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Non-destructive mango quality assessment using image processing: a novel, low-cost technology for the fruit handling industry in Thailand

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ABSTRACT

Thailand is one of the most important mango producers and exporters in Southeast Asia, but fruit sorting there is still done by hand which is tedious and inaccurate. Thus, the need exists for the improvement of efficiency and accuracy of fruit quality assessment that can meet the demands of international markets. Low-cost and non-destructive sensing technologies capable of sorting fruits according to their properties would help promote the mango export industry in Thailand.

Image processing techniques have been applied increasingly for sorting applications in recent years. Image processing is a non-destructive method which processes signals of an image and the output can be either an image or, a set of characteristics or parameters of interest related to the image. This work has assessed the application of image processing for detecting value parameters in Thai mango varieties, namely '*Nam Dokmai*' and '*Maha Chanok*'. A computer vision system was developed and laboratory experiments were conducted to obtain optical data and reference analyses. Fruit qualities including color and the presence of defects such as anthracnose, bruises and latex stains were monitored during the ripening process. To evaluate origins of mechanical damage, field research using mock fruits included in transport shipments was conducted to record conditions during the postharvest handling chain.

Image processing and quantitative analyses were used to assess the data. The Pearson correlation coefficients (r) and p-values ($p < 0.0001$) provided a confidence that the low-cost computer vision system was able to collect accurate color data from the mango fruits. The Pearson correlation coefficients for L*, a* and b* values were always greater than 0.81, except for the correlation coefficient for the L* values of the '*Nam Dokmai*' ($r = 0.69$).

For the defects detection, the images acquired by the computer vision system were processed (background extraction, noises deletion, image conversion) and the proper segmentation methods for each defect were identified. The images were then segmented by using ImageJ software and the defects were evaluated quantitatively. The evaluation of anthracnose disease was successfully performed by taking images under standard illumination (D65). The UV-A illumination showed its potential use for the early detection

of anthracnose infection. The severe bruises could be identified and assessed under standard illumination. The low-cost sensing technology developed in this study was not able to detect the early bruises. The latex stains were easily detected and evaluated under UV-A illumination using the low-cost webcam for image acquisition.

The findings of this study will be incorporated for development of a robust classification system for quality prediction and establishment of a computer vision system for automatic grading and sorting of mangos. However, further research and development of the techniques are required for the industrial application of the techniques. This work has also helped to recommend better postharvest practices. Proper postharvest handling and quality assurance will improve product value. As a result, farmers and exporters can have better access to high-value international markets, enabling them to increase their income and provide consumers with a premium product.