Computer Vision Techniques for Quality Assessment of Dates

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Abstract— **Computer vision (CV) is a technique in which the image of an object is obtained through any imaging system and the image is analyzed to characterize the quality of the object objectively. The advancement in electronics has made this technique utilized in various fields. In North America, food industry is one of the top ten industries utilizing CV technique for quality monitoring. However, CV technique is not much utilized in the food industries in Asia. Dates is an important fruit crop in Oman and many other Arab countries. The quality assessment of dates during handling and processing are mainly carried out through manual inspection method. But this method has many challenges such as the efficiency of a worker, subjectivity, and so on. There are lots of opportunities to utilize CV technique for measuring and monitoring various quality aspects of dates. Through an Open Research Grant program funded by The Research Council (TRC), Oman, potential of CV technique for various internal and external qualities of dates was determined. This paper describes the efficiency of CV systems for variety identification, surface crack detection, texture and hardness determination.**

***Index Terms*—Computer vision, dates, variety, surface crack, hardness**

I. Introduction

Quality assurance is one of the key factors in finding new customers, and maintaining the existing customers in global market. Similarly, in any country, it is essential to have a standard inspection procedure to ensure the quality of imported commodities in order to prevent cross contamination in domestic supply chain. In addition to export and import markets, robust quality assessment systems are required during harvesting, handling, processing and storage of agricultural and food products to minimize losses. Analytical and visual inspection methods are commonly used in food and agricultural sector. In general, most of the analytical methods are time consuming, laborious, expensive and sample-destructive nature. On the other hand, visual inspection is a subjective method of testing, and the results vary from person to person. Automated and objective quality assessment systems at various stages of supply chain would be highly beneficial to harvest at correct maturity stage, monitor the quality during handling, processing and storage.

In Sultanate Oman Dates is an important agricultural commodity. Approximately 50% of the total cultivated land is under date palm vegetation. The annual production of dates in Oman is around 276,400 metric tons which represents 4% of the total world production [1]. Recently His Majesty has issued a Royal order to plant one million date palm trees in Oman [2]. There are lots of opportunities for value addition and quality improvement to promote export of dates from Oman. Dates quality may be assessed using physical attributes such as fruit weight, size, dimensions, color and fruits volume, chemical attributes such as sugar content and total soluble solids (TSS) and other defects such as varietal purity, infestation, hardness, and surface defects [3].

II. Computer Vision Technology

Computer vision (CV) is a proven technology for the assessment of various qualities of agricultural and food materials in developed countries. In CV method, images of the object (to be tested) are captured, enhanced and analyzed to obtain useful information. Different types of cameras are used to acquire images remotely and characterize the quality of the object instantaneously. CV is a reliable, quick, non-destructive, non-contact and less expensive method of quality assessment. It is a potential alternative technology for most of the analytical and visual inspection methods. It can be effectively incorporated in the supply chain to improve food safety and profitability.

III. Identification of Dates Variety

Varietal purity is an important quality attribute in any agricultural commodity as each variety has different and distinct quality attributes. The mixing of variety is not permitted in any stage after harvesting. We conducted a detailed study to identify three varieties of dates using RGB color imaging system in two scenarios (n=108 samples in each variety): i. enhancement of color images using brightness histogram equalization (BPHE) technique and classification according to variety [4] ii. Classification of date varieties by considering the effect of motion blurring to simulate the online handling in processing facilities [5].

The BPHE technique enhanced the features and assisted in the classification of varieties (Fig. 1). The accuracy of artificial neural network (ANN) with 4 sets of hidden neurons (5, 10, 20 and 30) to classify three varieties of dates (Fard, Madina and Khalas) was 95.2%.

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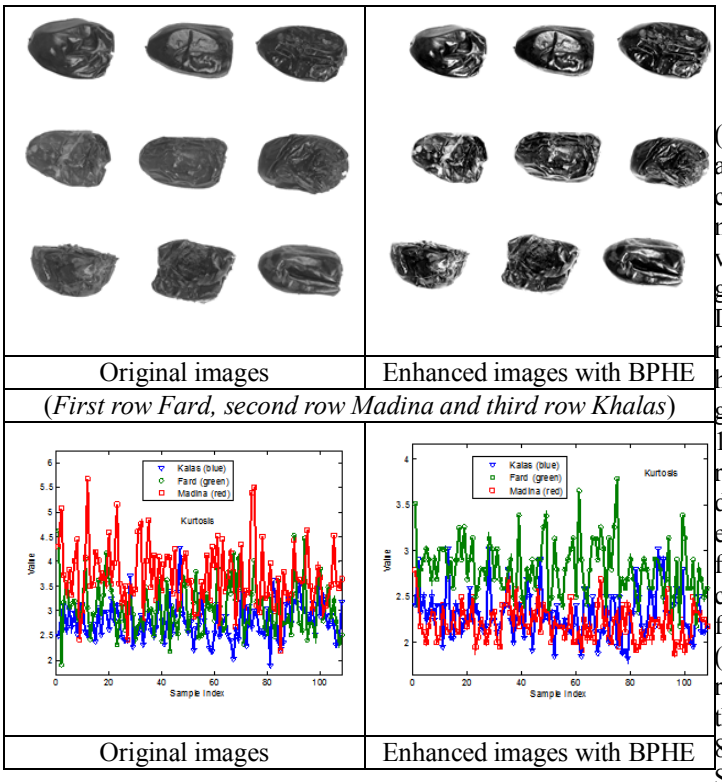


Figure 1. Kurtosis feature of three date varieties of original and enhanced images [4]

To test the accuracy of the imaging system for the motion condition, a blurring degradation function was used [5]. The effect of motion blurring causes to the statistical moments in a general sense was examined using random numbers drawn from the distribution in Pearson system. As motion blurring effect followed a tendency to change the distribution to a Gaussian density, the same features and classifiers yielded similar results despite of motion [5].

IV. DETECTION OF SURFACE CRACK ON DATES

The surface appearance is one of the most important quality parameters in determining the consumer acceptability of any product. An RGB color imaging system was developed to determine the quantity of surface crack on dates (Khalas variety) [6]. Three grades of dates such as no-crack, low-crack and high-crack, were obtained from two commercial dates processing companies in Oman (105 dates in each grade). From each image 11 features were extracted. The accuracy of a three class model was 62%, 58% and 78% for high-crack, low-crack and no-crack dates, respectively using linear discriminant analysis. In two class model (with crack and without crack (low and high together), it was 88% and 75% for dates with crack and without crack, respectively. The pairwise classification (comparison of two classes at a time), high-crack and no-crack pair yielded the highest accuracy (96%) and low-crack and high-crack pair yielded the lowest accuracy (59%).

The extracted color features were used to determine the classification accuracy using back propagation neural network (BPNN) [7]. The classification accuracy was 77% for three class model and 90% for two class model.

V. DETERMINATION OF TEXTURE AND HARDNESS OF DATES

As most of the dates are consumed as whole fruit (without processing), the texture, chewability and hardness are important quality parameters in determining the consumer preference. A non-contact imaging system with a monochrome camera was developed to classify dates (Fard variety). Date samples were obtained from three major growing regions in Oman (Al-Batinah, Al-Dakhliah and Al-Sharqiah). The bulk samples from each region was graded in to three categories such as hard, semi-hard and soft dates and confirmed by an experienced grader in a commercial factory. From the graded samples 1800 dates (200 dates/grade/region= 600 dates /region) representative samples were used to take images and develop classification models [8]. The features were extracted in spatial domain and frequency domain (total 36 features) using edge detection methods. The mean classification accuracy of a single ANN was 75% and 87% for three class (hard, semi-hard and soft) and two class (soft and hard (semi-hard and hard together) models, respectively. While using separate ANN for each region, the mean classification accuracies were 94%, 59% and 84% for soft, semi-hard and hard dates, respectively. Similarly, two class, region wise ANN model yielded 95% and 77% accuracy for soft and hard dates, respectively.

VI. CONCLUSION

Computer vision techniques with basic imaging cameras such as monochrome and RGB color were used to determine the important quality attributes of dates such as variety identification, detection of surface cracks and determination of hardness. Although the hardness is an internal quality, the color and surface texture of dates were different among three levels of hardness and therefore it was possible to classify even up to 95% accuracy using edge detection features. Computer vision techniques have great potential to characterize various internal and surface qualities of dates. Further work is required to determine the efficiency of the developed techniques in real time application in dates handling facilities.

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REFERENCES

[1] FAO (Food and Agriculture Organization of the United Nations). Food & Agriculture Organization of the United Nation. [Online]. Available: http://www.faostat.fao.org, 2011.

[2] Muscat Daily. His Majesty the Sultan orders 1,000,000 date palm trees planted. Muscat, Sultanate of Oman, November 04, 2009.

[3] R. Al-Yahyai and A. Manickavasagan, "Quality of dates: Influencing factors and assessment methods," *Acta Horticulture (ISHS)*, vol. 1012, pp. 1241-1246, 2013.

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[4] A. Manickavasagan, G. Thomas, R. Al-Yahyai and M. Hema, "Brightness preserving histogram equalization (BPHE) technique for classification of dates," *International Journal of Image Processing and Vision Sciences*, vol. 1, no. 3-4, pp. 27-29, 2012.

[5] G. Thomas, A. Manickavasagan, and R. Al-Yahyai, "Classification of date varieties and effect of motion blurring on standardized moment features," *Journal of Food Measurement & Characterization*, vol. 6, no. 1-4, pp. 21-26, 2012.

[6] S. Al-Rahbi, A. Manickavasagan, R. Al-Yahyai, L. Khriji, and P. Alahakoon, "Detecting surface cracks on dates using color imaging technique," *Food Science and Technology Research*, vol. 19, no. 5, pp. 795-804, 2013.

[7] S. Al-Rahbi, A. Manickavasagan, and G. Thomas. "Back propagation neural network (BPNN) to detect surface crack on dates using RGB images,"*Journal of Medical and Bioengineering*, vol. 4, no. 1, pp. 67-70, 2015.

[8] A. Manickavasagan, H. N. Al-Shekaili, G. Thomas, M. S. Rahman, N. Guizani, and D. S. Jayas, "Edge detection features to evaluate hardness of dates using monochrome images," *Food and Bioprocess Technology*, pp. 1-8, 2013.

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