ENHANCED AND AUTOMATED APPROACHES FOR FISH RECOGNITION AND CLASSIFICATION SYSTEM

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ENHANCED AND AUTOMATED APPROACHES FOR FISH RECOGNITION AND CLASSIFICATION SYSTEM

by

ALI SALEM ALI BIN SAMMA

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IN THE NAME OF ALLAH, MOST GRACIOUS, MOST MERCIFUL

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Page

LIST OF ABBREVIATIONS

AI	Artificial intelligence
ANN	Artificial Neural Network
BMQ	Bayes Maximum Quantification
CBSI	Combined Boundary and Skeleton Information
DR	Detection Rate
DT	Decision Tree
EASR	Enhanced Approach for Shape Representation
EBS	Enhanced Background Subtraction
EKM	Enhanced K-means Algorithm
EM	Expectation Maximisation
ESDRS	Enhancement Shape Description and Representation Using Slope
FCC	Freeman Chain Code
FD	Fourier Descriptor
GA	Genetic Algorithm
ICA	Independent Component Analysis
IE	Image Engineering
KDE	Kernel Density Estimation
LUT	Look Up Table

MKM Modified K-Means

OAA One-Against-All

OAO One-Against-One

PCA Principal Component Analysis

RGA Running Gaussian Average

SCS Simple Cluster Seeking

SKM Standard K-Means

SKDA Sequential Kernel Density Approximation

SVM Support Vector Machine

TMF Temporal Median Filter

PENDEKATAN YANG DIPERTINGKAT DAN DIAUTOMASIKAN UNTUK SISTEM PENGECAMAN DAN PENGELASAN IKAN

ABSTRAK

Pengecaman dan pengelasan imej ikan dengan darjah ketepatan dan kecekapan yang tinggi boleh menjadi satu tugas yang sukar kerana ikan mempunyai persamaan yang sangat tinggi dengan latar belakangnya, kehilangan beberapa ciri ikan, dan kos komputan yang tinggi. Tujuan tesis ini adalah untuk mengatasi masalah berkenaan dengan mencadangkan kaedah untuk mengatasi masalah kehilangan ciri-ciri ikan. Masalah kos pengiraan yang tinggi, pengekstrakan dan perwakilan ciri-ciri ikan yang tidak tepat, dan pemilihan rupa bentuk yang diingini yang tidak tepat dan tidak cekap untuk pengecaman dan pengelasan ikan juga disentuh. Tambahan pula, untuk pengesanan dan pengekstrakan ikan yang diautomasikan, pendekatan K-min dan penolakan latar belakang untuk segmentasi imej ditingkatkan. Pendekatan yang dipertingkat untuk perwakilan rupa bentuk yang menggabungkan kaedah panjang larian dan kaedah kod rantai yang diubahsuai dengan maklumat rantau juga dicadangkan. Satu pendekatan yang ditingkatkan untuk huraian rupa bentuk dengan menggunakan cerun juga dicadangkan untuk mengurangkan masa komputan. Untuk pengesanan titik-titik genting dengan lebih tepat dan cekap untuk sesuatu rupa bentuk ikan, satu teknik yang menggabungkan maklumat rangka dan sempadan dicadangkan. Akhirnya, untuk pengelasan ikan yang lebih tepat, kaedah-kaedah yang menggunakan analisis komponen utama dan algoritma genetik dengan dua kaedah mesin vektor sokongan dicadangkan. Dengan menggunakan pendekatan-pendekatan yang ditingkatkan tersebut, satu sistem pengecaman dan pengelasan ikan yang diautomasikan

dihasilkan. Kaedah-kaedah yang ditingkatkan berkenaan menjadikan sistem pengecaman dan pengelasan ikan mencapai ketepatan 98.4% dan lebih tepat daripada sistem-sistem sedia ada seperti yang ditunjukkan oleh penilaian yang telah dilakukan.

ENHANCED AND AUTOMATED APPROACHES FOR FISH RECOGNITION AND CLASSIFICATION SYSTEM

ABSTRACT

Recognition and classification of fish images with high degree of accuracy and efficiency can be a difficult task due to fish being very similar to the background, missing of some features and high cost of computation. The aim of this thesis is to overcome these problems by proposing methods that overcome the problem of missing features of fish. The problems of high cost of computation, inaccurate extraction and representation of features of fish, and inaccurate and inefficient selection of desirable shape for fish recognition and classification are also addressed. Furthermore, for automated detection and extraction of the fish, K-means and background subtraction approaches for image segmentation are enhanced. An enhanced approach for shape representation that combines run-length method and modified chain code method with region information is also proposed. An enhanced approach for shape description that uses slope is also proposed to reduce the computation time. For more accurate and efficient detection of the critical points for a shape, a technique that combines skeleton and boundary information is proposed. Finally, for a more accurate classification of fish, methods that use principal component analysis and genetic algorithm with two methods of the support vector machine are proposed. By utilising the above-mention enhanced approaches, an automated fish recognition and classification system is also established. The enhanced methods make the fish recognition and classification system achieves 98.4% accuracy and more accurate than the existing systems as shown by the evaluation that has been carried out.

CHAPTER 1

INTRODUCTION

1.1 Introduction

As humans, it is easy to recognise and classify objects, letters, numbers, voices of friends, and so on. However, making a computer solve these types of problems is a very difficult task. The objective of object recognition and classification system is to recognise and classify objects into different categories and classes, and it is a fundamental component of artificial intelligence and computer vision (Schalkoff, 1992). Therefore, the development of object recognition and classification system is an important area of computer vision research.

Object recognition and classification system is an integral part of machine vision and image processing and finds its applications in speech recognition, classification of text into several categories, recognition of handwritting, face recognition, biomedical image, remote sensing, and so on. However, it does have undesirable limitations in its efficiency and accuracy. Segmentation methods, shape representation and description approaches, and classifier techniques provide a number of solutions in overcoming these limitations (Roobaert and Hulle, 1999; Duda et al., 2000; Fu, 1982; Thomas et al., 2001; Pavlidis, 1977; Perner et al., 1996; Schuermann, 1996).

Image segmentation is a very important component of an image processing system because a mistake at this stage will influence feature extraction, representation and classification of an object. It is evident that the results of segmentation will have considerable influence over the accuracy of feature measurement (Zhang, 1995). Furthermore, image segmentation involves partitioning an image into a set of homogeneous and meaningful regions or separation of the image into regions of similar attributes. The homogeneity of the regions is measured using some image properties (e.g. pixel intensity) (Rosenfeld and Kak, 1992; Jain et al., 1999).

Feature extraction and selection play an important role in achieving high recognition and classification performance. A feature is an entity that provides some information on an object or an image, and the features can be low level ones such as boundary points, line segments or groups of points, and also higher level ones such as a group of line segments and junctions, or also even a group of objects (Bernd, 2006). Basically, objects contain many features (such as colour, texture, and shape) that have meaningful semantics. Moreover, shape is an important feature that conforms to the way human beings interpret and interact with the real world objects. And also, the critical points on the shape can affect the recognition rate (Basri et al., 1998; Liu and Srinath, 1990; Thomas et al., 2001).

The main aim of machine vision application is to teach a computer to discriminate some datasets automatically in a more accurate and efficient manner. There are two main divisions of classification: supervised (or discrimination) and unsupervised classifications (sometimes in statistics literature, it is simply referred to as classification or clustering). In supervised classification, there is a set of data samples consisting of measurements on a set of variables (training data) with associated labels (the class types). In other words, this type of classification requires training of data as the basis for classification whereas an unsupervised classification can be used to cluster pixels in a dataset based on statistics only without any user defined training classes (Perner and Petrou, 1999; Pedram et al., 2008; Tou and Gonzales, 1974; Rosenfeld and Kak, 1992).

Fish recognition and classification system is still an active area in image processing domain, and considered to be a potential research area. Many methods for fish recognition and classification system have been enhanced and even with the widespread of computers and software, existing systems are still limited in their ability to detect or classify fish. Many applications of fish recognition and classification system require solving of problems such as controlling the migration of fish and locating good species of fish. Manual fish classification is also a labourious work which can only be implemented by submarine specialists and scientists (Perner et al., 1996; Omran et al., 2006). Moreover, many people are killed every day because they do not have the ability to distinguish between poisonous and non- poisonous fish. Therefore, this thesis will focus on the challenges of fish recognition and classification system based on different stages of architecture of fish recognition and classification which consists of three stages namely image segmentation, feature extraction and representation, and classification stages.

1.2 Motivation

Information on the distribution of specific species of fish can assist biologists in studying issues such as food availability. Also, the number of fish in the water is of interest in many applications such as in fisheries management, evaluating the ecological impact of dams, and managing commercial fish farms.

Other researchers have addressed the monitoring and measuring of fish for various applications. Most commonly, previous work has been focusing on monitoring the size of a particular species in a fish farm or controlling a cutting machine for fish processing. Therefore, it is important to focus on developing object recognition and classification system. Many researchers have attempted to solve some problems related to fish recognition and classification but their methods have limitations and these will be described in Chapter 3.

1.3 Problem Statement

In many systems, a recognition and classification system is required to accomplish specific tasks. One of the problems in existing fish recognition and classification systems is that the current methods are not fully automated and therefore, consume too much time and effort. Another problem is due to a variety of sizes of fish and arbitrary shape of fish species that have to be considered when extracting fish in the image.

There is also a need to look into the fish recognition and classification system as a whole instead of looking only a particular component of the system as carried out by previous researchers. Existing systems face difficulty in extracting complete fish shape or in segmenting the whole fish. For examples, locating the critical points of the fish shape and also selecting the correct features in general cannot be done automatically. There is also a need to overcome the problem of missing features due to images being taken from different angles (Reddy et al., 2010; Zhang and Lu, 2004; Alsmadi et al., 2009). Therefore, a fish classification system must be able to classify and recognise the fish by having the capability to extract the fish from their background, represent and detect the critical points automatically and then select the desirable features for classification accurately and efficiently.

1.4 Objectives

The aims of this research relate to improving the efficiency and accuracy of fish recognition and classification system. In more detail, this thesis seeks to fulfill the following objectives:

1. To enhance image segmentation approaches for fish classification that allows automated approach to the segmentation stage with better accuracy and efficiency.
2. To develop an enhanced technique for representing and selecting a desirable boundary

for fish classification.

3. To develop a more accurate and efficient technique for detecting critical points so that more relevent features for fish recognition can be obtained.

4. To establish an automated fish recognition and classification system using the above-mentioned enhanced techniques.

1.5 Research Scope and Limitations

The scope of this thesis is on the problems of fish classification that classifies and recognises underwater images of fish. This research concentrates on enhancing the accuracy of the classification by focusing on enhancement of different stages (image segmentation, feature representation and selection, and classification) of recognition and classification system for fish classification in order to establish an automated system. The images are two dimensional (2-D) and clear images without noise, and the object is not completely or partially occluded.

1.6 Research Approach

Figure 1.1 shows the steps involved in this research namely problem identification, analysis of current techniques and enhancing approaches for different stages of fish recognition and classification system. Detail of the steps is given in the next subsections.

1.6.1 Problem Identification

Even with the difficulties encountered with object recognition and classification system, it remains an active topic for research. From the literature, this stage is carried out with the aim of addressing firstly the problem of image segmentation for fish in terms of extracting the fish from their background. Next, the problems of feature extraction and representation are identified in terms of shape extraction and representation of important critical points of the fish shape, and the problems of doing these automatically. Lastly, the problems of selecting and calculating more relevent features for fish recognition and classification are studied.

1.6.2 Analysis of Current Techniques

This stage is concerned with the analysis of the problems identified in the previous step (Section 1.6.1). The limitations of the existing approaches are analysed based on the problems identified through the determination of the problems adopted in this research.

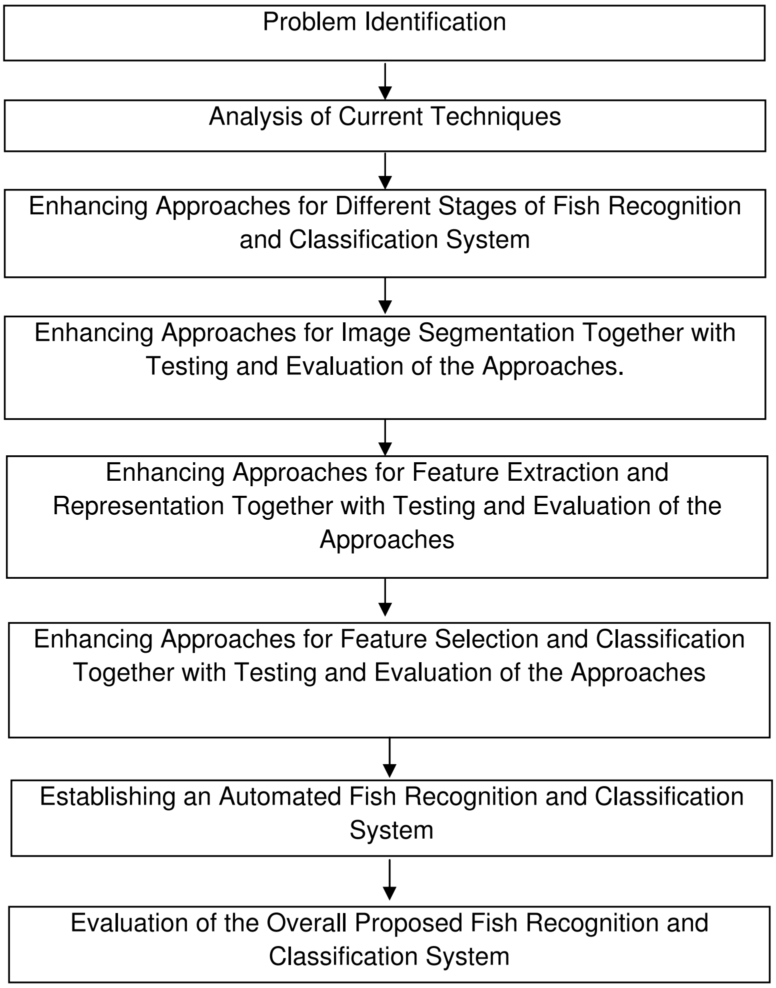

Figure 1.1: Research approach

1.6.3 Enhancing Approaches for Different Stages of Fish Recognition and Classification System

This step is concerned with enhancing methods and approaches so that the problems identified from the previous step (Section 1.6.1) can be overcome. In this research, the proposed enhanced methods and approaches are based on the stages in fish recognition and classification system, and the actions to be undertaken in each stage are as follows:

- Enhancing approaches for image segmentation techniques.
- Enhancing approaches for feature extraction and representation.
- Enhancing approaches for feature selection and classification leading to an automated system.

The detail for each of the above actions is given in the next subsections.

1.6.4 Enhancing Approaches for Image Segmentation

In this stage, the image is divided automatically into a region that contains the fish. Enhanced approaches for image segmentation namely Enhanced K-means algorithm (EKM) and Enhanced Background Subtraction algorithm (EBS) are proposed in order to extract and distinguish the fish from their background automatically. The results are evaluated and compared with their respective original counterparts, recent counterparts and related methods in terms of efficiency and accuracy. The results are also evaluated based on statistical analysis using ANOVA to evaluate the efficiency of the proposed approaches and to show the significance of the results by measuring the degree of relationship between a single dependent variable (processing time) which is considered to be a function of independent variable (segmentation methods).

1.6.5 Enhancing Approaches for Feature Extraction and Representation

In this stage, an enhanced and automated technique for shape extraction and representation is needed. An automated technique for locating the critical points on the fish shape is also needed. Therefore, enhanced approaches for feature extraction and representation namely Enhanced Approach for Shape Representation (EASR), Enhanced method for Shape Description and Representation by using Slope (ESDRS) and Combined Boundary and Skeleton Information (CBSI) that allows automated representation and selection of desirable landmarks of the fish shape. The results are also evaluated and compared with some related methods in terms of the number of corners not detected (CND), the number of false points detected (FPD) and the detection rate (DR). ANOVA is also used to evaluate DR of the proposed approach and to show the significance of the results. The proposed algorithm must be robust that it should require low computational resource with fewer parameters and simple mathematical processing when compared to other methods.

1.6.6 Enhancing Approaches for Feature Selection and Classification Leading to an Automated System

In this stage, an approach for selecting and calculating more relevent features for fish classification based on the critical points of the fish shape from the previous stage is required. Principal Component Analysis (PCA) and Genetic Algorithm (GA) are proposed with One-Against-One (OAO) and One-Against-All (OAA) SVM methods for fish classification. The results are also evaluated and compared between each other and with other systems in terms of efficiency and accuracy.

1.6.7 Establishing an Automated Fish Recognition and Classification System

In this step, an automated fish recognition and classification system is established by utilising the enhanced approaches from the previous stages (Sections 1.6.4, 1.6.5 and 1.6.6).

1.6.8 Evaluation of the Overall Proposed Fish Recognition and Classification System

The results of the overall proposed fish recognition and classification system against the existing systems are evaluated in order to ensure that the proposed system achieves high performance and efficiency. The criteria to evaluate the results are as follows:

1. *Efficiency:* the proposed system must be able to achieve high speed execution process when compared to the existing systems. Efficiency is the comparison of what is actually produced or performed with what can be achieved with the same consumption of resources (money, time, labour, etc.). It is an important factor in determining of productivity.

2. *Accuracy:* the proposed system must be more accurate in producing the results when compared to the other systems.

1.7 Research Contributions

This thesis has three major contributions and four minor contributions. The three major contributions of this thesis are:

- An enhanced chain code method which combines run-length method and modified chain code method together with region information that provides detection and representation of the desirable fish shape from their boundary.

- A method that combines boundary and skeleton information to detect convex and concave points (critical points) on the fish shape.
- An automated fish recognition and classification system that requires less user intervention.

Other contributions are:

- An enhanced and automated K-means algorithm that divides the images into clusters and separates the fish from their background.
- An enhanced and automated background subtraction algorithm for image segmentation that estimates the reference image from the original image and then subtracts between them in order to distinguish between the fish and their background and to avoid the problem of detecting incorrect object.
- An enhanced shape description that utilises the slope of straight lines from two points in the shape description to enhance fish shape representation and description and to reduce computation time.
- A fish classification method that selects more relevant features, achieves better accuracy and ensures correct classification by using Principal Component Analysis (PCA) and another method by using Genetic Algorithm (GA) with One-Against-One (OAO) and One-Against-All (OAA) SVM methods.

1.8 Structure of the Thesis

The thesis is organised into eight chapters. Chapter 2 introduces the background of this research with the concepts of object recognition and classification system. As such, this chapter describes image segmentation techniques as a first stage of object recognition and classification system. The chapter also presents feature extraction and representation systems in sufficient detail in order to understand the subsequent chapters. The ideas on Principal Component Analysis (PCA) approach and Genetic Algorithm (GA) approach with two types of Support Vector Machine (SVM) are also introduced.

In Chapter 3, the literature on fish recognition and classification is reviewed. Firstly, it covers fish recognition and classification. The second section is concerned with image segmentation techniques for underwater images. The third section investigates most of feature extraction and selection methods using shape representation and description. Finally, classifiers techniques for object recognition and classification with respect to support vector machine are also reported.

Chapter 4 presents the proposed framework of the fish recognition and classification system which is based on four stages. The detail of image segmentation, feature extraction, and representation and selection are presented. The recognition and classification techniques for the last stage of the proposed framework are also presented.

Chapter 5 presents the details of two image segmentation techniques of the architecture for fish recognition and classification system namely enhanced K-means algorithm (EKM) and enhanced background subtraction algorithm (EBS). The experimental results of the techniques are also discussed. Finally, the proposed enhancements are also evaluated and compared with their counterpart and other recent methods.

Chapter 6 presents an enhanced and automated method for fish shape extraction and representation based on run-length method, modified chain code method and region information. Another enhanced method for shape representation is also proposed. The method uses slope to represent shape by segmenting the boundary into straight lines to reduce the computation time. A method that combines boundary and skeleton information for detecting critical points of fish shape automatically is also described. The experimental results of the proposed enhanced methods are also presented together with a comparison with most related methods.

Chapter 7 presents several approaches involving Principal Component Analysis (PCA) and Genetic Algorithm (GA) with two types of support vector machine (SVM) namely One-Against-One (OAO) SVM method and One-Against-All (OAA) SVM method for classification with the aim of increasing the accuracy of fish classification. The overall automated system result is presented and discussed. Finally, the results are also compared with some related systems in terms of accuracy.

Chapter 8 concludes the thesis by presenting the thesis summary, limitations and future work.

CHAPTER 2

BACKGROUND

2.1 Introduction

This chapter introduces the background of this research namely the concept of object recognition and classification system. The focus is on methods and algorithms that are related to the research presented in this thesis. It also presents the purpose of computer vision, object recognition and the main steps of object recognition. This chapter also describes image segmentation techniques as the first stage of object recognition and classification system. The techniques of image segmentation used in fish recognition and classification system are also presented. Shape extraction and representation techniques are also presented in sufficient detail. The ideas on Principal Component Analysis (PCA) approach and Genetic Algorithm (GA) approach with two types of Support Vector Machine (SVM) are also introduced.

2.2 Object Recognition and Classification

In any object recognition and classification system, each object is characterised by a string of features and the classification of an object is based on representation, description and analysis of these features with respect to the features defining that object class.

Object recognition involves the following set of processes (Fu, 1982; Perner and Petrou, 1999; Perner et al., 1996; Majumdar and Ray, 2001):

- Detection and separation of a set of features that is the segmentation stage involving image segmentation techniques.

- Analysis of object representation and description by identifying the interrelationship among the features that is the selection and extraction stage involving shape representation and description techniques.

- Recognition and classification of the allowable structures defining the interrelationship between the object features performed by the classifiers.

Figure 2.1 shows a typical block diagram of an object recognition and classification system. This system consists of two parts: testing part and training part. Both parts consist of primitive extraction and object representation. The classifier performs based on the grammatical reference of the training part.

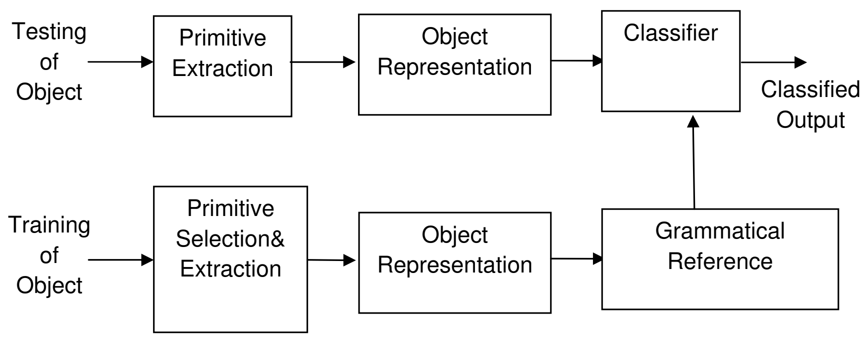

Figure 2.1: Object recognition and classification system (Perner et al., 1996)

Figure 2.2 shows another block diagram of a typical pattern recognition system. In this system, sensing is used for collecting data. In order to separate the object from its background, segmentation is performed. Then, feature extraction is performed to extract the desirable features. Next, the features stored in database and the features extracted from the previous step are used for matching. Finally, the post-processing helps in making final decision by using small training data.

The next sections describe in detail the image segmentation techniques.

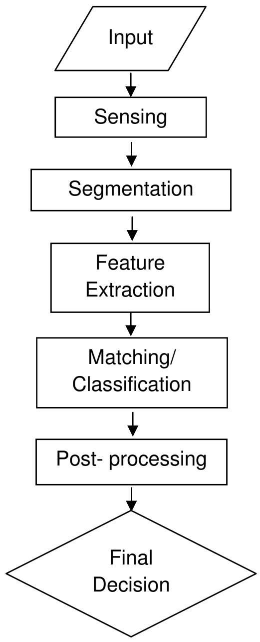

Figure 2.2: A typical pattern recognition system (Majumdar and Ray, 2001)

2.3 Image Segmentation Techniques

All image segmentation techniques can be grouped under a general image engineering (IE) framework which consists of three layers: image processing (low layer), image analysis (middle layer) and image understanding (high layer) as shown in Figure 2.3 (Zhang, 2002).

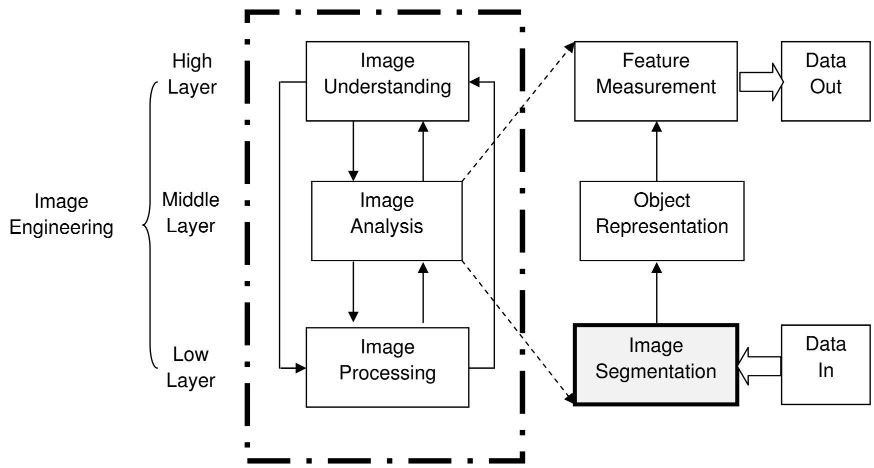

Figure 2.3: Image engineering and image segmentation (Zhang, 2002)

Image processing operations aim at a better recognition of object by finding suitable local features that allow them to be distinguished from other objects. Image segmentation is a very important component of an image processing system because a mistake at this stage will influence feature extraction and representation, and classification in the later stage. It is evident that the results of segmentation will have considerable influence over the accuracy of feature measurement (Zhang, 1995). Image segmentation involves partitioning an image into a set of homogeneous and meaningful regions or separation of the image into regions of similar attributes. The homogeneity of the regions is measured using some image properties (such as pixel intensity) (Rosenfeld and Kak, 1992; Jain et al., 1999; Forsyth and Ponce, 2003).

2.3.1 Thresholding Techniques

The simplest image segmentation technique is thresholding which divides an image into two segments namely object and background. A pixel above the threshold is assigned to one segment and a pixel below the threshold is assigned to the other segment. The advantages of the threshold method are that it is simplest method in segmenting images and it also does not need apriori information on the image. Its disadvantage, however, is constituted by the lack of local spatial information that can be supplied minutely by the edge detection technique (Pedram et al., 2008; Jain et al., 1999; Duda et al., 2000).

2.3.2 Region-Based Techniques

Region-based techniques, firstly suggested by Muerle and Allen in 1968 utilise spatial properties of an image for image segmentation. Split and merge image segmentation techniques are based on a quad-tree data representation whereby a square image segment is broken (split) into four quadrants if the original image segment is non uniform in attribute. If four neighbouring squares are found to be uniform, they are replaced (merged) by a single square composed of the four adjacent squares. The advantages of the region-based method are that the splitting criteria and the merging criteria can use different criteria and also clear edges can be obtained leads to good segmentation results. Its disadvantages include high cost of computational and it can not differentiate the fine variation of the images (Brice and Fenema, 1970; Pavlidis, 1977; Perner and Petrou, 1999; Forsyth and Ponce, 2003).

2.3.3 Boundary-Based Techniques

Boundary detection can be accomplished by using any edge detection methods that detects the boundary of each region. The methods work by seeking a significant change in image attributes and it is possible to segment an image into regions of common attributes. Moreover, if an image is noisy or if its region's attributes differ by only a small amount, a detected boundary may often be broken. Also, edge linking and grouping techniques can be employed to bridge short gaps in such a region boundary. The advantages of the boundary-Based method are the large numbers of segmented region result is reliable. Its disadvantage, the computation time is extensive and also it has over-segmentation (Nevatia, 1976; Kass et al., 1987; Pedram et al., 2008).

2.3.4 Clustering Techniques

Clustering techniques for image segmentation uses matrices data that partition the image pixels into clusters. Therefore, clustering techniques may be more appropriate than other techniques in segmenting images especially when each pixel has several attributes and is represented by a vector. Moreover, clustering techniques attracted much attention since the 1960's and have been applied in many fields such as optical character recognition system, fingerprint identification, remote sensing, and biological image segmentation. The steps of the clustering technique are presented in Figure 2.4 (Jain et al., 1999; Hall et al., 1999; Xu and Wunsch, 2005).

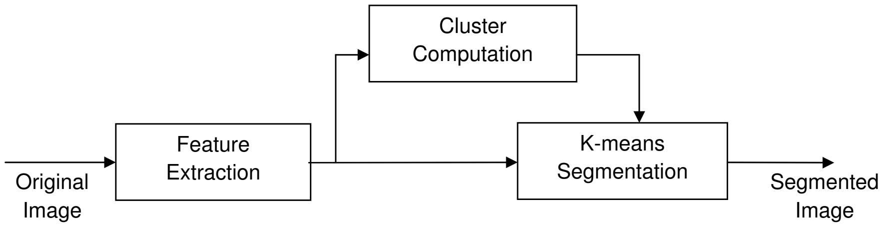

Figure 2.4: Simplified version of the clustering method for image segmentation (Jain et al., 1999)

2.3.5 K-means Algorithm

Usually, there are two general groups of clustering techniques for image segmentation and they are divided into hierarchical and partitional clustering algorithms as shown in Figure 2.5. K-means algorithm was proposed by Mac Queen in 1967 and it is the most important version of the partitional clustering techniques that provides a primary segmentation of the image. It is simple, has relatively low computational complexity and suitable for image segmentation (Chen et al., 1998; Amir and Lipika, 2007; Daoud and Roberts, 1996).

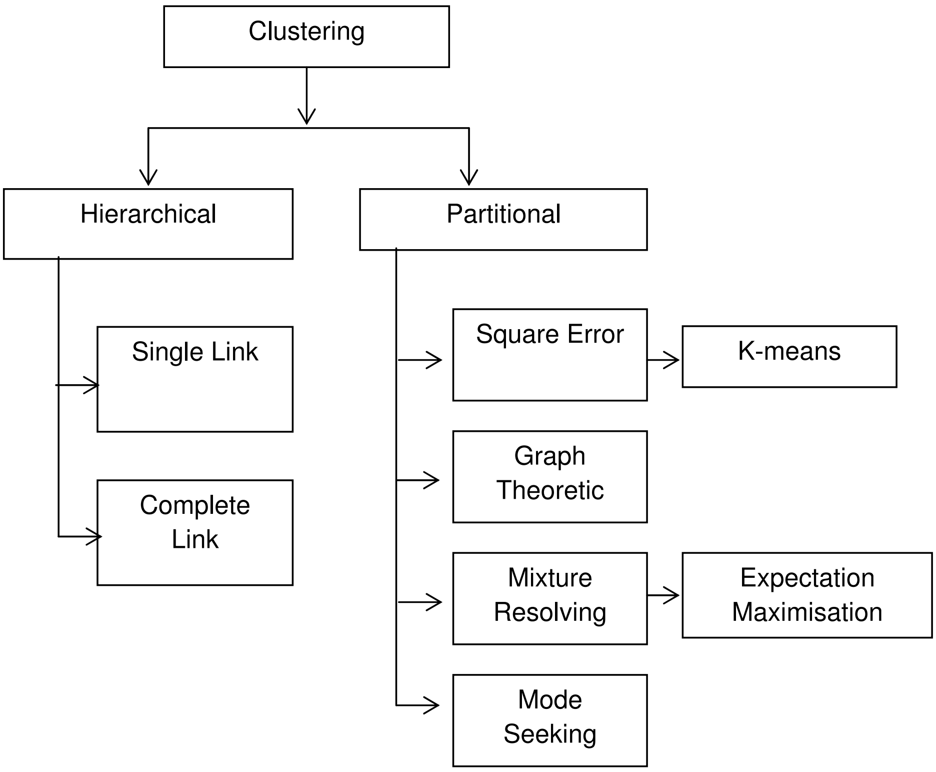

Figure 2.5: A taxonomy of clustering approaches (Chen et al., 1998)

Basically, a partitional clustering algorithm consists of an iterative model and its steps are as follows (Hall et al., 1999; Hamerly and Elkan, 2002; Omran et al., 2006):

Step 1: Initialise data by assigning some values to the cluster centres.

Step 2: For each data point x_i, calculate its membership value m $((C_j \mid X_i)$ W(X_i) X_i) to all clusters c_j and its weight w (x_i).

Step 3: For each cluster centre c_j, recalculate its location by taking into account all points x_i assigned to this cluster according to the membership and weight values as follows:

$$C_j = \frac{\sum_{i=1}^{n} m(C_j|X_i)W(X_i)X_i}{\sum_{i=1}^{n} m(C_j|X_i)W(X_i)} \tag{2.1}$$

Step 4: Repeat Step 2 and Step 3 until some termination criteria are met.

K-means clustering algorithm is a commonly used method in image segmentation because it is fast, a reliable target can be obtained and it involves less computation. In the preprocessing step, the data are separated into a background class and a potential target class (foreground) by using two different means for the data. The basic steps of K-means clustering are (Amir and Lipika, 2007; Chen et al., 1998) as follows and shown graphically in Figure 2.6:

Step 1: Assign all data elements a cluster number between 1 and k randomly where k is the number of clusters.

Step 2: Find the cluster centre of each cluster.

Step 3: For each data element, find the cluster centre that is the closest to the element. Assign the element to the cluster whose centre is the closest to it.

Step 4: Re-compute the cluster centres with the new assignment of elements.

Step 5: Repeat Step 3 and Step 4 till clusters do not change or for a fixed number of times.

K-means clustering follows a simple and easy way to classify a given dataset into a certain number of clusters (Liu et al., 2007).

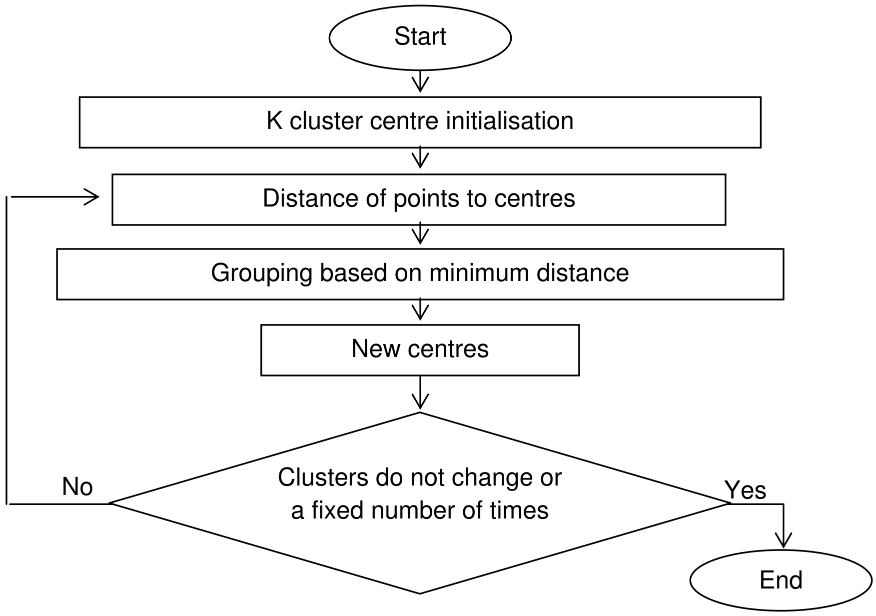

Figure 2.6: The main steps of K-means clustering

2.3.6 Background Subtraction Algorithm

A simple technique of subtracting the observed image from the estimated image is called background subtraction. The difference between the current image and a reference image is often called the background subtraction or background model. The general pattern of processing normally follows the background subtraction method as described and illustrated in Figure 2.7. A background subtraction algorithm is also a commonly used algorithm in image segmentation techniques for detecting the object of the scene (Alan, 2000; Mangasarian and Wild, 2007; Sen and Kamath, 2004; Elgammal et al., 2000; Stauffer and Grimson, 1999).

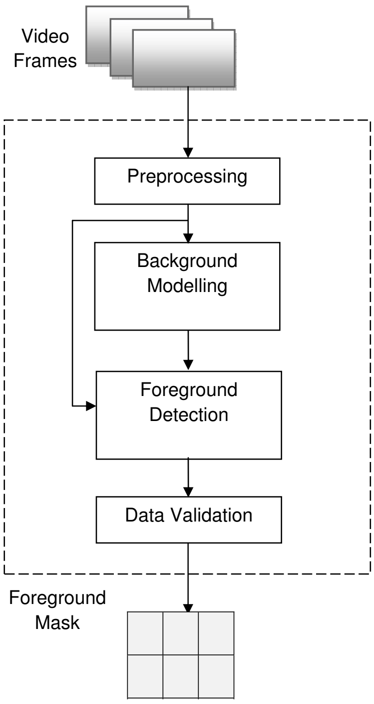

Figure 2.7: A general outline for background subtraction algorithms (Alan, 2000)

2.4 Feature Extraction and Representation

Feature extraction and representation play an important role in achieving high recognition and classification performance. A feature is an entity that provides some information on an object or an image, and the feature can be low level ones such as boundary points, line segments or groups of points. The higher level ones include a group of line segments and junctions, or also even a group of objects (Bernd, 2006). Basically, object contains many features (such as colour, texture, shape) that have meaningful semantics. Therefore, shape is an important feature that conforms to the way human beings interpret and interact with the real world object (Liu and Srinath, 1990; Thomas et al., 2001).

Shape representation and description of an object can have a significant impact on the effectiveness of a recognition strategy (Basri et al., 1998). Shapes have been represented as curves (Wolfson, 1990; Younes, 1998; Gdalyahu and Weinshall, 1999), as point sets (Ayache and Faugeras, 1986; Schwartz and Sharir, 1987; Umeyama, 1993), as feature sets (Bengio and