Research and Application of Traffic Sign Detection and Recognition Based on Deep Learning

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Abstract*—Nowadays, with the rapid development of society and economy, automobiles have become almost one of the convenient modes of transport for every household. This makes the road traffic environment more and more complicated, and people expect to have an intelligent Vision-assisted applications that provide drivers with traffic sign information, regulate driver operations, or assist in vehicle control to ensure road safety. As one of the more important functions , traffic sign detection and recognition[1], has become a hot research direction of researchers at home and abroad. It is mainly the use of vehicle cameras to capture real-time road images, and then to detect and identify the traffic signs encountered on the road, thus providing accurate information to the driving system. However, the road conditions in the actual scene are very complicated. After many years of hard work, researchers have not yet made the recognition system practical, and further research and improvement are still needed. Traditionally, traffic signage has been detected and categorized using standard computer vision methods, but it also takes considerable time to manually process important features of the image. With the development and progress of science and technology, more and more scholars use deep learning technology to solve this problem. The main reason that the deep learning method is widely accepted is that the model can learn the deep features inside the image autonomously from the training samples, especially for many cases that do not know how to design the feature extractor, such as expression recognition, target detection Wait. Based on the application of road traffic sign detection and recognition, this article focuses on the correctness and high efficiency of detection and recognition.Through Caffe[2] which is the open-source framework, a deep convolution neural network algorithm is proposed to train traffic sign training sets to get a model that can classify traffic signs and to learn and identify the most critical of these traffic signs Features, so as to achieve the purpose of identifying traffic signs in the real scene.

Keywords-Traffic Signs; Detection and Recognition;Caffe;

I. INTRODUCTION

Traffic signs occupy an important position in the road traffic system. The main function of the traffic signs is to display the contents that need to be noticed in the current road section, to prompt the drivers in front of the road the danger and difficulty in the environment, to warn the driver to drive at the prescribed speed, to provide a favorable guarantee for safe driving. Therefore, the detection and identification of traffic signs is a very important research direction, which is of great significance to prevent road traffic accidents and protect the personal safety of drivers.

Road traffic signs are divided into two major categories of main signs and auxiliary signs. The main sign is divided into warning signs, prohibition signs, mandatory signs, guide signs, tourist signs and road construction safety signs. Among them, prohibition signs mainly played a role in banning certain kinds of behavior, a total of 43 categories. mandatory signs indicate the role of vehicles, pedestrians, a total of 29 categories, mandatory signs mainly placed in the need to indicate vehicles, pedestrians road sections or near the intersection. Warning signs are mainly to alert drivers, vehicles and pedestrians to beware of dangerous targets, a total of 45 categories. They all play an important role in traffic signs. Among them, the most common speed-limit signs and the prohibition of left and right turning signs are of great significance for safe driving of drivers and therefore are the focus of the current research on traffic sign recognition.

The realistic application scenarios bring high reliability requirements for traffic sign detection and identification. If there is a misdetection or a misdetection, or a misidentification detected afterwards, it will result in erroneous information being input to the vehicle, causing erroneous operation and unpredictable consequences. Therefore, it is unavoidable to develop a traffic sign detection and recognition algorithm with high accuracy and robustness under various complicated situations and disturbances.

II. RELATED WORK

The study of traffic sign recognition technology started as the Prometheus (Program for European Traffic with Highest Efficiency and Unreasonable Safety) funded by non-governmental organizations composed of 14 large-scale automobile companies such as Mercedes Benz in order to study an automatic traffic sign recognition system.[3] The automatic identification of traffic signs mainly includes the detection of traffic signs and the identification of traffic signs. Traffic sign detection methods mainly include color-based methods and shape-based methods.[4] During the detection phase, the collected images are preprocessed, enhanced and segmented according to the basic attributes of color and shape. The detection of traffic signs in the image is

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to detect potential pixel areas which is the area of interest that may be road traffic signs in complex backgrounds. The potential object is then normalized to be an image of the specified size and entered into the recognition phase. Traffic sign recognition methods can be roughly divided into statistical-based methods and support vector machine-based methods. In recent years, however, deep learning approaches have come into the field of researchers. Convolutional neural networks[5] have achieved great success in image classification and target detection. Unlike traditional methods, convolutional neural networks can be trained automatically and extract image features, and the detection accuracy is significantly higher than the traditional machine learning methods[6]. The research results have attracted the attention of researchers.

III. TRAFFIC SIGNS DETECTION AND IDENTIFICATION

A. Data Set

Although the convolutional neural network has made remarkable achievements, the current applications in the field of traffic sign detection and recognition are still not much. The reason for this is largely due to the lack of traffic sign datasets. Training and verifying a deep convolution neural network traffic sign recognition model requires a large amount of traffic sign data as a basis.[7] However, the open traffic sign datasets in China is relatively scarce compared with European countries. More well-known traffic sign datasets now include GTSRB[8] in Germany, GTSDB[8] in Germany and KUL in Belgium. In this paper, GTSRB, GTSDB traffic sign datasets is used to study traffic sign detection and recognition. These two datasets include many types of complex traffic signs such as sign tilt, uneven lighting, traffic sign distortion, occlusion, and similar background colors, as well as actual scene maps. Through a variety of complex and difficult to distinguish traffic signs to verify the ability of the algorithm.

Figure 1. Different type of traffic signs

B. Image Preprocessing

Before the image is input to the neural network, the image is normalized so that the pixel value is between 0 and 0.5. To do this, adjust all pixel values. This is because the neural network performs better when the raw data is between 0 and 1. Instead of converting it to gray, the experiment decided to use a color traffic sign because humans classify it by the color of the symbol, and the machine can take advantage of it.

C. Network Structure

This paper uses a VGG-16[9] as a front-end network structure of the SSD[10] algorithm to detect and identify traffic signs. The VGG-16 network consists mainly of five stacked convolutional layers, three fully connected layers and a Softmax. Each stacked convolution layer consists of several common convolution layers, forming a local convolutional network structure followed by a pooling layer. After the completion of the convolution kernel pooling operation and the three fully connected layers, the output of the last fully connected layer is used as the input of the Softmax layer , and finally the traffic sign recognition result is obtained.

D. Feature Extraction and Training Model

In this paper, the data set is trained and a traffic sign detection and recognition model is constructed. For each input image, the model uses the convolution layer to extract the global convolution feature of the image, and then on different scale feature maps, Probability and regression analysis of the target object coordinates; Finally, the use of non-maximum suppression algorithm to eliminate the redundant test box to determine the result of what type of road traffic signs, the final test results will be the correct output.

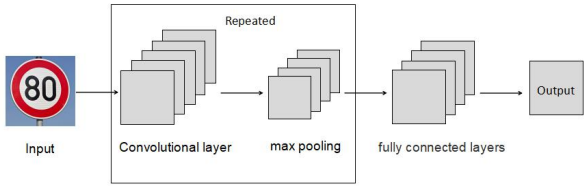

Figure 2. Network Structure

E. Experimental Verification

After several adjustments to determine the parameters of the experiment, the learning rate of 0.001, step-by-step attenuation, 4000 iterations decay 10 times the maximum iteration 20000 times.Training set and verification set batchsize 50 and 20 respectively, test_iter is 632 (12630/20), each of which just covers 12,630 test samples at a time and prints a snapshot every 5,000 times.

After iteration 20,000 times, the accuracy rate can reach about 96%.

The following figure shows the part of the logo image identifies the error, we can see that part of the image marked the human eye is well recognized but the algorithm identifies

the error, indicating that the network there is room for improvement in extreme conditions, there are some serious tilt, poor image quality, The smallest bounding box is not accurate enough and so on.

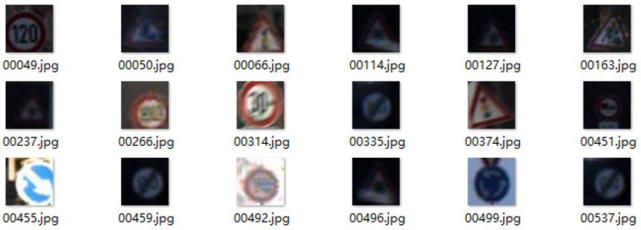

Figure 3. Detect the wrong traffic signs

F. Experimental Improvement

Add more data to the datasets. For example, some traffic signs have invariance of horizontal or vertical mirroring, and the images of the training samples can be randomly rotated by a small angle to deal with the sign tilt problem in the real scene.

In order to improve the reliability of the model, dropout algorithm can also be used. This algorithm refers to the neural network unit being temporarily discarded from the network according to a certain probability during the training process of the deep learning network. This prevents the model from overfitting.

IV. CONCLUSIONS

In this paper, we propose a novel and effective way to detect and identify traffic signs. The main contribution of this paper is as follows:

(1) Under the guidance of a fully convolutional network, a new framework of traffic sign detection and recognition based on SSD algorithm is proposed.

(2) It is challenging to extend SSD into a new application Traffic sign detection and identification problems.

(3) Deep learning reduces the time cost significantly, and can greatly reduce the training of negative samples, ensures the balance of positive and negative samples, and improves the accuracy of Softmax classifier. GTSRD experimental results show that the proposed method to achieve the latest results. In the future, we will learn how to identify the text part of the traffic signs and develop a real-time traffic sign system on that basis. Another future task is to be able to apply this to autonomous driving systems.

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