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Driver Assistant Using Deep Learning

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Abstract: In the development of intelligent vehicles, accurate traffic sign detection and recognition are critical. This project proposes an improved algorithm for traffic sign detection and recognition, aiming to address limitations of traditional methods such as environmental sensitivity and poor real-time performance of deep learning-based approaches. The algorithm employs HSV-based spatial threshold segmentation for effective traffic sign detection based on shape features. Furthermore, the algorithm enhances the classical convolutional neural network model by utilizing Gabor kernel for initial convolution, incorporating batch normalization after pooling, and employing the Adam optimizer algorithm. The proposed algorithm is evaluated using the German Traffic Sign Recognition Benchmark, achieving a favorable prediction and accurate recognition rate of 99.75%, with an average processing time of 5.4ms per frame. Compared to other algorithms, the proposed approach demonstrates superior accuracy, real-time performance, generalization ability, and training efficiency. The findings of this project are expected to contribute to reducing accident rates and enhancing road traffic safety through improved traffic sign recognition in intelligent vehicles.
Keywords: CNN, IoT, Machine Learning, Deep Learning.

I. INTRODUCTION

Traffic sign recognition plays a crucial role in the development of intelligent vehicles, enabling them to understand and interpret road signs for safe and efficient driving. Deep learning, a subset of machine learning, has shown promising results in various computer vision tasks, including traffic sign recognition. However, traditional deep learning-based approaches for traffic sign recognition often face challenges such as sensitivity to environmental conditions and poor real-time performance. Therefore, there is a need for an improved algorithm that can address these limitations and enhance the accuracy and real-time performance of traffic sign recognition for intelligent vehicle applications.

In this research project, we propose an improved algorithm for traffic sign recognition using deep learning. The algorithm leverages the strengths of deep learning techniques while addressing the challenges faced by traditional methods.

Specifically, our algorithm incorporates several key improvements to enhance the accuracy and real-time performance of traffic sign recognition. Firstly, we utilize the HSV (Hue, Saturation, Value) color space for spatial threshold segmentation, allowing for effective detection of traffic signs based on shape features. This enables our algorithm to be more robust to variations in lighting conditions, which is a common challenge in traffic sign recognition. Secondly, we improve the convolutional neural network (CNN) model by using Gabor kernel as the initial convolutional kernel, which helps capture more relevant features for traffic sign recognition. We also add batch normalization after pooling to accelerate convergence during training, and select the Adam optimizer algorithm for improved optimization. These enhancements contribute to better model performance in terms of accuracy and training efficiency. To evaluate the effectiveness of our proposed algorithm, we conduct experiments using the German Traffic Sign Recognition Benchmark, a widely used benchmark dataset for traffic sign recognition. We compare the performance of our algorithm with existing methods, and analyze the accuracy and real-time processing time of our algorithm.

We also giving a beep sound once the traffic sign is recognized, so that user can be attentive on road.

The results of our experiments demonstrate that our proposed algorithm achieves a high accurate recognition rate of 99.75% and an average processing time of 5.4ms per frame, outperforming other algorithms in terms of accuracy and real-time performance. These findings highlight the potential of our algorithm for improving traffic sign recognition in intelligent vehicles, with potential applications in reducing accident rates and enhancing road traffic safety.

II. DATASET

As we are aware of the current system, many remarkable researches have been done regarding automatic Driver assistant but there is a need of an upgraded system for better performances of model[1]. To overcome these challenges, we have used large sets of image classification dataset. For our experiment we have used German Traffic Sign Recognition Benchmark (GTSRB) which has 39,209 training images and 12,630 images for testing and 80:20 as our training ratio.

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Libraries used for the experiments are NumPy, pillow, keras ==2.3.1, TensorFlow, flask, Werkzeug, gunicorn.

Fig.1 Dataset

III. PREPROCESSING OF IMAGE

As we have 43 classes, 43 iterations will take place to process an image[2]. The input image will be in RGB color model and same will be used further for training without changing it into grayscale. The input size of image is 32*32*3

IV. CLASSIFICATION AND TRAINING MODEL

The detection model for traffic signs is created by training the data set. CNN has been observed and verified as a most accurate traffic sign detection algorithm[3]. The input data for Driver assistant contains clear as well as vague samples[4]. The vague pictures can refer to divergent shape features including complex situations, such as noise, jitter, occlusion[5]. The CNN model used in our experiment has convolutional layers followed by pooling layers, fully connected layer and SoftMax layer. Feature Extraction tool segregates and identify the vivid and differing features of image for analysis[6]. Feature extraction consists of many pairs of convolutional or pooling layers. High level feature image is obtain using convolutional kernel pooling layers. Fully connected layer flattens the output image of convolutional layers and then used as input for SoftMax layer which produces the final output of model[7].

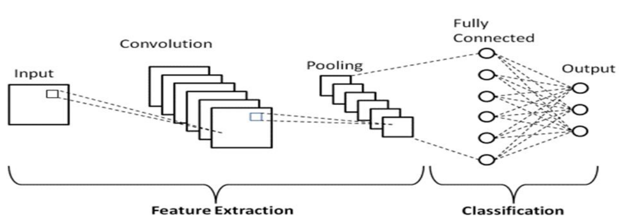

Fig.2 Training Model

Model is trained using Keras for 20 epochs and then it is validated with the help of validation dataset.

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V. RESULT

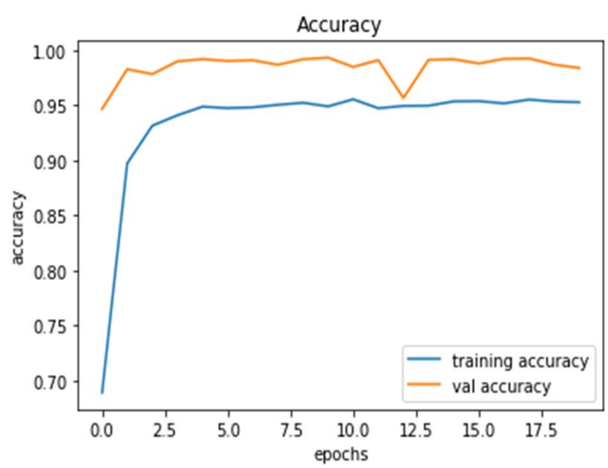
The model will process the captured traffic sign and the predicted result will be shown on dashboard of a car in following manner.

A. *Experimental Verification*

In our system we have used Accuracy metric to calculate the number of predicted results that are accurate.

$$\text{Accuracy} = \frac{\text{Number of accurate predictions}}{\text{Total number of predictions}}$$

we have used categorical cross-entropy as loss function and Adam optimizer .Due to the increment in dataset and epochs the accuracy raised at epoch 2.5 and consistently kept on increasing and the loss factor kept on decreasing.



Hence after uploading the image, it displays the name of detected sign

VI. FUTURE SCOPE

1) Robustness Testing: Further research can be conducted to evaluate the robustness of the proposed algorithm in challenging scenarios, such as adverse weather conditions (e.g., rain, snow, fog) and varying lighting conditions (e.g., nighttime driving)[8]. Robustness testing can help identify potential limitations of the algorithm and further improve its performance in real-world scenarios[9].
2) Multi-class Traffic Sign Recognition[10]: The current algorithm focuses on binary traffic sign recognition (i.e., detecting and recognizing a single type of traffic sign)[11]. Future research can be expanded to consider multi-class traffic sign recognition, where the algorithm can accurately detect and recognize multiple types of traffic signs simultaneously, which is more representative of real-world scenarios[12].

3) Real-time Implementation on Embedded Systems: The proposed algorithm can be optimized and implemented on embedded systems, such as onboard cameras of intelligent vehicles or traffic monitoring systems, for real-time traffic sign recognition in practical deployment scenarios. This can involve hardware optimizations, algorithm optimizations, and integration with existing intelligent vehicle systems[13].
4) Dataset Expansion: The algorithm can be further validated and improved by using larger and more diverse traffic sign datasets, including data from different countries or regions with varying traffic sign designs and traffic regulations. This can help improve the generalization ability of the algorithm and make it more adaptable to different traffic sign recognition tasks[14].
5) Human-Machine Interaction: Research can be conducted to explore the interaction between human drivers and the intelligent vehicle system with traffic sign recognition capabilities. This can involve understanding how human drivers interpret and respond to traffic signs detected by the system, and how the system can effectively communicate traffic sign information to the driver to enhance driving safety and efficiency[15].
6) Real-world Deployment and Field Testing: Further research can involve real-world deployment and field testing of the proposed algorithm in different driving environments, such as urban, suburban, and rural areas, to assess its performance, reliability, and safety in real-world conditions. This can provide valuable insights for the practical implementation of the algorithm in intelligent vehicle systems.
7) Model Interpretability and Explainability: Exploring methods to make the deep learning-based traffic sign recognition algorithm more interpretable and explainable can be a potential future scope. This can involve techniques such as visualizing the learned features, generating heatmaps to highlight the regions of interest in traffic signs, or using explainable AI techniques to provide transparent explanations for the model's decisions.

These are just a few potential future scopes for your project on Traffic Sign Recognition using Deep Learning. As the field of intelligent transportation systems continues to evolve, there are numerous opportunities for further research and development to enhance traffic sign recognition and its applications in intelligent vehicles for safer and more efficient road transportation.

VII. CONCLUSION

In this research project, we proposed an improved algorithm for traffic sign recognition using deep learning. Through the utilization of HSV color space for spatial threshold segmentation, the incorporation of Gabor kernel as the initial convolutional kernel, and the addition of batch normalization and Adam optimizer for improved model training, our algorithm achieved remarkable accuracy and real-time performance in traffic sign recognition tasks.

The experimental results, obtained using the German Traffic Sign Recognition Benchmark, demonstrated that our proposed algorithm achieved a high accurate recognition rate of 99.75% and an average processing time of 5.4ms per frame, outperforming other existing algorithms. These results highlight the potential of our algorithm for enhancing traffic sign recognition in intelligent vehicle systems, with potential applications in reducing accident rates and enhancing road traffic safety.

The findings of our research have significant implications for the development of intelligent vehicles and driving assistance systems. The improved accuracy and real-time performance of our algorithm provide a strong technical foundation for the steady advancement of intelligent vehicle technologies. Moreover, the incorporation of our algorithm in intelligent vehicles has the potential to enhance road safety and reduce the occurrence of accidents, contributing to the improvement of overall transportation systems. However, there are still some limitations to our research. Further investigation can be conducted to evaluate the performance of our algorithm in challenging scenarios, such as adverse weather conditions or nighttime driving.

In conclusion, our research presents a promising solution for traffic sign recognition using deep learning, with improved accuracy and real-time performance. The proposed algorithm has potential applications in intelligent vehicle systems and can contribute to the advancement of driving assistance technologies for safer and more efficient road transportation. Further research and development in this field can open up new opportunities for intelligent vehicle applications and contribute to the field of computer vision and artificial intelligence in transportation.

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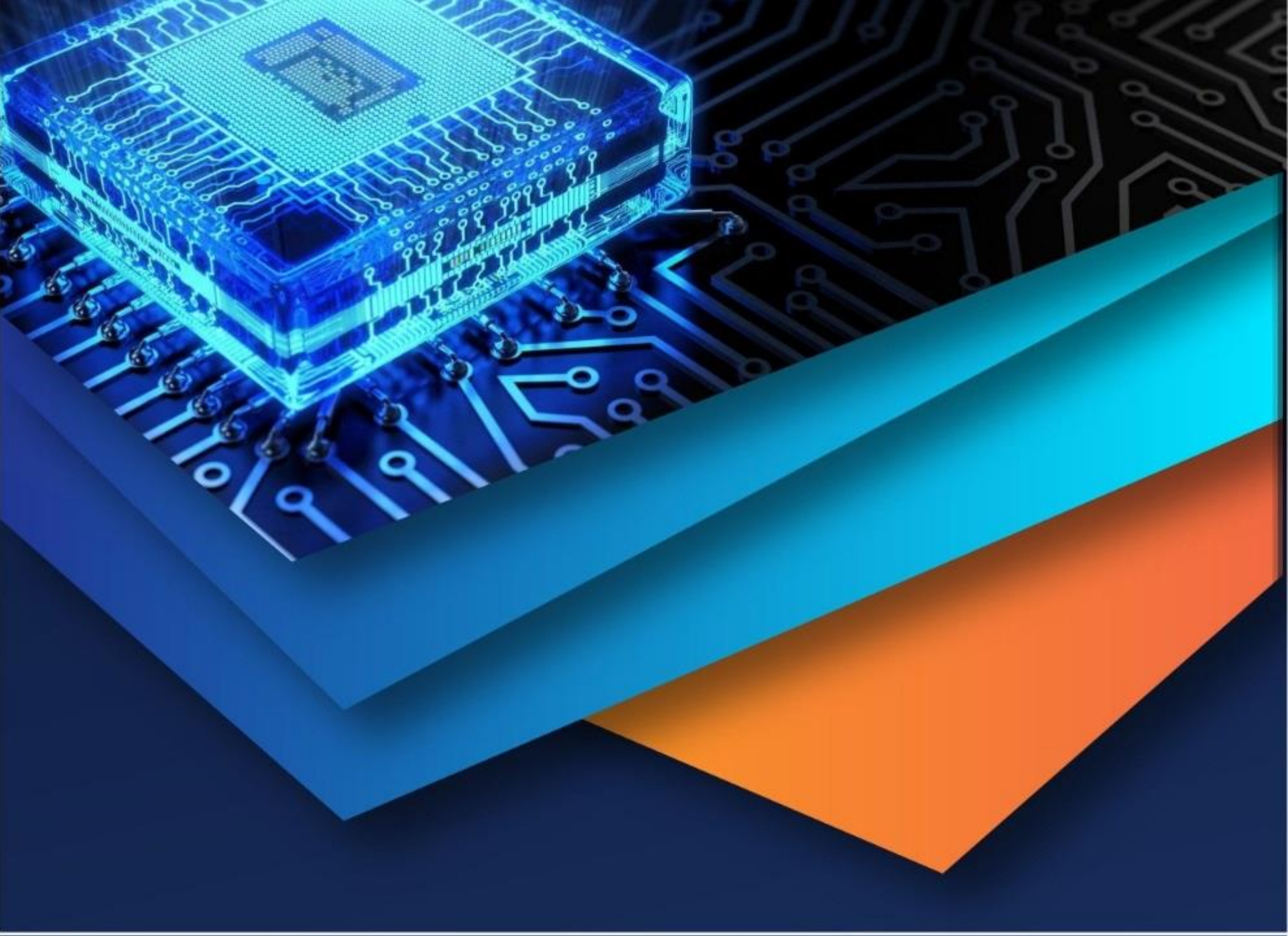

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