VESSELS CLASSIFICATION

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VESSELS CLASSIFICATION

NOR SURAYAHANI BINTI SURIANI

A project report submitted in partial fulfilment
of the requirements for the award of the degree
of Master of Engineering
(Electrical-Electronics & Telecommunication)

Faculty of Electrical Engineering
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ABSTRACT

Moment based invariants, in various forms, have been widely used over the years as features for recognition in many areas of image analysis. The proposed work will look at offline ship recognition using ships silhouette images which will include recognition of part of an object for situations in which only part of the object is visible. The model-based classification is design using Image Processing MATLAB Toolbox. The moment invariant techniques apply for features extraction to obtain moment signatures to do classification. The minimum mean distance classifier is used to classify the ships which works based on the minimum distance feature vector. This research study will address some other issue of classification and various conditions of images that might exist in real environment.

ABSTRAK

Momen yang tidak berbeza, dalam berbagai-bagai bentuk, telah banyak digunakan bertahun-tahun dahulu sebagai ciri-ciri untuk proces pengecaman dalam pelbagai bidang analisis imej. Cadangan projek ini akan melihat pada pengecaman kapal menggunakan imej bayang-bayang secara luar talian dan tumpuan diberikan kepada paparan sebahagian objek dalam situasi hanya sebahagian objek sahaja yang kelihatan. Klasifikasi berasaskan model ini direkabentuk dengan mengunakan perisian MATLAB. Teknik momen yang tidak berbeza digunakan untuk ciri-ciri pemisah bagi mendapatkan momen pengenalan bagi tujuan klasifikasi. Teknik klasifikasi yang digunakan untuk mengklasifikasi kapal ini menggunakan jarak purata minima bagi tiap-tiap vektor pencirian. Projek ini juga turut mengetengahkan isu-isu lain dalam proces klasifikasi dan pelbagai imej dalam situasi yang mungkin wujud dalam persekitaran sebenar.

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LIST OF SYMBOLS

μ	Mean
μ_x	Mean pixels values of x-coordinates
μ_y	Mean pixels values of y-coordinates
μ_n	n-th Central Moment
$\bar{x}, \bar{y}$	Centroid of image
σ^2	Variance
η_{pq}	Normalized Central Moment
γ	Normalisation factor
ϕ_n	n-th Moment Invariant
$d(X,i)$	Weighted distance
C	Covariance matrix

LIST OF ABBREVIATIONS

ROI	Region of Interest
FLIR	Forward Looking InfraRed

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CHAPTER 1

INTRODUCTION

Automatic object recognition has diverse applications in various fields of science and technology and is permeating many aspects of military and civilian industries. Autonomous recognition of ships can provide better tracking and automatic monitoring to control from potential enemy ships.

Recent advanced in imaging technology improves its ability to see ships at night and observed ships from any angle. Then, the classification is done to confirm its identity in the case of country of origin and vessels type. So, this project addresses model-based classification of warship of different categories with acceptable accuracy.

1.0 PROBLEM STATEMENT

Automatic ship recognition is an interesting research area in military industry. In current practice, a person is employed to watch the water area constantly to monitor and recognize the type of vessels. This process is very daunting for human to do. In present situation, a monitoring of the coastal area and recognizing the type of vessels that enter

the coastline is very important in security. Thus, the use of image processing algorithms that could detect and identify incoming vessels is very useful for automatic system.

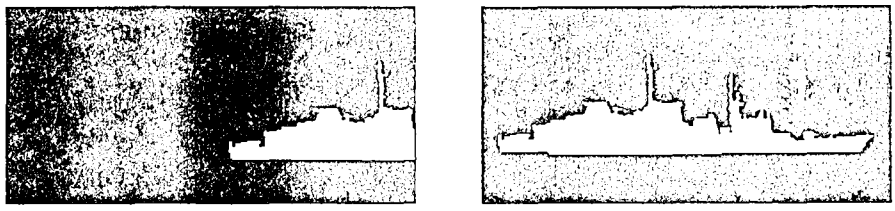

Figure 1.1: Left to right: clipped, overlapped with another silhouette

Figure 1.1 shows that classification of objects based on silhouettes is easily affected by scale changes, clipping and occlusions with another silhouettes. Moments based approached use to represent subregion of an object for situations in which only part of object is visible.

1.1 PROJECT GOALS

The main approach is model-based, where the types of warship to be recognized are known in advanced and can be categorized into different classes. Each class is defined by the structures it contains and their arrangement on the deck. The specific library divided into two categories which are Merchant (recorded image) and Combatant type. The specific model database contains 6 classes of ships: destroyer, frigate, aircraft carrier, patrol forces, mine warfare forces and merchant ship.

For each ship silhouette, feature vector will be extracted and calculate moment signatures. Then for testing purpose, compute the signatures for a ship image of unknown type. The unknown type could be change in positions, rotated in certain angle or scaled. Classification is done using the minimum mean distance classification by

finding the minimum distance among all pattern vectors. This is done through the representation of means and variance of each class.

1.2 OBJECTIVES OF THE PROJECT

The objectives of this project are:

a. To design, develop and produce technique for the classification of vessels
b. To select features that adequately and uniquely describe the vessels to be identified

1.3 SCOPE OF PROJECT

Many researches have been done in this area using Forward Looking InfraRed (FLIR) images, radar images, simulated images and visual-light images. In this project, the sample data set are the offline ships images which is not applicable for real-time applications.

The design coding will be implemented based on MATLAB 7.0 software using the Image Processing Toolbox. Then, this project need some pre-processing before the objects can be detected to obtain the silhouette images sample data set.

There are some limitations in this project, where the data collections are horizontal view images and the distance of object is unknown. Thus, the proposed algorithm is not intended for satellite or aerial view images.

1.4 PROJECT OUTLINE

The Project is organized into five chapters. The outline is as follows:

- **Chapter 1 Introduction**

  This chapter discusses the objectives and scope of the project and introduces some background with respect to the problem to be solved.

- **Chapter 2 Literature Review**

  This chapter is about previous work regarding to the pattern recognition especially to the vessels classification for military purposes. Moment techniques approach will be explained in details and the chronology of moments invariants apply for pattern recognitions. This chapter also subsumes the classification techniques apply for vessels classifications.

- **Chapter 3 Design Methodology**

  Chapter 3 elaborates the techniques and steps taken to complete the task. The important part is the development phase that explained in detail how to classify imperfect Region of Interest (ROI).

- **Chapter 4 Results and Discussion**

  The results will evaluate all experiments that have been done and discuss the performance of the proposed techniques. Sensitivity analysis of the results is also included.

- **Chapter 5 Conclusion**

  This chapter consists of conclusion for this work. It also describe the problems arises and recommendations for future research.

CHAPTER 2

LITERATURE REVIEW

2.0 OVERVIEW

Pattern recognition involved the following distinction steps which call *image processing chain* [M.Egmont-Petersen, D. Ridder, H.Handels, 2002]: Pre-processing, Feature Extraction, Segmentation, Object detection and Recognition, Image understanding and Optimization. Object recognition consists of locating the positions and possibly orientations and scales of instances of objects in an image. The purpose may also be to assign a class label to a detected object. Object recognition can be performed based on pixel data or features, e.g., principal component, moments.

Classification of objects based on their silhouette is particularly useful in autonomous ship recognition. Most work has been done on radar images which acquired by imaging sensors operating at different spectral ranges (CCD, FLIR, image intensifier).

There are many methods for features extraction in automatic target recognition. The general methods used for two-dimensional shape recognition can be categorized as either global or local. Global methods use global features of an object boundary like Fourier Descriptors (FD), regular moments, autoregressive models and Curvature Scale

Space (CSS) applied for ship identification in decision support system is, it is curvature extrema, instead of zero crossings, that are tracked during silhouette evolution which is part of MPEG-7 standard [Á. Enríquez, C. Miravet, D Otaduy, C Dorronsoro, 2005]. This system makes use of the deployment of imaging sensors for surveillance and intelligence operations in naval scenarios.

Local methods use features such as critical points or high-resolution pursuit (HRP). It describes only part of the image in an object; hence only a few parts of the object are corrupted and only a small subset of the feature vectors to be affected. A possible disadvantage of local features is that relatively complex classifiers may be required in order to take advantage of the spatial relation between object parts. There is a wide variety of published literature for global-based approaches.

One early work is [Dudani, 1977], which used moment invariants for feature extraction of six different aircraft types and the images were based on physical models. His training set was based on over 3000 aircraft images taken in a 140° by 90° sector. The testing set contained 132 images (22 images of each of the six classes) obtained at random viewing aspects. Then, by assuming that the distance to the object was known the classification accuracy achieved was 95%.

Then [Reeves, 1988] suggested 'standard moment', which is a geometrical-moment approach using moments of the image that are normalized with respect to scale, translation and rotation. He used the same training and testing data as Dudani and obtained better classification results of standard moment compared to the conventional moments. Later, [Paschalakis S. and Lee P., 1999] produced better classification accuracy in four aircraft sample images using Complex Moment Magnitude and reduce computational load.

It is unclear how well the work on aircraft classification extends to ships, as ships are mainly distinguishable in small features when [Qian and Wang, 1992] proposed ships superstructure moment invariant. They achieved better performance in 1440

number of sample images (four types of ship model, sample to 10 ranges and 36 angles). But the algorithm applied to obtain the superstructure of the ships was not practical since the information of ships length and height were eliminated.

There seems to general agreement on the poor performance of the conventional moments in ships classification where in recent work, [Sanderson C. and Gibbins D.,2004] conclude that moment invariant approach give worse result in adverse conditions such as clipping, overlapping, scaled and corrupted by speckle noise. They also compare the performance of holistic and local feature approaches based on Principal Component Analysis (PCA) and 2D Hadamard Transform. This feature extraction technique basically produces dimensionality reduced versions of binary images and it would expect to be affected by scale changes, clipping and rotations. While Hadamard Transform method opposed to the holistic feature extraction. Where a given image is analyzed on a block-by-block basis; each block overlaps neighbouring blocks by a configurable amount of pixels.

There are several new techniques to increase accuracy and efficiency of moment descriptor [Teh C.H and Chin R.T, 1988]. Previous work, [Khotanzad ,1990] used Zernike Moment to recognize image patterns. He tested on 26 uppercase English characters (A to Z). These images were generated with arbitrarily varying scales, orientations, and translations. Then, the orthogonal property of Zernike moments makes the image reconstruction from its moments computationally simple. He obtained 99% classification accuracy for a 26 class character data set and conclude that Zernike moment perform well in the presence of a moderate level of noise.

In view of all the related literatures, Moment Invariant method has been proposed in this work to be an effective method for ship recognition extracted from a side view of the object. Operations such as rotation, translation and scale change achieved more easily in the moment domain than in the original pixel domain. Furthermore, the set of moments offer a more convenient and economical representation of the essential shape characteristics of an image segment than a pixel-based

representation. This proposed processing scheme able to handle imperfectly Region of Interest (ROI). Further explanations of Moment Invariant technique will be presented in this chapter.

2.1 MORPHOLOGY

Morphology is the study of the shape and form of objects. Morphological image analysis can be used to perform object extraction, image filtering operations, such as removal of small objects or noise from an image, image segmentation operations, such as separating connected objects and measurement operations, such as texture analysis and shape description.

In this project the morphology techniques is used in pre-processing for background subtraction and apply to the recorded image, Merchant ship. This technique used to obtain the silhouette image that represents the shape of ships classes.

2.2 SHAPE DESCRIPTOR

In general, descriptors are some set of numbers that are produced to describe a given shape. The shape may not be entirely reconstructable from the descriptors, but the descriptors for different shapes should be different enough that the shapes can be discriminated. Recognition of objects is largely based on the matching of description of shapes with a database of standard shapes.