International Journal of Research Publication and Reviews, Vol 3, no 12, pp 1981-1986 December 2022

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Traffic Sign Classification Using CNN

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DOI: https://doi.org/10.55248/gengpi.2022.31262

Abstract

Autonomous driving cars are booming these days and the demand for a robust traffic sign recognition system that assures safety by recognizing traffic signs accurately and fast is increasing. We all must have heard about self-driving cars in which the passenger can fully depend on the car for traveling. But to achieve level 5 autonomy, it is necessary for all the vehicles to understand and follow the traffic rules. In the global world of Artificial Intelligence(AI) and advancement in technologies, many researchers and big companies like Tesla, Uber, Google, Mercedes-Benz, Toyota, Ford, Audi, etc are working on autonomous vehicles and self-driving cars Here in this paper we planned to use *CNN(convolution_neural_network)* algorithm is a part of a deep learning model to classify the images present in the dataset into different categories. It can classify 43 different signs of traffic from the German Traffic Sign Recognition benchmark dataset.

Introduction

Traffic signs(also called road signs) are signs which are placed above or side of the roads to provide or give information to the users(road users). They play a major role in one's life while driving. *It guides us and provides a multitude of information so that we can drive safely.*

Earlier signs were made up of wooden blocks or milestone stones. Later directional arms were introduced as signs. Pictorial signs were adopted by many countries in 1930 due to the increase in traffic volume. Pictorial signs use silhouettes (often symbols) in place of letters or words and are usually international protocol based. These signs were developed in Europe at first. Now, these signs are being adopted by many countries like India. They provide critical information to road users.

Traffic sign classification is used to inform or warn the driver beforehand about the violation of traffic rules by classifying or detecting the traffic signs. The proposed system or approach employs convolution_neural_network to implement traffic sign classification. The system automatically detects the traffic sign and it makes sure that the sign is displayed. So in case, the driver has lapsed in his particular concentration or if he misses identifying the sign then it would be detected. It accordingly forbids or warns the driver's certain actions like rash driving or speed driving. It also increases their comfort by disburdening them.

A convolution_neural_network is one of the classes of deep learning networks, used to check and examine visual imagery. It is used to recognize the model and train the image due to its high precision and accuracy.

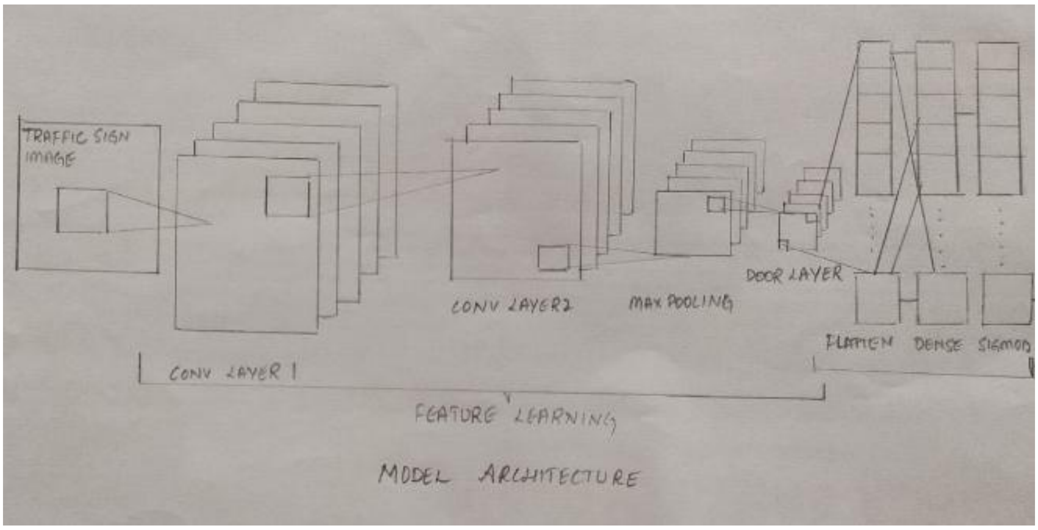

Figure _1

Overview of AI and ML

Artificial Intelligence and Machine Learning are emerging as critical tools in current technology. Artificial intelligence is used to solve complex problems similar to the way in which human beings solve problems through critical thinking. *Machine Learning is a subset of AI (Artificial Intelligence),* which learns from the available databases and builds an intelligent computer system using statistical techniques. One of the ways through which machine learning solves problems is by letting the particular computers learn to program themselves by experience.

Malone noted in one of his works (Future brief) that the machine learning model works best when *the* ***dataset is large-thousands or millions*** of examples like ATM transactions, sensor logs, recommendation algorithms, image analysis, object detection, fraud detection, automatic helplines or chatbots, medical imaging and diagnostics. Another example is Google Translate. It was possible because it was trained on the huge amount of information that was available on the internet. Machine Learning is associated with various other Artificial intelligence subfields like

a)NLP(Natural_language _processing) b)Deep_learningc)Neural_networks.

MIT initiative researchers outlined a twenty-one (21) questions rubric to determine whether the machine learning task is suitable.

The researchers found that the way to unleash the success of machines in jobs, few of which could be done by machine learning and others would require a human.

Deep learning is one of the key components of *state_of_the_art_vision systems,* especially in Convolution neural networks(CNN).To apply algorithms in applications that are real-time, one as to address many challenges of computational complexity and memory.

About dataset.

Here we have used GTSRB (German_ Traffic_Sign_Recognition_Benchmark) dataset. The proposed method uses the GTSRB dataset since it can be used for both classification and detection. Testing, validation, and training datasets are further divided in the dataset. The dataset used to train the model is called the training dataset. Generally speaking, the model is assessed and the hyperparameters are updated using the validation dataset. Hyper factors, like the choice activation function or a number of epochs, are used to regulate the learning process and increase accuracy. Only after the model has been trained is the test dataset used. It is used to determine whether or not the model is capable of making accurate predictions.

The dataset contains 51,000 and more images of different traffic signals. There are 42 other classifications for it. There is a wide variety in the dataset; some classes have many photographs, whereas other datasets contain few of them. The dataset is separated into two folders: test, where our model would be tested, and train, which contains images from each class. *GTSRB (German_ Traffic_Sign_Recognition_Benchmark) dataset* is popular because

- A Large number of images are included in the dataset.
- The traffic signs which are present are of different backgrounds, variety, and color variation which indirectly will help the machine learning model to perform accurately.

Gray Scaling

One of the crucial tasks before utilizing CNN for classification is to convert RGB data set into grayscale. This has various benefits, including images that have been converted to greyscale makes it easier for the neural network to process them because the undesirable biases are eliminated. Because there are fewer channels after conversion, grey scaling the photos reduces the amount of computations. The data shape of the image before gray scaling is (30,000, 32, 32, 3). This indicates that the graphics were 32x32 in size and RGB-colored. After grey scaling, the form of the training data set's picture becomes (30000, 32, 32, 1).

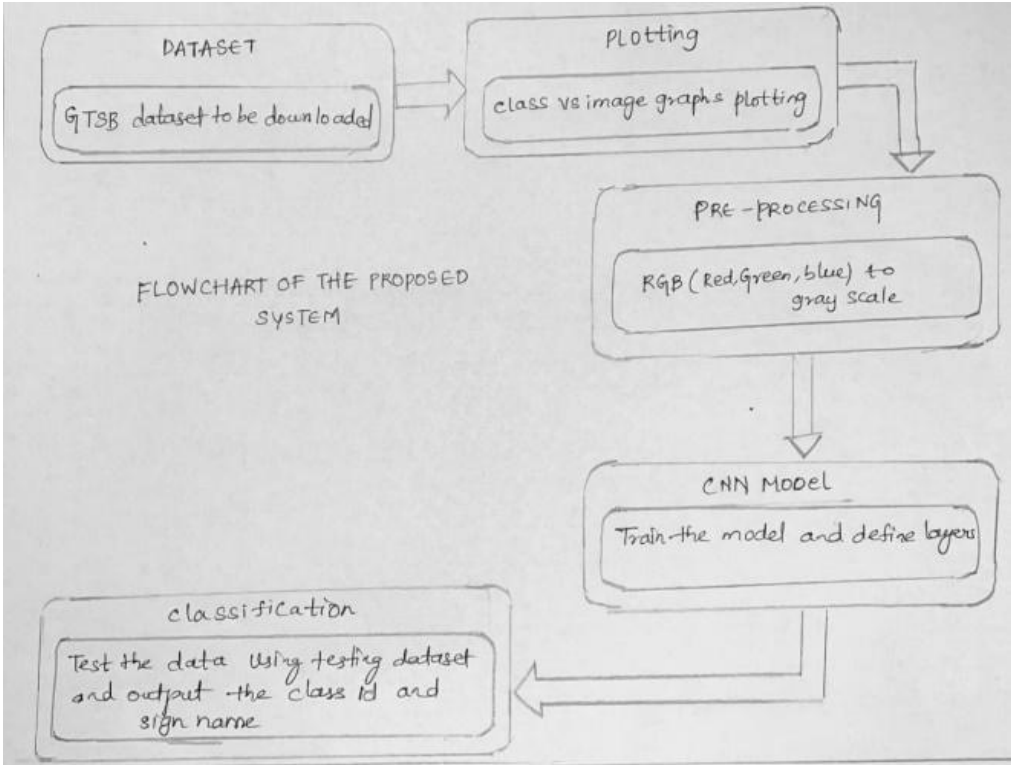

Figure _2

1.Construction of the model: This mostly entails converting the images to grayscale, histogram equalization, normalising images(normalization speeds up the training process and improves the performance of the model), model training, layers addition to the model, getting predictions on the test data set and finally displaying some example images with their corresponding class ID and traffic signs as the output. The suggested system has a test, train, and validation split proportion of 25%, 65%, and 10%, respectively.

Prediction of unidentified photos is one of the key functionalities used in this work. In this case, a tiny dataset was created by compiling images from various sources.

2.It was the critical facet since it contained a variety of images with various structures and colors. Despite the fact that there are numerous datasets existing, a tiny dataset (composed of 13 photos) is produced. The dataset includes caution sign symbols (like no entry and stops), speed limit symbols, yield signs, and informatory signs (like ahead only, roundabout mandatory, no passing, and pedestrians).In this model feature, extraction is not easy from the images. The reasons for this are that these images have backgrounds with diverse colors and are more distorted. Despite all the problems, the model correctly predicted about 10 out of the 13 photos. Only images that are circular or curvilinear are not accurately predicted. For such images, the model predicts traffic signs which are closet.

Steps to construct the project.

Pre-requisites required.

Image classification, pandas, Scikit- learn PIL and matplotlib.

To install the particular packages we are supposed to

1)Explore - the dataset.

2)Construct - CNN model.

3)Train the model and validate it

4)use a dataset to test the model.

Step 1) Each of the 43 folders in our "train" folder corresponds to a different class. The folders range from 0 to 42. We iterate through each class using the OS module, adding photos and the corresponding labels to the data and labels list.

To feed the list into the model, we must transform it into NumPy arrays.

The data's shape is (39209, 30, 30, 3), which indicates that it contains coloured images. There are 39,209 images that are 30 pixels by 30 pixels in size (RGB value).

We divide training_and_testing data using the train test split() technique from the sk.learn package.

We utilize the categorical method from the keras. utils package to encode the labels from y-train and t- test using *one- hot_encoding.* We will create a CNN model to classify the photos into their corresponding categories (Convolutional Neural Network). For image classification, CNN is the most effective.

*Step2)*The model of our architecture is:

1)(kernel size =(4,4) , activation = "RELU", filter =32)-2Convo2D layer.

2)(Pool size = (2,2)) – MAXpool2D layer.

3)(Rate = 0.25) – DropOut layer.

4) (kernel size =(3,3) , activation = "RELU", filter =64)-2Convo2D layer.

5)(Pool size =(2,2)) -Maxpool2D layer.

6)(rate=0.25)-DropOut layer.

7)To squeeze the layers into 1 dimension flatten the layer.

8)(activation = "relu") – Dense_Fully_connected_layer.

9)(rate=0.5)-DropOut layer.

10) (activation = "softmax" , 43 nodes) -Dense_layer.

Adam optimizer is used to compile the model which performs-well and the loss is "categorical cross-entropy" since we have multiple classes to categorize.

Step 3) Training and validating the model.We train the model with the help of model.fit() after training the architecture model.We tried with batch size 64 and 32.

With 64 batches, our model fared better. And the accuracy was stable after 15 epochs.

The dataset trained yielded a 95 percentage accuracy for our model. We visualised the graph for accuracy and loss using matplotlib.

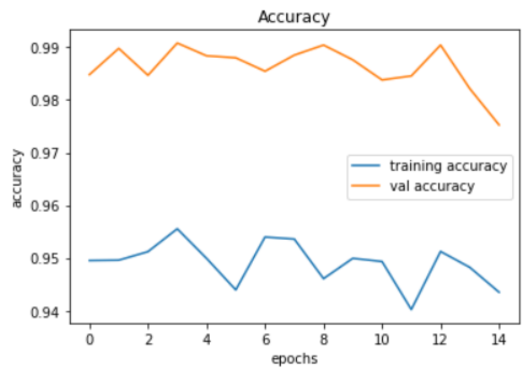

Figure _3

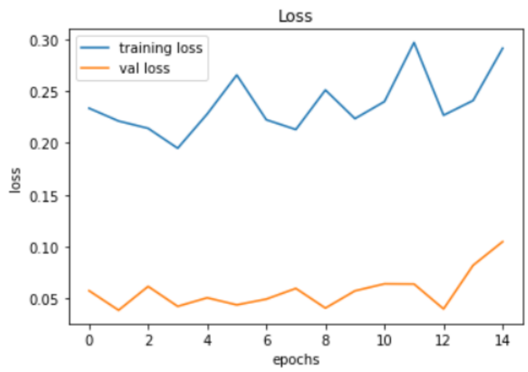

Figure _4

Step 4) Testing our model with the help of test_dataset.

A test folder is part of our dataset, and a test.csv file contains information about the class labels and image paths for each image. Using pandas, we extract labels and image paths. We must then scale our images to 30 cross 30 pixels and create a numpy array with all of the image data in order to predict the model. We imported the Accuracy Score from sk.learn. metrics and looked at how (our) model predicted the real labels. Our model had a 95% accuracy rate in this.

We will ultimately store the model that we trained with the Keras model. the save() method.

About the Activation Function.

Here we have used RELU activation function.One of the non-linear activation functions used in multi-layer neural networks is called ReLU. ReLU does this by applying the function f(x) = max (0, x) to each and every input value. The positive values are left alone while the negative values are simply changed to 0 by the ReLU layer. ReLU is now the standard activation function to be applied in the neural network's hidden layers. Since there are no intricate mathematical calculations are required, the ReLU function is straightforward and it is less expensive computationally, which speeds up model learning and training.'

As demonstrated in fig aside, the model accurately predicts the bulk of the images with a success rate of 93%. Only those images with circular elements are inaccurately anticipated.

Conclusion

The suggested method is simple and achieves classification pretty correctly on the GTSRB(German traffic sign recognition benchmark) dataset as well as the freshly generated one (containing of genuinely existing images of all the data types), and finally, the model can effectively capture images and forecast them accurately even if the image's background is not very apparent. To train the model, the proposed approach utilizes Convolutional Neural Network (CNN). The images are pre-processed, and grey scaling is done prior to CNN to enhance the simplicity of the algorithm and reduces the complexity of the model. The resulting accuracy on the test dataset is 94% and 68% on the created dataset. The model's forecasts for webcams are also accurate and take very little time. The advantages of a "Traffic Sign classification and detection system" are mostly centered on the driver. Despite the benefits of traffic sign classification, there are also disadvantages. There may be occasions when the traffic signs are obscured or blurred. This can be risky since the driver will be unable to keep track of his vehicle's speed, which might lead to accidents that risk other pedestrians or motorists, prompting further investigation.

Result

Traffic sign classification is the process that automatically determines the traffic signs (such as speed limit, caution signs, yield, etc) and classifies them accordingly. Prediction on the newly generated dataset and live webcam traffic sign detection are the two primary features of the research. Accuracy is measured as the ratio of correct predictions to total forecasts (eqn. 1). (The_number_of _correct_predictions) / Accuracy (Total_predictions).

Traffic signs are useful to anyone who is operating a car on the road. Traffic signs direct drivers to respect all traffic laws and to avoid causing any kind of inconvenience to pedestrians. Environmental restrictions like illumination, distance (the sign is pretty far away), air pollution, conditions, shadow, motion blur, weather conditions , and vehicle vibration, all of which are common in almost any actual world, may impair detection and consequently categorization. As a result, more studies and developments are required to address these concerns. Furthermore, certain traffic indicators may not be precisely predicted. Augmentation and *one-hot_encoding* techniques can be employed for this. Augmentation entails shifting the image, zooming in, and rotating the images (if applicable).

Thus, Traffic_Sign_Classification has a broad application in the development of smarter cars, such as self-driving cars, in which the system recognizes, detects, and displays traffic signs automatically.

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