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 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 features 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.

Self-organizing Map (SOM) is a very popular algorithm that has been used as clustering algorithm and data exploration. SOM consists of complex calculations where the calculation of complexity depending on the circumstances. Many researchers have managed to improve online SOM processing speed using Heterogeneous Computing (HC). HC is a combination of Central Processing Unit (CPU) and Graphic Processing Unit (GPU) that work closely together. Standard HC can be represented by CPU and GPU accessing separate memory blocks. In spite of excellent performance using standard HC, there is a situation that causes computer hardware underutilized when executing online SOM variant. In details, the situation occurs when number of cores is larger than the number of neurons on map. Moreover, the complexities of SOM steps also increase the usage of high memory capacity which leads to high rate memory transfer. This situation is caused by the standard HC implements "deep copies" in storing processing objects which lead to communication latency. Recently, combination CPU and GPU that integrated together on a single chip are rapidly attractive the design paradigm for recent platform because of their remarkable parallel processing abilities. This kind of microprocessor is based on Heterogeneous Unified Memory Access (HUMA) model. This model allows both CPU and GPU to access and store into the same memory location which avoids redundant copies of objects by "deep copies" method. Therefore, the main goal of this research is to reduce computation time of SOM training through implementing on HUMA platform and improve GPU cores utilization. This research has three main objectives to be achieved. Firstly, this research attempts to study the processing natures of original SOM algorithm on standard HC platform. Secondly is to model an enhanced parallel SOM on HUMA-GPU platform and adapting multiple stimuli approach in order to improve the processing speed. Lastly is to evaluate the enhanced parallel SOM in terms of performance accuracy, efficiency, and scalability. This research attempts to improve the processing of SOM algorithm through three stages. The research works start with conducting a preliminary study on sequential SOM algorithm. The research continues to design a parallel SOM architecture based on literature study and implements on two types of architecture; standard HC and HUMA model. Finally, this research designs and implements an enhanced parallel SOM architecture through combining two parallel methods which are network and data partitioning. The combination of the two methods are realized via adapting multiple stimuli approach. This research employs datasets that are acquired from UCI repository. As a result, the enhanced parallel SOM that executed on HUMA platform is able to score up to 1.27 of speed up overall for large map size compared to standard parallel SOM. The proposed work also scores better for smaller map size with scored up to 1.03 of speed up overall compared to standard SOM on the identical platform. Accordingly, the proposed work is able to offer a better solution for small to medium sized of data analysis software. Overall, the solution is enhanced through utilizing recent hardware technology and improved method.