Fruit Image Classification Using Deep Learning Algorithm: Systematic Literature Review (SLR)

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ABSTRACT
Systematic literature review (SLR) research studies various classification models with deep learning algorithms on fruit with digital images. In recent years, computer vision and processing techniques are increasingly useful in the fruit industry, especially for quality and color inspection, sizing, and shape sorting applications. Research in this area demonstrates the feasibility of using a machine computer vision system to improve product quality. Utilizing deep learning in the field of image processing or digital image processing, Image Processing is used to assist humans in recognizing and/or classifying objects quickly, and precisely, and can process large amounts of data simultaneously. Classifying fruit through a computerized system using deep learning algorithms with CNN, MASK-RCNN, FASTER-RCNN, and SSD models. Developed on the multilayer perceptron (MLP) layer, the algorithm is processed into two-dimensional data, to the image and is capable of classifying images with larger classes.

1. Introduction

Fruit classification is one of the topics studied in the agricultural industry. As part of the current research area, the classification of these fruits using image processing techniques was developed. This fruit classification can be used to identify the fruit and generate its price automatically in stores or supermarkets. Farmers will benefit if there is an automated analysis to classify various types of fruits and vegetables in the agricultural industry [1]. Fruits provide an important role as food in our daily lives. It provides essential nutrients for the health and maintenance of our body. Those who eat more fruit as part of a healthy diet tend to reduce their risk of several chronic diseases. However, not all fruit is treated equally, and this is a concern because not everyone knows every fruit well. With the help of Artificial Intelligence (AI) and Deep Learning (DL), this research can develop an automatic fruit classification system with dataset information for each fruit. Recent approaches in computer vision, especially in the areas of machine learning and deep learning have increased the efficiency of image classification tasks. Deep Learning (DL) is deep learning from the derivative of machine learning (Machine Learning) and artificial intelligence (Artificial Intelligent). Deep learning is an artificial neural network that uses input metadata to be processed using a hidden layer. Deep learning algorithms can reduce programming load by selecting explicit features. Each hidden layer trains features based on the output on the previous network. Based on this, deep learning can solve complex problems consisting of several non-linear transformations [2]. An image is a moving image or image taken using a camera [3]. An image that can be processed using a computer, the image will be represented first numerically with discrete values. A pixel or image element is the intersection of a column and a row in the image. The image can be divided into 3 parts, namely Color Image (RGB), gray image, and binary image [2]. Images can be divided into analog images and digital images. In terms of visual content, images can be divided into color images, gray-level images, and binary images. Image processing can be performed using various color spaces, according to the application domain. The color spaces used in addition to RGB are CMYK, HSV, HSL, Lab, Luv, YCbCr, and HCL [4]. Defect detection and classification of fresh and rotten fruit is
one of the main challenges in agriculture. Rotten fruit can cause damage to other fresh fruit if not classified properly and can also affect productivity. Traditionally this classification was carried out by men, which was labor-intensive, time-consuming, and an inefficient procedure. In addition, it also increases production costs. Therefore, we need an automatic system that can reduce human labor, increase production, and reduce production costs and production time.[5]. Deep Learning is a learning process that uses algorithms that refer to mathematical laws that work like the human brain. Deep Learning is used for various kinds of work, such as predicting opportunities or events, recognizing objects, to diagnosing diseases. One of the uses of Deep Learning is in the field of image processing. Deep learning is designed to continuously analyze data like the human brain in making decisions [6]. An image processing system assists humans in recognizing or classifying and analyzing an object in the form of a video or image efficiently, quickly, precisely, and can process a lot of data at once [7]. Deep learning can classify fruit quality, fruit maturity level, and fruit weight, each fruit has time to reach perfect maturity. To get good results, an automation system is needed that can classify fruit ripeness accurately and precisely. The level of maturity is seen from the texture of the color and skin of the fruit, the classification of fruit maturity can use the Convolutional Neural Network (CNN) method. Because the implementation of CNN is very good for image classification. A previous study on the classification of expressions in real time using CNN obtained a final accuracy of 64.26% [2]. The development of an accurate fruit detection system is an important step towards achieving a fully automated harvesting robot. Deep Learning (DL) and detection frameworks such as Single Shot MultiBox Detector (SSD) or You Only Look Once (YOLO) are more powerful and accurate alternatives with a better response for very complex scenarios[8]. The CNN LSTM classifier identified 4 types of disease and normal fruit.

2. Method

The research method used is to systematize the literature to find out the methods used by researchers in identifying and classifying image processing. The steps taken are Looking for similarities (Compare), Looking for dissimilarities (Contrast), Giving views (Criticize), Comparing (synthesizing), and Summarizing (Summarize) [4]. Looking for Similarities (Compare); is the technique of conducting a literature review by finding similarities between several kinds of literature and concluding. Looking for Dissimilarity (Contrast); is the technique of conducting a literature review by finding differences between several kinds of literature. Giving Views (Criticism); is the technique of conducting literature by making their own opinion. Comparing (Synthesize) is; a technique of conducting literature by combining several sources into a new idea. Summarize (Summary); the technique of doing literature by rewriting the source with the sentence itself. So that it can find out what are the stages of research, techniques, methods, or algorithms that can be used in other research.

3. Results and Discussion

Deep learning involves training machines using large amounts of data. This enables highly efficient processing and prediction capabilities. Many deep learning algorithms use multiple layers of neural networks to improve their performance of these algorithms. This layer allows for more complex calculations and can drastically improve performance. Processing images directly with deep learning can be done in several ways. These include hand-coded neural networks, GPUs, and field-programmable gate arrays (FPGAs). These three methods have their respective advantages and disadvantages. Image processing techniques can be used to improve agricultural practices, by increasing the accuracy and consistency of the process. This paper presents recent advances in using computer vision-based applications in agriculture. Computer vision using image processing techniques involves five basic processes such as image acquisition, preprocessing, segmentation, object detection, and classification. This Systematic Literature Review highlights the approach in the context of fruit farming practices in particular and summarizes its relevance.

3.1. Literature Review

The analysis of the literature review is shown in the research conducted by Subhan and Basri, 2019, the classification of the quality of nutmeg using the deep learning method of the R-CNN architecture. Detection of fruit quality classification in real time using multi-class with the best accuracy of 86% [9]. Natural image processing methods are used to detect various types of nutmeg. Initially, raw images of whole nutmeg seeds were processed using natural filtering methods such as brightness, contrast, color-matching filters and thresholding methods, and morphological operations. This is followed by edge detection and region labeling with an algorithm-assisted feature extraction method to generate boundary labels in an error-free manner. To raise the standard of quality control for spices such as nutmeg, deep learning programs could revitalize spices industry by helping researchers identify counterfeit products based on visual characteristics alone. Additionally, natural image processing techniques could help uncover new uses for the spice that researchers haven’t yet discovered – such as treating gastric conditions with whole nutmeg seeds or using the outer shell of the nutmeg seed as a topical application for skin disorders.

Research conducted by Halstead et al., 2020, detect and exploit fruit with different plantings techniques, namely using different cultivars, a cultivar is defined as a group of plants that have been selected for one or more specific characteristics (subspecies) and in a different environment. different (field vs. greenhouse) using the MASK-RCNN model with sub-class classification that the percentage of correct detection with an accuracy of 0.900 in cross-domain evaluation, this multitasking learning technique was shown to increase the F1-Score of cross-dataset detection from 0.323 to 0.700, indicating the potential to reduce new annotation requirements through improved generalizability of the model[10].

Boukhris, 2020, conducted a study to detect damage to leaves and fruit, find the location, classify the severity and visualize the severity using the MASK-RCNN model with a convergent model classification to an accuracy of 0.99 and a loss value of 0.0011[11]. De Luna et al., 2020, presented research on monitoring tomato growth stages for smart farming using deep learning transfer with machine learning-based maturity assessment by comparing deep learning models, namely R-CNN and SSD. SSD detecting flowers and fruits with an accuracy of 100 and 95, 99%, compared to R-CNN 1.67 and 19.48%. under the following conditions: flowers only, fruit only, and flowers and fruit. Each condition has 30 images to be evaluated. It can be concluded that SSD performed better than RCNN for flower and fruit detection[12].

Cai et al., 2020, conducted a study of fruit image recognition and classification methods with an improved SSD model, Modifying Default-boxes on SSD Models to Improve Detection Accuracy is a study to increase the detection accuracy of the Single Shot MultiBox
Detector method, which is an increase of 92.4%, 11.0% higher than the original SSD algorithm with detection accuracy in various environments has reached 92.4%[13].

The study by Hameed et al, 2020, carried out fruit and vegetable classification with an AdaBoost-based CNN optimization and experimented (GoogleNet, MobileNet-v2, and 15-layer CNN), with positive results where a low custom CNN-based classification was considered the most effective despite the number of parameters and computationally lower for fruit and vegetable classification [14].

Vasumathi and Kamarasan, 2021, melakukan penelitian dengan model CNN berbasis LSTM pada mengklasifikasikan buah delima menjadi dua kelas normal dan abnormal dengan optimisasi Teknik capung, hasil eksperimen menunjukkan akurasi 92% dalam klasifikasi menggunakan teknik CNN-LSTM dan optimasi menggunakan teknik capung menunjukkan peningkatan akurasi klasifikasi sebesar 97,1%[15].

Iskandar Mulyana et al, 2022, melakukan optimasi klasifikasi buah anggur menggunakan data augmentasi pada proses klasifikasi 13 jenis citra buah anggur. Dengan menggunakan dua model sequential presisi 98,54% dan loss 0,027%, dan model VGG16 presisi 99,37% dan loss 0,029%[16].

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4. Conclusion

This paper presents a survey on the use of image processing techniques used in agriculture for fruit classification. Processes such as segmentation, feature extraction, and fruit clustering. Image processing techniques have been used in various agricultural productions. It can be effective in fruit quality assessment, fruit defect detection, and weeds. Several models can be selected in the deep learning algorithm for the implementation and classification of digital fruit images. One of the factors that can increase the development of image processing techniques for agriculture is the availability of datasets for maximum training and test data processing. Several models can be used for fruit classification with different levels of accuracy according to the type of fruit and assessment, the models that can be used include CNN, Faster R-CNN, Mask R-CNN, and SSD and can be done with several optimizations on the model to get maximum.

Acknowledgment

This paper is compiled based on knowledge from research papers on classification using deep learning algorithms to find the best model in the digital image processing process in agriculture, especially fruits.

References


