Research on automatic monitoring and recognition method of crop growth status based on machine vision.

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Abstract: Research on automatic monitoring and recognition methods for crop growth status based on machine vision is an important direction in the development of modern agriculture. By conducting real-time monitoring and recognition of the growth status of crops, it is possible to detect problems in crop growth in a timely manner and improve crop yield and quality. This method utilizes image processing and computer vision technology, extracts useful feature representations from images using deep learning methods, and classifies the growth status of crops based on these features. This method is of great significance, as it can not only improve agricultural production efficiency and reduce production costs, but also improve the quality of agricultural products and bring more economic and social benefits to agricultural production. At the same time, this method also provides technical support for precision agriculture, achieving precise management and regulation of the farmland environment through monitoring and recognition of crop growth status, and improving the output efficiency of farmland. In the future, with the continuous advancement of technology and the continuous expansion of application scenarios, the application prospects of machine vision technology in the agricultural field will be even broader.

Key words: Machine Vision, Neural Network, Growth Status Monitoring and Recognition

1. Introduction

In recent years, with the rapid development of artificial intelligence technology, machine vision technology has gradually emerged as a research hotspot in the agricultural field. Machine vision technology enables automatic monitoring and recognition of crop growth status through image processing and computer vision technology. The widespread application of this technology has brought revolutionary changes to agricultural production.

By monitoring and identifying the growth status of crops in real time, machine vision technology can detect problems in crop growth in a timely manner. By monitoring the color, shape, texture, and other characteristics of crops, it can be determined whether they are growing normally and whether there are pests and diseases. Once problems are identified, appropriate measures can be taken in a timely manner to intervene and prevent crop losses, thereby improving crop yield and quality.

2. Application of machine vision technology in agriculture

Machine vision technology is widely used in the agricultural field, mainly for monitoring the growth status of crops, realizing the automatic management and precise fertilization, watering and other operations of crops, and can also be applied to the quality inspection and grading of agricultural products, improving the quality and added value of agricultural products. Despite the achievements made, there are still challenges such as the complex and changing growth environment of crops, the wide variety of crops with different growth status, and the need to optimize and improve the technical cost and efficiency. To solve these problems, it is necessary to strengthen the research and application of machine vision technology, improve the recognition accuracy and stability, enhance the versatility and adaptability, reduce costs and optimize efficiency, and strengthen the integration and innovation with other agricultural technologies, so as to promote the automation and intelligent development of agricultural production.

3. The principle and method of automatic monitoring of crop growth status

1. Basic concepts and evaluation indicators of crop growth status

The growth status of crops refers to the morphological, physiological, and biochemical characteristics exhibited by crops during their growth process. These characteristics can reflect the growth, nutrition, pest and disease status of crops. By monitoring and analyzing these characteristics, the growth status of crops can be timely understood, providing a scientific basis for agricultural management and decision-making.

Evaluation indicators are important criteria for measuring the growth status of crops, including plant height, leaf area, dry weight, root status, and yield. These indicators can reflect the growth status of crops from different perspectives and provide a basis for automatic monitoring.

2. Feature extraction and selection methods

Feature extraction is the process of extracting feature information related to the growth status of crops from preprocessed images. These feature information includes color, shape, texture, etc., which can reflect the growth status of crops, pests and diseases, etc. There are many methods of feature extraction, including pixel-based feature extraction, region-based feature extraction, edge-based feature extraction, etc. Feature selection is the process of selecting features that are closely related to the growth status of crops from the extracted features. Due to the large number of extracted features, there are redundancies and irrelevant features, so feature selection is needed to improve efficiency and accuracy. There are also many methods of feature selection, such as statistical-based feature selection, clustering-based feature selection,

and decision tree-based feature selection.

3. Design of crop species automatic recognition algorithm based on deep learning

The crop species automatic recognition algorithm based on deep learning automatically learns useful feature representations from images by constructing a deep neural network model, and then uses these feature representations for classification and recognition. The specific algorithm design includes the following steps:

Construct a deep neural network model: You can choose a classic convolutional neural network (CNN) or its variant network structures, such as VGG, ResNet, etc.

Data preprocessing: Preprocess the collected image data, including size normalization, normalization, etc., to facilitate input into the neural network model.

Feature learning: Use the deep neural network model to perform feature learning on the preprocessed image data and automatically extract useful feature representations.

Classification and recognition: Input the extracted feature representations into the classifier for classification and recognition, and you can choose classic classifiers such as support vector machines (SVM), random forests (RF), etc.

4. Optimization strategies for automatic monitoring models of crop growth status

Using deep learning methods, a convolutional neural network (CNN) model was established. This model can extract crop features from images and classify the growth status of crops based on these features. To further improve the performance of the model, the following optimization strategies were adopted:

Improve network structure: Several network structures such as VGG, ResNet, etc. were tried to find the most suitable model structure for monitoring crop growth status.

Increase data volume: By increasing the amount of training data, the model's generalization ability is improved, making it better adapted to different growing environments.

Adjust hyperparameters: By adjusting hyperparameters such as learning rate, batch size, etc., the model training process is optimized to improve convergence speed and accuracy.

Ensemble learning: Using ensemble learning methods, the predictions of multiple models are fused to improve prediction accuracy and stability.

4. Design of automatic monitoring and recognition system for crop growth status

1. Overall design scheme and module division of the system

The automatic monitoring and recognition system for crop growth status plays an important role in the process of agricultural modernization. Building a comprehensive system to achieve real-time monitoring and analysis of crop growth status, the overall system design mainly covers the following aspects:

Data acquisition module: Collect relevant parameters of the crop growth environment, such as temperature, humidity, light, soil moisture, etc. Various sensors can be used to achieve real-time monitoring of these parameters, such as temperature sensors, humidity sensors, light sensors, etc.

Image processing module: Collect image information during the growth of crops through cameras or drones, and analyze the growth status of crops using image processing technology. For example, based on multi-threshold parameter crop segmentation algorithm, through the analysis of the illumination characteristics of crop real-time images, a multi-threshold parameter green vegetation segmentation method is proposed.

Data storage and processing module: Stores and processes various types of collected data, such as data preprocessing, feature extraction, etc. Data analysis can be performed through data mining and machine learning algorithms to extract meaningful features for crop growth status.

Model establishment and optimization module: Based on the collected data and processing results, establish a prediction model for crop growth status. For example, use algorithms such as support vector machines (SVM) and neural networks to predict crop growth status. At the same time, continuously optimize model parameters based on actual application effects to improve prediction accuracy.

Monitoring and alarm module: Monitor the growth status of crops in real time based on the model prediction results. When abnormal conditions are detected, timely alarm signals are sent out to facilitate agricultural producers to take corresponding measures.

Data visualization and analysis module: Visualize the collected data and processing results to facilitate agricultural producers' intuitive understanding of crop growth conditions. At the same time, provide data statistics and analysis functions to help agricultural producers make decisions.

Communication and remote control module: transmit monitoring data to the cloud through wireless communication technology (such as 4G, 5G, etc.), enabling remote monitoring and analysis of data.

2. Database design

As the core component of the automatic monitoring and recognition system for crop growth status, the database is responsible for storing and managing various types of data collected by the system. When designing the database, we need to fully consider the following key aspects:

Data table design: Construct corresponding data tables based on the actual needs of the system, such as environmental parameter tables,

image information tables, processing result tables, etc. These data tables will help us store and manage various types of data in an orderly and convenient manner.

Field design: Set up corresponding fields for each data table, including key fields and supplementary fields. Key fields are mainly used to uniquely identify a piece of data, such as ID, time, etc. Supplementary fields are used to describe the detailed information of the data, such as temperature, humidity, light, etc. Rational design of fields can help improve the efficiency and accuracy of data processing.

Data type and length: Select the appropriate data type and length based on the specific meaning and data range of the field. This will help ensure data storage and query efficiency, laying the foundation for subsequent data analysis and processing.

Indexes and constraints: In order to improve data query speed, it is possible to create indexes for key fields. At the same time, data constraints can be set to ensure data integrity and consistency. For example, a primary key constraint can be set to ensure that each piece of data has a unique identifier.

5.Conclusion

In the development of modern agriculture, the importance of automatic monitoring and recognition systems for crop growth status is self-evident. This article discusses hyperparameter tuning, model establishment and optimization, system design, and other aspects, aiming to improve the accuracy and stability of crop growth status monitoring and recognition. Through integrating learning, data preprocessing, and feature extraction techniques, the accuracy of crop growth status prediction models has been significantly improved.

On this basis, the overall architecture of the automatic monitoring and recognition system for crop growth status was designed, including data acquisition, image processing, data storage and processing, model establishment and optimization, monitoring and alarming, data visualization and analysis, and communication and remote control modules. The database design provides stable and efficient data support for the system, ensuring real-time updates, secure storage, and accurate analysis of crop growth status data.

The automatic monitoring and recognition method for crop growth status based on machine vision provides technical support for precision agriculture. Through monitoring and recognizing the growth status of crops, it can achieve precise management and regulation of the farmland environment, and improve the output efficiency of farmland. This method is not only applicable to agricultural production, but also can be extended to other fields, such as ecological environment monitoring and food quality testing. At the same time, the research and application of this method also help to promote the development of artificial intelligence technology, providing technical support for other fields. In the future, with the continuous progress of technology and the continuous expansion of application scenarios, the application prospect of machine vision technology in the agricultural field will be more promising.

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