

Chapter 44

In-Line Sorting of Processed Fruit Using Computer Vision: Application to the Inspection of Satsuma Segments and Pomegranate Arils

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ABSTRACT

*Nowadays, there is a growing demand for quality fruits and vegetables that are simple to prepare and consume, like minimally processed fruits. These products have to accomplish some particular characteristics to make them more attractive to the consumers, like a similar appearance and the total absence of external defects. Although recent advances in machine vision have allowed for the automatic inspection of fresh fruit and vegetables, there are no commercially available equipments for sorting of minority processed fruits, like arils of pomegranate (*Punica granatum* L) or segments of Satsuma mandarin (*Citrus unshiu*) ready to eat. This work describes a complete solution based on machine vision for the automatic inspection and classification of these fruits based on their estimated quality. The classification is based on morphological and colour features estimated from images taken in-line, and their analysis using statistical methods in order to grade the fruit into commercial categories.*

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INTRODUCTION

The habits of the consumers are constantly changing and nowadays there is a growing demand for quality fruits and vegetables that are simple to prepare and consume. Minimally processed fruits are fresh products that are slightly processed, with the aim of providing a food ready to eat and with characteristics similar to whole fresh products. Consumers expect that these products are free of defects, an optimum degree of ripeness and a high organoleptic and nutritional quality, along with a guarantee of hygienic safety.

The minimum processing of fresh fruit includes various operations that, in general, include several operations such as pre-cut, sliced, portioned or pre-packed in consumer retail packs. After these operations, the expected product has to accomplish some particular characteristics to make them more attractive to the consumer, like similar size, shape, colour or the total absence of discolorations or external defects. Moreover, the maker needs to be sure that foreign objects like seeds, leaves, pieces of skin, etcetera that could be released during the processing, are detected and removed from the product line. Traditionally, manual inspection has been the unique chance to ensure the quality of this kind of products but, as the decisions made by operators are affected by psychological factors such as fatigue or acquired habits, there is a high risk of human error in the evaluation or sorting processes. This is one of the most important drawbacks that can be prevented by automated inspection systems based on computer vision. A study carried out with different varieties of apples, where various shape, size and colour parameters were compared by trained operators, showed the limited human capacity to reproduce the estimation of quality, which the authors defined as ‘inconsistency’ (Paulus et al., 1997). Moreover, as the number of parameters considered in a decision-making process increases, so does the error of classification.

Although the recent advances in machine vision for the automatic inspection of fresh fruit and vegetables, there are no commercially available equipments for sorting some particular and minority processed fruits, like arils of pomegranate (*Punica granatum* L) or segments of Satsuma mandarin (*Citrus unshiu*) ready to eat. Hence, it is important for this industry to research in new specific devices to handle and physically separate these kinds of products, and specific image processing techniques and data analysis to sort them in quality categories. The objective of this chapter is to describe a complete solution based on machine vision for the automatic inspection and classification of two kinds of minimally processed fruit based on their estimated quality: Satsuma segments and pomegranate arils. The inspection is based on the extraction of morphological and colour features from images taken in-line, and their analysis using some statistical methods in order to grade the fruit in commercial categories.

BACKGROUND

The application of machine vision in agriculture has increased considerably in recent years. There are many fields in which computer vision is involved, including terrestrial and aerial mapping of natural resources, crop monitoring, precision agriculture, robotics, automatic guidance, non-destructive inspection of product properties, quality control and classification on processing lines and, in general, process automation. This wide range of applications is a result of the fact that machine vision systems provide substantial amounts of information about the nature and attributes of the objects present in a scene. One field where the use of this technology has spread rapidly is the inspection of agri-food commodities and particularly the automatic inspection of fruits and vegetables (Cubero et al., 2010), since it is more reliable and objective than human inspection. The quality of a particular fruit or vegetable

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