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Digital image processing for quality ranking of saffron peach

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A b s t r a c t. A machine vision system was introduced for the evaluation and classification of the Iranian saffron peach. Physical features such as size and colour were measured to categorize peaches into three quality classes of red-yellow, yellow-red, and yellow. The HIS model hue, saturation, and luminance was used for colour processing of flawless samples and four boundaries were selected for the peach size image. The colours of peaches estimated by the system were well correlated with the colorimetric index values that are currently used as standards. Experimental results are promising and suggest that using the USDA standard, the size classification accuracy achieved is almost 96%, while the colour classification accuracy is around 90%, and that the spot detection algorithm performs well with correct detection levels of 97 and 85% for brown and white skin spots, respectively.

K e y w o r d s: saffron peach, machine vision, image processing, size, colour

INTRODUCTION

Human-based sorting and grading of fruits may result in improper grading. Machine vision systems can be considered as an appropriate alternative to manual sorting and grading of many fruits (Brosnan and Sun, 2002). Size, which is a parameter identified with quality, has been estimated using machine vision by measuring area, perimeter, volume, and diameters in visible range (Du and Sun, 2004; Khojastehnazhand *et al.*, 2009; Moreda *et al.*, 2009;). Colour is also an important quality factor that has been widely used in automatic sorting (Blasco *et al.*, 2009; Dobrzański and Rybczyński, 2002). Colour change of apple is a result of storage, shelf-life, and bruising. Non-destructive and rapid methods have been developed for detecting damaged fruits based on ultraviolet fluorescence (Slaughter *et al.*, 2008) or hyperspectral imaging for detecting apple bruises (Xing and De Baerdemaeker, 2005). Blasco *et al.* (2003) developed an on-line machine vision system which obtained four images per fruit for automatic quality grading of apples, peaches and oranges. In a study by Miller and Delwiche (1989), the maturity of market peaches was evaluated by colour analysis. Their method was based on comparing peach ground colour with reference peach maturity colour to estimate the amount of blushed surface area. However, an accuracy of only 54% agreement with manual classification was achieved for the 160 peaches examined. Zwiggelaar *et al.* (1996) used spectral information and machine vision for bruise detection on peaches and apricots. The success rate for bruise detection was approximately 65%. McClure and Morrow (1987) conducted vision inspection of potatoes for size and shape. Throop *et al.* (2005) investigated apple surface defects. Feature extraction and pattern recognition techniques were developed by to characterize and classify carrots for forking, surface defects, curvature, and brokenness. Heinemann *et al.* (1996) developed an automated inspection station for machine vision grading of potatoes. Bato *et al.* (2000) used a computer software package for arranging strawberries. In their work, Akihime strawberries were graded based on the shape and size, regardless of direction, with an accuracy of 98.6 and 100% in succession.

Current commercial systems classify fruits based on some physical parameters such as size, shape, colour, or skin defects. However, since these machines need to work at a very high production speed, the resolution of the image must be low enough to facilitate real time analysis (Blasco *et al.*, 2008). The low resolution of the images makes it almost impossible to detect small skin defects. Several thresholding and classification-based techniques were employed for

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