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# THE DOCTORAL RESEARCH ABSTRACTS

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**Name :** KHAIRUL ADILAH BINTI AHMAD

**Title :** EDGE DETECTION AND CONTOUR SEGMENTATION FOR FRUIT CLASSIFICATION IN NATURAL ENVIRONMENT

**Supervisor :** ASSOC. PROF. DR. SHARIFAH LAILEE SYED ABDULLAH (MS)  
ASSOC. PROF. DR. MAHMUD OTHMAN (CS)  
ASSOC. PROF. DR. MOHD NAZARI ABU BAKAR (CS)

This thesis addresses the problem of automatic delineation and recognition of the images of Harumanis mangoes acquired in the natural environment. Harumanis is one of the main export produce in Perlis as it is very popular because of its deliciousness, sweetness and aromatic fragrance. In the agricultural industry, the fundamental factor for consistent marketing of the fruit is its quality. The quality of Harumanis is based on the shape and size of the fruits. The ability to efficiently and consistently manufacture high-quality products, and to ensure correct delineation and recognition processes, are the basis for success in the highly competitive fruit industry. Computer vision is a technology that imitates effects of human vision by electronically perceiving and understanding an object in the image. In fact, computer vision is gaining more attention in image-processing applications especially in the agricultural area. The technology involves several stages relating to image acquisition, pre-processing, segmentation, feature extraction and classification. The aim of this research is to assess of the Harumanis fruit quality in natural images. This research adapted a methodology of computer vision and algorithms that exploit image segmentation, feature extraction and fuzzy classification to guide the research activities. In general, image segmentation isolates an object from the images, feature extraction creates features for classification phase while object classification categorizes objects into the correct groups. However, segmentation is challenging for images that are acquired in the natural environment as non-uniform illumination, noisy background, and external appearance are the critical issues that must be addressed. Based on previous researches, most existing segmentation methods focused on a

specific environment. Therefore, this research has developed an improved edge detection and contour segmentation algorithm that is able to correctly segment various objects from both indoor and outdoor images. This improved algorithm, known as the edge-template Contour Delineation (etCD), is based on the fusion of edge detection with corner-template detection and dynamic thresholding to produce enhanced edge map. Then, two morphological operators that are embedded with condition inversion and dynamic threshold is used to produce robust and accurate contour objects. Next, contour-tracing and ellipse-tracking are employed to provide precise object boundaries. From each successful contour segmentation, four basic morphological features are extracted to create the Harumanis data set. Feature extraction gathers higher-level information of the fruit from segmentation images. Feature extraction and selection reduces the number of features. In this research, the shape and size feature were extracted using aspect ratio of selected morphological features. The shape and size are measured to estimate the maturity stages and grade levels of the Harumanis. Due to the inherent and uncertain variability of the Harumanis features, fuzzy learning algorithm has been designed to classify these fruits similar to the ability of human experts. Therefore, this research has designed fuzzy learning algorithm that is able to classify fruits based on their shape and size features using Harumanis dataset. This learning algorithm represents an automatic generation of membership functions and rules from the data. Experimental results show that the developed methods and model are able to classify the Harumanis quality with accuracy of 79% using fuzzy classification based on shape and size.