Classifying maturity of cherry tomatoes using Deep Transfer Learning techniques

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Abstract. This research studies a method to classify the tomatoes' maturity by using deep transfer learning techniques. We carry out sorting systems adopting three pre-trained convolutional neural networks of VGG16, VGG19, and ResNet101. The experimental results show that the VGG19 model obtains a high precision on both the train set and the test set.

1. Introduction

Tomatoes are one of the popular vegetable crops that are grown all over the world. They are healthy because of their good source of vitamin A and C. Along with the constant increase in demands for tomatoes, the consumer also pays more attention to their quality. Tomatoes maturity level plays an important role in product quality. However, the traditional classification of tomatoes is often based on the practical experience of farmers. It takes a lot of time and inaccuracy in harvesting the crop. There have been researches in the field of automatic classification of tomatoes over the last decade [1, 2, 3].

The rapid growth of recent techniques in image processing, computer vision and especially Machine Learning (ML) paved the way for high-quality agriculture. In [4], the authors implemented a fuzzy architecture based on RGB color to classify six categories of tomatoes. This approach obtained a good classification in RGB color space. The limitation of this paper was that the result is a suited prediction in the conditional environment with controlled lighting, fixed black background. In another study, by combining histogram feature extracting and Naïve Bayes Classifier, Kusuma et al. proposed a new tomato maturity classification [5]. The histogram feature acquired the pixel intensity values of the tomato's image, the information of a relative, brightness, and contrast. Hence, the Naïve Bayes Classifier learned the extracted values obtained from the histogram feature to make a more accurate prediction. According to the results, the proposed method produced an accuracy rate of 76%. In fact, the main concern of the classification method was accuracy and computational cost.

Recently, Deep Learning (DL) has attracted intensive research interest in the classification of tomatoes. By using a lot of labelled images of tomatoes as the input, the DL model is trained to learn the tomato's features. After a period of training, the "learned model" was then used to predict what type of tomatoes. However, the traditional DL techniques acquired big data to conduct a good classification. In recent years, many researchers have used transfer learning methods to overcome these problems [6, 7]. For instance, to detect the tomato crop disease, Ouhami et al. obtained deep learning models DensNet, 161 and 121 layers, and VGG16 [6]. The results show that transfer learning has a suitable architecture for the task of plant disease detection with less time-consuming and high accuracy.

In this study, we focused on the task of maturity classification of tomatoes. Based on the dataset of 1374 tomato images, we divided tomatoes into 3 categories: green, yellow, and red. By taking advantage