Construction Method of Network Teaching Resources Based on Deep Learning

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Abstract

In this paper, the construction method of network teaching resources based on deep learning is researched. In this paper, a teaching resource integration method based on convolutional neural network is designed, including the design of Arduino device identification program based on convolutional neural network and the construction of Arduino device learning resource library. Based on this, this paper proposes a network multimedia teaching resource integration system based on constrained clustering algorithm. In order to realize the system, the use cases of the system are analyzed. On the basis of use case analysis, the function and overall architecture of the system are designed respectively, and the collaborative recommendation module is mainly designed. In order to improve the accuracy of recommendation, this paper uses constrained clustering algorithm to complete the integration of network teaching resources. The experimental results show that the system can improve the accuracy of recommendation matching and the integration efficiency of network teaching resources.

Keywords*: Deep learning, teaching resource integration, Arduino, learning resource library.*

I. Introduction

Paper textbooks are the most common carrier of educational resources at this stage. Learners generally like to use paper textbooks for learning, which is related to the habit that learners always use paper textbooks, because paper textbooks can let learners take notes and sketch, and the visual comfort is far higher than electronic textbooks. With the development of information technology, the form of teaching material is constantly changing, from a single paper teaching material to "teaching material + CD", and then to the popular new media teaching material of "teaching material + digital resources". Teaching materials from a single paper-based teaching materials to "teaching materials + digital resources" of the new media teaching materials change process, but also the degree of learning information continues to improve the process [1-2]. With the continuous improvement of the degree of informatization, the learning mode has gradually changed from the traditional learning mode to the information and digital learning mode.

The emerging network technology represented by the Internet and mobile Internet is driving the traditional teaching mode, learning resources and learning methods to digital, networked and intelligent, and driving the traditional paper teaching materials to integration and three-dimensional development. Web address and two-dimensional code are directly forbidden in teaching materials, which makes teaching materials, especially composite teaching materials, separate from teaching resources [3]. This not only restricts teachers to use diversified teaching methods in teaching, but also has an impact on students' autonomous learning after class. At the same time, the prohibition of web address and two-dimensional code poses a new challenge to the construction of composite teaching materials, and urges the builders of teaching materials to rethink the interaction between teaching materials, digital resources and learners. Therefore, we need a new method to connect teaching materials and teaching resources, so that more teaching resources can better serve education, and effectively promote the deep integration and mechanism innovation of information technology and education and teaching.

II. Design of teaching resource integration method based on convolution neural network

2.1Overall design of teaching resources integration method based on convolution neural network

The resource integration method based on convolution neural network is mainly composed of two parts. The first part is the technology part, that is, Arduino device recognition program based on convolutional neural network, which realizes the classification and recognition of Arduino devices through the program; the second part is the learning resource part, which completes the construction of Arduino device learning resource library by collecting and screening the existing learning resources and making videos. The whole process of resource integration method based on convolution neural network is shown in Figure 1:

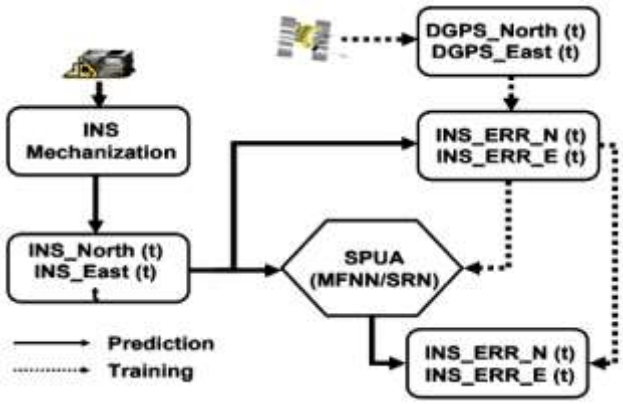

Figure 1 The whole process of resource integration method based on convolution neural network

In the learning process, learners use Arduino device recognition program based on convolutional neural network. The recognition program tells learners the name of the identified device, and pushes learning resources related to the identified device to learners, including text resources and video resources [4-5]. Arduino device learning resource library is composed of many text resources and video resources. Learners are connected with the learning resource library through recognition program.

2.2Design of Arduino device identification program based on convolutional neural network

The main idea of constructing convolutional neural network flow of Arduino device recognition is to collect hundreds of pictures of 10 commonly used Arduino devices by using image acquisition equipment, so as to form image data set. Then, the convolutional neural network model is obtained by training the image data, and then the Arduino devices are classified and identified by the network model, and the device types of the output test are output. The complete construction process is shown in the following figure:

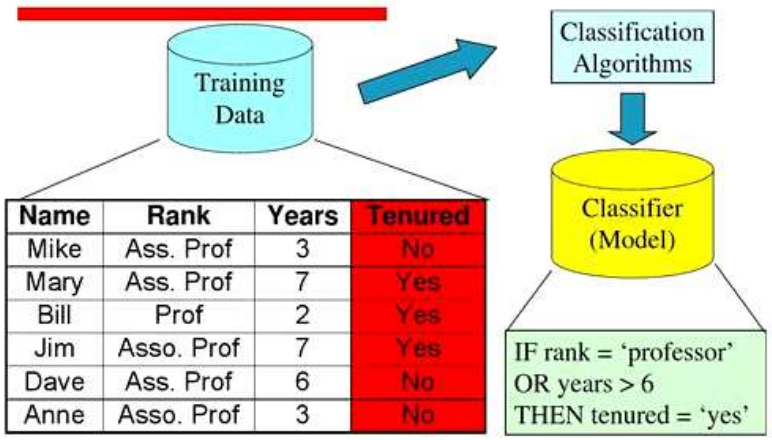

Figure 2 Structure flow chart of Arduino device identification

The construction process of Arduino device recognition is divided into three parts: data set construction process, model training and generation process, and image classification and recognition process. Next, the construction process is described in detail.

(1)Data set construction process:

The training and generation of deep learning neural network model is based on the learning of a large number of image features. This paper studies the deep learning model of Arduino device recognition, which is based on a large number of previously selected pictures of 10 kinds of Arduino devices [6]. The images of all Arduino devices are collected by the same image acquisition device to ensure that the resolution of the images is the same. Based on this, the image data sets of 10 devices are constructed. After the code program, the image will be divided into training set, test set and verification set, the number of images in each set will be automatically divided according to the percentage set in the code.

(2)Model training and generation process:

After the completion of image collection and data set construction, we need to transform the image format. In this process, it is necessary to transform the JPEG image file into a file format that can be recognized by convolutional neural network. In the process of training convolutional neural network model, the image is transformed into tfrecord file as the initial data input of the network [7-10]. After the processing of image data, convolution neural network realizes the output of network model through multi-layer convolution and pooling operation. By comparing the error information between the actual output and the expected output, the test accuracy value and error loss function describing the advantages and disadvantages of the model are observed and analyzed. Then, the network parameters of the model are changed. The training phase of the model is a process of changing parameters and optimizing. This process continues until the output data value converges and tends to a stable state, or the number of iterations ends, and the model training ends. At this time, a classification model can be obtained and used in the image classification process.

(3)Image classification and recognition process:

In the process of image classification, the verification image is used to test the network model obtained in the training process. First, the picture must be transformed by format, then the model generated by training will be used to classify and identify the pictures and test the effect of recognition.

III. The implementation and test of Arduino device identification program

3.1Construction of Convolutional Neural Network

1) Load the image

Because the training set, validation set and validation set have all been converted to TFRecord format, the image is loaded according to TFRecord file instead of JPEG file. Load the training image by matching all TFRecord files found in the directory where the training set is located. Every TFRecord file contains multiple images, which can be trained by batch operation at the same time. however, in batch processing, the system must have enough memory, so this paper chooses to call the function tf.parse_single_example, which will only extract a single sample from the file.

2) Turn images into TFRecord files

The brightness, contrast and other attributes of the image have great influence on the image, and the same object has great differences under different brightness and contrast. However, in the problem of image recognition, these factors should not affect the final recognition result. Therefore, preprocessing the image data can make the trained neural network model affected by irrelevant factors as little as possible.

TensorFlow specially designed a built-in file format, called TFRecord, in order to store binary data and trained category label data in the same file. It requires a preprocessing step before model training to convert the image into TFRecord format. The biggest advantage of this format is that each input image and its associated tags are placed in the same file.

TFRecord file is very useful, because it does not compress data, it can be loaded into memory quickly. Images are saved as TFRecord files and can be loaded again. In the training stage, it is necessary to load images and their labels. Turning images into TFRecord files saves some time compared with loading images and their labels separately.

3.2Test of Arduino Device Recognition Program on Newly Collected Pictures

In this experiment, we still use the iPhone 6s mobile phone with the rear camera of 12 million pixels. For the 10 types of Arduino devices mentioned above, more than 100 pictures were taken in each category. In order to imitate the real scene as much as possible, Arduino devices will be placed in various background environments in this photo collection, including simple environments, including desks and books, as well as complex environments, such as a bunch of messy boxes and clothes, and some pictures are deliberately blurred or incomplete. These pictures are recognized one by one by using the made recognition program, and the recognition situation is counted as shown in the following table:

Table 1 Usage of Identification Procedures

	Total number of devices	Recognition succeeded	Identification failed	Recognition success rate
Arduino UNO board	128	116	12	90.6%
Potentiometer	108	97	11	89.8%
Liquid crystal LCD	114	103	11	90.4%
Serial wireless transparent transmission module APC220	119	107	12	89.9%
Active buzzer	109	89	20	81.7%
Ultrasonic module	154	135	19	87.7%
L298N drive board	122	110	12	90.2%
Hall sensor	130	110	20	84.6%
rocker	141	124	17	87.9%
PIR human body induction sensor	152	136	16	89.5%

It can be seen from the above table that the recognition success rate of the recognition program on newly collected device pictures is higher than 80%, and the recognition success rate of some devices is higher than 90%. It can be seen from the above table that the success rate of program recognition is quite different from that of program

recognition on test set and verification set. It can be seen from the detailed analysis of the data in the table that the recognition effect of the program is better for devices with relatively large volume, such as Arduino UNO board, liquid crystal LCD, L298N driving board, etc. However, for devices with relatively small volume, such as active buzzer and Hall sensor, the recognition effect has dropped significantly, or it is said that the fitting phenomenon is serious. In order to test the effect of Arduino device recognition program better, the program will be tested again in the actual teaching environment.

3.3Test of Arduino Device Recognition Program in Practical Teaching Environment

This section is to make bow alarm as the theme, organized a teaching activity, to test the use of recognition program in the actual teaching environment. The purpose of the activity is to hope that through the learning and production of this lesson, students can make a bow alarm. Its function is that when the learners sit upright, the bow alarm will not make a sound, but when the learners' head is too close to the desktop, the bow alarm will make a "didi" alarm. According to the working situation of the low head alarm, if you want the low head alarm to realize this function, you need an ultrasonic module to detect the distance between the head and the desktop, and decide whether to change the level value of the active buzzer pin. If the learner sits upright and the distance between the head and the desktop is long, the level of the active buzzer pin will not be changed. If the learner's head is too close to the desktop, change the level value of the active buzzer pin to make the active buzzer sound an alarm. It can be seen that the main devices used in this teaching activity are Arduino uno board, active buzzer and ultrasonic sensor. During the activity, the author provided students with equipment and guidance on how to use the identification program, and other contents were completed by students themselves. By using the recognition program, students call the camera on the notebook to scan Arduino experimental devices. According to the scanning results, the program will push the link of learning resources to students. Students can access learning resources through the browser to learn. A total of 30 students participated in this teaching activity. The following table shows the use of the recognition program:

Table 2 The use of identification procedures in Teaching

	Recognition succeeded	Identification failed	Recognition success rate
Arduino UNO board	27	3	90.0%
Active buzzer	24	6	80.0%
Ultrasonic sensor	25	3	83.3%

It can be seen from table 2 that the accuracy of the recognition program in the real teaching environment is lower than that of the previous tests, especially the recognition success rate of the active buzzer and ultrasonic sensor in the actual teaching environment is less than 85%.

IV. Optimization of Arduino device identification program

4.1Extension of sample data set

When using deep learning method to deal with problems, we must prepare sufficient sample data, because the basis of deep learning to solve problems is based on big data. As the input of convolutional neural network structure, the number of images directly affects the final effect of the model. In the training process, the convolutional neural network extracts and learns effective classification features with the help of the input sample image, and finally generates the classification model. If the number of samples is too small, the network can extract less feature information. In this case, the generalization ability of the generated classification model is poor, which can only classify a small range of images and does not have strong representativeness. Therefore, the number of image samples should be as many as possible, and the same type of image should be collected in many different scenes.

The model trained by this method can classify the images in most cases, and the effect will be good when it is applied to the real environment.

In the previous experiment, the sample image size is about 5000. Although the classification effect of the model is not bad, the number of sample images is still small, and the application scope of the model is not wide enough. Therefore, in the later experiments, this paper expands the previous image database to a certain extent, so as to achieve the purpose of optimizing the model.

There are two ways to expand the sample image. First, search for images, on the basis of existing images, through Internet search to obtain more sample images. Secondly, image processing technology is used to expand the image data set. The image processing technology used in the process of image processing includes angle transformation, rotation, adding blur and other processing means. After image processing, the number of image data sets will increase, and it will not have additional impact on the final classification effect of the model. When the number of images in the data set is not enough, this is a common expansion method. After expansion, the sample image size is about 8000.

4.2Parameter optimization

Convolutional neural network model is affected by many factors, such as the size of data set, the structure of the network can affect the final effect. In order to achieve the goal of improving the model, we should start from these factors. In the design part of the model, we have explored the influence of convolution layers, iterations and other parameters on the model, and summarized the change rules. Although the framework of the network is suitable, some parameters can be optimized, including the number of batch images, the size of the input image, the size of the convolution kernel and so on.

Batch as a batch process, the amount of images at a time, has a certain impact on the effect of the model. The current value of batch is not optimal. We can improve the classification ability of the model by adjusting the value of batch. In the process of feature learning, the convolution kernel performs convolution processing, and operates on each region of the sample image to obtain the feature image, which is used as the input data of the next layer network. Different number and different convolution kernel size can have different influence on the model. So in the optimization part, the two parameters are adjusted.

4.3Optimization of Arduino Device Recognition Program

On the basic convolution neural network model, the optimized convolution neural network model for Arduino device recognition includes three convolution layers, three pooling layers and two fully connected layers. Compared with the previous convolution neural network model, the optimized model adds a convolution layer and a pooling layer, and reduces a fully connected layer. The size of convolution kernel has also made some changes. The convolution kernel size of the first convolution layer C1 has become 7 in height, 7 in width and 64 in depth. The convolution kernel size of the second convolution layer C2 is the same as that of C1, but the depth becomes 128; The convolution kernel size of the newly added third convolution layer C3 is the same as that of the previous two convolution layers, but the depth becomes 256. The activation function and pooling mode in the model are consistent with the model before optimization, and are not modified. In the adjusted network model, the image data is input from the bottom layer of the network. After three convolution processing and corresponding pooling processing, the data is converted into one-dimensional vector and input to the full connection layer, and finally its test accuracy and error loss function value are output.

V. Conclusion

In this paper, convolution neural network technology is used to realize the integration of teaching resources.

Specifically, a convolution neural network program for Arduino device recognition is designed and constructed. The program is used to realize the classification and recognition of Arduino devices and push the learning resources related to devices. The interaction between learners and learning resources is innovated.
In order to realize Arduino device recognition, a large number of Arduino device images are collected as sample data set, and Arduino device recognition program based on convolutional neural network is designed. Through many experiments, the convolutional neural network structure suitable for the data set and the parameters in the network structure are determined. Finally, the convolutional neural network model for Arduino device identification is obtained through training, and the device identification program is made by using the model to realize Arduino device identification, and provide device related learning resources.

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