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Image Classification of Crop Diseases and Pests Based on Deep Learning and Fuzzy System

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ABSTRACT

The automatic classification of crop disease images has important value. The classification algorithm based on manual feature extraction has some problems, such as the need for professional knowledge, is time-consuming and laborious, and has difficulty extracting high-quality features. In this article, the theory of the fuzzy system is discussed. The theory of the fuzzy system is applied to the pretreatment of blurred images. A local blurred image deblurring method based on depth learning is proposed. By training convolutional neural network models with different structures, the image of diseases and insect pests is segmented using normalized segmentation algorithms based on spectral graph theory, and the segmentation knot of leaf diseases is obtained. Finally, the optimal network structure is obtained by comparing the segmentation results with the traditional machine learning algorithm. Experiments show that the segmentation results of pests and diseases obtained by this algorithm have better robustness, generalization, and higher accuracy.

KEYWORDS

Convolutional Neural Network, Data Enhancement, Deep Learning, Fuzzy System, Image Classification, Image Segmentation

INTRODUCTION

Crop diseases and insect pests are one of the main agricultural disasters. They have the characteristics of many kinds, great impact and frequent outbreaks. Their occurrence scope and severity often cause great losses to the national economy, especially agricultural production. In recent years, the worsening global climate and the increasingly fragile ecological environment have led to more and more serious phenomena of crop diseases and insect pests. As the quality of plant growth environment declines, the dissemination speed of diseases and insect pests has been accelerated. Only by timely acquisition and identification of information on diseases and insect pests in crops can effective control measures be taken. With the rise of precision agriculture, the application of information technology in agricultural production provides a new way to identify pests and diseases in crops (Long, 2014).

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In the past, visual hand inspection was often used to detect plant diseases and insect pests. This method not only requires the inspector to have considerable professional knowledge and rich work experience, but also the manual counting and statistical operation are extremely complex in the whole detection process. Visual hand-searching method cannot meet the current requirements of real-time monitoring of pest information and cannot use real-time control means. In particular, the symptoms of some plant diseases and insect pests in the early stage of injury are very similar, and it is difficult to distinguish them by visual method (Zhao et al., 2012; Gao et al., 2018; Jiang et al., 2017).

Digital agriculture can make the whole growth process of plants be managed finely, mainly because of the higher requirement of timely and accurate information acquisition for plant diseases and insect pests. According to the damage degree of leaves to determine the spraying dose of pesticides, digital agriculture requires a very high precision of the spraying dose of pesticides, which will inevitably become the most critical step in the implementation of precision management (Liu & Chen 2018; Shen et al., 2017). In the field of digital agriculture, the specific damaged parts of leaves in the damaged plants can be identified by using intelligent detection methods to monitor the plants in real time, and the damaged degree of leaves can be accurately identified by this method.

Computer vision technology is mainly based on image processing. In the process of detecting plant diseases and insect pests, the technology extracts the tissue of the injured plant, the edge of the disease spot or the insect body of the pest, and obtains the degree of plant damage through the area and the quantity of the injured plant, so as to adopt effective control measures. Computer vision technology mainly focuses on the morphological characteristics of the object of study. The image data information collected is generally perceived by the naked eye, so the amount of data collected is relatively small.

Some of the collected images of diseased leaves are blurred. We need to extract features from these blurred images and data mining in these features. This is a research related to fuzzy system and data mining. Using data mining technology to analyze and process the blurred and clear areas in images is a very practical technology, which can be used as the precondition of image object extraction, image segmentation, image deblurring, image retrieval and so on.

In order to achieve the objectives of the project, the following issues are urgently awaited:

1. Crop disease image belongs to the data of the industry, currently there is no standardized data set, how to design sample image processing technology combined with sensor acquisition to obtain samples with sufficient polymorphism and significant representation.
2. Feature extraction and recognition of the set of convolutional learning network, and how to design it. A well-structured training convolution network enables it to achieve satisfactory recognition accuracy and faster convergence speed in disease recognition.
3. Whether the semi-supervised learning restricted Boltzmann machine network can extract the features of disease images, how to design the recognition algorithm of feature samples, and how to evaluate the performance of the feature process, so as to ensure that dimensionality reduction can achieve self-optimization in the learning process (Spanhol et al., 2016).

Aiming at the above problems, this paper focuses on image segmentation characteristics and application based on graph theory to avoid the complexity and limitation of manual feature extraction and realize automatic classification of crop diseases and insect pests images. At the same time, advanced data enhancement methods and migration-fine-tuning learning are used to prevent in-depth learning algorithm from training over-fitting on small sample sets and improve the image. Recognition rate to meet high standards of production demand.

The specific contributions of this paper include:

- The image segmentation is studied systematically. Aiming at image segmentation technology based on graph theory and its application, the basic framework of image segmentation technology