

Application of Deep Learning Based on Garbage Image Classification

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Abstract: - In recent years, with the rapid development of economy, the country's various construction is thriving, and remarkable achievements. At the same time, resources and the environment have been seriously damaged. This phenomenon is directly related to the irrationality of garbage classification and delivery, and the contradiction between the two is becoming increasingly acute as people strongly reflect the problem of environmental pollution but do nothing about it. This paper designs a garbage image classification system based on deep learning, the main research content is to compare multiple deep learning neural network models, find the optimal classifier, develop web applications and deploy neural networks, which includes image data acquisition, image pre-processing, and comparison of VGG16, Inception, and Resnet neural network model accuracy

Key-Words: Garbage Image Classification; Deep Learning; VGG16; Inception.

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1 Introduction

At present, the main way of garbage classification is that residents consciously classify garbage when they dump it and throw it into the corresponding garbage [1-3]. However, this garbage classification method based on residents' consciousness is difficult to be deeply implemented, and residents cannot accurately distinguish the types of recyclable garbage and classify each kind of garbage in detail [4]. Through some city residents forced garbage classification in recent years, but through a period of implementation, the effect is not good, most of the general public is not entirely correct in classifying rubbish, so to enforce garbage classification was fined not only let the masses themselves, and also for the recyclable garbage classification is not too big effect [5].

Therefore, it is not an effective method to classify garbage solely by the waste producers' consciousness. Instead, it should be simply classified by the waste producers, then the waste recycling plant will carry out detailed garbage classification and classify and treat the recyclable garbage [6]. Garbage problem is increasingly

serious, with the rapid development of economy, the urbanization process is gradually accelerating, people's living water. In order to meet people's growing needs for life, a variety of diversified commodities and articles of daily use have been pouring in. This is followed by an increasing amount of household garbage, which has caused great pressure on the environment. Some cities have already seen garbage [7]. The phenomenon of siege, garbage classification is a reform of the traditional way of garbage collection and disposal, is an effective disposal of garbage management methods.

How to deal with recyclable waste is a major research issue globally. The classification and reuse of recyclable garbage is an important link between resource recycling and reuse [8]. The effect of garbage resource recycling is closely related to the quality of garbage classification. Rapid and effective garbage classification can greatly reduce the environmental pollution and resource waste caused by garbage. The classification of recyclable garbage by deep learning has the characteristics of high precision, fast speed and high adaptability [9] [10]. The establishment of a precise garbage

classification system can not only help garbage recycling plants to carry out garbage classification, because of its simple operation, but also help people to identify the types of recyclable garbage, help them to accurately put garbage, and realize the intelligent development of garbage classification.

An automated machine that can automatically sort recyclable garbage [11]. The machines input images from external devices, such as cameras, and then calculate the types of garbage using a deep learning network inside the machine. At the time, however, the machine could only sort the valuable rubbish from the huge amount of rubbish waiting to be sorted, not really sort the huge amount of rubbish. Subsequently, computer vision technology has been widely applied to image detection and classification in the academic world, and computer vision is used to classify various objects in the industry. However, due to the diversity of recyclable garbage, mature garbage classification algorithm is still a difficult problem. Plastic accounts for a large proportion of recyclable waste, and the accuracy of a traditional computer vision-based algorithm for classifying plastic bottles is greatly reduced due to the transparent nature of plastic and the complex background of garbage classification [12]. Later, a plastic sorting method based on infrared spectrum analysis equipment was also proposed, but this equipment is relatively expensive, so it is not suitable for large-scale commercial use. It can be seen that the traditional computer vision is not ideal for the classification of recyclable garbage. On the one hand, the identification accuracy is not high enough; on the other hand, the classification cost is too high, which is not suitable for large-scale application in manufacturers.

2 Overview of Deep Learning

Deep Learning is a kind of neural network technology. Its most revolutionary point is that as long as there is enough learning data, the neural network itself can automatically extract the features of the data group. The analysis of images and data before this requires the operation of the extraction algorithm according to each data and problem. However, deep learning does not require manual

operation, but automatically extracts features. Slightly crudely, this is what it means: simply inject data into a neural network and you can extract any feature you want.

A neural network is a network of connected brain nerve units that mimic neurons [13]. The input signal is propagated. One of the characteristics of this method is that each layer of neural network can be phased learning. For example, let the first layer learn to output the input information as is, let the second layer learn to reproduce the input in the same way on the basis of the first layer, the third layer after the same operation. Deep learning is best at pattern recognition of data that cannot form symbols, such as image data and waveform data, and stage learning after inputting images through the input layer. The commonly used neural network is a perceptual neural network with all layers connected together. But in the case of image recognition, it is easier to adopt a special connection method. This is called a convolutional neural network. It is the prototype of deep learning. It is characterized by a multi-scale intermediate layer for different size segmentation of input data and feature extraction. Input an image of a car, for example, and you can extract everything from detailed patterns to large structures and overall Outlines.

Deep learning is a division in the field of artificial intelligence as a whole. Some researchers believe that the neural network before deep learning has made a leap forward, but there is still some gap between it and the social cognition that suddenly approaches human beings [14]. Moreover, it takes time and stages to reach a point where it is truly useful to society. At present, the development of technology for practical purposes in many fields is proceeding rapidly all over the world. In particular, the neural network is characterized by the repetition of market calculation and the large number of parallel calculations. As a result, graphics boards equipped with gpus, which support the gaming and computer graphics industries can be used.

In a word, deep learning can help us classify recyclable garbage reasonably and efficiently, and create a society in which garbage resources can be reasonably reused and resources can be fully

recycled. Deep learning technology has a mature application case in the field of classification of various images, so it is feasible to use neural network for garbage classification technically. At the same time, the classification accuracy of garbage image is low by using traditional image processing methods, but the classification of garbage image by using deep learning can quickly improve the speed and accuracy of garbage image classification.

3 Proposed Method

Convolutional neural network is an important component of current deep learning [15]. The emergence of convolutional neural network and back propagation algorithm makes deep learning and artificial intelligence enter a new stage of development. Convolutional neural network is designed after the structure of biological neurons. It is generally divided into convolution layer, pooling layer, full connection layer, activation function, loss function and random inactivation.

Convolutional neural network can extract features through the sliding window in the convolutional layer, and then summarize the extracted features through the full connection layer, which accounts for a large proportion of the parameters of the whole neural network. Then the pooling layer is responsible for compressing and simplifying the matrix of the output of the previous hidden layer, so as to facilitate feature sampling. Finally, the output of convolutional neural network similar to image classification cannot be directly utilized by us, but the output of the model should be transformed into various categories through the model structure similar to classifier.

The loss function, the activation function and the random inactivation is a part of the model control effect, loss function is the key to the convolution back propagation neural network model, through calculating the loss function, the model can be error between the predicted value and actual value, which based on loss function to adjust the parameters in the model. Activation function is to prevent only linear changes in the whole model. The whole network can not change in a linear

direction through activation function. Typical activation functions include Sigmoid function and Relu function. Random inactivation function will randomly discard some parameters, so that the whole network will not overfit in the training process..

After obtaining the data that can be used for testing, three models VGG16[16], Xception[17] and InceptionResnetv2 are respectively used for transfer learning in order to obtain better detection effect, and the optimal model is selected by comparison. Finally, InceptionResnetv2 was selected as the model according to the average accuracy and prediction speed of the model.

In order to extract image features more effectively, Inception module uses a structure that combines several different convolution operations in parallel to extract image features more effectively. But the corresponding tighter module also makes the parameters of the module larger. At the same time, the Resnet structure can not only accelerate the training speed, but also simplify the complexity of the model and prevent the gradient diffusion. The author of the model combined Resnet and Inception structures, so that the model would not have a large increase in the number of parameters without reducing the accuracy of the model, resulting in high training costs. Figure 1 shows the model structure.

This model is continuously iterated from Inception series models, and combined with Resnet residual network, a downsampling structure is added to increase model parameters so as not to cause explosive growth of model parameters. The model starts with a 299×299 pixel RGB image input through the Stem structure of the first layer, which includes multiple convolution processes and merge operations. The matrix data through Stem will enter the following multiple Inception-resnet structures. The general principle of these structures is the same. They are all carried out in parallel by multiple convolution operations, and then merged. At the same time, the Inception-resnet module is different from the previous Inception module in that it adopts the residual structure, which greatly reduces the

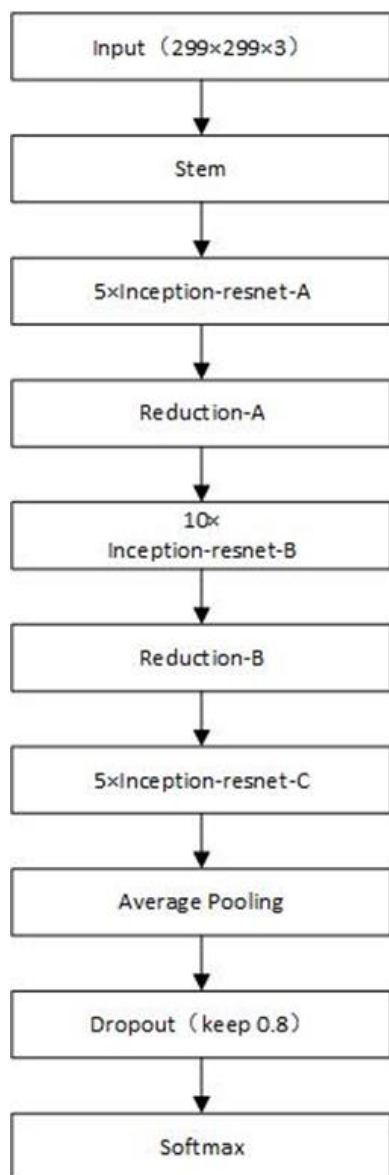


Fig.1. Overview of InceptionResnetv2

time required for training the model and achieves higher accuracy in fewer epochs.

In the final Average Pooling operation, the Average Pooling structure carries out the Average sampling operation on the model of the upper layer, which replaces the fully connected layer and greatly reduces the number of parameters of the model. Finally, the one-dimensional parameters after average pooling are transferred to the linear classification layer of the network through Dropout processing. Finally, Softmax function is used to normalize the obtained parameters, and finally the probability values of different types of model prediction are obtained.

4 Experimental

In this section, we firstly collect the recyclable garbage data, and then data preprocessing is to convert the original obtained data into the data format that meets the requirements of the project through a series of transformations.

4.1 Data Collection

In order to obtain the common recyclable garbage data, and the garbage data acquisition and pretreatment, in order to obtain qualified data set, so as to carry out the training and construction of identification system. The main collection methods are as follows:

(1) Crawler acquisition: Requeset + Selenium is used to obtain image data from large search websites such as Baidu by directly searching target items and crawling them with Python crawlers. The data crawled by crawler are generally messy and need to be manually cleaned to delete pictures of non-target objects and repeated pictures.

(2) Related projects: Transplant the data used in part of the old garbage identification system. Clean data, do not need too much cleaning, storage by category.

(3) Data filling: For the above two methods to obtain a sufficient number of garbage categories, we use to search some well-known image online and second crawler to fill the database imbalance.

After obtaining the summary data, we obtained a total of 17,088 pictures, including 24 categories, respectively: Pans, cutting boards, leather shoes, bottle, bag, pillow, beverage bottle, socket, old clothes, cans, charging treasure, cardboard boxes, glasses, condiment bottles, plastic bowl bowl, plastic hangers, plastic toys, plug wire, shampoo bottle, plush toys, cosmetics bottles, Courier bags, metal food cans, food cans, are common in daily life of recycled garbage.

4.2 Data Processing

Data preprocessing is to convert the original obtained data into the data format that meets the requirements of the project through a series of transformations. Whether the data format is correct or not has a crucial impact on the accuracy of model

training. After obtaining 24 categories of data, 24 folders are read respectively, and a series of operations are carried out on the data in them to produce data sets that meet the requirements of the model.

(1) Image renaming. Through traversing each image under 24 folders, all the images are stored in the format of category name + serial number, and all the serial numbers are stored in the format of five digits (all the insufficient digits are filled with 0). Data preprocessing is to convert the original obtained data into the data format that meets the requirements of the project through a series of transformations. Whether the data format is correct or not has a crucial impact on the accuracy of model training. After obtaining 24 categories of data, 24 folders are read respectively, and a series of operations are carried out on the data in them to produce data sets that meet the requirements of the model.

(2) Image renaming. Through traversing each image under 24 folders, all the images are stored in the format of category name + serial number, and all the serial numbers are stored in the format of five digits (all the insufficient digits are filled with 0).

4.3 Experiment results

The training results of the model need certain evaluation standards. Firstly, a new validation data set should be created in addition to the training data set of the model to verify the accuracy and loss value of the model. When verifying the accuracy of the model, the data set during the training of the model cannot be used, because the model may have over-fitting, that is, the model has a very high fitting degree to the training data, but the prediction accuracy of the data other than the training data used is very low, or even cannot be fitted basically.

Therefore, a separate validation dataset needs to be created to calculate the exact results of the model. InceptionResnetv2 has a detection accuracy of 89% and a loss value of 0.8. Compared with the above two migration models, InceptionResnetv2 has better detection performance, as shown in Fig.2.

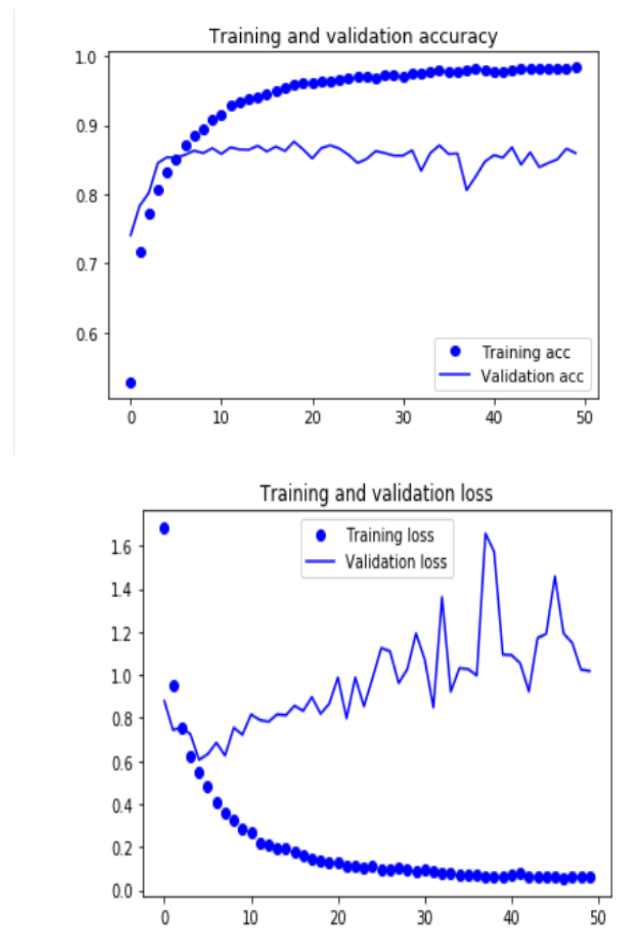


Fig. 2. Experiment results

5 Conclusions

In this paper, we design a garbage image classification system based on deep learning method, the main research content is to compare multiple deep learning neural network models, find the optimal classifier, develop web applications and deploy neural networks, which includes image data acquisition, image pre-processing, and comparison of VGG16, Inception, and Resnet neural network model accuracy

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