Digital Image Processing Technique for Smart Traffic Management

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Abstract - Convolutional Neural Networks are now being used to solve an increasing number of object recognition tasks (CNN). Convolutional neural networks have improved most current new computer vision tasks have emerged due to their high remembrance rate and quick attainment. In this paper, we propose a convolutional neural network implementation of a traffic sign recognition algorithm. TSR (traffic-sign recognition) is an important component of driver-assistance systems that can help drivers avoid a wide range of possible hazards and enhance their driving experience. The TSR, on the other hand, is a practical challenge with numerous limitations, including the visual environment, physical losses, and partial occasions, among others. Convolutional neural networks were developed to deal with the constraints. Convolutional neural networks (CNN) are used to extract visual features of traffic signs and classify them into corresponding groups in order to deal with the constraints.

Key Words: Machine Learning, Customer Segmentation, Artificial Intelligence.

1.INTRODUCTION

. The various advancements in the technological level of modern mobile processors, many automotive manufacturers are now able to integrate computer vision systems into their vehicles. These systems contribute to a major increase in safety and are an essential step toward autonomous driving.

The traffic sign recognition (TSR) problem, among other tasks solved with computer vision, is one of the most prominent, widely discussed and considered by many researchers. Despite that, weak detection accuracy and a high demand for hardware i.e. efficient in terms of computation, besides the inability of certain systems to interprets traffic signs from different countries, are the key issues with such systems. Traffic sign recognition is generally accomplished in two steps: localization and classification.

In this Research, we present a new end-to-end technology for recognizing and detecting traffic signals in real time in this paper. The developed system makes use of the vehicle's speed. This allows you to anticipate not just the object's position in the surrounding frame but also its movement, size and exact coordinates. As a result, detection performance improves while computational complexity remains constant. Convolutional neural networks are used to classify entities that are localized (CNNs). This paper makes a significant contribution by outlining the method of constructing a convolutional neural network.

Fig. 1. Input image convolution

To obtain an activation map, each convolutional layer is made of a collection of trainable filters that compute dot productions betwixt these filters and the layer input. These filters, also known as kernels, allow for the detection of the same features in multiple places. The outcome of applying convolution to a four-kernel image, as shown in Fig.1.

2. Literature Review

Since they have delivered the current state of traffic signs into different systems, traffic sign recognition (TSR) has benefited a significant range of practical applications, such as driver assistance systems, autonomous vehicles, and intelligent mobile robots. However, computers face some challenges in recognizing traffic signs on the lane, which stem primarily from two factors: One is about unbalanced class frequencies in datasets [3], and the other is about the dynamic traffic scene [1].

In terms of the complexity of real-world traffic scenes, traffic signs are often well designed for drivers to clearly read and understand the signs during driving time, including bright colors, strong and bolded phrases, as well as various basic and simplified shapes; however, designing features combined with polluted environments is a challenging job. [2]. Poor lighting, small-size signs in scenes, partial occlusions, rotations, and physical damage are examples of the conditions. All of these variables would have a major effect on the output of computer algorithms for traffic sign recognition.

When it comes to benchmark characteristics, the distribution of data categories is typically unequal. As we all know, traffic signs come in a variety of shapes and sizes. The GTSRB, for example, contains 43 classes, with the lowest frequency rate of 0.5% and the highest frequency rate of nearly 6% across all classes [4].

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3. Methodology

Convolutional neural networks (ConvNet's or CNNs) are one of the most common types of neural networks used to recognize and classify images. CNNs are commonly used in areas such as object detection, face recognition, and so on. To train and test deep learning CNN models, each input image will be passed through a series of convolution layers with filters (Kernels), Pooling, completely connected layers (Fully Connected), and the SoftMax function to classify an object with probabilistic values ranging from 0 to 1. CNN image classifications take an input image, processes it, and categorizes it into different groups. An input image is seen by computers as an array of pixels, with the number of pixels varying depending on the image resolution. It will see h x w x d (h = Height, w = Width, d = Dimension) based on the image resolution. For example, a 32 x 32 x 3 array of RGB matrix (3 refers to RGB values) and an array of grayscale matrix image, as shown in Fig.2 and Fig.3.

Fig. 2. Speed Limit (20 km/h)

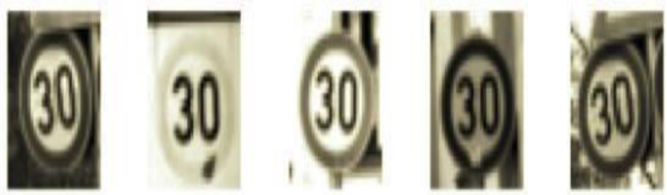


Fig. 3. Speed Limit (30 km/h)

We saw earlier that there was a clear imbalance in the data across the 43 groups. Despite the class imbalance, we are able to achieve very high accuracy, so it does not appear to be a debilitating issue. Some of the pictures in the test set are also blurred, as shown in Fig.4.

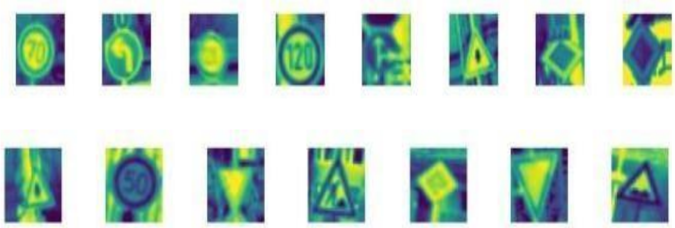
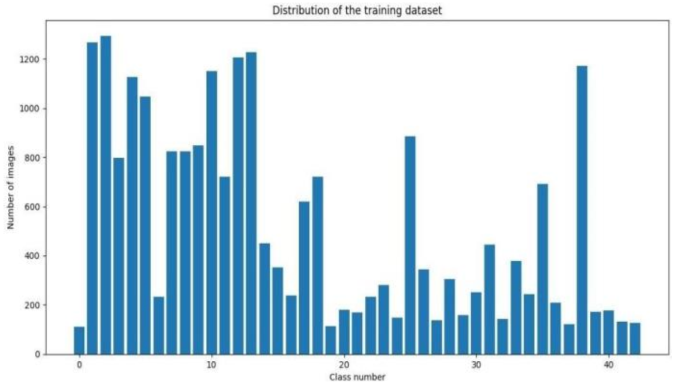


Fig. 4. Color imbalance or distorted image dataset.

In the training set, there is also a major imbalance between grades, as seen in the histogram below. There are fewer than 200 pictures in some classes, while there are more than 2000 in others. This means that our model can favor over-represented groups, particularly when its predictions are uncertain. We'll look at how data augmentation will help us deal with this disparity later.



ClassId	Name
0	Speed limit (20km/h)
1	Speed limit (30km/h)
2	Speed limit (50km/h)
3	Speed limit (60km/h)
4	Speed limit (70km/h)
5	Speed limit (80km/h)
6	End of speed limit (80km/h)
7	Speed limit (100km/h)
8	Speed limit (120km/h)
9	No passing
10	No passing for vechiles over 3.5 metric tons
11	Right-of-way at the next intersection
12	Priority road
13	Yield
14	Stop
15	No vechiles
16	Vechiles over 3.5 metric tons prohibited
17	No entry
18	General caution
19	Dangerous curve to the left
20	Dangerous curve to the right
21	Double curve
22	Bumpy road
23	Slippery road
24	Road narrows on the right
25	Road work
26	Traffic signals
27	Pedestrians
28	Children crossing
29	Bicycles crossing
30	Beware of ice/snow
31	Wild animals crossing
32	End of all speed and passing limits
33	Turn right ahead
34	Turn left ahead
35	Ahead only
36	Go straight or right
37	Go straight or left
38	Keep right
39	Keep left
40	Roundabout mandatory
41	End of no passing
42	End of no passing by vechiles over 3.5 metric tons

Fig. 5. Distribution of images in training set

4. Experiment Results

TensorFlow includes a range of tools for visualizing models at various levels of abstraction, from high-level mathematical operations to low-level mathematical operations. TensorBoard is widely used for these methods. The convolutional block and the completely linked block are two stacked blocks in the presented model.

The initial dataset was split into train and test datasets. They are in some proportion to train and evaluate the model. The network operated a batch of 10 images derived from the training dataset per recurrence during the training stage. The intermediate accuracy was calculated using ten images from the test dataset in a batch. The precision and validation were calculated using all images from the dataset defined for testing after successful training. As the number of training iterations increases demonstrates how classification accuracy and validation improves, as shown in Fig.6.

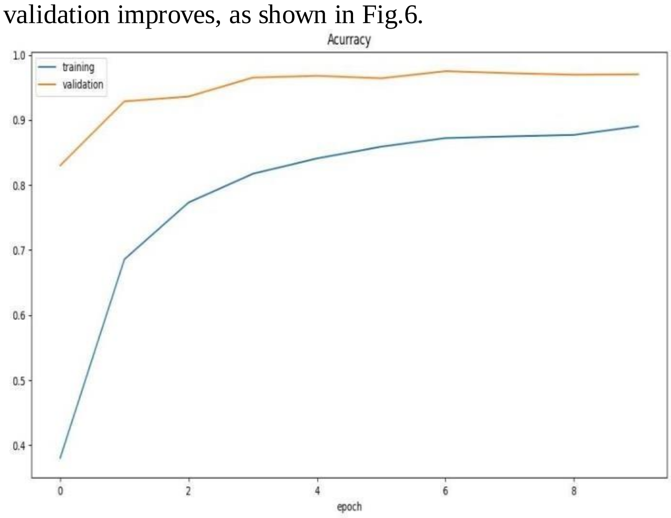


Fig. 6. Accuracy Model

Furthermore, we discovered some erratic loss behavior on the validation set after a certain number of epochs, suggesting that our model was overfitting on the training set and not generalizing, as shown in Fig.7.

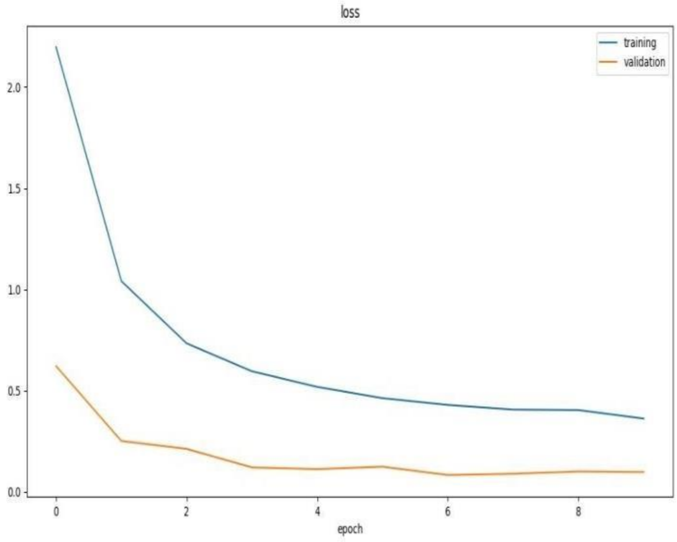


Fig. 7. Loss Model

3. CONCLUSIONS

This paper considers how deep learning can be used to accurately identify traffic signs using a variety of pre-processing and regularization techniques (such as dropout), as well as a variety of model architectures. We created a versatile way of testing multiple architectures by writing highly configurable code. On the test range, our model was close to 95% accurate, with a score of 90% on validation set. The TensorFlow method is used to implement the proposed classification solution. In future study, we want to train the CNN to take into account further traffic sign groups as well as the possibility of bad weather. We also plan to use a CNN for object detection as well as classification.

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