

Optical sensing system for detection of the internal and external quality attributes of apples

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Abstract

An optical sensing system for the detection of surface bruises and the internal qualities of apples has been developed. Isohyipse line extraction combined with marker constraint watershed segmentation (ILE-WSM), as a method to resolve the uneven brightness problem in apple images during bruise detection was investigated. The method has three steps: first, morphological filtering to reduce the random noise in the raw images; second, the ILE to locate the bruise position in the de-noised images; and finally, the WSM to complete the final image segmentation. For a 300 undamaged and bruised apples, the correct classification rate was 97.3 % using the ILE-WSM method, showing better segmentation ability than the Otsu method. For internal quality detection, the normalized spectral ratio (NSR) method has been proposed to correct the light scattering effects in the raw spectra. The NSR has the advantages of a simple calculation and high precision over the other methods. The final detection models for the apple soluble solids content (SSC) and dry matter content (DMC) were built on the key variables after selection by the competitive adaptive reweighted sampling (CARS) method. The root mean square error of the prediction dataset ($RMSEP$) and the correlation coefficient of the prediction dataset (R_p) of the final model prediction for the SSC and DMC were 0.412 % and 0.957 and 0.602 % and 0.937, respectively. The size of the whole system was 1600 mm × 500 mm × 1500 mm and the total time required to inspect each apple was 0.42 s. The optical sensing system can successfully be applied to apple surface bruise and internal quality detection.