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The translucent and yellow gummy latex of mangosteen by using autoregressive coefficient method

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Abstract

A nondestructive measurement to predict an internal translucent disorder and yellow gummy latex in mangosteen fruit has proposed by using Vibration Frequency base on Strain gage Sensor (VFSS). This measurement were used vibrate with frequency 0 – 50 Hz The VFSS of 100 mangosteen samples were obtained an evaluation of various existed VFSS signal features base on time and frequency domains. From the experimental results, Auto-regressive (AR) coefficient was suggested to use as a feature for the VFSS measurement. We will be obtained the classification accuracy on good sample and device the sample into two groups.

Keywords: Vibration Fruit base on Strain gage Sensor (VFSS), Auto-regressive (AR) coefficient, feature extraction, yellow gummy latex and translucent.

1. Introduction

The mangosteen is the queen of fruit and one of the high economical fruit in Thailand. However, the problem and the quality of mangosteen is measured not only by external factors such as color, shape, size, skin blemishes, latex straining and insect damage, but also by internal factors such as translucent flesh disorder and yellow gummy latex which are also very importance for consumer acceptance Sontisuk (2007). Moreover, the high accuracy in section for a translucent fresh disorder is by opening the flesh up. Obviously, a nondestructive inspection is needed

In quality determination of mangosteen, Neua Gaew (the Thai for flesh translucent) Physiological disorder of mangosteen using a destructive technique. Voraphat (1996) studied the effect of water to flesh translucent disorder using a chemical technique.

From the literatures, there are many excited the non-destructive measurement of mangosteen in Thailand such as a floating technique (Pankasemsuk,1996), microwave technique Tongleam (2004), non-destructive 2D cross-sectional visualization (Arunrungrusmi,1999), near infrared spectroscopy (Sontisuk,2007), X-ray and NMR (Yantarasri et al,1996) and resonance frequency (Rittisak,2001). However, translucent fresh disorder and yellow gummy latex are relation with the different of hollow and water volume in mangosteen. So, the resonance frequency measurement was applied to detect the translucent fresh disorder and yellow gummy latex must be relation with the resonance frequency measurement to detect the different of hollow and water volume in mangosteen. In recent year, Kongrattanaprasert (2001) using to vibration in durian, acoustic measurement and a intrusive method in kiwifruit (Muramatsu,1997), acoustic impulse transmission in muskmelons (Sugiyama,2005), vibration in melon (Nourain,2005), Laser Doppler Vibrometer(LDV) in pear (Terasaki,2006), acoustic impulses in watermelon (B. Diezma Iglesias,2002), acoustic response in melons (L. Lleó,2005).

In this paper, we propose a nondestructive technique by using VFSS measurement combine with the AR coefficient to detect flesh translucent and yellow gummy latex in mangosteen.

2. Material and Methods

2.1 Fruit sample and VFSS Instrument

Mangosteens were purchased from a local fruit auction in Nakornsritummarat, Thailand. the samples were delivered to the laboratory of Electrical Engineering Laboratory, Prince of Songkla university and kept in a room, about 100 Thai mangosteens were used to study by VFSS measurement and 26 intact mangosteens were used for evaluating the accuracy of translucent flesh disorder detection, 20 intact mangosteen of translucent flesh disorder combine with gambol and 4 intact mangosteens of only yellow gummy latex to the recording of VFSS by a instrument. The vibration signal were vibrated in medium sample at frequency was 25 to 40 Hz, amplitude input is 2.5 volt. After, the experiment was complete, the peel of each sample was slit with knife are take a photograph by digital camera, the sample were cut to record the internal. After the VFSS measurement was complete, the peel of each sample was opened to investigate internal defects and were taken with a digital camera (Fujifilm, FinePix F700, Japan), then the samples were cut through and the fruit was record the internal features of measurement as shown in Fig. 1(a-d). The response of fruit to vibrations depends on their modulus of elasticity, their mass and their shape. Different types of vibrations can be used the most common being acoustic and mechanical. Using a microphone or a piezoelectric sensor, acoustic methods measure the signal have audible range: about 0-20,000 Hz (Peleg,1993). The acoustic signal captured is Fourier transformed and the main frequencies calculate. This paper, varieties of VFSS at 25, 30, 35 and 40 Hz are used as representative data in this study. Differential amplifiers were set gain are 500 time and sampling frequency was set at 1000 Hz using a 16 bit analog-to-digital converter board (NI, DAQCard-6024E). In the analysis, the window length of VFSS samples was set for 256 ms with the objective of real-time signal processing. In other words, the maximum permissible delay for VFSS sample should be 10 ms. Finally, we can observe these signal on computer by labview programming and process them by mathlab programming for classification of translucent fresh disorder and yellow gummy latex of mangosteen (Rittisak, 2012)

2.2 Data analysis

2.2.1 The resonance frequency

In this case, the characteristic of mechanical vibration most parts of the energy radiated from the surface propagates as a transversal wave in the medium when the frequency of low frequency vibration is less than about 1 kHz, the velocity of transversal wave can be expressed as equation (1-4) in medium related to characteristic of medium are given by

$$V_i = \left(\frac{2\left(\mu_1^2 + \omega_b^2 \mu_2^2\right)}{\rho\left(\mu_1 + \sqrt{\mu_1^2 + \omega_b^2 \mu_2^2}\right)} \right)^{1/2} \qquad (1)$$

Where V_i is velocity of vibration. ρ is the density of the medium. ω_b is the angular frequency of vibration. μ_1 and μ_2 are the coefficients of shear elasticity and shear viscosity. Respectively, Velocity of vibration related to frequency and wave propagation of vibration. So, property of shear elasticity can be found by velocity measurement of vibration and wave propagation at low frequency. In equation (1), if the shear elasticity is dominant compared with the shear viscosity so that $\mu_1 >> \omega_b$ then μ_2 is satisfied. The velocity is written as

$$V_i = (\mu_1 / \rho)^{1/2} \tag{2}$$

The signal of output vibration fruits, when reference voltage output vibration fruits from the prototype for determine velocity of vibration which can be obtained from

$$V_i = \frac{A}{\alpha T} \tag{3}$$

$$A = \frac{\alpha V_i}{F} \tag{4}$$

Where A is the voltage of the output vibration, T is the time of output vibration. α is voltage of output vibration from the prototype. F is the resonance frequency vibration.

The amplitude and frequency of vibration determining have many methods such as ultrasonic and accelerometer and LDV methods which can fix sensor on sample; there have response of vibration accuracy. In this paper, we used VFSS measurement that has been used in the vibration measuring of mangosteen. We choose the frequency vibration between 25 to 40 Hz and input signal is 2.5 Volt, for the mangosteen with different texture property when transfer input signal. Output signal has different amplitudes and frequency has related to internal air cavity, weight and diameter follow to texture property of mangosteen. In Fig 2(a-d), the good mangosteens have patterned signal difference with abnormal mangosteen, translucent flesh order and yellow gummy latex.

2.2.2 Auto-regressive (AR) coefficients

AR model described each sample of VFSS signals as a linear combination of previous VFSS samples (x_{n-i}) plus a white noise error term (w_n). In addition, p is the order of AR model. AR coefficients (α_i) are used as features in VFSS. The definition of AR model is given by

$$x_n = -\sum_{i=1}^{p} a_i x_{n-i} + w_n \tag{5}$$

3. Results

From experiment result, the signal from time axis at 25,30,35,40 Hz on the vibration characteristics of the fruits is different when analyzed by AR coefficient. We found the vibration frequency at 25 Hz, coefficient order four was the most interesting that the fruit is divided into three groups. The first group has a coefficient less than -1, the secondary group has a coefficient more than 1, the last group has a coefficient between -1 to 1, respectively, some normal mangosteen have a coefficient between 1 and 1. In addition, the mangosteen in group2 has a coefficient between -0.05 to -0.1. As well as, the mangosteen in group3 have a coefficient between -0.05 to -0.1 the some normal mangosteen has the same range. In the other hand, in the coefficient order 5 to 10 was the cluster which was difficult to separate.

The vibration frequency in 30 Hz, coefficient order 4 was the most interest because the normal mangosteen has ranged between 0 to -0.2. However, some abnormal mangosteen has the same range. Moreover, some normal mangosteen in the coefficient order1 has a coefficient less than -0.6. The coefficient of translucent fresh disorder was separate from the most group. In the other hand, in the coefficient order 5 to 10 was the cluster which was difficult to separate.

The vibration frequency in 35 Hz, coefficient order 2 was the most interest the normal mangosteen has ranged between 0 to -0.1. Moreover, the coefficient order 4, the normal mangosteen has coefficient between -0.1 to -0.2. However, in the coefficient order 1,3,5,6,7,8,9 and 10 to 10 was the cluster which was difficult to separate.

The vibration frequency in 40 Hz, coefficient order 4 was the most interest the normal mangosteen has ranged between -0.1 to -0.2. Moreover, the coefficient order 5, the normal mangosteen has coefficient less than -0.1. In addition, the coefficient order 2, the normal mangosteen has coefficient between 0 to -0.1. As well as, the coefficient order 10, the normal mangosteen has coefficient less than 0. However, the coefficient of other mangosteen was the cluster which was difficult to separate.

4. Conclusion

From the experiment result, the vibration frequency in 25 Hz, coefficient order 4 was the most interest. Moreover, the vibration frequency in 30Hz, the vibration frequency in 35 Hz, coefficient order 2,4,6 and 9 and the vibration frequency in 40 Hz, coefficient order 2,4,5 and 10 were the most interest the normal mangosteen were the most interest the normal mangosteen which can separate the good sample from the other sample. However, the coefficient of other mangosteen was the cluster which was difficult to separate.

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References

Diezma B., Ruiz-Altisent M., Orihuel B.(2002), "Acoustic impulse response for detecting hollow heart in Seedless watermelon", Acta Horticulture 599, 249-256.

L. Lleó, P. Barreiro, A. Fernández, M. Bringas , B. Diezma and M. Ruiz-Altisent.(2005), "Evaluation of the storability of *Piel de Sapo* melons with sensor fusion", The fifth International Conference on Information and Technology for Sustainable Fruit and Vegetable Production, Montpellier, France, pp.523-531.

Junichi Sugiyama, Muhammad Imran Al-Haq and Mizuki Tsuta.(2005), "Application of Portable Acoustic Firmness Tester for Fruits", The fifth International Conference on Information and Technology for Sustainable Fruit and Vegetable Production, Montpellier, France, pp.439-443.

Kongrattanaprasert, S., Arunrungrusmi, S., Pungsiri, B., Chamnongthai, K., and Okuda, M. (2001), "Nondestructive Maturity Determination of Durian by Force Vibration", The IEEE International Symposium on Circuits and System (ISCAS), Sydney, Australia, pp 441-444.

Muramatsu N., Sakura N., Yamamoto R., Nevins D.J., Takahara T., Ogata T.(1997), "Comparison of non-destructive acoustic method with an intrusive method for firmness measurement of kiwifruit", Postharvest Biology and Technology 12, 221-228.

Nourain Jamal, Ying Yi-bin, Wang Jian-ping, Rao Xiu-qin and Yu Chao-gang.(2005), " Firmness evaluation of melon using its vibration characteristic and finite element analysis", Journal of Zhejiang University 6B(6), 483-490.

Pankasemsuk, T.,O.Garner, J., B. Malta,F., and L. Silva, J.(1996), " Translucent fresh disorder of mangosteen(*Garcinia mangostana L.*) ", HortScience 31(1), 112 -113.

Peleg K.,. (1993), "Comparison of non-destructive measurement of apple firmness", J Agr Eng Res 55(3), 227-238.

Rittisak jaritngam, Chusak Limsakul, Sayan Sdoodee, Saravut Jaritngam and Mareena Mani.(2001), "To Detect Gumming Fruit of Mangosteen (*Garcinia mangostana Linn*.) by the Autoregressive Model Analysis Method", Journal of Agricultural Science 32, 1-4.

Rittisak Jaritngam, Chusak Limsakul and Booncharern Wongkittiserka (2012), "The translucent and yellow gummy latex of mangosteen by using the VFSS Measurement", Journal of Biology. Agriculture and Healthcare 2(1), 83-91.

Shoji Terasaki, Naoki Sakurai, Jacek Zebrowski c,g, Hideki Murayamad, Ryoichi Yamamotoe, Donald J. Nevins f.(2006), "Laser Doppler vibrometer analysis of changes in elastic properties of ripening 'La France' pears after postharvest storage", Postharvest Biology and Technology 42, 198–207.

Somchai Arunrungrusmi, Dejwoot Khawaparisuth, Kosin Chamnongthai.(1999), "Nondestructive 2D Cross-Sectional Visualization of A Mangosteen", The fifth International Symposium an Signal Processing and its Applications, Brisbane, Australia, pp. 443-445.

Sontisuk Teerachaichayut. (2007), "Non-destructive prediction of translucent flesh disorder in intact mangosteen by short wavelength near infrared spectroscopy", Postharvest Biology and Technology 43 , 202–206.

Tawatchai Tongleam, Nutthacha Jittiwaranghl, Pinit Kumhoml, Kosin Chamnongthai.(2004), "Non-Destructive Grading of Mangosteen by Using Microwave Moisture Sensing", International Symposium on Communications and Information Technologies,Sapporo, Japan, pp 650-653.

Voraphat Luckanatinvong.(1996), "Effect of Water on Physiological Disorders of Mangosteen Fruit (*Garcinia Mangostana Linn*) ", Developmental Physiology, Master of Science(agriculture) Department of Horticulture, Kasetsart University, Thailand.

Yantarasri, T., C. Sivasomboon, J. Uthaibutra and J. Sornsrivichai. (1996), "X- ray and NMR for nondestructive internal quality evaluation of durian and mangosteen fruits", Acta Horticulture 464, 97-101.

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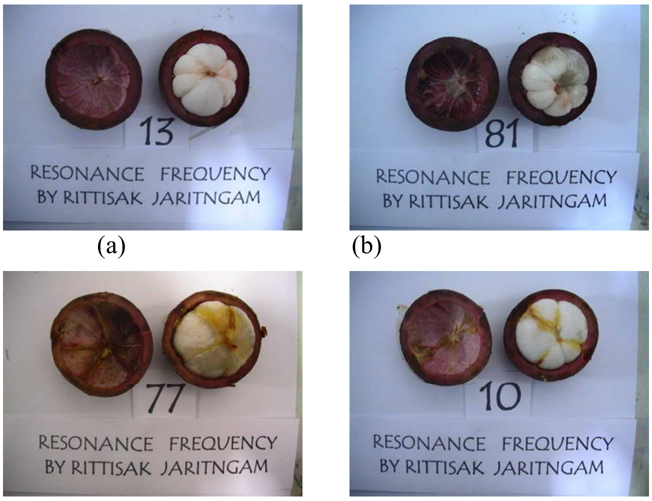
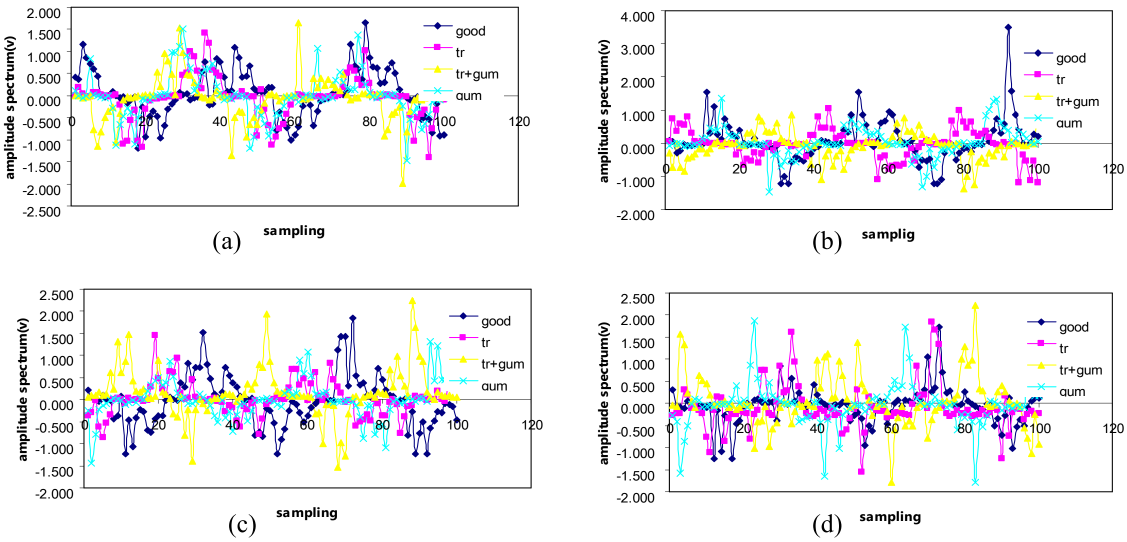


(a) (b) (c) (d)

(a) good sample (b)) translucent fresh disorder sample

(c) translucent fresh disorder and yellow gummy latex (d) yellow gummy latex

Fig 1 the property of mangosteen

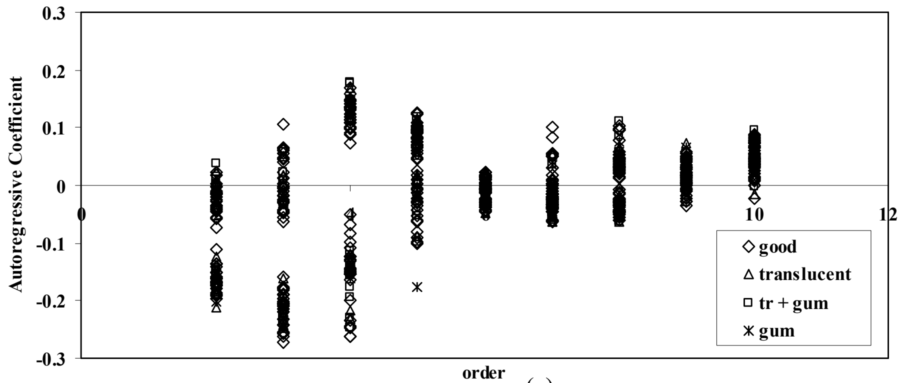


(a) (b) (c) (d)

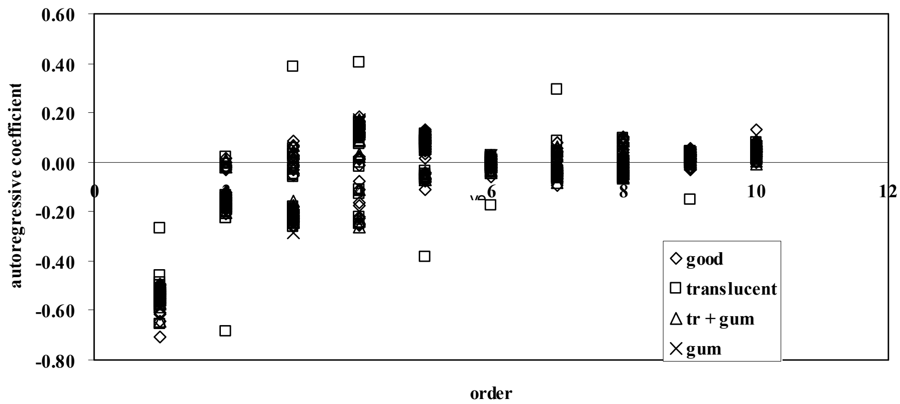
(a) time domain at 25 Hz vibration base, (b) time domain at 30 Hz vibration base

(c) time domain at 35 Hz vibration base, (d) time domain at 40 Hz vibration base

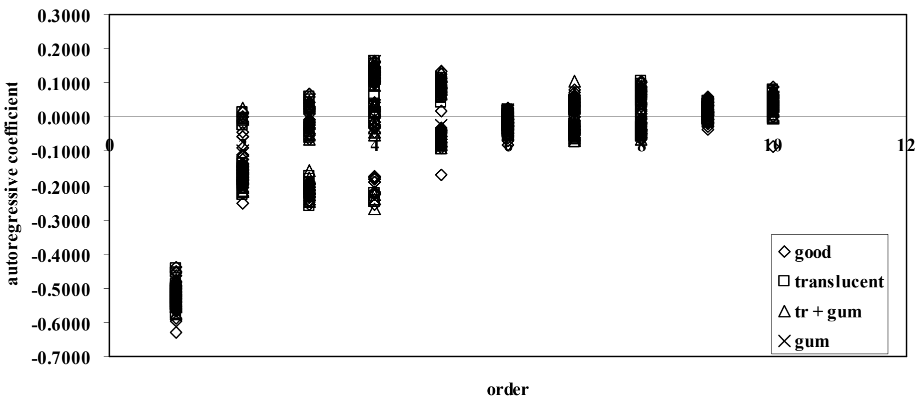
Fig 2 the differential real time signal of texture property of mangosteen


Autoregressive Coefficient
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
0
10
12
order
good
translucent
tr + gum
gum

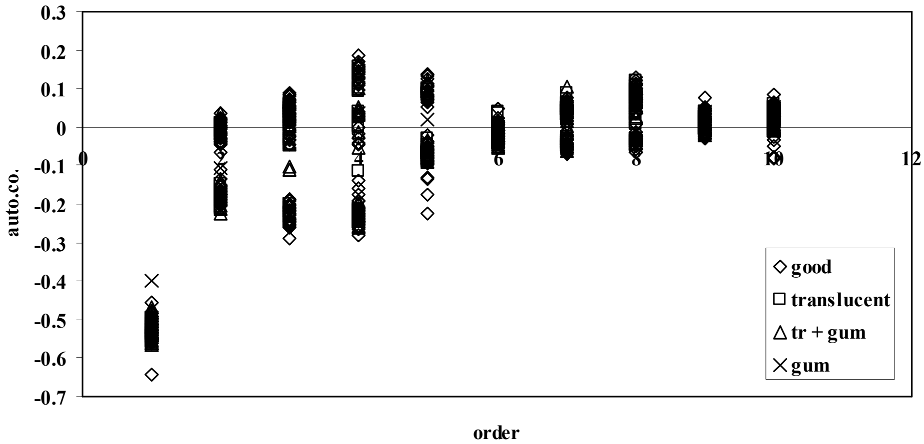
(a)


autoregressive coefficient
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
0
6
8
10
12
order
good
translucent
tr + gum
gum

(b)


autoregressive coefficient
0.3000
0.2000
0.1000
0.0000
-0.1000
-0.2000
-0.3000
-0.4000
-0.5000
-0.6000
-0.7000
0
4
10
12
order
good
translucent
tr + gum
gum

(c)



(d)

(a) AR coefficient at vibration frequency at 25 Hz (b) AR coefficient at vibration frequency at 30 Hz

(c) AR coefficient at vibration frequency at 35 Hz (d) AR coefficient at vibration frequency at 40 Hz

Fig 3 the AR coefficient from the vibration based on VFSS measurement