ORIGINAL ARTICLE

Automatic apple grading model development based on back propagation neural network and machine vision, and its performance evaluation

A. K. Bhatt · D. Pant

Abstract This paper describes a new apple classification system based on machine vision and artificial neural network (ANN), which classifies apple in real time on the basis of physical parameters of apple such as size, color and external defects. A specific hardware subsystem has been developed and described for every stage of input and output. The hardware subsystem is interfaced with the software to make the whole system automatic. The purpose of this paper is to automate apple classification. Presently, ANN is used in a wide range of classification applications. We have trained a back-propagation neural network to classify apple. Two sets of variables are used for the training purpose. First set is the independent variable, which is the surface level apple quality parameter. Second set is the dependent variable, which is the quality of the apple. The results of ANN model are discussed; however, the modeling results showed that there is an excellent agreement between the experimental data and predicted values, with a high determination coefficient, very good performance, fewer parameters, shorter calculation time and lower prediction error. The classification accuracy achieved is high, showing that a neural network is capable of making such classification. A low level of errors in classification confirmed that the neural network models are an effective instrument for apple classification. This model might be an alternative method for assessing the quality of apple and provide consumers with a safer food supply.

A. K. Bhatt (✉)
Department of Computer Science, Birla Institute of Applied Sciences, Bhimtal, Nainital, Uttarakhand, India
e-mail: ashutoshbhatt123@gmail.com;
ashutoshbhatt123@rediffmail.com

D. Pant
Department of Computer Science, Uttarakhand Open University, Dehradun, Uttarakhand, India
e-mail: durgesh.pant@gmail.com

1 Introduction

Artificial neural network (ANN)-based research and application has tremendous growth over the past few years. Many applications of ANN have been reported for the interpretation of images in the agri-food industry. ANNs have been used successfully as a modeling tool in several food-processing applications such as sensory analysis and quality control (color analysis, textural evaluation, human preferences, and so on), classification, microbiology, and drying (Ni and Gunasekaran 1998; Edwards and Cobb 1999; Farkas et al. 2000; Hussian et al. 2002). ANN is used in different fields and in different applications such as forecasting/prediction, classification.

Agriculture is the most important sector for the economy of the country, and it is directly related to all the sections of the society. Quality assessment of fruit and vegetable is an urgent need due to the demands of modern customers in big cities. Apple is one of the most popular fruits containing an impressive list of antioxidants and essential nutrients required for good health. More than 63 million tons of apples is produced annually worldwide. The leading producer is China, producing around 40 % of the world's total production, followed by the United States, with more than 5 million tons (http://www.yara.us/agriculture/crops/apple/key-facts/world-apple-production/default.aspx). Therefore,