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Application of Pattern Recognition in Sugarcane Seed Cutting Operation

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Abstract—**According to the actual needs of sugarcane seed cutting operation and pattern recognition technology, an intelligent sugarcane seed cutting recognition system is constructed based on deep separable convolution neural network. The system can identify sugarcane buds in the sugarcane planting and cutting process, so that they will not be damaged, thus reducing the rate of injured buds and improving the cutting quality. The system has the characteristics of simple structure design and strong practicability. It can effectively solve the problem of visual sorting in sugarcane seed cutting operation. It helps to realize intelligent recognition and accurate cutting, with the recognition rate of 99%.**

Keywords—deep learning; pattern recognition; sugarcane seed cutting; image acquisition

I. PRINCIPLES AND METHODS OF PATTERN RECOGNITION

A. The Concept of Pattern Recognition

With the continuous improvement of the level of information technology in social development, people's perception of information is getting rid of the dependence on people's perceptual organs. With the help of computer system processing, people can recognize the most valuable information from different patterns or images and realize computer intelligent image recognition, which has become an indispensable part of modern social life. Using computer pattern recognition can not only improve the accuracy of information recognition, but also improve the efficiency of information recognition. Therefore, pattern recognition technology has been widely used in various fields of social life.

B. General Principles of Pattern Recognition

Pattern recognition integrates image and recognition technology, transforms image information into digital signal, and processes it by computer system, so that the processed image information is not easy to be disturbed, and can be preserved for a long time, so as to facilitate the transmission or conversion between different media, and achieve the purpose of improving image recognition. For example, relying on high sensitivity technology, it can take a high definition image in dark environment, thus simplifying the optical processing of the image. Moreover, the image taken in a darker environment is also conducive to maintaining the color and clarity of the image itself. The key of pattern recognition is the pattern of image recognition, which mainly includes the process of sample image preprocessing, selection and feature extraction. Then the classifier is designed according to the actual needs. Among them, the size and distribution of sample sets are related to the selection and performance of classifiers. After the sample is pretreated and put into the classifier, the target features and classification information can be extracted quickly, and finally the intelligent recognition can be realized.

C. Technical Method of Pattern Recognition

At present, pattern recognition mainly relies on image recognition software, which needs to be processed twice on the basis of fixed hardware architecture. There are three main forms as shown in Figure I.

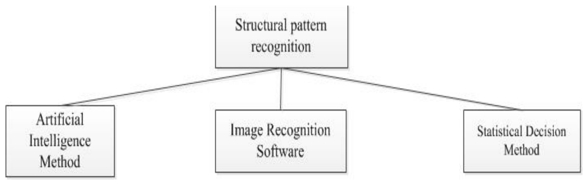

FIGURE I. THREE FORMS OF IMAGE RECOGNITION

Because different methods have their own characteristics and advantages, they can be selected depending on different image recognition requirements in practical use.

D. Current Status of Model Technology Development

With the development of image recognition technology and the improvement of computer operation speed, the existing image recognition algorithms can recognize target objects efficiently and accurately [1]. Image recognition simulates the cognitive and understanding process of human vision through modern information processing technology and computer application technology. Its main content is to analyze image features to achieve the purpose of recognition and classification. Image recognition technology has been widely used in many fields [2]. In the field of agriculture, computer image recognition technology has played an important role in promoting agricultural automation and electrification. For example, image recognition technology can be used to identify and diagnose diseases. Sixiuli of Jilin Agricultural University used this technology to diagnose cucumber diseases by recognizing the shape of cucumber leaf spot, combining plant physiology, chroma and pattern recognition [3]. BaoZhiyan of North China Electric Power University used image recognition technology to recognize flower images on the basis of feature extraction, which can help people effectively identify flower species [4].

II. APPLICATION OF PATTERN RECOGNITION IN SUGARCANE SEED CUTTING OPERATION

A. Application Background Analysis

1) Current situation of sugarcane planting in China

Sugarcane is an important sugar crop and cash crop, mainly distributed in tropical and subtropical areas of China [5]. It is widely used in people's daily life. It has been a pillar industry of local development and has good economic benefits. Although sugarcane planting has a long history, it still encounters many problems in sowing. One of the most typical is the inaccuracy of cutting seeds, which causes injury buds. As a big country of sugarcane consumption, in order to improve the output value of sugar crops and increase the income of sugarcane farmers, it is of great significance to solve the problems of low cutting efficiency, or of cutting seeds and injuring buds encountered by sugarcane farmers in the process of sugarcane planting. Although real-time cutting machines have been developed and popularized in China since 1970s, on the whole, the disadvantages of high labor cost still existed. Therefore, we can design an operation system which can automatically identify the stem nodes of sugarcane by pattern recognition technology, so as to achieve accurate cutting.

2) Tensorflow application of pattern recognition in sugarcane seed cutting operation

Tensorflow was developed by the Google Brain team on the basis of DistBelief, the first generation DL system in Google. This universal computing framework has become the most popular open source tool for machine learning. The system used Opencv technology and Tensorflow's deep learning framework information processing unit interface to process, extract the relevant characteristics of sugarcane cutting sites, realize the recognition and judgment of sugarcane cutting when planting sugarcane, and then provide the results to the visual system control unit to realize the precise sugarcane seed. In the early and middle stages of implementation, we need to configure the open source framework Tensorflow environment for deep learning, and then carry out a small number of identification tests of cutting sites. After reaching the test target, we label cutting sites and make data sets. After training through the Tensorflow API framework, we get the training set and then use the built-in camera for identification testing and debugging. After debugging, the system can be transplanted to the development board to realize real-time identification.

B. Hardware Support System

Hardware support system mainly includes cutting box, camera, conveyor belt and computer. The conveyor belt conveys the sugarcane stalk of the feeding equipment so that it enters the shooting range of the camera at a uniform speed, and then automatically cuts the sugarcane stalk in the cutting box controlled by the computer. The application of this system is mainly to ensure the quality and speed of seed cutting. The system uses image acquisition and computer signal processing to control the movement of motor conveyor belt in order to realize intelligent monitoring and ensure the cutting quality.

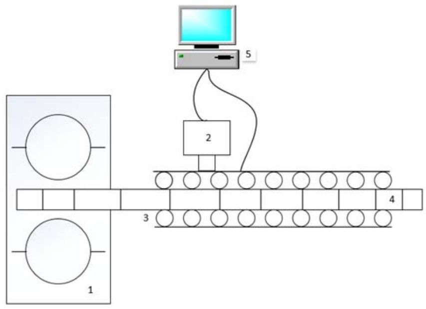

FIGURE II. DEVICE STRUCTURE SKETCH：1. CUTTING BOX, 2. CAMERA, 3. CONVEYOR BELT, 4. SUGARCANE, 5. COMPUTER

C. Key Technologies of the System

1) Technology roadmap

Firstly, we built an environment for deep learning and development. Tensorflow and Opencv platforms are configured under Windows and Linux systems respectively. Tensorflow and object detection API modules are downloaded and installed. Code is edited and debugged using Jupyter Notebook and development package management using Anaconda3. After installation, image acquisition was carried out, and original image acquisition was carried out by manual acquisition combined with Opencv image acquisition module. After completion, the cutting site of sugarcane seed was accurately labeled by labeling software LabelImg. Then we used the interface in the Tensorflow framework to make sample data sets, and used the existing image recognition salgorithm to conduct deep learning training sample data sets. During the training process, Tensorboard can be used to view the training process, after the training is completed, the model can be derived, and the test data can be used to test. When the goal was achieved, the camera linked to the computer can be used to identify the operation.

2) Image acquisition

Using camera to collect sugarcane bud images, we get 100 original samples of sugarcane bud images.

FIGURE III. THE COLLECTED SUGARCANE BUD IMAGE

3) Data set training algorithms

In this application, ssd_mobilenet model was used to identify. Mobilenet is a lightweight deep network model proposed for mobile and embedded terminals, which can also meet the desired speed requirements even on CPU and balance the contradiction between accuracy and speed. In this system, the standard convolution was decomposed into two convolutions by means of Depthwise Separable Convolution: one is depthwise convolution, which was applied to each input channel; the other is pointwise convolution of 1×1. This convolution combined the output of each deep convolution, thus reducing the computational complexity: introducing Width Multiplier to reduce the channels of input and output; introducing Resolution Multiplier to reduce the size of feature map of input and output [6].

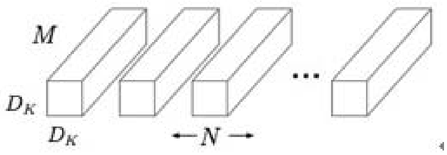

FIGURE IV. STANDARD CONVOLUTION FILTERS FIGURE

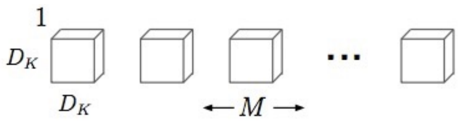

FIGURE V. DEPTHWISE CONV OLUTION FILTERS

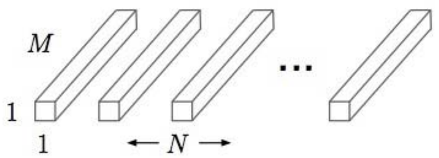

FIGURE VI. 1*1 CONVOLUTIONAL FILTERS CALLED POINTWISE CONVOLUTION IN THE CONTEXT OF DEPTHWISE SEPARABLE CONVOLUTION

As can be seen from the figures above, standard convolution can be replaced by depthwise convolution and pointwise convolution, thus forming depthwise separable convolution.

$$G1_{M\times(D_F\times D_F)}=DW_{M\times(1\times D_K\times D_K)}\times F_{(M/M\times D_K\times D_K)\times(D_F\times D_F)} \quad (1)$$

The obtained G1 is then converted into a (M×1×1)×(DF×DF) matrix G2.

G3 can be obtained by convolution with PW.

$$G1_{M\times(D_F\times D_F)}=DW_{M\times(1\times D_K\times D_K)}\times F_{(M/M\times D_K\times D_K)\times(D_F\times D_F)} \quad (2)$$

In this way, the basic decomposition calculation process of depthwise separable convolution network was realized.

4) Image preprocessing and data set training

Firstly, we made a training set, labeled 100 images by LabelImg, and divided them into training set and test set according to 10:1. The recognition area was named cane.

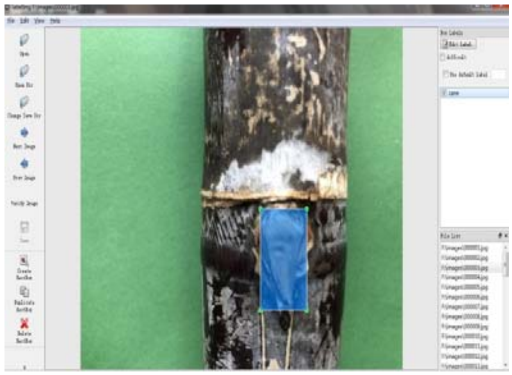

FIGURE VII. IDENTIFICATION REGION LABELING PROCESS

Then, we used the code to convert the XML generated by the previous tag image into CSV files of the training set and the test set, and then used the generated_tfrecord.py in the raccoon_dataset project under the downloaded Tensorflow folder to generate the identifiable Tfrecord files of Tensorflow. Finally, we used ssd_mobilenet_v1_coco file and corresponding instructions to generate model cane in Windows, Python 3.6, Tensorflow 1.2.0 environment. From Fig. 8, we can see that after training, the loss function of the neural network is close to 0.

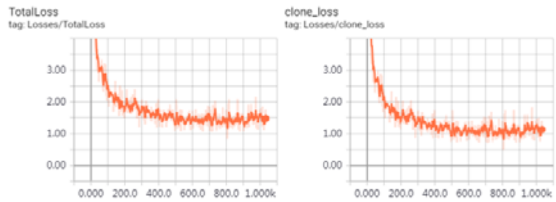

FIGURE VIII. LOSS FUNCTION CURVE

5) Pattern recognition results

After the training set was completed, the data set after the training was imported through the code. We Successfully identified the sugarcane bud area, and the recognition rate reached 99%.

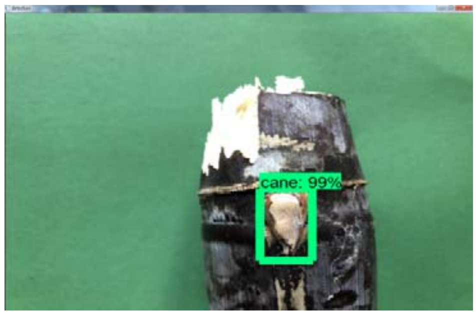

FIGURE IX. PATTERN RECOGNITION RESULTS

6) Proposed optimization scheme

Considering the optimization part of the whole system, we can improve the efficiency of training and recognition by simplifying and improving the existing image recognition algorithm, or improve the performance of the system by using the computing power of Hadoop, a distributed platform, so that Tensorflow can run in a distributed system to improve the efficiency of deep learning. Because most image recognition algorithms are open source, it is easy to use these codes to improve, remove the redundant part of the code to simplify the code, meet the application requirements and improve efficiency; and Tensorflow supports distributed training, which combines the analysis ability of Tensorflow with the expansion ability of Hadoop, and we can also upgrade the computing power of the processor to make the whole system more efficient.

III. CONCLUSION

This application combines pattern recognition technology with modern agricultural equipment, which has the characteristics of simple structure design and strong practicability. It can effectively solve the visual sorting problem of sugarcane in cutting operation, realize intelligent recognition and accurate cutting, and reduce labor intensity, which greatly improved the cutting efficiency of sugarcane and reduced the rate of injury of buds. It is of great significance to further promote the development of modern agriculture.

ACKNOWLEDGMENT

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