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Traffic Sign Classification using Deep Learning

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Abstract— Detecting and classifying traffic signs has been of uttermost importance ever since the emergence of Advanced driver assistance system and autonomous vehicles. Traffic signs are one of the decisive factor for traffic supervision. Because of complexities in driving nature it is difficult to detect the traffic signs and classify them because of partial occlusion and their small size. Different methods were contemplated for the same but there is a need to enhance them to fulfill the necessities of autonomous vehicles. Detection and recognition of small objects with the help of image processing system was an arduous task. Deep learning algorithms have been a key factor for recognition of traffic signs. Convolution Neural Networks are used for the mechanism. These method aids to get the accuracy in spite of the disturbances. Training of neural networks is implemented with the help of Tensorflow and Keras library.

Keywords: CNN , Deep learning , Sign classification ,Sign detection , Autonomous driver Assistance system (ADAS).

I. INTRODUCTION

Traffic sign classification and recognition is a riveting part in computer vision and is an important task in ensuring efficiency and safety of traffic flow. Most often the task is Performed manually. Traffic signs are captured by front camera, mounted on the vehicle and recognition is performed offline by human to check for consistency. This is time consuming and an arduous task. Automating this task reduces the amount of manual work done and it increases the safety by quicker detection of traffic signs. Traffic sign recognition is an innovation by which vehicle is able to recognize traffic signs which are on the streets. For example speed limit or turn left. They insist the driver by giving admonitions and commands. For example for 60 km/HR speed zone ,if driver surpasses that speed the system gives warning. The main problem here is to detect the objects of smaller size and classify it into different traffic signs. Different methods were contemplated for the same. Although convolution neural networks have shown their power for object detection and recognition. A lot has happened since Mobil Eye developed the first commercially deployed traffic sign recognition system in collaboration with Continental AG for the BMW-7 series vehicles. Quite a few vehicles have used this technology since. Establishing a reliable Traffic Sign Classification mechanism is a major step in our journey towards building semi-autonomous/autonomous driving systems. This paper intends to explain an approach to solve the problem of traffic sign classification. CNN is used for classification and recognition for its highest accuracy. Recognition of traffic signs is usually done in two ways localization and recognition. First part is responsible for identification of region of interest (ROI) by creating rectangular boxes by marking off the areas where signs are located. In the recognition part these rectangular boxes are taken as input and it uses the data of those regions to tell which traffic signs are located there. Correct classification are dependent on both parts working and communicating quickly , accurately and efficiently.

II. MOTIVATION

A. Road Safety

Road accidents causes death of over 1.35 million of people per year according to World health organization with 3287 deaths per day on an average. The causes of these frightening and daunting numbers are numerous. It may be because of driver error due to drunk driving, fatigue and driver distraction remains the leading causes of deaths on the road. Given the frightening number of road deaths, the researchers took advantage of rise of artificial intelligence and deep learning in computer vision to develop driver assistance system and reduce the number of accidents due to poor, partial occlusion. So to improve the road safety numerous works have been undertaken in this task. An onboard vision system that could detect and identify the road sign could help the driver by assisting in many ways. The onboard system could serve to augment reality and display upcoming warning signs quickly or keep them displayed on the screen even once the signal is passed. This would decrease the livelihood that driver failed to see an important sign.

B. Navigation

Another motivation for sign reading capabilities in vehicles may be to navigate in dense urban environment with limited GPS availability. By identifying unique road sign precise location can be determined and looking up their geolocation in image database. Although it may be attractive for marketing purposes road safety and convenience remain leading motivation for traffic sign recognition.

III. TECHOLOGY USED

A. OpenCV

Open Source Computer Vision Library was built to provide a common infrastructure for OpenCV applications to boost up the use of machine use in commercial products.OpenCV algorithms can be used to recognize faces, classify human actions in videos, identify objects, remove red eyes from images, finding similar images from a database, etc. Many companies like Yahoo, Google, Sony that make use of OpenCV.

B. Deep Learning

Deep Learning is a subfield of Artificial Intelligence that imitates human brain to process data and create patterns for decision making. It aims at learning feature hierarchies extracted from the composition of lower-level features. Automatically learning features allows a system to learn complex functions by mapping the input directly to the data.Deep Learning algorithms make full use of the unknown structure in the input data in order to discover good representations, frequently at various levels, with higher-level features are described in terms of lower-level features.It allows models that have multiple processing layers to learn representations of data with multiple levels of abstraction.

C. Tensorflow

Tensorflow is a google developed end to end open source deep learning framework that was launched in 2015. It is well known for its documentation and training assistance, as well as its scalable production and deployment options, many abstraction levels, and support for a variety of platforms , including android. It is a symbolic math library for neural networks, and its perfect for dataflow programming across several platforms.

IV. LITERATURE SURVEY

Now a days detecting traffic signs and classifying them is important task especially for automatic driving. A lot of research has been done on detection and classification of traffic signs. In [1] the authors proposed a CNN model where in the model was divided into two parts, localization and recognition . The solution is too slow but it is easy to implement. The model produces some strange mistakes by detecting car's stop light as traffic sign. The proposed model achieved 63% accuracy. In [2] authors proposed a model utilizing an approach based on Mask R-CNN detector. Further data augmentation technique was proposed on their won novel dataset termed as DFG. In [3] Gabor filter was used for text analysis. The image analysis is done in three steps ,Detection, Segmentation and classification.

The proposed small scale CNN model in [4] achieved 97.71% testing accuracy , which is improved than the LeNet model. The only condition for implementation is the input size of image which should be 32*32 pixels. In [5] A novel two level architecture was proposed which consists of two modules RPM and CM. In this model YOLOV3 network is used to detect small size objects precisely.In [6] LeNet model was modified by authors which achieved 99.39% accuracy. Use of relu and softmax function improve the overall result of recognition. In [7] authors proposed CNN model which is divided into two parts Attention Proposal Modeller (APM) and Accurate Locator Recognizer (ALR). The model could detect the objects less than 322. Pixels which was a great achievement.

V. PROPOSED SYSTEM

A. Approach

The main aim is to detect a traffic sign and classify it into different classes using Deep Learning Algorithm. The contribution of this paper is to develop and design Deep Learning CNN architecture for traffic sign classification. Fig 1 shows high level view of the system .The collected dataset is given as input to the proposed CNN architecture for training and testing. The detailed explaination is about CNN architecture is provided in the next section. Once the CNN is trained it is ready to classify the input images that were not the part of dataset. Deep CNN Architecture is proposed for this system.

Steps for Proposed System methodology:

- Split Dataset
- Preprocessing
- Load Dataset
- Train Model
- Test Model
- Predict Classes

B. Flowchart

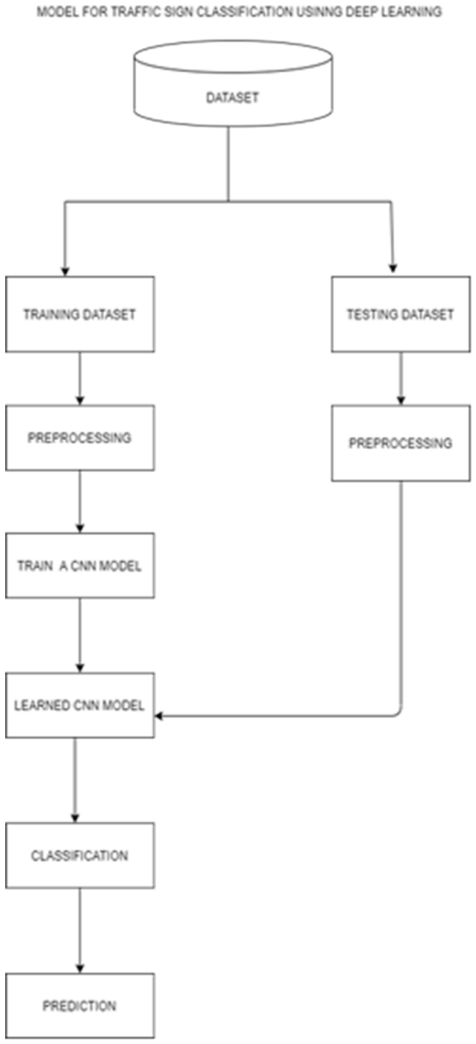

Figure 1

VI. METHODOLOGY

The proposed methodology [13] is Deep CNN architecture .

A. Data Collection

1) The first step is to collect the data of traffic sign images .
2) The datasets available can also be used for testing and training purpose.

B. Data Pre-processing

1) The CNN model has some limitations, one of which is that it cannot be trained on images with different dimensions. Because training the model with different dimensions is difficult, we must resize the input image to single dimensions. While resizing the image, choose the dimension that is in between and keep the data accurate.

C. *Split Dataset*

1) The dataset is splitted into testing and training.

D. Build the Model

1) Now model is trained on training set and feed to CNN to classify images and predict classes.

E. Test the Model

1) The model is tested by making predictions on the testing set.
2) The testing dataset is passed through learned model and accuracy is calculated

F. Predict the Classes

VII. CNN ARCHITECTURE

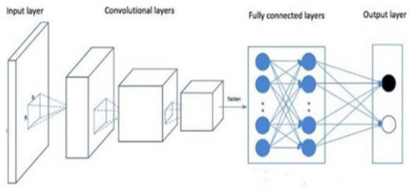

Figure 2

For image categorization, face recognition, and object identification, the CNN network is commonly utilized. It takes image as input, processes it, and then sorts it into various categories. Each input image in deep learning training and testing models travels through a series of convolution layers. Kernel, filter, FC, and the activation function are all part of this layer. The following is the flow of the process:

A. Input Images

The model is given an input image. The photos come in a variety of sizes. The CNN model has several size restrictions. To ensure that picture data is accurate, all input images should have the same pixel size.

B. Select Parameters

Apply filters with strides, and padding if necessary. Apply ReLU on the picture after convolution Layer. The first layer of the CNN model, the convolution layer, extracts the features of the input images. It takes the photos as input and applies a filter or kernel to them. Different filters can be used to sharpen an image, blur it, and identify edges.

1) *Strides:* Strides represent the number of pixels that have been relocated across the images . It gets shifted two pixels if stride is two. If there are three pixels, then there are three pixels, and so on.
2) *Padding:* If the filter does not properly match the input images, padding can be utilized. Padding can be of two types: same and valid. The same padding is when a picture is padded with zeros to make it fit. The images whose only valid part are kept are know as valid padding.

Non-linearity is a term used to describe a phenomenon It's called ReLu since it's utilized for non-linear operations. In the model, the ReLu function introduces nonlinearity. Other activation function exist , such as tanh and sigmoid, however relu surpasses the other two.

C. Pooling Layer

Occasionally, the input images are very huge. When images are too huge, the pooling layer minimizes the number of parameters. Maximum pooling, average pooling, and sum pooling. are the three types of pooling. This approach will employ max pooling, which takes the largest element from the feature matrix. Take as many as CNN layers which fits model the best.

D. Fully Connected Layer

The resulting matrix is flattened into a vector, which is then sent to the neural network's FC.In the output layer, the Softmax activation function is applied. The multinomial probability distribution is predicted. The function is mapped in such a way that the sum is equal to one. The image is classified using an activation function (Logistic Regression with Cost Functions) and the classes are predicted.

E. Dense Layer

The regular deeply linked neural network layer is the dense layer. It is the most popular and often utilized layer. The operations are performed on input by dense layer and output is relu.

VIII. CONCLUSION

Different models were built for traffic sign detection and recognition which are Le Net model, CNN, ImageNet, Mask-RCNN, and Gabor filter was also used. CNN models is mostly used for traffic sign detection and classification. In [13] CNN model was used and it achieved 100% accuracy for epoch 150. All those models were compared based on accuracy, limitations and advantages. Accuracy obtained by CNN is higher as compared to other models in spite of limitations on the pixel size of images .Still improvements are needed to be done as there are some discrepancies and errors in classification.

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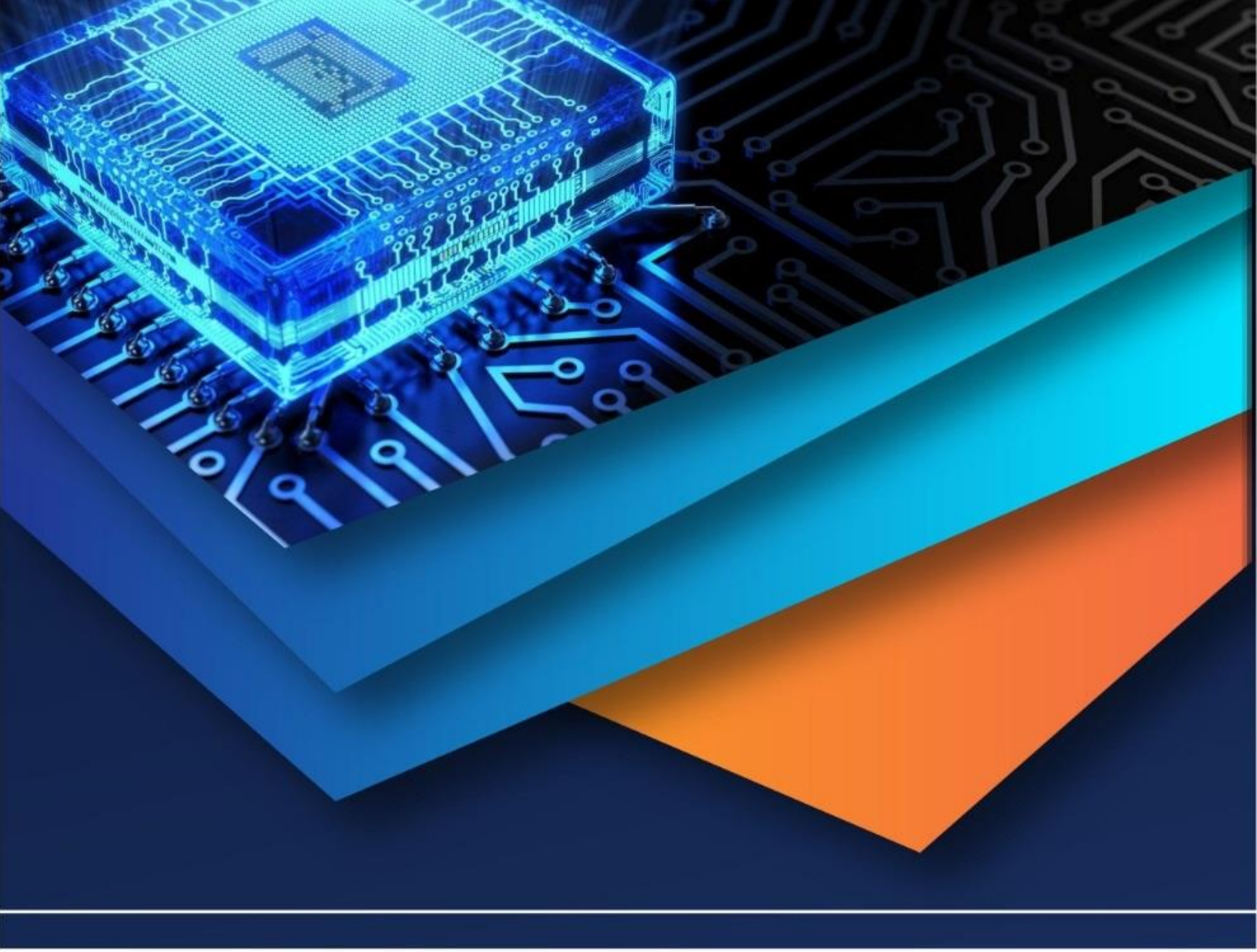

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