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Deep Learning Based Approach For Automated Food Inspection And Grading Using Computer Vision

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Abstract

Quality assessment of fruits plays a key part in the global economy's agricultural sector. In recent years, it has been shown that fruits are affected by different diseases, which can lead to widespread economic failure in the agricultural industry. Traditional manual visual grading of fruits could be more accurate, making it difficult for agribusinesses to assess quality efficiently. The quality and safety of food is an important issue to the whole society, since it is at the basis of human health, social development and stability. Ensuring food quality and safety is a complex process, and all stages of food processing must be considered, from cultivating, harvesting and storage to preparation and consumption. However, these processes are often labor-intensive. Nowadays, the development of machine vision can greatly assist researchers and industries in improving the efficiency of food processing.

Computer vision based food recognition is a technology that uses machine learning algorithms to identify and classify different types of food in digital images or videos. This technology has a wide range of applications, including dietary analysis and tracking, nutrition labeling, and food safety. One of the key benefits of food recognition is the ability to automatically extract nutritional information from food images.

Keywords: Automated Food Inspection, Food Grading, Deep Learning, Convolution Neural Networks (CNN), Image Classification, Object Detection, Image Segmentation.

I. INTRODUCTION

Computer vision based food recognition is a rapidly growing field that involves using machine learning algorithms to identify and classify different types of food in digital images or videos. This technology has a wide range of applications, including dietary analysis and tracking, nutrition labeling, and food safety. One of the key benefits of food recognition is the ability to automatically extract nutritional information from food images. This can be particularly useful for individuals who are trying to maintain a healthy diet, as it allows them to easily track their daily caloric intake and ensure that they are getting the necessary nutrients.

Food processing is the transformation of either raw materials such as natural animals and plants into food, or of one form of food into other forms which are more suitable for the dietary habits of modern people. Therefore, food processing is closely related to the quality of modern people's life and the economic development of the whole society. Food processing includes diverse aspects (e.g., the manufacturing,

modification and manufacturing of food), which require a series of physical and chemical changes of the raw materials. However, due to an increase in environmental pollution, people are concerned about the safety of both the food sources and the food processing procedures.

Agriculture is vital to countries' economies of most developing nations, including some highly populated countries like China and India. Producing and distributing fresh fruits and vegetables to vendors and marketplaces worldwide is an essential aspect of agriculture. Several novel technologies have been created and employed in the food business to meet the rising demand for adequate food production and market supply. Governments invest a significant amount of money each year in new technologies, and new agricultural practices and tactics are being deployed to combat pests, natural catastrophes, and drought. Many merchants have increased their delivery of fruit in recent years. Many businesses seek high-quality food to compete for clients. As a result, retailers pressure suppliers to achieve quality standards.

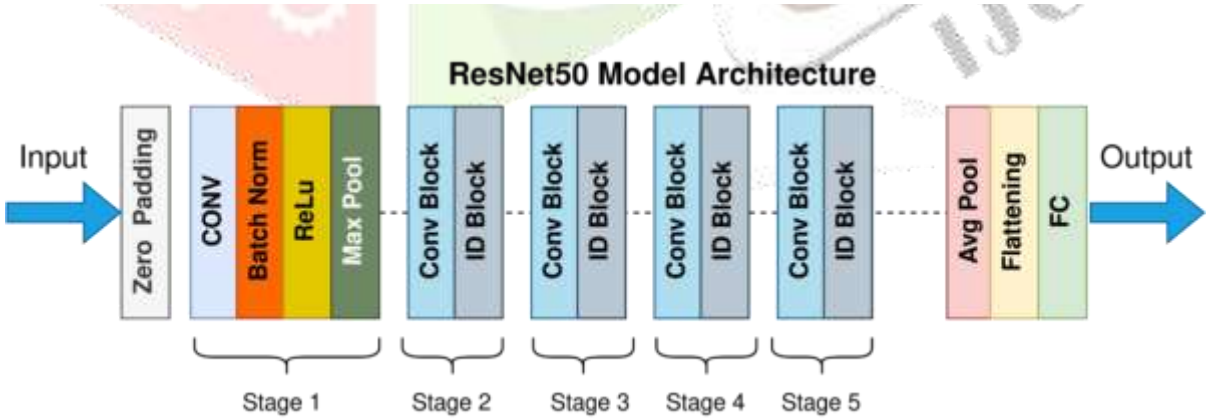
Discussion

OpenCV (Open Source Computer Vision Library) is a key player in computer vision, offering over 2500 optimized algorithms since the late 1990s. Its ease of use and versatility in tasks like facial recognition and traffic monitoring has made it a favorite in academia and industry, especially in real-time applications. The field of computer vision has evolved significantly with the advent of deep learning, shifting from traditional, rule-based methods to more advanced and adaptable systems. Earlier techniques, such as thresholding and edge detection, had limitations in complex scenarios. Deep learning, particularly (CNNs), overcomes these by learning directly from data, allowing for more accurate and versatile image recognition and classification.

This advancement, propelled by increased computational power and large datasets, has led to significant breakthroughs in areas like autonomous vehicles and medical imaging, making deep learning a fundamental aspect of modern computer vision.

Deep Learning Models:

ResNet-50 is a variant of the ResNet (Residual Network) model, which has been a breakthrough in the field of deep learning for computer vision, particularly in image classification tasks. The "50" in ResNet-50 refers to the number of layers in the network – it contains 50 layers deep, a significant increase compared to previous models.



1. **Residual Blocks**: The core idea behind ResNet-50 is its use of residual blocks. These blocks allow the model to skip one or more layers through what are known as "**skip connections**" or "shortcut connections." This design addresses the vanishing gradient problem, a common issue in deep networks where gradients get smaller and smaller as they back propagate through layers, making it hard to train very deep networks.

2. **Improved Training**: Thanks to these residual blocks, ResNet-50 can be trained much deeper without suffering from the vanishing gradient problem. This depth enables the network to learn more complex features at various levels, which is a key factor in its improved performance in image classification tasks.

3. **Versatility and Efficiency**: Despite its depth, ResNet-50 is relatively efficient in terms of computational resources compared to other deep models. It achieves excellent accuracy on various image classification benchmarks like ImageNet, making it a popular choice in the research community and industry.

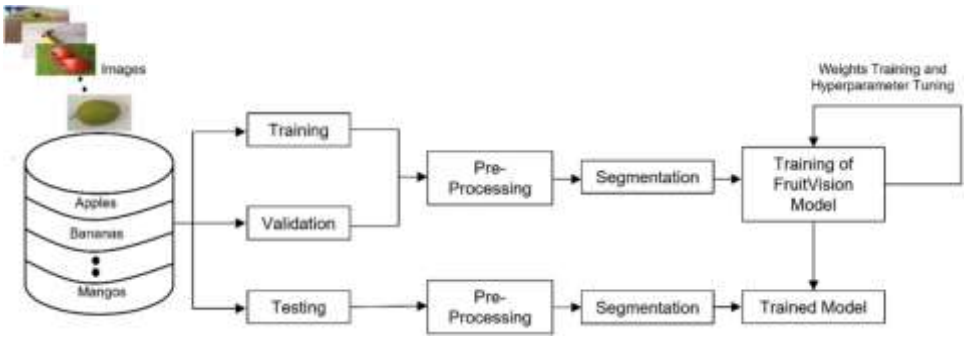
4. **Applications**: ResNet-50 has been widely used in various real-world applications. Its ability to classify images into thousands of categories makes it suitable for tasks like object recognition in autonomous vehicles, content categorization in social media platforms, and aiding diagnostic procedures in healthcare by analyzing medical images.

Impact on Computer Vision:

ResNet-50 has significantly advanced the field of image classification. Its architecture serves as a foundation for many subsequent innovations in deep learning and computer vision. By enabling the training of deeper neural networks, ResNet-50 opened up new possibilities in the accuracy and complexity of tasks that computer vision systems can handle.

Deep learning models are based on neural network architectures. Inspired by the human brain, a neural network consists of interconnected nodes or neurons in a layered structure that relates the inputs to the desired outputs. The neurons between the input and output layers of a neural network are referred to as hidden layers. The term “deep” usually refers to the number of hidden layers in the neural network. Deep learning models can have hundreds or even thousands of hidden layers.

Deep learning models are trained by using large sets of labeled data and can often learn features directly from the data without the need for manual feature extraction. While the first artificial neural network was theorized in 1958, deep learning requires substantial computing power that was not available until the 2000s. Now, researchers have access to computing resources that make it possible to build and train networks with hundreds of connections and neurons. The objective of this work is to develop a deep learning–based automatic system for evaluating multiple fruits into different grades based on their quality. depicts the proposed methodology for an automated fruit grading system. This system is further benchmarked against a variety of state-of-the-art deep-learning techniques to assess its performance.



Conclusion and future scope

Fruits are rich in nutrients, including oxidants and flavonoids, which reduce the incidence of heart disease, cancer, and high blood pressure. Defective fruits cause economic loss and may affect health. Identifying and evaluating fruit quality became a significant issue of research. Manual grading of fruits is time-consuming and error-prone. Therefore, it is important to have a computer vision-based system that will automatically grade the fruits based on their quality.

The proposed deep-learning model has produced remarkable results, but it also has certain limitations. The first one is that the proposed model should be tested with larger and multiple fruit datasets for better generalization and robustness. The second limitation is that the proposed system was trained and tested on the single view of fruit images. It will be interesting to see the performance of the system trained on multi-view fruit images.

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