

A robot system for the autodetection and classification of apple internal quality attributes

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Abstract

Soluble solids content (SSC) is an important index of apple internal quality. To invent a more flexible and efficient method of apple internal quality detection and classification, a robot system for the autodetection and classification of apple internal quality attributes was developed. Visible and near infrared (Vis/NIR) spectroscopy is a promising technology for the nondestructive detection of the internal quality attributes of apples. The end effector of the robot system mainly carried the Vis/NIR spectra collection module and gripping mechanism. The Vis/NIR spectrum was collected when the end effector gripped the apple. Single shot multibox detector (SSD) target detection algorithm was applied to process the images and calculate the position of the apple, which greatly reduced the low accuracy of apple identification caused by light intensity and complex backgrounds, and the speed was approximately 0.055 s per frame. In comparing different modeling results, the normalized spectral ratio (NSR) pretreatment combined with the competitive adaptive reweighted sampling algorithm (CARS) obtained the best modeling result, with R_c and R_{cv} values of 0.979 and 0.969 and $RMSEC$ and $RMSECV$ values of 0.335% and 0.385%, respectively. The classification accuracy of independent validation was 90.0% with R_p and $RMSEP$ values of 0.952 and 0.393 %. The robot system required approximately 5.200 s to complete a classification for each sample. The results showed feasibility of the robot system to detect the internal quality attributes of apples.