

Application of Machine Learning in Vegetable Classification and Recognition

Hongyi Chen *

Jiangnan High School, Hangzhou, Zhejiang, 310000, China

* Corresponding author: chenhongyi0118@163.com

Abstract. The rapid development of artificial intelligence plays an important role in People's Daily life today. Vegetable classification is closely related to life. With the continuous advancement of artificial intelligence technology, similar applications in the agricultural and retail industries are expected to play a more significant role. This paper aims to envision a vegetable identification system based on a convolutional neural network to provide intuitive and accurate vegetable classification information for supermarket managers and customers. This study mainly uses the convolutional neural network model as the main research model to carry out the design of a vegetable classification system. In this paper, the usefulness and disadvantages of the CNN model are summarized, how to use the model for deep learning and big data is learned, and the problems that may be encountered after the model is run are also predicted. Furthermore, the future development direction of the project is predicted too. As technology continues to evolve, it is expected that more innovative solutions will emerge, delivering enhanced benefits to society.

Keywords: Artificial Intelligence, Vegetable Recognition, Convolutional Neural Network, Classification.

1. Introduction

With the swift progress of artificial intelligence technology, deep learning-based image categorization has become increasingly crucial in the agricultural domain. Developing an automated categorization system for fruits and vegetables using artificial intelligence and big data technology presents a notable challenge. However, it has emerged as a research trend to create more intelligent systems that assist supermarket administrators and customers in making purchases effortlessly [1].

In today's information age, image recognition is regarded as a fundamental technology that utilizes models and computers to achieve the identification of physical information and data. This technology currently possesses significant advantages, particularly in terms of intelligence and convenience. It not only engages in deep learning through continuous sample accumulation, but also enhances work efficiency and recognition accuracy. Currently, existing technology primarily focuses on the rapid identification of various pre-packaged and weighed food products. The designed model aims to unlock the potential of the vegetable classification system, while also helping administrators reduce labor costs and save customers' time by eliminating the need for weighing and queuing. The system is dedicated to driving comprehensive intelligent management by optimizing the subtle differences between vegetable categories and improving the image recognition system.

This paper revolves around a vegetable recognition and categorization model using CNN model, aiming to leverage deep learning techniques to enhance the accuracy of vegetable recognition and categorization, providing greater convenience for agricultural production and retail businesses [2]. The use of models and computers to complete the identification of physical information and physical data, this technology has outstanding advantages at present, mainly reflected in the level of intelligence and convenience, not only through continuous sample accumulation of deep learning, but also improve the efficiency of work at the same time, the recognition accuracy is also higher. Through the collection of extensive vegetable image data and annotation and training processes targeting different varieties and characteristics. The efficient vegetable recognition system not only aids farmers in crop management but also offers supermarket administrators and customers intuitive and precise vegetable categorization information, enabling them to conveniently select and purchase

desired products. For example, Antonio's team has proposed a framework for a shopping assistance system that helps elderly or disabled people make purchases in supermarkets based on a shopping list using a robot that holds the system [3].

This research represents not only technological innovation but also an exploration of the application of artificial intelligence in the agricultural sector. Believing that as artificial intelligence technology continues to advance, similar applications will play an increasingly significant role in agriculture and retail industries, delivering enhanced convenience and benefits to society.

2. Data and methods

2.1. Data Source

The fundamental concept behind the vegetable recognition system involves initially gathering a vast array of vegetable images, which entails acquiring a large database for subsequent model training in the vegetable image recognition system. The image sources mainly consist of vegetables found in supermarkets on the internet and those obtained from online databases. The main source of this study data focuses on selecting patterns that closely resemble actual shelf displays while avoiding vegetable pictures taken in agricultural settings.

2.2. Data Preprocessing

Before feeding the data images into the model, they undergo a crucial step known as image preprocessing. This process involves separating each text image and providing it to the recognition module for further analysis. Image preprocessing plays a vital role in image analysis, particularly before feature extraction, segmentation, and matching. Its primary objective is to eliminate any irrelevant information present in the image while recovering useful, genuine information. By enhancing the detectability of relevant information and simplifying the data to its maximum extent, image preprocessing aims to improve the reliability of subsequent tasks like feature extraction, image segmentation, matching, and recognition. This ensures that the model receives clean and refined input data, ultimately leading to more accurate and reliable results.

For image data preprocessing method, the first one is simple scaling in data normalization, which aims to re-adjust the value of each dimension of the data, which is very important for subsequent processing, and many default parameters assume that the data has been scaled to a reasonable range. For images, normalization can remove the average brightness value of the image. The next step is featuring normalization, so that each dimension of the data has zero mean and unit variance. After simple normalization, whitening is often used as the next preprocessing step, and many deep learning algorithms rely on whitening to get better features.

2.3. Method

This study selected the Convolutional Neural Network (CNN) as a choice algorithm, which is widely used in various domains such as image processing and speech recognition. CNNs excel at extracting intricate features from data through convolutional kernels. These features can either be manually designed or obtained through training processes. By using local connections and weight sharing, CNNs reduce the number of parameters in the network, enhancing its feature extraction capabilities [4]. specific parts of an image and then utilizing these features to analyze the entire image. Compared to other deep learning algorithms, CNNs boast superior classification accuracy and excel across diverse datasets [5].

The structure of a CNN model typically includes convolutional layers, pooling layers, and fully connected layers. This composition forms a hierarchical structure that enables effective learning and improves overall accuracy through interconnected layers. In terms of learning, the learning method of convolutional neural network is the same as that of traditional multi-layer perception, using back propagation model and so on.

3. Discussion of Possible Outcomes

The paper has predicted several challenges for future testing of this model, one major obstacle was the limited availability of data sets. Deep learning models typically rely on a large volume of data for effective training. However, in the context of vegetable classification and recognition tasks, it can be difficult to collect a sufficient amount of labeled data [6]. As a result, the model's ability to generalize and accurately classify new fruits and vegetables becomes compromised.

There is a viable solution for this problem: data augmentation. By employing techniques such as image rotation, scaling, and flipping, it can generate additional samples and diversify the data set. This approach aims to improve the model's ability to generalize and enhance its overall performance. Additionally, exploring the use of transfer learning, which involves leveraging a pre-trained model from an image classification task and fine-tuning it with a smaller data set. This strategy not only can expedite model convergence but also boosts the classification accuracy.

By implementing these solutions, the model can successfully address the challenge of limited data sets, empowering its deep learning model to excel in vegetable classification and recognition tasks.

Furthermore, due to the similarities in appearance between vegetables and fruits, such as color, shape, and size, it is challenging for deep learning models to differentiate them effectively. While the human eye can easily discern these differences, the model may struggle. For instance, various types of watermelon share similar shapes and colors, posing a challenge to the model's recognition accuracy [7].

To solve this issue, there are two solutions. Firstly, incorporate a feature extraction layer and employ a deeper convolutional neural network to extract more sophisticated features. This approach aimed to enhance the model's capacity to distinguish between different vegetables and fruits. Secondly, train the model's attention mechanism to focus on crucial feature areas, thereby improving classification accuracy.

During the model training process, a diverse set of vegetable images can be utilized for iterative learning. In the testing phase, the best model was selected by comparing the recognition accuracy and recall rate across different iterations. Accuracy, which measures how often a model correctly classifies data points, served as a crucial performance metric, particularly suited for classification problems with a moderate number of samples. Additionally, by calculating the recognition results and the recall rate of real labels to evaluate the model's recognition capabilities.

4. Conclusion

In this paper, a novel vegetable recognition system based on convolutional neural network is proposed to provide intuitive and accurate vegetable classification information for supermarket managers and customers, so that they can easily choose and buy the required products. The vegetable recognition and categorization model discussed in this article can be further expanded to include other food products, such as fruits and pre-packaged dishes. By implementing these systems, it will be possible to reduce errors in ingredient allocation and improve overall work efficiency in food production processes. Additionally, the use of artificial intelligence in the agricultural sector can also contribute to sustainable farming practices. By accurately categorizing and monitoring crops, farmers can optimize their cultivation methods and reduce waste. This can lead to improved resource management and increased crop yields.

Furthermore, the development of intelligent systems that assist supermarket administrators and customers in making purchases effortlessly can greatly enhance the shopping experience. This can include personalized recommendations based on individual preferences and dietary restrictions, as well as real-time inventory updates to ensure the availability of desired products.

Overall, the application of artificial intelligence in the agricultural and retail industries holds immense potential for improving efficiency, sustainability, and convenience. As technology continues to evolve, it is expected that more innovative solutions will emerge, delivering enhanced benefits to society.

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