signs using Deep Neural Network Model".

[7]Jiawei Xing, Minh Nguyen, Wei Qi Yan "The Improved Framework for Trafc Sign Recognition Using Guided Image Filtering".

[8]P.H.Kassaniand A.B.J.Teoh, "A news parse model for traffic sign classification using soft histogram of oriented gradients," Appl. Soft Com put. J., vol. 52, pp. 231–246, 2017, doi: 10.1016/j.asoc.2021.

[9]Jack Greenhalgh and Majid Mirmehdi "Real-Time Detection and Recognition of Road Traffic Signs," IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS , VOL.13,NO.4 , DECEMBER 2021.

[10]Jung-Guk Park , Kyung-Joong Kim "A METHOD FOR FEATURE EX TRACTION OF TRAFFIC SIGN DETECTION
AND THE SYSTEM FOR REAL WORLD SCENE ," IEEE International Conference on Emerging Signal Processing Applications, 12-14 Jan. 2020.

[11]Sungho Kimh and Soon Kwon "Improvement of traffic sign recognition by accurate ROI refinement," 15th International Conference on Control, Automation and Systems (ICCAS 2021) Oct. 13-16, 2021 in BEXCO.

[12]Hurriyatul Fitriyah, Edita Rosana Widasari, Gembong Edhi Setyawan "Traffic Sign Recognition using Edge Detection and Eigen-face," International Conference on Sustainable Information Engineering and Technology (SIET), 2021.

[13]H. Fleyeh, E. Davami "Eigen-based traffic sign recognition," IET Intelligent Transport Systems (Volume: 5 Issue: 3 September 2021).

[14]Ioan Cristian Schuszter "A Comparative Study of Machine Learning Methods for Traffic Sign Recognition," 19th International Symposium on Symbolic and Numeric Algorithms for Scientific Computing (SYNASC), 2021.

[15]David Soendoro, Iping Supriana "Traffic Sign Recognition with Color-based Method, Shape-arc Estimation and SVM," International Conference on Electrical Engineering and Informatics 17-19 July 2022.

[16]Rongqiang Qian, Bailing Zhang, Yong Yue and Frans Coenen "Robust Chinese Traffic Sign Detection and Recognition with Deep Convolutional Neural Network," 11th International Conference on Natural Computation (ICNC), 2021.