



Recognition of worm-eaten chestnuts based on machine vision

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ABSTRACT

The overall qualities of chestnuts are greatly affected by worm-eaten chestnuts, as they lead to a reduction of profits. Hence a fast, accurate and non-destructive method for sorting chestnuts is in great demand. In this study, the technology of machine vision was employed to grade chestnuts. A recognition method to identify worm-eaten chestnuts is presented based on the edge image of the wormhole. First, by applying a Sobel operator, binary images were gained through extracting the edges of the gray images, which were preprocessed with the denoising method of a Wiener filter. The binary image contained both the edge of the contour and the wormhole. The wormhole edges were obtained through separating the wormhole edge in light of the character that the gray degree of pixels in the neighborhood of the wormhole edge is lower than the threshold value set. Second, through morphological dilating and eroding, the denoised wormhole edge images were obtained. The connected component of the binary images of the wormhole edge were labeled, and the first three longest components were considered as feature values of the worm channel, which were then normalized. Third, the normalized data were input to a back-propagation (BP) neural network for training, where the hidden layer was 7. And only three steps were needed for iteration. When the model was utilized for prediction, the recognition rate was as high as 100%. The results showed that the proposed worm-eaten chestnut recognition method is accurate and fast, and it can provide a basis for on-line detection. Since the gray degree of the wormhole region is close to the normal region, this study used an enhanced boundary detection method to extract the edge of the worm channel solely, rather than the normally used region segmentation.

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1. Introduction

The chestnut is one of China's important economic crops and fruit; it has rich nutrition value and high food and medicinal value. Chestnuts are popular among domestic and foreign consumers. As many worm-eaten chestnuts exist, which seriously affect the overall quality of chestnuts, the separation of chestnuts is an important process. Therefore, developing a fast and accurate non-destructive testing (NDT) method for sorting chestnuts will be significant for the chestnut industry.

Machine vision (MV), which uses machines instead of human eyes in carrying out measurement and judgment, is a new subject which is related to artificial intelligence, neurobiology, psychophysics, computer science, image processing, pattern recognition and other emerging interdisciplinary fields. With continuous development and improvement of computer technology, especially multimedia technology, digital image processing and analysis theory, machine vision is now widely used [1–5]. The research and application of machine vision in agriculture began in the late 1970s, mainly for non-destructive testing of the quality and classification of fruits and vegetables [6–9].

Li et al. studied a method for the detection of mouldy chestnuts based on near-infrared spectra [10–12]. Fang et al. [13] designed an MV-based real-time chestnut rating system. The system used the results of image processing and pattern

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