Turkish Journal of Computer and Mathematics Education Vol.12 No.9 (2021), 2458– 2467
Research Article

bject Classification of Traffic Signals Using Neural Network

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Article History: Received: 10 January 2021; Revised: 12 February 2021; Accepted: 27 March 2021;
Published online: 20 April 2021

Abstract: In today's world AI(Artificial Intelligence) and computer vision application are inevitable. There are so many applications based on AI and computer vision which are developing now to make more improvement in human's daily routine and lifestyle. It has application in several domains like medical, researcher, defence etc. For classifying traffic sign board photos, we used a computer vision programme. Our project's main goal is to create a model that can distinguish objects. Image classification model can be created with neural network or can be created using convolutional neural network. To define, we used various forms of traffic sign boards in this process. Our model is trained using 43 different types of traffic sign board videos. Once model trained, we can be able to use this model to classify other images too. In this model we used python programming for building our model and used tensor flow, keras frame works for various processes. It's also can be used in automation cars. There are two popular method to made image classification (or) object detection in neural network and CNN(convolutional neural network).Each method have their own advantage and disadvantage. CNN is very useful in object classifier. CNN usually consists of number of layers depend upon the application and accuracy of a model required. So we used CNN model in our project to classify images.

Keywords: Convolutional NeuralNetwork, Object detection, AI

1. Introduction

Computer vision is a modern technique which is under developing and processing stage. Today we have more advanced technology like automate car, Alexa, Siri, Ok google which are able to give answer by themselves as they are programmed these technologies are existing due to advancement in the field of machine learning, deep learning and computer vision. Self-driving car are made on base of computer vision that only made the car to drive on its own. It's possible only when the computer vision identify the objects, other cars, driving region, other obstacles etc.

It's also necessary to follow the traffic signals also for driving the car. So computer vision need to identify the traffic sign board and wants to follow the rule. For that processes we need to train the model with n numbers of traffic sign board. This process can be done by object classifier or by an object detection model. As part of it we made our model to classify between 43 different signs of traffic sin board by using convolutional neural network. Telsa, Uber, Google, and other specialised companies use this programme. Other uses for this convolution neural network and object detection model include loan prediction, music suggestion, face recognition, text mining, and so on.for creating object classification model we used python software, tensor flow frame network for convolutional neural network and image processing.

2. Literature Review

Nadia Jmour et al., presented a model that can classify images with high precision using convolutional neural networks for image classification (Nadia Jmouret 2018), this paper was presented at the International Conference On Advanced Systems and Electric Technology (IC ASET). MiniBatchEffect was used to train the model. The consequences of using various epoch numbers when scheduling provided classification rates over a long planning cycle, ranging from 0.5866 to 0.7541, and Mini batch size 60 is a big batch size. The topic of memorization is addressed by slowing down the tempo.

Unsupervised Transfer Learning through Multi-Scale Convolutional Sparse Coding for Biomedical Application (Hang Chang, 2017) was published by Hang Chang, Cheng Zhong, Ju Han, and Jian-Hua Mao. They also developed Multi-Scale Convolutionary Sparse Coding (MSCSC), a new technique that automatically learns filter banks at various scales in a traditional methodology of applied scale-specificity that increases classification efficiency on a variety of biomedical tasks while also offering an unsupervised classification method.

"Image classification using super-vector coding of local image descriptors (Zhou, X., 2010)," Zhou et al., The European Conference on Computational Linguistics (ECCV) presented this paper in 2010. The outcomes of the experimental work have shown that the CNN model deep learning algorithm is a simple and efficient solution for the challenge of classification of multi-class images. The CNN model deep learning algorithm has the potential to adapt flexibly for a wide variety of data sets about criteria. A basic database for training data was generated and submitted to

a powerful computer for the training process, as seen on the local machine and with python scripts. As suggested, the CNN model deep learning algorithm has been learned and the weight of the model has been fine-tuned. For the latest data-set, the model was modified. With a few training tests, the model's accuracy has increased. The CNN deep learning algorithm has a more accurate value than Super-vector local image descriptor process coding and almost equal RRSVM system precision, as shown in the multi-class image classification challenge.

Sara Khalid, Nazeer Muhammad, and Muhammad Sharif proposed a denoising strategy that uses a weighted fusion of KNN and SVM to minimise false positives (Sara Khalid, 2018). The GTSRB data collection is exposed to a recognition procedure in order to formulate the feature vector. The suggested solution was well received, receiving a precision score of 99.32 percent. It holds up well against cutting-edge techniques.

A new kernel law for road sign designation was proposed by P. Paclik, J. Novovicova, P. Pudil, and P. Somol. The RS 2 (Road Sign Recognition System) (P. Paclik, 2000) includes it. The aim of RS 2 is to recognise road signs in a traffic situation and assist a human driver in making decisions. The algorithm provided here is large enough to refer to any ideogram-based road sign. It deconstructs the issue using previous road sign classification knowledge. The decision tree employs Laplace kernel classifiers.

K. Hornik, M. Stinchcombe, and H. White wrote "Multilayer Feedforword Networks are Uniform Approximators (K. Hornik, 2012)." Clearly, the findings discussed here are just the beginning of a deeper analysis into the capacities and characteristics of multilayer feedforward networks. Nonetheless, they have an important and previously unknown theoretical framework that demonstrates that the successes obtained by such networks

3. Existing Method

In deep learning we can able to create an object classifier or object detection model by using artificial neural network (ANN). It can able to classify different types of inputs such as images, audio input, text etc. neural network is consists of many neurons interconnected with each other like neurons connected in human brain. Artificial neural network exactly work as neurons in human brain they take a part of the input and do linear calculation with weights and bias of the respective layer and at last it contain a nonlinear activation function at the end of each node to convert it into an nonlinear function and to feed to next layer. At the end we can have a softmax function for classification of our model this is the overview of a artificial neural network model. It have few limitations too so we are moving to convolutional neural network.

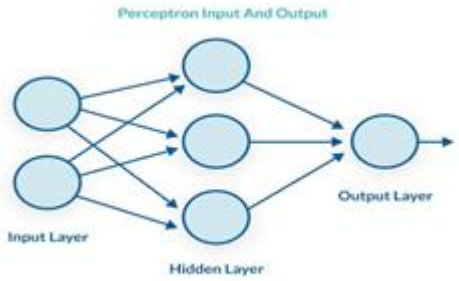

Figure 1: Structure of Neural Network

The limitations of artificial neural networks are

- The most challenging part of artificial neural networks is reading the outputs, debugging, and tuning the algorithm to boost its performance.
- Millions of parameters are generated when training a neural network model with images, resulting in over fitting and a decrease in test outcome accuracy, resulting in a bad model.

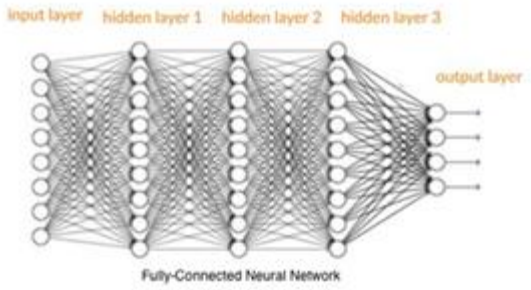

Figure 2: Full connected layer of CNN

4. Prosposed Method

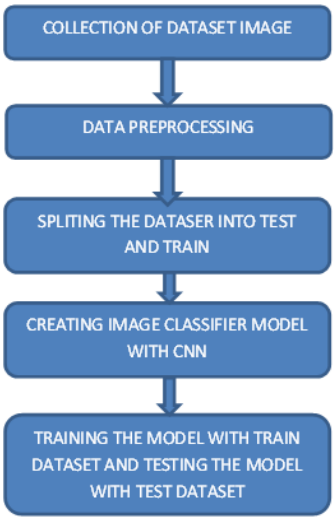

Figure 3: Block Diagram of proposed method

Due to the limitations of artificial neural network we created object classifier model using convolutional neural network as it's overcome the limitations of ANN .Every object classifier model starts with data pre-processing steps. We need to process the entire dataset which we going to feed the model.

4.1 Dataset

We collected a dataset of 39206 images which represent 42 different traffic sign board images totrain the model those images are colour images RGB format.

Figure 4: Different Traffic Sign Board Images

Like the images above mentioned we have 43 classes in that. We going to process this images and give to the convolution neural network as train and test dataset.

All images are of different shapes and orientation. The shape of the dataset is (39206,30,30,3) 30x30 denotates the length and breadth of the images and 3 denotates the number of channels of the images (RGB).

4.2 Data Augmentation

We used data augmentation method to train the model with more images in different orientation and colour. Data augmentation is process through which we can transfer our present images into different one by cropping rotating it. As a result, the model is less likely to find undesirable properties in the data set.

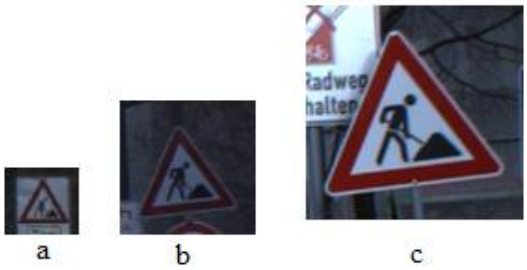

Figure 5: Sample Images of Data Augmentation

4.3 Splitting Dataset

Splitting the dataset into train and test dataset. Splitting the dataset is more important test set must be normally distributed then only we can able to get correct result. We divided the dataset into two sets 80% as train set and 20% as test set.

4.4 Convolutional Neural Network

In convolution, any output value is represented by a set of weighting coefficients multiplied by the number of input values. On the basis of the weighting co-efficients, convolution processing is used for signal low-pass and high-pass filtering in the spatial domain. An picture may be smoothed or sharpened by transforming it with respect to low-pass and high-pass filter masks. In the development of pyramid images, this word is commonly used. Convolution can be used for image compression, image enhancement, image recovery, attribute extraction, and model matching, to name a few.

The discrete convolution of two signals x[n1,n2] and h[n1,n2] in two dimensions is given by

$$y[n_1,n_2] = \sum_{k1=-\infty}^{\infty}\sum_{k2=-\infty}^{\infty} x(k_1,k_2)\,h(n_1-k_1,n_2-k_2)$$

now we need to create a convolutional neural network. We created a model with 4 layers with the help of keras and tensorflow framework. Every image shape is 30x30x3 so we have 30x30 pixel values with stack of 3 layers as it have a 3 channel (RGB).

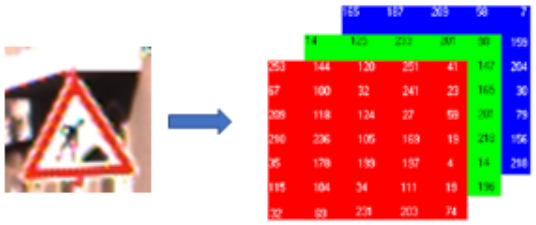

Figure 6: Image to pixel value

4.5 Filter

Now we need to apply the filter for this input layer and do convolutional between the input and the filter layer to get output layer. We have different type of filter

1. Vertical filter

1	0	-1
1	0	-1
1	0	-1

2. Horizontal filter

1	1	1
0	0	0
-1	-1	-1

Convolution of filter and input layer:

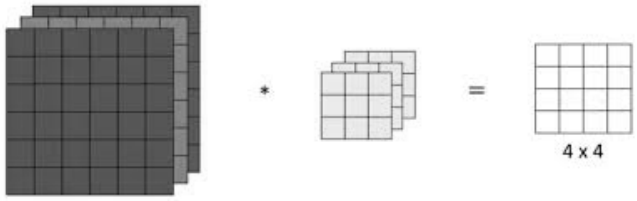

Figure 7: Convolution of input layer and filter

4.6 Padding

By default, a filter begins on the left side of the image, with the left side of the filter on the left side of the image pixels. The filter is then moved one column at a time around the image until the far right pixels of the image sit on the right side of the filter. To overcome this we can use padding the input layer. padding we can pad the input layer with zeros to keep the information in the edges of the images. It will also used in edge detection also. For object detection we can train the model with or without padding feature.

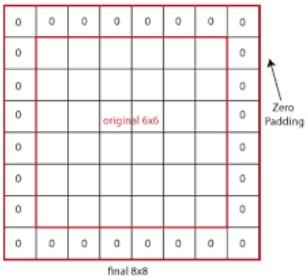

Figure 8: Padding layer

4.7 Pooling Layer

Pooling is a feature we can apply for the outputted matrix after convolution with filter. It will reduce the dimensional of the outputted matrix.
Pooling can be separated into two groups.

a. MAX POOLING
b. AVERAGE POOLING

4.7.1 Max Pooling

Max pooling is the most commonly used pooling method in convolutional neural network. Hyper parameters of max pooling are shape and stride. For example if shape = 2x2 stride = 2

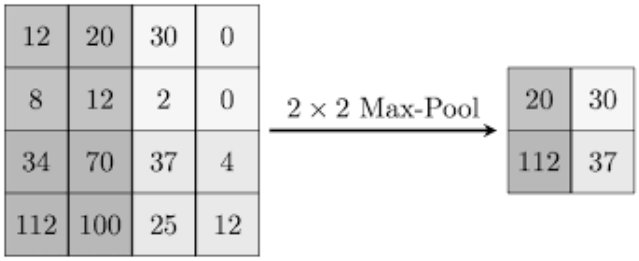

Figure 9: Max Pooling

It will take the max value from the first 2x2 values in the input matrix stride means how much column we need to shift after one value is take form them.

4.7.2 Average Pooling

The average of the first 2x2 values in the input matrix is used in average pooling, and vice versa.

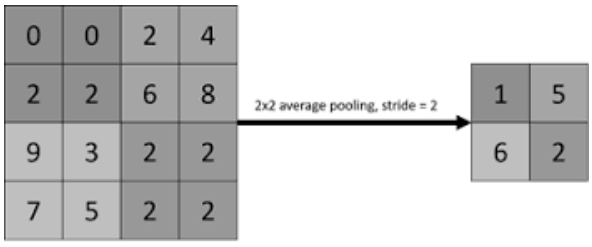

Figure 10: Average Pooling

In this project we applied max pooling for more convince.Each layer is consisting of input layer, filter layer, pooling layer.

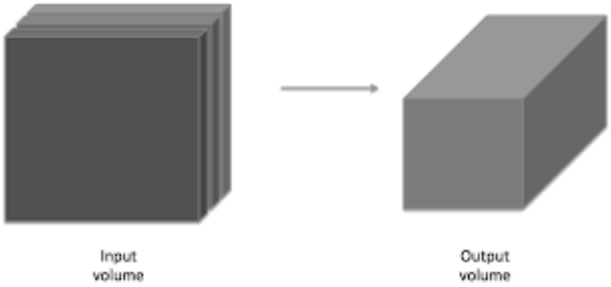

Figure 11: Transforming of shape

After adding 3 more layers of convolutional we get a fully connected layer.

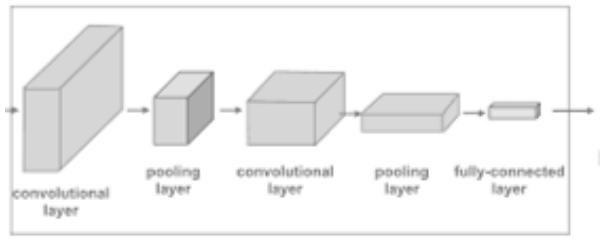

Figure 12: Layers of CNN

This is the fully completed model for object classification

4.8 Determining the Dimension of the Resultant Matrix

The dimensions of the corresponding matrix, x(m, n), and h, are determined by the dimensions of the input matrices (m, n). x(m, n) has a 2 x 3 form (two rows and three columns). h(m, n) has a 3 x 1 dimension (three rows and column). The dimension of the resulting matrix is determined as

Dimension of resultant matrix =

(No. of rows of x(m, n) + No. of rows of h(m, n)-1)

X

(No. of columns of x(m, n) + No. of columns of h(m, n)-1)

4.9 Softmax Activation Function:

We need to add a final layer with a softmax activation feature with 43 groups to predict 43 different types of traffic sign boards at the end of the model.

SOFTMAX:

$$\sigma(\vec{z})_i = \frac{e^{z_i}}{\sum_{j=1}^{K} e^{z_j}}$$

Where
$\vec{z}$ is denotes input vector to the softmax function.
z_i is denotes the values of the element of the input vector.
K is the number of classes we needed in this case k=43.
Now we need to complie our model and test with the test set which we splited from the orginal dataset.

5. Result and Discussion

With the aid of a 39000 labelled image dataset of various traffic signs, we trained a broad deep convolutional neural network capable of classifying around 43 groups. We can see the result of our model which predicts correct class of a traffic sign images. The accuracy of the model which we developed is 94.03% which is considered as good percentage of accuracy for an image classifier model. With the above model which we create using that we can able to classify 43 different classes of traffic signs. We can able to classify a huge classes of images with the model we created but we need huge computational power for that and it also cost huge for providing that much of computational power for developing the model. The CNN model was used to categorise about 11,000 image types, and the work was done on massive computationally effective devices, also known as supercomputers. The activation functions used in hidden layer are the key feature for increasing accuracy of the model while predicting image class. In that we came to understand that softmax activation function is most suitable for image classification model in the output layer which is final layer. And RELU (rectified linear unit) activation function is suitable for the hidden layers it gives more non-linear function to the hidden linear then logistics and other activation function. We can also use tanh activation function for hidden layers. The above created model is also having limitations like we cannot to able classify image if more than one class traffic sign presented in same image. This problem can be more come with another type of model know as object classifier. It is interesting that if a single convolutional layer is excluded, the efficiency of our network deteriorates. For instance, for the top-1 output of the network, eliminating either of the middle layers results in a loss of around 2 percent. So the depth is very necessary for our conclusions to be reached.

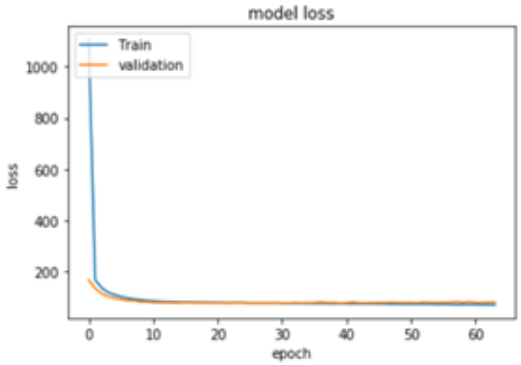

Figure 13: Model Loss for each epoch

Table 1: Comparison of results between train and test.

TYPE	TRAIN	TEST
Recall	93.9	91.0
Accuracy	96.7	92.0

5. Conclusion

Increasingly efficient, the concept of AI, phenomena known as the AI effect, is frequently excluded from tasks perceived to involve "intelligence" "A quip in Tesler's Theorem says "AI is something that has not yet been achieved." For example, identification of optical characters is mostly omitted from items perceived to be AI, having been a routine technology. Currently known as AI, Strong human voice interpretation, high-level strategic game systems (such as chess and Go), and autonomous vehicle management, intelligent routing in information distribution networks and military simulations are all examples of modern computing technology.

In the twenty-first century, following parallel advancements in computing resources, vast volumes of data, and scientific awareness, AI techniques have undergone a resurgence; and AI techniques have become an integral part of the technology sector, helping to solve many difficult computer science, software engineering, and operations research problems.

In this area, image classification is also crucial. It introduces capabilities to software to make them more stable. This technique can be used in a large dataset for classify in web or for a social media algorithm to find which type of images are popular now. We have not used any unsupervised pre-training to simplify our studies This will help, particularly if we can get enough computing power to greatly increase the computational power. By far, our outcomes have increased as we have grown and educated our network longer. In order to equal the output of the human visual system, they have several orders of magnitude to go.

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