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Application of AI-driven cloud services in intelligent agriculture pest and disease prediction

Yiyu Lin[1,6,*], Huixiang Li[2], Ang Li[3], Yadong Shi[4], Shikai Zhuang[5]

[1]Computer Science and Engineering, Santa Clara University, CA,USA
[2]Information Studies, Trine University, AZ, USA
[3]Business Analytics, University College Dublin, Dublin,lreland
[4]Computer Science, Fudan University, ShangHai,China
[5]Electrical Engineering,University of Washington,Seattle,WA,USA

[6]y.lin5@scu.edu
*corresponding author

Abstract. Cloud computing technology helps agricultural operators collect the most valuable information by providing information push platforms, supply and demand information platforms, and expert interaction platforms for agricultural operators. Agricultural operators use cloud computing technology to monitor the growth of diseases, pests and grasses in farms, soil changes and weather conditions in real time, and use the data information analyzed by the cloud computing center to accurately judge the growth status of crops at any time and understand the growth laws of crops, which is conducive to improving crop yields. The article discusses the extensive application of cloud computing technology in advancing agricultural informatization in China. It outlines how cloud computing facilitates data collection, analysis, and decision-making in various agricultural sectors, leading to improved efficiency and productivity. Specific applications include monitoring crop growth, managing livestock health, facilitating agricultural e-commerce, ensuring product quality and safety, and predicting diseases and pests. The article also presents a methodology for developing an improved model for tea disease detection, leveraging techniques such as self-attention mechanisms, feature fusion networks, and transfer learning. Overall, cloud-based solutions play a crucial role in modernizing agriculture, enhancing sustainability, and increasing profitability in the sector.

Keywords: Cloud computing, Crops, Disease and pest prediction, Intelligent drive, forecast

1. Introduction

Cloud computing technology has vast development prospects and has greatly promoted the process of agricultural informatization in China, which is of great significance to the rural agricultural development in our country. This article firstly introduces the current application status of cloud computing technology in agricultural informatization in China. Secondly, it summarizes the roles and challenges of cloud computing technology in the fields of agricultural production, agricultural management, and agricultural operation. Finally, it proposes suggestions for the further application of cloud computing technology in agricultural information in the future.

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Cloud computing is the virtualization and centralized management of data center resources. Its characteristics such as virtualization, large scale, high flexibility, low cost, and security and reliability have greatly improved the efficiency of people's lives and work in today's society. In the process of agricultural informatization development,[1] Cloud computing technology helps agricultural operators collect the most valuable information by providing information dissemination platforms, supply and demand information platforms, and expert interaction platforms. It significantly reduces the cost of information search and management, promotes the rational and effective allocation of land, labor, capital, and technology, and promotes the integration and development of secondary and tertiary industries with agriculture in the process of promoting agricultural informatization.

2. Related work

2.1. The application of cloud computing in agricultural production

1. Farming

At present, the cloud computing technology has a preliminary research and application in China's planting development. [2]Agricultural operators can place wireless sensors in greenhouses or fields, and then collect temperature, humidity, light intensity, carbon dioxide concentration and other information in the environment, and then the information is transmitted to the control system, that is, the cloud computing center, the control system can provide corresponding countermeasures according to the stored information, and agricultural operators can carry out corresponding agricultural activities according to these decisions. In addition, automatic fertilization systems and automatic irrigation systems have also been introduced into the crop production process.

2. Facility gardening

Facility gardening itself is to artificially create a specific environment to produce horticultural crops such as vegetables, fruits and flowers in an environment that is not suitable for the growth of horticultural crops. Cloud computing is introduced into facility horticulture to ensure the production quality and efficiency of horticultural crops by collecting and analyzing a large number of data indicators. At the same time, it is also conducive to improving production, and with the blessing of cloud computing technology, the information management level of facility horticulture is higher.

3. Animal Husbandry

The application of cloud computing technology in animal husbandry has also been preliminarily developed. [3] Through cloud computing technology, the information of each livestock can be entered into the control center, and the information management system based on cloud computing technology stores and manages the data, and the farmer can fully understand the nutritional health level of each livestock. Knowledge of livestock feeding, breeding, health conditions and other information can reduce manpower, improve feeding efficiency, and bring convenience to farmers to manage and raise livestock.

2.2. Application of cloud computing in the field of agricultural management

1. Agricultural e-commerce

With the application of cloud computing technology, the upsurge of national agricultural information construction has risen again. [4]IT is regarded as the third wave of IT after computer technology and Internet technology. Internet agriculture is rising, Taobao, Tiktok and other e-commerce platforms are popular marketing venues, we must make good use of marketing platforms, strengthen the commercial e-commerce work of agricultural products. [5] Select competent e-commerce anchors to display featured agricultural products on the live broadcast platform, and take advantage of the Internet's fast and interactive advantages to establish a comprehensive modern agricultural product circulation system. The use of cloud computing technology can screen web page information that is favorable to farmers, and understand more comprehensive supply and marketing prices, marketing strategies, etc. Help farmers form a comprehensive, stable marketing network.

2. Circulation of agricultural products

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The application of cloud computing technology to the circulation of agricultural products requires only a simple operation on the computer or mobile phone. It can realize the data collection of agricultural products in the transportation process, so as to realize the logistics tracking of specific agricultural products. At the same time, it can help agricultural operators reduce the application cost of logistics system, analyze and organize data based on cloud computing center, and also help agricultural operators make business decisions.

2.3. The application of cloud computing in agricultural management

1. Quality and safety management

Using the cloud computing center to store and process data, all localities can uniformly establish corresponding agricultural product quality and safety management information platforms. To realize the information query of agricultural products from planting to production, harvest, circulation until the hands of consumers. The application of agricultural product quality and safety monitoring platform and agricultural product quality and safety traceability system is conducive to improving people's quality of life.

2. Marketing management of agricultural products

Cloud computing technology is used to help agricultural product sellers solve the reliability of agricultural product marketing information by using information push platform, supply and demand information platform and expert interaction platform. [6] Nowadays, there are various agricultural information websites on the Internet, so it is necessary to establish an authoritative platform to ensure the transmission of agricultural information. Farmers use the required information to choose the appropriate marketing channels for agricultural products and livestock, so as to achieve the purpose of increasing farmers' income and effectively allocating resources.

2.4. Intelligent prediction of agricultural diseases and pests

Traditional measurement and reporting of pests and diseases refers to the investigation and monitoring of various factors affecting the occurrence of pests and diseases according to the law of the occurrence and growth of pests and diseases mastered by research and practice, and the acquisition of data, combined with the observation data over the years and the meteorological forecast, the application of a variety of forecasting methods for comprehensive analysis. [7] Estimating the future occurrence period, occurrence amount, harm degree, spread distribution and epidemic trend of pests and diseases is called forecasting. Plant protection agencies at or above the county level publicize the forecast results to the public through radio, newspapers, television, websites, public accounts and other channels, which is called forecast. Usually referred to as "disease and insect forecasting", referred to as "disease and insect monitoring".At present, the system has been successfully applied to agricultural demonstration projects in many provinces and cities, providing an effective reference for the detection and warning of insect and disaster situation, and assisting in guiding the control and control of diseases and pests in the monitoring area.

Based on the extensive research and application of cloud computing technology in various facets of agricultural production and management, it is evident that cloud computing plays a pivotal role in advancing the agricultural informatization process in China. Cloud computing facilitates efficient data collection, analysis, and decision-making for agricultural operators, leading to improved crop yields, reduced labor and land use costs, and enhanced agricultural production efficiency. Furthermore, the integration of cloud computing with agricultural e-commerce and product circulation promotes the development of modern agricultural marketing networks and ensures the quality and safety of agricultural products.In summary, the application of [8]AI-driven cloud services in intelligent agriculture significantly contributes to enhancing productivity, sustainability, and profitability in the agricultural sector.

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3. Methodology

In the process of crop growth, diseases can have a significant impact on yield and quality. The types and scale of diseases are different, and they usually only affect certain parts of the crop. Due to the complexity of the crop growing environment, the process of intelligent detection of diseases may be interfered. In addition, some crop diseases are widespread and need to be judged through global information. Therefore, this paper analyzes the prediction of pest and disease in tea plants and proposes an improved tea plant disease detection model.

3.1. Experimental design

Tea disease data collected from Maoshan Tea Factory in China were used in this experiment. We use a self-attention mechanism to enhance the model's ability to obtain global tea disease information. BiFPN feature fusion network and adaptive spatial feature fusion [9] (ASFF) technology were used to improve the multi-scale feature fusion of tea diseases and make the model more resistant to the interference of complex background. Then, we integrated the Shuffle attention mechanism to solve the problem that small tea diseases are difficult to identify. In addition, we extended the dataset with data enhancement methods and transfer learning, and retuned parameters learned from other plant disease datasets to enhance the detection of tea disease. Finally, the SIoU technique was used to further improve the accuracy of regression. The experimental results show that the model can solve many problems in the intelligent recognition of tea diseases, the detection accuracy is ahead of the mainstream target detection model, and the detection speed reaches the real-time level.

3.2. Prediction model

With the rapid development of machine learning technology, image processing and machine learning have been widely used in crop disease recognition. Many studies have applied adaptive neural fuzzy reasoning system and color blindness technology to tea disease recognition, and used artificial neural network technology to improve the recognition accuracy. For example, some researchers have improved the random forest classifier and combined the attribute evaluation method with the case screening method for peanut disease classification. Other studies used K-means neighborhoods and support vector machines [10] (SVM) to classify rice leaf diseases with 91% and 93% accuracy, respectively. Some researchers also use SVM classifier to detect grape leaf diseases, and use SVM for feature extraction and classification after K-means clustering, with an accuracy of 85%. Combining support vector machine with linear iterative clustering to extract tea disease image from complex background, it is helpful to identify tea disease further.

In the process of feature fusion, the neighborhood component analysis was used to remove the redundant features, and the experimental results showed that the segmentation and classification accuracy of grape leaf disease reached 90% and 92%, respectively.

1.Support Vector Machine (SVM)

Support Vector Machine (SVM) is a commonly used machine learning algorithm, mainly used for classification and regression analysis. SVM separates different classes of data points by finding an optimal hyperplane in a high-dimensional space. This hyperplane maximizes the spacing between the two types of data points, thereby improving the model's ability to generalize, that is, its performance on unknown data. SVM can handle both linear and nonlinear classification problems. Nonlinear classification maps data into a high-dimensional space by using kernel functions (such as polynomial kernel, radial basis function kernel, etc.), so that data that is inseparable in the original space is separable in a high-dimensional space.

The advantages of SVM mainly include the following aspects. First, SVM still performs well in high-dimensional Spaces, even if the number of features is greater than the number of samples. Secondly, SVM has good generalization ability, which can effectively prevent overfitting, especially in the case of a small number of samples but a large number of features. Third, SVM can flexibly deal with linear and nonlinear problems by using different kernel functions. Furthermore, SVM is less sensitive to outliers

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because it focuses primarily on support vectors (i.e. the few key data points that determine the hyperplane) rather than all data points.

SVM plays an important role in the prediction model. It makes the model perform well in classification tasks by constructing a classifier that can effectively distinguish different categories. SVM is widely used in various practical problems, such as image classification, text classification, disease diagnosis and so on. In these applications, SVM uses its powerful classification and generalization capabilities to accurately classify and predict new data, improving the reliability and accuracy of the model. Therefore, SVM has been widely used in the fields of data mining, pattern recognition and machine learning.

2.K-means clustering prediction algorithm

In [11]K-means clustering analysis, an important step is to choose an appropriate K, or number of groups called clusters, which is usually unknown. K-means is ideal for exploratory analytics, perfect for understanding your data and providing insights into almost every data type. Whether it's images, graphics or text, K-means is flexible enough to meet almost every need.For this reason, it is common practice to run the algorithm multiple times with different starting points and evaluate different initialization methods (such as Forgy or Kaufman methods).

3.3. Data enhancement

The mixed use of data enhancement methods can not only expand the data set, but also avoid overfitting and improve the robustness of the model. Data enhancement methods include online enhancement and offline enhancement. Online data enhancement is the dynamic generation of enhanced data during training. These methods are typically applied to the data loading phase, where the data of a batch is randomly transformed each time a batch of data is loaded. For example, the image can be randomly cropped, rotated, flipped, scaled, color adjusted, and so on. The advantage of this method is that it can generate new transformation data in each training cycle, so that the model is constantly exposed to different variants during the training process, so as to improve the generalization ability of the model and reduce the risk of overfitting.

Figure 1. Input image on the left, random erase on the right

This hybrid strategy can not only greatly expand the data set, but also make the model better adapt to different scenarios and data changes, thus improving the robustness and stability of the model. In general, data enhancement is an important technical means to improve the performance of deep learning models. In the process of random stitching, the same picture may have different kinds of tea disease. A richer picture background can lead to more efficient model training.

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3.4. Experimental result

Figure 2. Prediction rendering

The training in this paper requires a large number of samples to ensure the training performance. Due to the limited number of data samples, it is difficult to obtain good detection results by training directly from scratch. Transfer learning is a technique that applies knowledge from a known domain to a target domain. Plant Village is a very large plant leaf disease dataset consisting of 54,306 plant leaf images, including 14 plant species, grouped into 38 groups based on species and disease. We used plant village datasets collected from the Internet and other plant disease datasets for pre-training.

4. Conclusion

Even though the concept of cloud computing has been deeply rooted in the hearts of the people in agricultural development, it has also been promoted and applied to a certain extent, but this promotion and application is limited by the information technology infrastructure and cannot meet the large-scale promotion requirements of cloud computing technology. At the same time, the cloud computing center is generally composed of hardware resource pool, cluster management platform, Hadoop platform, and service application platform. Therefore, enterprises and cloud computing technology research centers must pay attention to the key role of cloud security in agricultural promotion, update the customer terminal system, upgrade the cloud computing center security protection platform, and ensure the user's information exchange experience.

In conclusion, the widespread adoption of cloud computing technology has revolutionized agricultural practices in China, driving significant advancements in efficiency, productivity, and sustainability. By leveraging cloud-based solutions, agricultural operators can make informed decisions, optimize resource allocation, and enhance product quality and safety. Furthermore, the integration of AI-driven predictive models, such as the improved tea disease detection system, showcases the potential for technology to revolutionize disease management and crop protection. As China continues to embrace digital transformation in agriculture, the role of cloud computing as a catalyst for innovation and growth cannot be overstated. Its continued application promises to further propel the sector towards greater resilience, profitability, and environmental stewardship.

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