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Determination of translucent flesh mangos teens using support vector machine

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Abstract— Translucent flesh is an undesirable disorder in mangosteens. The segmentation using support vector machine (SVM) is an alternative approach for grading translucent flesh disorder. This method adjusts the classification hyper plane calculated by using SVM and required minimum training and time. The accuracy of this classification method was conducted for 84 mangos teens as the training set to the adjustment SVM classification model achieved consistent and accurate results. The purpose of this research was to evaluate the effective and robust segmentation for sorting translucent flesh mangos teens using support vector machine technique. The results indicated that the overall accuracy of classification was achieved using weight and diameter parameters presenting 64.96% compared with 55% when using manual sorter.

Index Terms— **Mangos teen, translucent flesh mangosteen, support vector machine**

I. INTRODUCTION

Mangosteen (*Garcinia mangostana L.*) is a tropical fruit and economic crop in Thailand. The quality of the mangosteen is determined by external and internal factors including color, shape, size, skin blemishes, flesh, yellow gummy latex and the hardening of the pericarp. Flesh translucency disorder is an undesirable in mangosteens. At present, detection of translucency disorder in mangosteen for export is carried out by half cut open to allow visual evaluation of the flesh. For local markets, a floating technique which related to the specific gravity is usually applied for evaluating of the flesh translucency disorder. However, this technique still obtained a low accuracy of prediction [3].

Support vector machine is a logarithm developed by the machine learning community and is a supervised machine learning algorithm originally designed to solve the two-group classification problems by generating the optimal separation hyper plane in a multi-dimensional space. In addition, support vector classification (SVC) has difference mathematical formulation and accept slightly different sets of parameters [1]. This research aims to evaluate the effective and robust segmentation for sorting translucent flesh mangos teens using support vector machine technique.

II. METHODS

- ***Fruit samples***

A sample set of 84 mangosteen fruits with maturity stage of 3-5 by consideration of fruit skin colour was purchased from a wholesale market in Chantaburi province, Thailand. Each sample was investigated weight, diameter as well as specific gravity and the peel of each sample was cut to the stem-calyx axis to record the internal defects including translucent flesh.

- ***Weight and diameter segmentation by linear support vector machine***

This research selected support vector machine classification and the soft margin hyper plane algorithm is applied for data. Given a training set of instance-label pairs , *i*= 1,…, *n* where is the training set sample and is the class label. The SVM required the maximal margin in the higher dimensional space as the following equation:
Subject to
Where e is the vector of all ones, C>0 is the upper bound, Q is an ɳ by positive semi definite matrix, , where is the kernel. This training vectors were implicitly mapped into a higher dimensional space by the function .The final step of classification were applied the decision function via following equation:
In the process of training the classification model the kernel function that commonly used for supported vector classification such as linear function, polynomial function and radial basis function were applied to the testing data and compare which one gets the most accurate results. An overall procedure for SVC classification is shown in Fig.1

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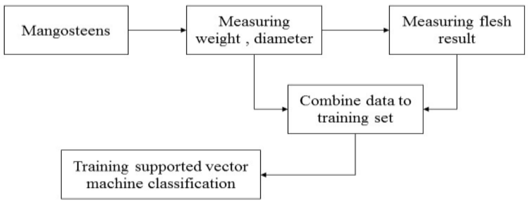

Fig. 1 Training SVM classification

After the supported vector machine classification were establish from training set. The experimental process to applied support vector machine classification with the test data to predict the mangosteens were translucent flesh or not. The procedure for experimental process classification is presented in Fig 2.

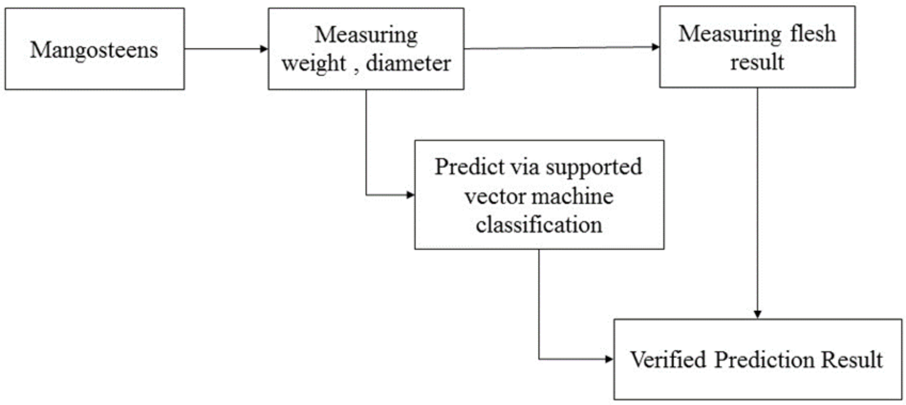

Fig.2 Experimental process classification

- ***Data analysis***

The set of mangosteen was separated into two groups (Training data set and testing data set). The fraction in which SVC model training data were 37% of translucent flesh and 63% of normal mangosteens. While the testing data composed of 35% translucent flesh. The distribution of data was separated by weight and diameter as presented in Fig. 3.

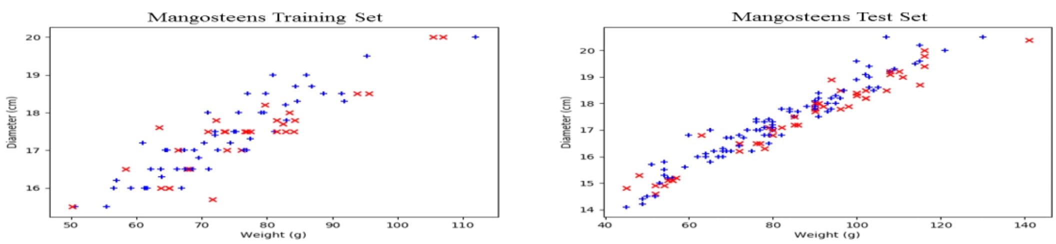

Fig.3 Mangosteen distribution data for (a) training and (b) testing set
+ = normal flesh, × = translucent flesh

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III. RESULTS AND DISCUSSION

- *Accuracy of classification*

Example classification results for the mangosteen training set are presented in Table 1.

Table 1: Training data set of mangosteen

Numbers of normal mangosteen	Number of translucent flesh mangosteen	Total number of mangosteen
52	31	84

After that, the prediction of the translucent flesh mangosteen was generated using SVC. The accuracy of the classification for the normal flesh group was 64.96% compared with 55% when using manual sorter as presented in Table 2.

Table 2: Experimental data set of mangosteen

	Numbers of normal mangosteen	Number of translucent flesh mangosteen	Total number of mangosteen	Classification accuracy (%)
Total	89	48	137	64.96
Correct	71	18	89	
Incorrect	18	30	48	

Table 2 indicated that the accuracy of the prediction of the translucent flesh was 64.96% and the prediction was based on the multiple criteria including weight and diameter. [2] indicated that the translucent flesh disorder had the specific gravity greater than one. Changing the supported vector machine kernel function including linear, polynomial and radial basis gave the differentiation as shown in Table 3.

Table 3: Accuracy of prediction in different kernel function

Kernel Function	Classification accuracy (%)
linear	51.82
polynomial	64.96
radial basis	50.36

From Table 3, the polynomial kernel function provided the most accuracy (64.96%) compared with 51.82% when using liner kernel function and 50.36% when using radial basis function. Therefore, the polynomial kernel function with 3rd degree was selected in this research. In addition, the multiple parameters including weight and diameter were used to analyze and two groups of the normal and translucent flesh were separated by SVM with polynomial kernel as shown in Fig 4.

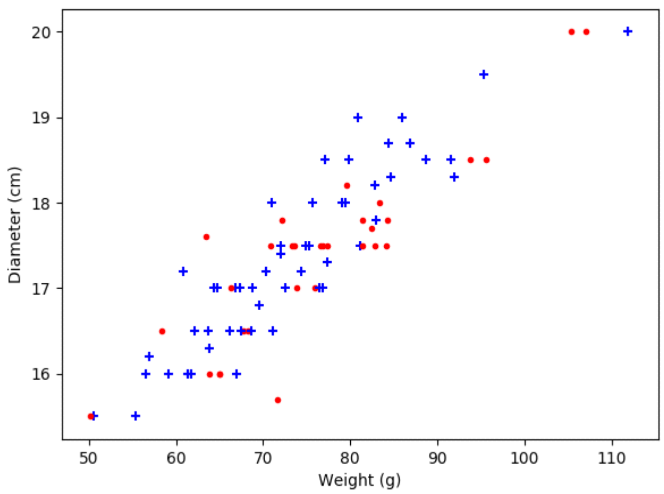

Fig 4. Mangosteen samples were separated by weight and diameter

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