Research review on automatic detection of crop pests based on intelligent vision

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Abstract: With the continuous development of science and technology, intelligent technology has become one of the main trends of today's social development. In the field of agriculture, intelligent vision technology, as a new technical means, has been widely used in the automatic detection of crop pests. Through intelligent vision technology, the automatic identification, classification and counting of pests can be realized, and the quality and efficiency of agricultural production can be improved. This paper will review the research on automatic detection of crop pests based on intelligent vision, aiming to provide reference and reference for the research in related fields.

Key words: intelligent vision; Crop; Pests; Automatic detection; Overview

I. Research status of computer vision application in automatic detection and identification of crop pests at home and abroad

1. Foreign research status

Since the British government launched the "DAISY" project, foreign scholars have conducted a lot of research on insects. LiuJ. D.D.,Paul SenM.R. et al., University of Michigan, applied machine vision to the automatic recognition of Trichopteridae insects, with wing veins as the main feature and similarity as the criterion for identification, which has higher credibility. However, this study was only based on hand-drawn images by experts, which could not distinguish the true species of cantharidin, and manual intervention was needed in the identification process.

HabibGassoumi, NadipuramR.Prasa et al. of the University of New Mexico in the United States applied artificial neural networks to the classification and identification of pests in cotton fields. Firstly, the original insect image is continuously enhanced by morphological erosion, expansion and other methods, and then the image is segmented so that only the most basic elements are retained, while the main and useful features are retained.

Sena et al. obtained the image of the upper leaf of corn by vertical photography of corn plants, and proposed an automatic detection algorithm of corn borer based on image analysis, with a correct recognition rate of 94.7%. Dr.Jeffrey, T.Rake et al. have developed a pest identification method for the United States Department of Agriculture. This system takes large-scale samples as the main research object, and its image segmentation algorithm can accurately extract a single sample from a massive sample and obtain good insect specimen segmentation results.

C. K. arunakaran et al. extracted the histogram of Meicoccus ruficococcus and made use of its texture features and order to establish an insect target classification and recognition method based on four-layer reverse neural network. Paulweeks and lanGauld et al. have completed semi-automatic identification of some similar species of Ichneumonidae. Switzerland is also developing computer-assisted insecticide sprayers that can target the distribution of weeds, diseases and pests in the field.

Zayas, an American scholar, conducted a preliminary study on the adult cereal worms in wheat by using the off-line method and found that the method had a good recognition rate, but its recognition effect was greatly affected due to the imperfections of grains, the presence of grass seeds and the posture of pests. In addition, this method can not achieve online detection.

2. Domestic research status

In the early 1990s, an image identification research group composed of Qiu Daoyin and others first proposed the use of image identification technology for online pest detection. It mainly combines machine vision, digital image processing and simulation recognition to realize real-time monitoring of stored grain pests. Its main working principle is: the sampling mechanism will transport the grain from the sampling point to the sampling equipment through negative pressure. The transmission mechanism transmits a single grain sample in a single layer, and collects the sample in real time through the charge-coupled device camera installed on it. The acquisition card sends the acquired image signal to the single chip computer through PCI bus. From the image processing, image analysis, fast fuzzy, neural network and other dimensions of pest species and density real-time feedback, and then comprehensive control of agricultural pests to provide strong data support.

Shen Zuorui et al. first introduced the method of automatic statistics of whitefly pests in greenhouses by using image processing technology, and carried out related experimental research. Zhao Ya 'e, Kong Xiangwei, Zhou Haojie et al., invented a method to automatically identify human parasites. Fu Chengbin, under the guidance of his mentor, developed an automated classification system for paragonimus. Yu Xinwen, Zhao Hanqing and others have also done a lot of research on the segmentation and feature extraction of insect images. Xu Fang, Zhang Hongtao, Liu Suhua, Chen Zhiwu et al studied the image preprocessing, image processing, numerical segmentation of lineal domain, feature extraction and fuzzy recognition, etc. Neural network, intelligent detection, hardware and software design, simulated annealing method and other aspects of automatic identification of warehouse pests were studied.

Shen Zuorui and Yu Xinwen used 11 mathematical morphological indexes such as insect body area and perimeter to realize automatic

identification of 40 different species of pests, and calculated their weights in different types. Professor Li Zhigang published the research report "Automatic Insect Pest Identification Technology in Cotton Field based on machine Vision" at the ASABE International Seminar, mainly elaborated on the dynamic identification and real-time precision application of insect pests in cotton field. Wang Jianhua, Ma Jun et al. proposed a classification method of crop pests and diseases based on mathematical morphology, and extracted insect bones using two methods of swelling and rust. On this basis, a classification method of insect pests based on geometric features was proposed.

Huang Zhikai, Wang Bingxi et al., by studying the color features of various spectral techniques such as near-infrared spectroscopy and visible spectroscopy, built the sparse forest-based color histogram index structure of true color images, which is convenient for point retrieval and regional retrieval, and has a high spatial utilization rate.

Wang Keru and Li Shaokun took the rapid diagnosis of crop pests and diseases as the research object, used computer image processing, neural network and other methods, combined with the professional knowledge of crop pests and weeds hazards, and conducted research on the remote image recognition and diagnosis of crop pests and diseases, and achieved some good research results.

Qiu Daoyin et al. introduced wavelet technology into the field of image processing, and based on it, studied the pest identification algorithm based on color, texture and other characteristics, and fed these characteristics information to the ANN classifier to realize the identification of insect pests. However, the software and hardware design of the system still have many shortcomings, and the recognition speed, feature extraction and hardware design need to be further improved in order to improve the recognition ability of agricultural pests.

Zhang Hongmei et al. proposed an automatic identification method of stored grain pests based on BP neural network, which mainly analyzed the mathematical statistics, texture and geometric shape features, and could effectively improve the detection accuracy of stored grain pests.

Lian Feiyu et al. applied the wavelet transform to the high-dimensional image vector compression of stored grain pests, and used the high-frequency region corresponding to the image edge and contour to realize the effective compression and description of the insect pest image features, and proposed a SVM classification and discrimination.

II. Problems in automatic detection of crop pests based on intelligent vision

Although the traditional machine learning algorithm has successfully realized the intelligent identification of insect pests, there are still many problems that have not been well solved.

First, artificially designed feature operators can hardly capture deep semantic features. In recent years, domestic and foreign scholars have proposed a variety of detection models based on human visual features (Haar, HOG), which can better depict shallow features, so as to improve the intelligent detection ability of agricultural pests. However, in reality, due to the influence of occlusion, illumination, distance and other factors, the traditional feature extraction methods have the problem of low robustness, and the extracted features contain less useful information.

Second, when the data scale is too large, the intelligent identification system can not be well adapted to the needs of agricultural pest detection. In recent years, researchers have achieved good results in the case of small pest information by optimizing feature extraction algorithms, classifiers and other methods, but most of the methods used to select areas by sliding Windows have poor detection results, especially in the case of a large number of pest data and a wide variety of algorithms. This fully shows that the intelligent identification system has obvious shortcomings in processing time, storage space and detection accuracy, etc. It is necessary to improve and optimize these deficiencies in time to promote it to meet the needs of agricultural production.

Third, the algorithm is too simple, easy to cause the overfitting of the model, can not well show the complex relationship between the data. At present, although the traditional machine learning algorithm has the advantages of small computation, simple structure and easy implementation, the extracted features are difficult to reflect the complex semantic relationships. In addition, in the learning process, the initial value has a great impact on the learning effect of the network, and it is likely to produce overfitting.

In short, compared with traditional machine learning algorithms, the use of deep learning technology for intelligent pest detection has greater advantages. However, at present, the use of deep learning technology to achieve intelligent visual recognition of agricultural pests is still facing a number of problems to be solved.

III.The prospect of automatic crop pest detection based on intelligent vision

Compared with traditional machine learning algorithms, the deep learning-based intelligent pest detection technology has great advantages in automatic pest detection, and is expected to break through the current bottlenecks of low efficiency, low detection accuracy and poor model robustness. Specifically, it can be started from the following points:

First, the establishment of a complete insect photo library. Aiming at the difficult problem of agricultural insect image acquisition, from the perspective of "Agriculture 4.0", through the development of intelligent robot arm suitable for farmland work and the use of high-resolution camera to collect pest images, not only can enrich the image of farmland pest, but also can mark the pest, and establish a certain scale, high quality and marked insect resource library. On this basis, a scientific and reasonable information management strategy was proposed to promote the opening and sharing of agricultural insect image information in our country.

Second, the deviation of data distribution is dealt with robustly. In view of the similar agricultural pests in the detection map and training map, the distributed generalization method should be studied. At the same time, in order to deal with the new species that are not labeled in the training set, intrusion detection methods in open scenarios such as comparative learning and twin networks should be studied.

Third, we need to strengthen deep learning features. In view of the advantages of deep learning over conventional machine learning, this project intends to carry out research on intelligent pest detection based on deep learning. Use methods such as VisionTransformer to build a more complete backbone network that can obtain richer information in the pest identification area. At the same time, when the sample data is small, the transfer learning algorithm is used to fine-tune the existing initial parameters, thus greatly improving the accuracy of the model.

Fourthly, the network is optimized to effectively improve the accuracy of detection results under multiple scenarios. The existing cutting-edge technology is used to optimize the current network, so that it can better meet the needs of automatic detection of pests in agricultural environment. For example, through parameter sharing, improve the operational efficiency of the backbone network and the speed of the system operation. In addition, the method of data enhancement can also be used to increase the diversity of data sets, so that it has a wider application prospect. On this basis, feature fusion technology can also be used to better capture the key information in pest images, and further improve the accuracy of pest detection.

In summary:

All in all, this paper reviews the research on automatic crop pest detection based on intelligent vision, introduces the background and application of intelligent vision technology, as well as the research achievements in this field in recent years and the shortcomings of existing research. Future research should strengthen the simultaneous detection and identification of multiple pest species, and strengthen the information mining of pest activity rules and ecological habits, including: building a complete insect image database; Robust processing of data distribution bias; Enhancing deep learning features; And optimization of network structure. In this way, it can effectively improve the automatic identification ability and accuracy of crop pests, provide more comprehensive and accurate technical support for the safety management of agricultural products, and promote the sustainable development of agriculture in China.

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