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Novel Feature Extraction for Oil Palm Bunches Classification

Hui Hui Wang[1,2,*], Yin Chai Wang[1,2], Bui Lin Wee[1], Shiang Wei Sim[1]

[1] Faculty of Computer Science and Information Technology, Universiti Malaysia Sarawak, 94300 Kuching, Sarawak, Malaysia
[2] Institute of Tourism Research and Innovation, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia

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ABSTRACT

This paper presents research on an image processing approach for oil palm fruit brunches classification on automating the process of classifying palm fruit brunches based on their visual characteristics, which can have applications in the agriculture and palm oil industry. The research aims to classify the bunches into four categories which are unripe, under ripe, ripe and over ripe. Additionally, this approach can reduce the manual labour involved in palm oil grading and provide a more objective and consistent method for grading the oil. The proposed approach consists of the process of image acquisition, image pre-processing, colour processing, image segmentation and classification. The ripeness of the oil palm fruit bunches is determined based on the percentage of ripeness areas masked on the fruit surface. The proposed algorithms successfully classified the palm oil bunches and improved the accuracy of grading palm oil, achieving 85% accuracy from the experiment results.

1. Introduction

The agriculture industry plays an important role in Malaysia and had become a major source of income for the country, with oil palm being the main commodity. In 2020, Malaysia accounted for 25.8% and 34.3% of world's palm oil production and exports, respectively [1].

The global demand for palm oil will continue to rise, owing to the growing population and economy [19]. Due to the high demand in palm oil industry, Malaysian Palm Oil Board (MPOB) needs to regulate the fresh fruit bunch (FFB) quality in accordance with the ripeness of fruit, to ensure that the produced palm oil products are in high quality [2]. To increase the production of good quality crude palm oil for food industry and cosmetic industry, one of the challenges is to harvest the oil palm fresh fruit bunches at the optimum ripen stage [3,4].

Currently, human graders conduct the palm fruits classification process of the oil palm fruit manually. However, this manual grading process can lead to misconduct and human error when inspecting the category of oil palm fruits [2]. Human subjective judgments are unable to accurately analyse the content and quality of oil palm fruits. Moreover, the visual similarity of the fruits makes manual inspection challenging and also poses problems for conventional computer vision techniques

* *Corresponding author.*
E-mail address: hhwang@unimas.my

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[10]. This has led to low-quality palm oil and kernel oil production. Additionally, Malaysia is facing a shortage of expertise in manual grading of the oil palm fruit due to the tremendous production of the oil palm. Furthermore, manual grading is a tedious and time-consuming process.

Unfortunately, oil palm fruit ripeness classification based on computer vision has not gained many satisfactory results [5]. To ensure the quality of the oil palm fruit is classified accurately, a novel feature extraction for oil palm fruit brunch's classification is needed and proposed to reduce the inaccuracy of quality classification of oil palm fruit.

The main objective of this research is to classify the oil palm fruit brunches into four different categories which are unripe, under ripe, ripe and over ripe. The aim of study is to focus on the extraction of oil palm fruit brunches features for classification.

2. Related Works

Choong *et al.,* [6] used the content of palm fruit to highly correlate it with the redness of the palm oil fruits under controlled environments. The images were manually edited for consistency using image processing techniques. Ghazali *et al.,* [7] used the RGB colour components as features for palm oil classification. The captured images captured were processed by eliminating the non-red colours, and the resulting images into 3 categories: ripe, under ripe and unripe. This study has provided valuable insights into the use of image processing techniques and feature extraction for oil palm fruit classification.

Shabdin *et al.,* [9] then improved by using the hue, saturation, and colour intensity as the main features. Classification is only based on two classes (underripe and ripe) while images were captured in a controlled environment. Septiarini *et al.,* [10] proposed a method for ripeness classification of oil palm fruit into three classes, including raw, under-ripe and ripe. This method is applied against images that contain a single palm fruit by combining RGB and grey colour features and SVM that are preceded by threshold-based segmentation using the Otsu method. Artificial Neural Networks [ANN] is integrated for analysis and achieved accuracy of 70% [9]. Advanced artificial intelligence tools such as machine learning or deep learning are also used [5,11-16]. Images are collected, pre-processed and trained under the artificial neural network (ANN), and the ANN learns the features from those images [9,18]. Moreover, the support vector machine (SVM) [6] and naive Bayes classifier are applied to maturity grading after colour images are captured [19].

Ghazali *et al.,* [20] processed images with image segmentation and colour feature extraction. Hue measurement was used as a feature to determine the ripeness of FFB. They also trained and tested the model using a support vector machine. In addition, they used the bag of visual word model. The average accuracy for the 4 classes of the palm oil fruit brunch by colour features was 57%, while the accuracy for ripeness classification using the bag of visual word was 70%.

Septiarinia *et al.,* [10] used the contour-based approach for segmenting oil palm fruit, as the fruit can have various shapes and colours. This method involved implementing the Canny algorithm along with several morphology and reconstruction operations to eliminate noise. The segmentation accuracy achieved an average of 90.13%, with false positive and false negative error rates of 2.92% and 5.20%, respectively.

Wong *et al.,* [21] used linear segmentation to classify bunches based on mean hue value and achieved an accuracy of 85%. However, they only made predictions across two classes, ripe and unripe. Teh *et al.,* [24] then performed classification by extracting mean RGB values and colour ratios, and they were the first to explicitly use edges as a supplementary feature to colour data through the use of Canny edge detection. This resulted in an accuracy of 68.75% over three classes.