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Research Progress of Crop Disease Image Recognition

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Abstract

Crop is one of the food crops that our people depend on for survival. The occurrence of diseases will cause the decline of yield and quality, so it is very important to timely and accurate control of diseases. With the development of computer vision, crop disease recognition based on image has become the development trend of crop disease recognition. Firstly, this paper briefly introduces the related theories of image recognition, and then introduces in detail the research progress of crop disease recognition methods based on traditional machine vision technology, deep learning technology, deep learning and transfer learning at home and abroad, and analyzes the advantages and disadvantages of each recognition method, It is pointed out that the recognition methods of deep learning and transfer learning will become the main development direction of crop disease research.

Keywords

Crop Diseases; Image Recognition; Deep Learning; Transfer Learning.

1. Introduction

Crop is one of the food crops that our people depend on for survival. With the growth of population and the reduction of farmers' cultivated land, the grain output needs to be increased by more than half on the existing basis to ensure the supply of food security in our country. Unfortunately, in the growth and development cycle of crops, under the influence of fungi and climatic conditions, the normal growth and development functions of crops are damaged and interfered, thus showing a variety of abnormal symptoms. Crop diseases occur, and the occurrence of diseases will affect the yield and quality. Therefore, timely and accurate prevention and control of crop diseases is very important.

In recent decades, with the continuous maturity of computer vision, it is of great significance to identify crop diseases by using images. It can not only provide timely and accurate identification information for the prevention and control of crop diseases, effectively alleviate the large-area spread of crop diseases, leave time for the early detection and control of diseases, but also reduce the economic cost loss, In the early stage of the disease, less pesticides were sprayed to reduce the environmental pollution caused by pesticide residues and improve the quality and quantity of agricultural products.

2. Image recognition method of crop diseases

2.1 Data preprocessing

Data preprocessing is the key of image recognition, which directly determines the quality of all images in the later stage. It mainly includes data cleaning such as eliminating anomalies and filling missing data by deleting and adding the unbalanced distribution of different types of sample size.

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2.2 Data enhancement

Data enhancement is commonly known as data amplification. Because the conditions we can take are limited, we have carried out operations such as flipping, rotating, scaling, clipping, shifting, color enhancement, etc. on the images, so that the limited data can be slightly adjusted to produce more data value.

2.3 Image segmentation method

Image segmentation is to separate the disease spot from the adjacent leaves and complex background environment. The common use is threshold segmentation. By setting different thresholds, the gray value of pixel points in the image is compared with the threshold value. According to the comparison results, the pixel points are classified.

Threshold segmentation is simple and fast, but it will be interfered by noise. Because crop disease recognition is affected by complex background and weather, image processing may have some limitations. Convolution neural network can directly input the image into the network, without the segmentation process of crop disease spot image and surrounding background, which reduces the difficulty of data modeling.

2.4 Image feature extraction method

Image feature extraction methods mainly include shape feature, color feature, sift and convolution neural network.

(1) Shape feature: Based on the classification of the contour and regional features of the research object, the recognition is based on the complex background of the field, the crops are close to each other, so the extraction of shape features is not very good to judge directly, which makes it more difficult to calculate the shape similarity extraction.

(2) Color feature: it is a surface feature based on image pixels, which is not affected by the change of image angle and size, but it does not express the information of the contribution distribution of color space, so it is difficult to distinguish those with high similarity.

(3) Sift: find the feature points in different scale space, and calculate the location and scale information of the feature points that will not change due to the degree of illumination and noise interference.

(4) CNN: The convolutional neural network structure (Figure 1) includes an input layer for normalization and de mean processing of the image; Convolution kernel is used to obtain the convolution layer of high-level feature information; The dimension of the output matrix of the convolution layer is reduced to half of the original size for later calculation of the pooling layer; The high-level feature information extracted from convolution layer is re fitted to obtain the expression of high-dimensional spatial data, so as to reduce the loss of feature information; And an output layer for outputting prediction probability results of each category. Without complicated preprocessing, feature extraction and other intermediate modeling process, the end-to-end structure is adopted, and the abstract high-level features are automatically extracted layer by layer driven by data. The design of CNN model structure and setting of super parameters can get all kinds of features of the picture, which reduces the incompleteness of artificial design features.

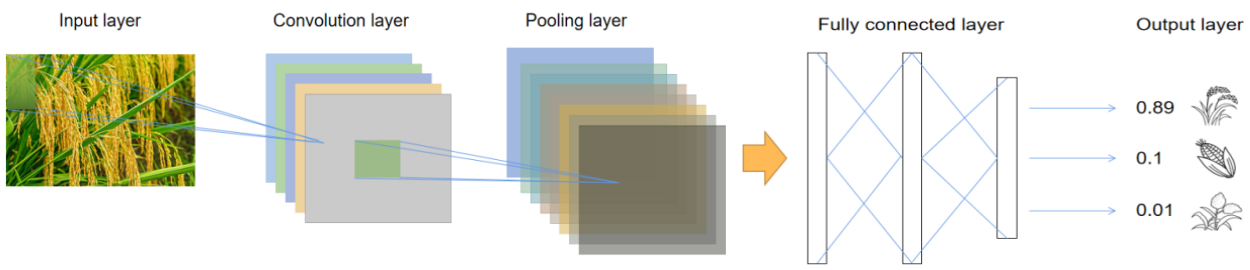

Figure 1. Convolution neural network structure

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2.5 Image feature classification method

In the field of image classification algorithms commonly used include nave Bayes, KNN and CNN algorithm.

(1) Nave Bayes: for the prediction of unknown categories, if the probability of which category is relatively high, the sample will be classified into this category.

(2) KNN: it's a very lazy classification, similar to the idea that the minority obeys the majority in real life. In the training data set, for the new input instance, find out the K instances closest to the unknown sample x, see which class most of the K instances belong to, and then classify x into this class. The disadvantage is that it stores all the training data sets and does not classify until classification is needed. If the training data set is complex, it will lead to a large amount of calculation, which is not conducive to real-time deployment.

(3) CNN (convolutional neural network): soft Max layer can output the prediction probability of each category to the advanced abstract features extracted by the convolution layer, which has potential application prospects.

3. Research progress of crop disease image recognition technology

3.1 Crop disease recognition method based on traditional machine vision technology

In China, Deng Jizhong et al. [1]. proposed an image recognition method of wheat diseases based on image recognition + SVM. Firstly, a single wheat disease image is separated by image recognition, and 16 texture and shape features are extracted; Then, six representative features are selected; Finally, the extracted 96 disease images are classified and recognized by BP neural network, SVM and minimum distance method. The results show that SVM is superior to the other two methods in classification and recognition of wheat disease images, and the recognition rate is 82.9%. Zhang Kaixing et al. [2]. proposed an image recognition method based on image preprocessing and BP neural network for six common diseases of corn leaves collected in the field. Firstly, the image of corn leaf disease was preprocessed (background elimination, graying, threshold segmentation, noise elimination, etc.) to achieve the separation of leaf disease image and surrounding background image; Then, 17 shape and color feature parameters are extracted as inputs; Finally, BP neural network is used to classify the disease image, and the average recognition rate is 93.4%.

In foreign countries, Dubey SR et al. [3]. proposes a healthy image recognition method for apple and three kinds of diseases based on k-means+ feature combination + multi classification support vector machine. Firstly, K-means clustering method was used to detect the fruit infection; Then, the feature based on color, texture and shape is calculated on the segmentation image, and it is combined into a single descriptor; Finally, the apple is divided into infection and health classes by using multi classification support vector machine. The results show that the method has better effect than the single feature method, and points out that shape feature is not suitable for this. Zhang s et al. [4]. proposed a method for the identification of seven major diseases of Cucumber Leaves Based on k-means+ sparse representation (SR). Firstly, the image of disease leaves is segmented by K-means, and the shape and color characteristics are extracted from the information of the disease leaves; Then, the sparse representation (SR) is used to classify the image of the disease leaves; Finally, the comparison is made with SVM, kmsnn, TF and PLI. The results showed that SR was 85.7% of cucumber identification rate, which was better than other methods.

Because of its intuitive and easy to implement characteristics, this technology has achieved some results, but there are still some problems to be considered when it is applied to the complex field environment. In the complex field background environment, the interested objects need to be separated from the surrounding objects, so the background segmentation is difficult, which leads to the reduction of recognition accuracy; Data preprocessing, image segmentation, feature extraction, feature classification and other cumbersome processes are needed. The manual design of features increases the workload of modeling and has certain subjectivity; This method relies on the accurate

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extraction of feature parameters. Once the wrong features are extracted, it is difficult for the model to accurately identify the diseases with similar features. And this kind of method generally only extracts several typical features to represent all the information of the disease, and then carries on the classification recognition verification on the small data set. In fact, there are many kinds of diseases in the process of crop growth, and the effect of disease recognition method which only extracts a small number of typical features is not good. Moreover, it is difficult to obtain the feature expression closest to the natural attribute of the target from the extracted target, which leads to the semantic gap problem. Therefore, the artificially designed features need expensive resources and professional knowledge. Therefore, the use of traditional recognition methods often can not achieve good recognition results.

3.2 Crop disease recognition method based on deep learning

In China, Lu Yang et al. [5]. proposed an image recognition method of common rice leaf diseases based on deep convolution neural network in northern cold region. Firstly, PCA (principal component analysis) is used to reduce dimension; Then, using the deep learning framework Caffe, the convolutional neural network structure is designed, which includes four convolution layers, three pooling layers and one fully connected layer; Finally, 2000 rice disease images were trained and simulated, and the robustness of the model was evaluated by 10 fold cross validation. The results showed that the average recognition rate of rice diseases was 96.9%. Tan Yunlan et al. [6]. proposed an image recognition method based on deep convolution neural network for eight common rice diseases collected in natural scenes. Firstly, the training set is expanded by data enhancement technology; Then, fine tune is used to adjust network parameters and network construction; Finally, rice disease images are input into the network model for training and testing. The results showed that the recognition rate of sheath blight reached 93%. This paper broke through other methods to recognize rice leaf and panicle, realized the recognition of multiple rice plants, and provided technical support for remote automatic identification of rice diseases.

In foreign countries, Zhong y et al. [7]. proposed an image recognition method of apple leaf disease based on deep convolution neural network. Firstly, using 2462 image data sets including 6 apple leaf diseases, based on densenet-121 deep convolution network, three methods of regression, multi label classification and focus loss function were proposed to identify apple leaf diseases; Then, data modeling and method evaluation are carried out. The results show that the accuracy of this method is 93.51%, 93.31% and 93.71% respectively, which is better than the traditional multi classification method based on cross entropy loss function, and the accuracy is 92.29%. Liu B et al. [8]. proposed a new method of grape leaf disease image recognition based on improved convolution neural network field collection and public data collection. Firstly, based on 4023 images collected in the field and 3646 images collected in the public data set, 107366 grape leaf image data sets were generated by image enhancement technology; Then, the perception structure is used to enhance the performance of multi-dimensional feature extraction; Finally, dense join strategy is introduced to encourage feature reuse and enhance feature propagation. The results show that the dicnn is constructed and trained from scratch, and the overall accuracy reaches 97.22% with the reserved test set. Compared with Google net and resnet34, the recognition accuracy is improved by 2.97% and 2.55% respectively.

Using the disease training set image to train all layers of CNN from the beginning, the trained model can be used to verify the test set, which can obtain better accuracy, but it is difficult to obtain and annotate the large-scale data. And training all layers of CNN from scratch, as the model becomes more and more complex, the parameters of the model will also increase, and the training time will also increase. Especially in the field of real-time disease recognition, there are some difficulties. So deep learning combined with transfer learning for crop disease identification is the direction of future research.

3.3 Crop disease recognition method based on deep learning and transfer learning

In China, Xu Jinghui et al. [9]. proposed a method of Corn Disease Image Recognition Based on improved convolution neural network. Firstly, the full connection layer of vgg-16 is redesigned, and

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the weight parameters of the convolution layer trained by vgg-16 in image net dataset are applied to the model through migration learning; Then, the image data set of corn disease is divided into training set and test set according to the ratio of 3:1, and the image data of training set is expanded by data enhancement methods such as rotation and flipping; Finally, the sample size of the training set before and after the expansion and two transfer learning methods (only the full connection layer of the training model and the convolution layer and the full connection layer of the training model) are compared. The results show that the recognition ability of the model is improved when the sample size of the training set is expanded and the convolution layer and full connection layer of the training model are used. The average recognition accuracy is 95.33%. Wang Yanling et al. [10]. proposed an image recognition method based on convolution neural network and transfer learning for 10 kinds of tomato disease leaves and healthy leaves. Firstly, 14529 tomato leaf images were randomly selected and divided into training set and verification set according to the ratio of 7:3. Aiming at the problems of long training time and large amount of model parameters of convolution neural network, transfer learning was introduced into Alex net network to classify tomato leaves; Then, through transfer learning, the Alex net model is put in the image net public data set, and the trained Alex net model and weight parameters are obtained. The tomato disease leaf image is taken as the input, the low layer is fixed and the high layer network parameters are fine tuned, and 20 groups of experiments are carried out to classify the tomato disease leaf. The results show that the network model converges in 474 training iterations, and the average recognition rate of the verification set is 95.62%. Compared with the ab initio training Alex net network model, this method speeds up the training time and improves the average accuracy by 5.6%.

In foreign countries, cecotti h et al [11]. proposed a grape image recognition method based on convolutional neural network and transfer learning. Firstly, the influence of input feature space (color image, gray image and color histogram), block size and data expansion of convolutional neural network are studied; Then, 11 pre trained deep learning architectures are created; Finally, transfer learning method is used for classification. The results show that the grape image can be segmented effectively by using different feature spaces, and the color image has the best segmentation performance. In convolution neural network combined with transfer learning, res net network has the best performance, and the accuracy rate of red grape and white grape is 99%. It is pointed out that data enhancement, image normalization and input feature space have key effects on the overall performance. Chen j et al. [12]. proposed a method of plant disease image recognition based on transfer learning of improved deep neural network. Firstly, the pre trained mobilenet-v2 is extended by classification activation map (CAM), which is used for visualization and plant lesion location; In the first stage, the weights of the new extension layer are deduced from the beginning, while the lower convolution layer is frozen with the parameters of image net training; In the second stage, the model trained in the first stage is loaded, and the weight is retrained by using the target data set. Finally, the optimal model is applied to plant disease identification. The results show that the method can improve the learning ability of micro lesion symptoms on public data sets, and the average recognition accuracy is 99.85%. Even under the condition of multi category and complex background, the average accuracy of the collected plant disease images is 99.11%.

In conclusion, convolution neural network combined with transfer learning is used to identify crop diseases. It can not only solve the problem of small samples of specific crop diseases in the field of agriculture, but also realize the automatic extraction of crop disease features by using the parameters of public image data set pre trained in convolution neural network, so as to ensure the accuracy. The combination of deep learning and transfer learning will become the main development direction of crop disease recognition in the future.

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