

Chapter 7

Computer Vision Based Technique for Surface Defect Detection of Apples

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ABSTRACT

The automatic inspection of quality in fruits is becoming of paramount importance in order to decrease production costs and increase quality standards. Computer vision techniques are used in fruit industry for fruit grading, sorting, and defect detection. In this chapter, we review recent approaches for automatic inspection of quality in fruits using computer vision techniques. Particularly, we focus on the review of advances in computer vision techniques for automatic inspection of quality of apples based on surface defects. Finally, we present our approach to estimate the defects on the surface of an apple using grow-cut and multi-threshold based segmentation technique. The experimental results show that our method effectively estimates the defects on the surface of apples significantly more effectively than color based segmentation technique.

INTRODUCTION

The appearance of fresh agricultural products is a primary criterion in making purchasing decisions. In this context, the appearance of unities of products is evaluated by considering some characteristics contribute to the overall appearance, which is globally evaluated either in a metric or a subjective manner. This is an important quality indicator throughout the commercial-utilization chain, from the production, to the storage, the

marketing and finally down to the consumer. In order to develop an automated system for food quality evaluation, image processing techniques are often combined with mechanical and instrumental devices to replace human manipulative effort in the performance of a given process. Quality inspection is very important to deliver high-quality products to the customers. For fruit grading, there are many factors that farmers use for measuring the fruit quality. These factors can be classified into two groups—the external quality factors and the internal quality factors (Bennedsen,

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2005). The external quality factors can be defined and extracted from the visual appearance of the fruit. Commonly used factors are size, shape, color, gloss, surface defects and decay, and texture (fruit surface patterns). The internal quality factors can be defined by the fruit smell like aroma, taste, flavor, sweetness and sourness, and fruit nutritive value like vitamins, minerals, nutrients and carbohydrates, and other elements like dry matter content, total soluble solids content, sugar content, and juice acidity. There are some quality factors like firmness, crispness, and toughness that can be defined by touching the fruit and may be considered external or internal factors.

In many industries, at present, grading is performed primarily by visual inspection for a particular quality attribute. Humans are easily able to perform intensive tasks like harvesting and pruning using basically the optical sensory mechanism. Traditionally done by hand, fruit sorting and grading is a very labour-intensive aspect of the fruit processing industry. Labour shortages and a lack of overall consistency in the process resulted in a search for automated solutions (Li, 2002). Visual quality grading remains one of the most difficult processes to automate in fruit and vegetable processing as well as in other areas of the food-processing industry. The use of image processing for grading is being applied to many products, including oranges, potatoes, apples, carrots, green peppers, tomatoes and peaches. Current guidance research includes harvesting oranges, tomatoes, mushrooms, apples, melons and cucumbers. See Figure 1. The guidance research also focuses its attention on navigating robot vehicles

using machine vision strategies or other simple sensors in order to obtain autonomous mobile capabilities. Increased demands for objectivity, consistency and efficiency have necessitated the introduction of computer vision techniques. Recently, computer vision employing image processing techniques has been developed rapidly, which can quantitatively characterize properties of fruits. The performances of grading systems depend on the quality factors that are used in their design. Computer vision techniques offer flexibility in application and can be reasonable substitutes for the human visual decision-making process. Computer vision techniques for fruits are proving to be an objective investigation tool. Grading and sorting of fruits using machine vision in conjunction with pattern recognition techniques offers many advantages over the conventional, optical or mechanical sorting devices. The automatic inspection of quality in the fruits is becoming of paramount importance in order to decrease production costs and increase quality standards.

There are efforts to build general fruit sorting and classification systems, but most of the systems are dedicated systems like the system that can sort tomatoes, apples. A. Herrero-Langreo et al. (2012) have developed the machine-vision system to check the fresh peach and confirm the peach maturity by comparing the peach color to the standard hue of different maturity. The image analysis system (Nimesh S et.al., 1993) was developed to evaluate the color of the stone fruit. Miller (1995) took into account the mean fruit color and a measure of the dispersion (normalized mean squared differences) of the color, plus a shape parameter to grade citrus fruits according to their external quality. The author compared three different classifiers and had the best results with Bayesian–Gaussian techniques, with between 69 and 86% of the fruit correctly graded into two classes (accepted or rejected).

The pistachio nuts grading system (Ghazanfari et.al., 1996) was designed using a neural network and machine-vision system. The apple image data

Figure 1. Defected fruits (a) orange (b) tomato (c) strawberry



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