Research and Application of Pest Identification Technology Using Geographic Information System and Computer Image Recognition

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Abstract. The research and application of key technologies of pest identification based on deep learning the paper analyzes the status quo and problems of pest identification in my past. It studies the key technologies of pest identification based on deep learning. On this basis, a GIS based pest data management cloud platform is proposed, which is composed of intelligent terminals and data centers. The intelligent terminal can quickly acquire the photos of pests and upload them to the data center of cloud platform. The data center can identify the pests returned by the intelligent terminal, automatically generate the spatiotemporal distribution map of insect situation, and use machine learning technology to warn the pests, and assist the farmers to take effective measures against the pests.

1. Introduction
China is a country with many, serious and frequent agricultural and forestry crop pests. Prevention and control of pests is related to food security, agricultural product quality security, ecological environment security and farmers’ income. The key to prevention and control of pests is to correctly identify pests, and then apply the correct drug and dosage. At present, most provinces in China have carried out the information work of pest forecasting system, using modern information technology to promote the pest prevention and control work, and achieved great results, but at present, it still mainly relies on manual judgment and forecast on the test platform, and the pest forecasting is still in a relatively backward semi artificial state, mainly in two aspects:

(1) Due to the limitation of personnel shortage and collection equipment, it is difficult to meet the needs of real-time and comprehensive update of pest data.

(2) The data sources used in pest prediction are few, and the historical pest situation, current pest situation, meteorological situation, geographical location and other data are not integrated together for pest prediction. There is a big gap between the prediction method and the latest machine learning method, and the accuracy and timeliness of actual prediction still need to be further improved.

Therefore, the application of modern advanced information technology such as cloud computing, artificial intelligence and big data technology in crop pest identification will help to improve and improve the ability of coping with large-scale agricultural and forestry pests in China, and explore and form a new mode of coping with agricultural and forestry pests. At the same time, cloud computing mode is also conducive to saving the development and deployment costs of pest identification system,
exploring a new situation of artificial intelligence and big data technology in the field of agricultural production, and promoting the transformation of agricultural production management mode.

2. Key technologies of pest identification based on deep learning

Insect recognition mainly uses the target detection technology based on deep learning. In recent years, the target detection technology has made rapid progress at home and abroad.

2.1. Domestic and international technology development of target detection

Object detection is a core research field and an important branch of deep learning in computer vision (CV). The task of target detection is to determine whether there are interested targets in the image, and then accurately locate the interested targets. At present, the method used for target detection is usually based on machine learning or deep learning. For machine learning methods, first, we define the features by SIFT and hogs, and then classify them by SVM and AdaBoost. But the traditional machine learning target detection method has the following problems: when the light changes rapidly, the algorithm is not good; The feature pixel points can not be extracted when the slow motion is consistent with the background color; The time complexity is high; The noise resistance is poor. However, using the deep learning method, the deep learning technology can detect the end-to-end targets without the special definition of features, and is usually based on convolutional neural network (CNN). Therefore, the target detection method based on deep learning has been widely used. The framework of the target detector is divided into one stage and two stage, of which two stage accounts for the majority.

In recent years, the target detection has developed rapidly. From 2013 to 2019, from the earliest r-cnn, fast r-cnn to later Yolo V2, Yolo V3 and this year's m2det, the new models emerge endlessly and the performance is getting better and better!

Figure 1. The development of target detection framework in recent years

2.2. Development of image based insect recognition technology

In recent years, with the development of machine learning and deep learning technology, great progress has been made in the field of insect image classification based on computer vision at home and abroad.

In order to recognize insect image, we need to collect insect image first. Image based insect recognition methods can be divided into the following three ways according to the way of image acquisition.

(1) Laboratory based insect recognition: this method is the most accurate, because it can adjust the posture of insects, and can select samples to avoid interference caused by overlapping of multiple samples. This method needs to collect insect samples, process the samples, adjust the sample posture, and then carry out image acquisition and recognition. The reason for the high recognition accuracy of
the laboratory is that the insect samples have been screened, the insect posture has been corrected, and the lighting is in an ideal state. The disadvantage is that the construction of laboratory needs to be limited by objective conditions, and insects need to be collected from the field by special personnel. At home and abroad, insect image recognition is mainly based on laboratory.

(2) Insect recognition based on automatic device: the automatic device includes three parts: insect trapping device, insect processing device and insect recognition device. Under the condition of no supervision, it can automatically complete the system operations of trapping, killing, scattering, photographing, transportation, collection and drainage, and upload the environmental meteorology and insect damage to the designated data center in real time. According to the results, the software can automatically identify brown planthopper, rice leaf roller, white backed planthopper, big borer and other insects.

(3) Insect recognition based on artificial way: relying on artificial way, take the image acquisition equipment to collect insect samples outdoors, and the collected images are identified by the portable equipment, or uploaded to the server for identification. At present, the development of insect recognition system in the open field is less than the former two methods, the main reason is the difficulty of recognition: more recognition background (cluttered background, active insects, etc.). Compared with the former two methods, the main disadvantage of this open area insect image acquisition method is that it is difficult to recognize. The main reason is that the collected image is a live insect image, which is restricted by the attitude, background interference, lighting and other factors of insects. At present, the recognition accuracy is not as good as the former two methods.

In the field of insect image classification based on computer vision, most researches focus on the extraction of insect features, including texture, shape and local features. The difficulty of feature extraction lies in: in the case of the original posture of insects, the process of feature extraction is very complex, and those extracted features may not accurately represent the image features of insects. In practical applications, the complex image background, illumination and insect posture changes will also increase the difficulty of feature extraction.

To sum up, insect image recognition has made great progress at home and abroad, but the shortcomings of the research at home and abroad are: the types of insect recognition are relatively small, the cost of image acquisition device is high, and it is still in the laboratory stage, followed by the cost of automatic image acquisition device is relatively high, and the amount of deployment is small, so the collected insect images are relatively limited.

2.3. Problems in key technologies of pest identification based on deep learning
Due to the need to develop insect recognition system in the open field, the difficulty of recognition is relatively large: the main reason is that the images of living insects are collected, which are restricted by the attitude, background interference, lighting and other factors of insects. At present, the recognition accuracy is not as good as the methods of laboratory acquisition and automatic device acquisition.

There are several important problems to be solved in the algorithm of insect recognition
(1) There are many kinds of insects, so it is difficult to collect samples
There are many kinds of insects, and the insects of the same family or genus are very similar. Therefore, it is more difficult to recognize them. It is very easy to confuse the known insects in target detection, and it is also difficult for human eyes to recognize many insects of the same family or family. This makes it very difficult to accurately identify the insect species, and the error rate is relatively high, which has the most direct impact. It is the result of target detection that can not identify the insect species that the insect matches well, and the recognition result may be similar.

After the preliminary test, each insect needs more than 1000 sample images to be recognized. At present, only a few insects have such a large sample library. How to collect insect image samples quickly is the primary problem to be solved in insect recognition.

(2) External interference
Based on the outdoor collection of insect photos, because more recognition background (cluttered background, living insects, etc.), and the stacking and bonding of insect samples have a certain impact
on the insect recognition photos. In addition, insects usually have protective colors, and sometimes it is difficult for the naked eye to distinguish whether there are insects on crops.

(3) Determination of target detection frame
The size of target detection frame plays an important role in insect recognition. Due to the different size of insects, the number of insects detected in the target box, how to select only the most accurate one for display is a difficult problem to be solved: narrow the target box detection, narrow the detection range, discard more target detection; Increase the target detection frame, and there may be multiple detection targets (insects, background, etc.) in the detection frame.

3. Application of pest identification technology based on deep learning
Applying pest identification technology based on deep learning, a cloud platform of pest data management based on GIS is developed. The collection of pest data of the platform comes from users using smart terminals such as mobile phones, such as farmers, agricultural plant protection personnel, etc.

3.1. Design of intelligent terminal of insect data management cloud platform based on GIS
The process of intelligent terminal identifying insects is shown in Figure 2

![Figure 2. The process of insect identification](image)

(1) Image acquisition and preprocessing process:
① The mobile phone takes pictures of insects in the frame;
② According to the position of the box, take out the insect area map from the big picture;
③ Zoom the image to 640 * 640;
(2) SSD target detection method is used to detect and identify pests;
Due to the low hardware configuration of the mobile terminal and the relatively slow calculation speed, the research group plans to use the SSD target detection algorithm of one stage in the terminal. The algorithm is fast, but the accuracy is relatively low. A small number of samples are directly identified by the mobile terminal, and do not use the server operation. The algorithm flow to be adopted on the mobile terminal is shown in Figure 3
(3) The image is uploaded to the server for identification
① Read the trained model library;
② Fast r-cnn target detection method is proposed for pest detection and recognition;
③ The position box and insect category are obtained;
According to the position of the box and the category of insects, the repetitive box is removed. If there are similar insects in the recognition result, the insect pictures in the insect box are cut out and put into the convolution neural network model trained in advance for further recognition to confirm the category of insects, and the position box does not change.

![Figure 3. Target detection network architecture](image)

(4) The data is sent back to the mobile terminal for data filtering and display
According to the number of insects to be displayed, the recognition results with high accuracy are selected; The results are returned to the user's mobile terminal and displayed by matching the knowledge base

3.2. Construction of cloud platform for pest data management based on GIS
The cloud platform of insect data management based on GIS includes the following parts:
(1) Sample collection
The sample collection comes from three aspects: first, the existing knowledge base, the project team collected 200000 related insect sample pictures, mainly from the network collection and insect research institutions; The second is the automatic device, which includes three parts: insect trapping device, insect processing device and insect recognition device. The main working principle is to trap, kill, process and recognize insects. The third is that users get insect samples from their mobile phones, which is the main source at present. As long as users take photos of insects using the app, insect images are uploaded to the server,
(2) GIS display
A GIS platform is established. When the insect pictures are collected by mobile phone, the longitude and latitude information and time information are uploaded at the same time, and displayed to the end users in the form of map through coordinate transformation on the GIS platform.
(3) PEST analysis and prediction system
It can automatically generate the spatial and temporal distribution of pest situation, establish comprehensive safety prevention and control technology, use machine learning and other technologies to predict the pest situation, and build a comprehensive monitoring system of agricultural crop explosive diseases and pests.
(4) Insect information recommendation system
Based on the powerful big data capability, the user portrait technology is used to generate user portrait according to the end user's account number, accurately screen and personalize push messages to recommend relevant insect information.
After obtaining the static data, we need to carry out factor and cluster analysis on the population. Different purposes are classified according to different static data, including user name, collected data, longitude and latitude, landing time, etc. After background analysis, users are tagged, such as “rice...
farmers", "corn farmers", "cotton farmers", etc. the system can accurately push the basic information of related pests, Prevention and control suggestions and pesticide business information.

4. Conclusion

Using the crop pest identification algorithm based on deep learning technology, an application based on Android smart phone terminal is developed. Users can take insect photos on the mobile phone and send them to the cloud through the application. Artificial intelligence and big data technology are applied in the cloud to quickly and accurately identify more than 70 common agricultural and forestry pests, with an accuracy rate of more than 90%. Applying artificial intelligence and big data technology, a cloud platform for pest management based on GIS and intelligent system is established, which can automatically generate the spatiotemporal distribution map of pest situation. Machine learning and other technologies are used to early warn pests, build knowledge base of agricultural and forestry insects, make user images for end users, understand user intentions, and make personalized recommendations, Assist farmers to take timely and effective control measures against pests.

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