

## Research Article

# Classification of Date Fruits into Genetic Varieties Using Image Analysis

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Academic Editor: Javier Martinez Torres

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A great number of fruits are grown around the world, each of which has various types. The factors that determine the type of fruit are the external appearance features such as color, length, diameter, and shape. The external appearance of the fruits is a major determinant of the fruit type. Determining the variety of fruits by looking at their external appearance may necessitate expertise, which is time-consuming and requires great effort. The aim of this study is to classify the types of date fruit, that are, Barhee, Deglet Nour, Sukkary, Rotab Mozafati, Ruthana, Safawi, and Sagai by using three different machine learning methods. In accordance with this purpose, 898 images of seven different date fruit types were obtained via the computer vision system (CVS). Through image processing techniques, a total of 34 features, including morphological features, shape, and color, were extracted from these images. First, models were developed by using the logistic regression (LR) and artificial neural network (ANN) methods, which are among the machine learning methods. Performance results achieved with these methods are 91.0% and 92.2%, respectively. Then, with the stacking model created by combining these models, the performance result was increased to 92.8%. It has been concluded that machine learning methods can be applied successfully for the classification of date fruit types.

## 1. Introduction

Date fruit (*Phoenix dactylifera*), which has about 200 types and more than 2500 species worldwide, is an edible and a nutritive fruit [1–3]. Date fruit can be classified by evaluating with image analysis and pattern recognition techniques. The differences in view, distance, and lighting exposure are the obstacles encountered in terms of performing a reliable classification. In order to make a successful classification, interclass similarities and differences should be handled cautiously. Therefore, the studies on fruit recognition and classification have been carried out based on the visual features extracted from images.

In short, easily determining the changes in the surface area and color values of the agricultural products with image analysis techniques facilitates the classification studies [4]. In the literature, there are numerous automatic classification and sorting systems based on image processing for various

fruits, such as citrus, apple, date fruit, strawberry, mango, lemon, tomato, and pulses [5–10]. Morphological features are frequently used in the classification of fruits and vegetables [11, 12]. In another study carried out with seven different date fruit types, the k-nearest neighbor (cityblock), k-nearest neighbor (Euclidean), discriminant analysis, and neural networks classification methods have been tested by properly preparing 15 different visual features on the image data. The highest accuracy rates achieved as a result range between 89% and 99% [13]. In addition to the local binary pattern (LBP) and Weber local descriptor (WLD) methods used in order to extract the details of a date fruit's tissue pattern, the feature extraction method based on the Fisher discriminant ratio (FDR) was also applied to select more important features than these two methods. The data obtained through these methods were classified using the multiclass support vector machine (SVM) [14]. The data obtained as a result of the segmentation of the images

























