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Traffic Sign Recognition System Using CNN

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Abstract— Traffic sign recognition is an important part of the intelligent transportation system and has important application prospects in driverless vehicles and driver assistance systems. In the image recognition of traffic signs, according to the image features of traffic signs, the common methods include traditional template matching method, SVM method, random forest and the best Convolutional Neural Networks (CNN) method.

Traffic sign recognition system (TSRS) is a significant portion of intelligent transportation system (ITS). Being able to identify traffic signs accurately and effectively can improve the driving safety. Our project will brings forward a traffic sign recognition technique on the strength of deep learning, which mainly aims at the detection and classification of different types of signs.

Keywords: traffic, sign, system, cnn

Introduction

Traffic sign recognition has high industrial potential in intelligent autonomous vehicle and driver assistance system. Improvement in traffic quality and safety cannot be achieved without correctly applying and maintaining road traffic signs, traffic signals and road markings. The traffic indication sign essential information for safe and efficient navigation. Traffic sign can improve the traffic flow and provide safety for the drivers. Traffic sign detection and recognition are widely experimented due to the wide application used in the intelligent vehicles as driver's support system. Several applications have been developed focused on the traffic sign area such as alert system of the potential danger, navigation and driving safety. Examples of such a system include adaptive cruise control, lane departure warning system, collision avoidance system, night vision, traffic sign recognition, and etc. Recently, many researches focus on the traffic sign identification area.recognition is essential to the ITS (Intelligent Transport System). Every year 1.3 million people worldwide are killed on roads, and between 20 and 40 million are injured. A good solution to this problem

would be to develop system, which take into account the environment. That is why today, driving safety is becoming a popular topic in many fields, from small projects to large car factories. However this topic also raises many questions and problems. It is required to define the width of the edges of the road, recognize road signs, traffic lights, pedestrians, and other objects which contribute the driving safely.

There are many methods for solving these tasks. Road sign detection is a technique due to which vehicle is able to recognize the different signs put on the road. Traffic signs are used to regulate traffic. Traffic signs are used to provide guidance to driver. Automatic traffic sign recognition is essential task of traffic regulation and guiding and warning driver.

Literature review

In 2019, Wei-Jong Yang et al. proposed an approach to recognize traffic sign. They worked with shaped based detection algorithms and for classification purpose they choose convolutional neural network. After simulation they got 97% sign recognition accuracy[1]. In his work[2] author proposed SVM based classification algorithm to recognize traffic sign. Here, they considered 8 types of road signs. For training purpose they used 600 different images for each signs and for test purpose 120 images was considered. In their work they tested individual signs with

real data and their accuracy level was 66.6% to 100%.

In a study by Zhang J et al. [3]the importance of traffic sign (s) detection it has been stated that Chinese traffic signs have unique features compared to traffic signs in other countries[3]. In this study, a Chinese traffic sign detection algorithm based on a deep convolutional network is presented. To realize real-time Chinese traffic sign detection, an end-to-end convolutional network inspired by YOLOv2 has been proposed[3]. Considering the characteristics of traffic signs,multiple 1 x 1 folded layers are taken in the intermediate layers of the network, and convolution layers are reduced in the upper layers to reduce computational complexity. The input images are divided into dense grids to effectively detect smalltraffic signs and obtain finer feature maps.

In the study by Alexander Shustanov and Pavel Yakimov, several CNN architectures compared to each other were also shown and the whole procedure for traffic sign detection and recognition was carried out on a mobile GPU in real-time[4]. GTSDB[5] and GTSRB[6] were used as data set. The training process was carried out using the mobile Nvidia CUDA GPU card for images with a resolution of 1920x1080 pixels[4].The developed method was implemented on a device with Nvidia Tegra K1 processor.

In the study by Fatin Zaklouta and Bogdan Stanciulescu, a three-stage real-time Traffic Sign Recognition system consisting of segmentation, detection and classification is presented[7]. Color enhancement is combined with an adaptive threshold to remove red areas from the image. Detection was carried out using an efficient linear.

In 2016, for detecting and classifying the traffic signs they proposed an approach. It has 2 main steps: road sign detection, after that classification with recognition. To classify the traffic sign they used neural network and to complete this work they picked four types of traffic signs: Stop, No Entry, Give Way, and Speed Limit Sign. Considered total 3 hundreds sets images, and they got 90% and 88% 4 accuracy for detection and recognition purpose[11].

Proposed Methodology

Traffic sign recognition using convolutional neural networks (CNNs) is a popular approach that has shown promising results in recent years. Here's a proposed methodology for building a traffic sign recognition system using CNN:

1. Data collection and preprocessing: Collect a dataset of traffic sign images and pre-process them to normalize the lighting conditions, color, and size. It's essential to have a diverse and representative dataset to train your CNN model.

2. Model architecture: Design a CNN architecture that can classify the traffic signs accurately. The architecture should include convolutional, pooling, and fully connected layers, and the number of layers and filters should be optimized through experimentation.

3. Training: Train the CNN model on the pre-processed dataset. Use an appropriate loss function, such as cross-entropy, and an optimizer like Adam, to minimize the loss and update the model's parameters.

4. Hyperparameter tuning: Tune the hyperparameters, such as learning rate, batch size, and dropout, to optimize the model's performance on the validation set.

5. Evaluation: Evaluate the trained CNN model on the test set to measure its accuracy and other performance metrics like precision, recall, and F1 score.

6. Fine-tuning and deployment: Fine-tune the model if necessary to improve its accuracy and deploy the model on a platform that can recognize traffic signs in real-time.

Design

PROCESS

TSR system is divided into two modules: detection and classification. Primarily in system an image is captured from certain distance and image undergoes procurement to eliminate the unnecessary data and background of the image. In Detection module, the image sustains colour segmentation along with shape analysis of the traffic sign available in the image. Once the detection module is implemented and complete, the generated output from the previous module forwards to the classification module in which the sign gets classified and compared to the existing database on the system. The second module generates the output of uniquely identified and recognized traffic and show the output on screen and give information about the traffic sign. To overcome the challenges of identification of traffic sign TSDR system plays a major role which detects and recognizes the traffic sign and generates a output and give suitable information about the traffic sign.

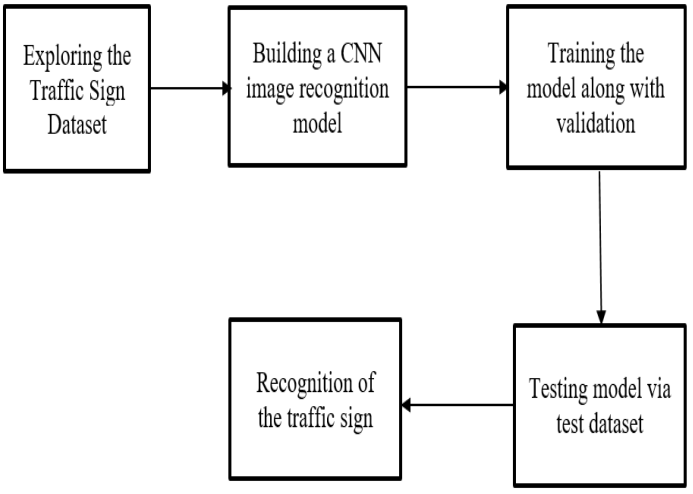


Fig: Process of traffic sign system

Collection of data

The data collectionprocess is responsible for the framework to do an inspection of the data collected and the data that can be compared to previously obtained data. Thistask further leads to the next task which is preprocessing which is applied to normalize the dataset using normalizing techniques. This task helps in dealing with data collecting and balancingto make a dataset that will be based on Machine learning.
The image dataset is consists of more than 40,000 pictures of various traffic signs (speed limit, crossing, traffic signals, etc.).Around 43 different classes are present in the dataset for image classification. The dataset classes vary in size like some class has very few images while others have a vast number of images.

The Dataset name German Traffic Sign Recognition Benchmark(GTSRB) is available on Kaggle website[8].

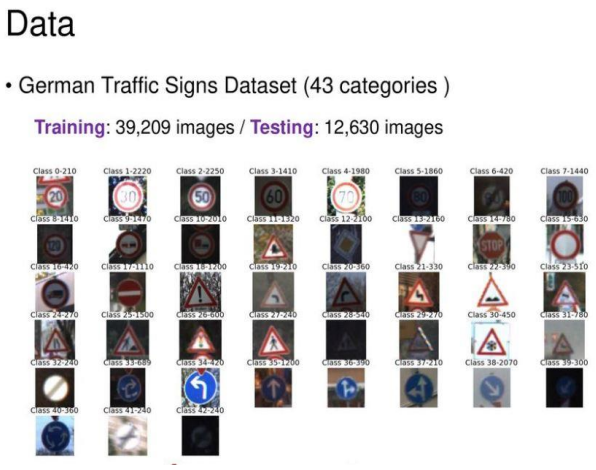


Figure: GTSRB Dataset

Experiments and Results

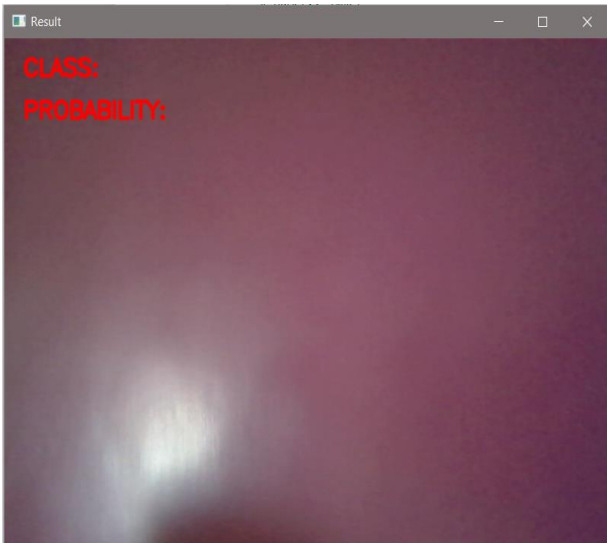
1. The image should be shown to the output screen to detect the traffic sign.

2. The information will then go through the model in following manner:

3. Convolutional neural network is used to classify the traffic signs and predict the traffic sign based on the input.

4. Here opencv has been used to process and analyze visual data.

5. After analyzing all the data the system will respond by showing the correct traffic sign.



Screenshot 1: Output Screen

Screenshot 2: Detected Traffic Sign

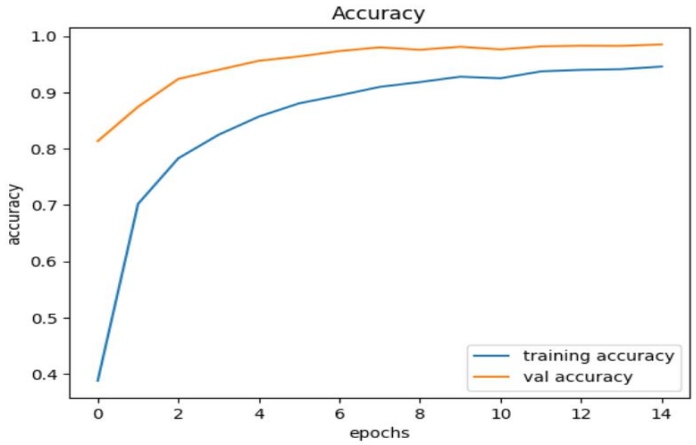


Fig: Accuracy graph

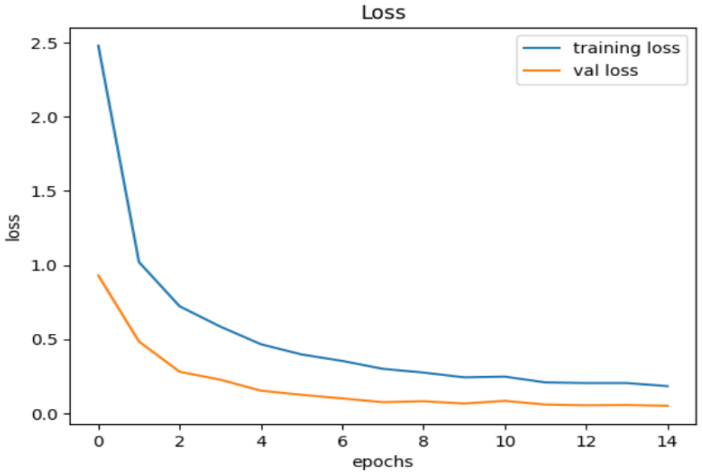


Fig: Loss graph

Above are the graph related to accuracy and the loss with respect to the epochs on the training and testing dataset.

Conclusion & Future Scope

By the end of our project, we concluded that if traffic sign recognition system based on traffic signs was properly designed, implemented, and evaluated, it could be used as an effective tool to improve safety and reliability for automated cars.
The accuracy changes for different images of various traffic signs. Accuracy can be improved by adding more data into the system. The increase in the number of data values will help in the formation for cnn algorithm to work more precisely, thereby improving the accuracy of the system.
In the future, we plan to expand our project to include incorporation of multiple sensors.To improve the accuracy and reliability of real-time traffic sign recognition, multiple sensors can be incorporated into the system. This can include cameras, LiDAR, and radar sensors, which can work together to provide a more comprehensive understanding of the traffic environment.

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