UNIVERSITI PUTRA MALAYSIA

SIMULATION MODELS FOR STRAIGHT LINES IMAGES DETECTION USING HOUGH TRANSFORM

QUSSAY ABBAS SALIH AL-BADRI

SIMULATION MODELS FOR STRAIGHT LINES IMAGES DETECTION USING HOUGH TRANSFORM

By

QUSSAY ABBAS SALIH AL-BADRI

Thesis Submitted in Fulfilment of the Requirement for the Degree of Master in the Faculty of Engineering
Universiti Putra Malaysia

April 2001

In the name of God, Most Gracious, Most Merciful

Dedication to

My Perants,

Professor Dr. Abbas Salih Al-Badri

Professor Dr.Layla Abd Al-Wahab

My Brothers

Oday, Ghaith, Meis, and the rest of my family

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirements for the degree of Master of Science.

SIMULATION MODELS FOR STRAIGHT LINES IMAGES DETECTION USING HOUGH TRANSFORM

By

QUSSAY ABBAS SALIH AL-BADRI

April 2001

Chairman: Abdul Rahman Ramli, Ph.D.

Faculty : Engineering

The Hough transform (HT) is a robust parameter estimator of multi-dimensional features in images. The HT is an established technique which evidences a shape by mapping image edge points into a parameter space. Recently, the formulation of the HT has been extended to extract analytic arbitrary shapes which change their appearance according to similarity transformations. It finds many applications in astronomical data analysis. It enables, in particular, to develop auto-adaptive, fast algorithms for the detection of automated arc line identification. The HT is a technique which is used to isolate curves of a given shape in an image. The classical HT requires that the curve be specified in some parametric form and, hence is most commonly used in the detection of regular curves. The HT has been generalized so that it is capable of detecting arbitrary curved shapes.

Abstrak tesis yang dikemukakan Senat Universisti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

MODEL SIMULASI BAGI PENGESANAN IMEJ GARIS LURUS MENGGUNAKAN HOUGH TRANSFORM

Oleh

QUSSAY ABBAS SALIH AL-BADRI

April 2001

Pengerusi: Abdul Rahman Ramil, Ph.D.

Fakulti : Kejuruteraan

Hough Transform (HT) merupakan satu parameter penganggar yang lasak bagi ciri-ciri multi-dimensi dalam imej. HT merupakan satu teknik yang membolehkan pembentukan bentuk degan memetakan titik sisi kepada ruang parameter. Kebelakangan ini, formulasi HT telah diluaskan kepada pengekstrakan bentuk pengaduran secara terperinci yang berubah bentuk mengikut 'similarity transformations'. Teknik ini mempunyai aplikasi yang luas dalam analisis data astonomi. Teknik ini juga pembolehkan perkembangan algoritma yang cepat dan menyesuai secara otomatik dalam pengesanan pengenalan garis lengkuny lengkurs terkawal. HT merupakan satu teknik yang yang digunakan untuk mengasingkan lengkungan daripada suatu bentuk tertentu dalam imej. HT yang klasik memerlukan lengkungan ini dihuraikan dalam bentuk parametrik tertentu dan oleh yang demikian, paling kerap digunakan dalam pengesanan lengkungan biasa. HT telah disesuaikan dalam bentuk yang umum supaya berupaya mengesan sebarang bentuk berlengkung.

Faedah utama teknik transformasi ini yang merupakan HT klasik bagi pengesanan garisan adalah amat toleransi dalam jurang ke atas sempadan objek sebenar, kami akan menunjukkan bagaimana ia boleh digunakan dalam pengesanan bentuk rambang. HT merupakan satu kaedeah untuk mengesan lengkungan berparameter dalam imej dengan memetakan pixel sisi imej kepada gandaannya dalam ruang parameter. Parameter yang konsisten dengan gandaannya adalah sejajar dengan lengkungan imej. HT mempunyai aplikasi yang umum dalam pengesanan garis lurus.

Kadangkala, HT garis lurus adalah cukup berkesan dalam mengesan ciri-ciri seperti lengkungan tiruan. HT merupakan satu teknik matang dalam mengekstrak bentuk geometri berpandukan fungsi berkembar titik atas lengkungan dan parameter mereka. Teknik ini telah dibangunkan bagi mengekstrak bentuk geometri yang mudah seperti garisan, bulatan dan bujur selain bentuk rambang. HT adalah tahan dalam mengesan ciri-ciri yang tidak bersambung atau tidak lengkap. Titik atau sisi dipetakan kepada pembahgian parameter atau ruang-Hough sebagai individu pengundi di mana ciri-ciri yang diberi tumpuan diwakili dalam bentuk jadual yang tidak analitik. Kelemahan utama HT adalah keperluan pengiraan yang memerlukan ruang ingatan serta masa pemrosesan berkembang secara eksponensi kerana bilangan parameter yang digunakan untuk mewakili satu 'primitive' bertambah. Oleh itu, kebanyakan penyelidikan berkenaaan HT bertumpu kepada mengurangkan beban pemrosesan dalam mengekstrak bentuk geometri mudah. Thesis ini membincangkan kaedah HT bagi pengesanan garisan termasuk pengekstrakan garis lurus yang rambang. Dengan menghuraikan kaedah-kaedah untuk

mengesan dan melaksanakan klasifikasi zarah dalam persekitaran industri, satu algoritma standard bagi pengesanan garisan ini dan mengkaji kesan jarak dan sudut dalam HT bagi pengesanan garisan dengan mengubah parameter ini untuk mencapai ketepatan dalam pengesanan imej garis lurus. Kaedah dan algoritma ini telah dilakukan bagi imej nyata 3 dimensi yang diperoleh dan kemudian diubah kepada 2 dimensi, kemudiannya diuji untuk mencapai pengesanan imej garis lurus.

ACKNOWLEDGEMENTS

First of all, I would like express my utmost thanks and gratitude to Almighty Allah S.W.T for giving me the ability to finish this thesis successfully.

The author gratefully with to express his profound appreciation and gratitude to his supervisor, Dr.Abdul Rahman Ramli, for his supervision, guidance, supporting, and constructive suggestion and comments throughout the duration of the project until it turns to real success

The author also indebted to the members of his supervisory committee, Dr. Md. Mahmud Hasan and Dr. V. Prakash, for their affectionate guidance, prompt decision and valuable assistance during this period.

Appreciation also to the assistance rendered by the respective lecturers, staffs, technicians of the faculty of engineering for providing the facilities required for undertaking this project.

The author would like to thank his family for the encouragement and support without which is impossible for the success of this project, and my friends, specially Ku Day Chyi, Suzan T. for offering helps all the time.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

CAD	:	Computer Aided Design
1 D	:	One Dimension
2 D	:	Tow Dimension
3 D	:	Three Dimension
GHT	:	Generalized Hough Transform
GOL	:	Geometric Object Location
HHT	:	Hierarchical Hough Transform
HT	:	Hough Transform
PHT	:	Probabilistic Hough Transform
SHT	:	Standard Hough Transform

CHAPTER I

INTRODUCTION

The Hough Transform is known as the popular and powerful technique for finding multiple lines in image, and has been used in various applications.

Detecting geometric primitives in images is one of the basic tasks of computer vision. The Hough Transform and its extensions constitute a popular method for extracting geometric shapes. The Hough transform is a technique which can be used to isolate features of a particular shape within an images, cause it requires that the desired features be specified in some parametric form, the classical Hough transform is most commonly used for the detection of regular curves such as lines, circles, ellipses, etc.

Primitives on the HT are represented by parametric curves with a number of free parameters. The principal concept of the HT is to define a mapping between an image space and a parameter space. Each edge point in an image is transformed by the mapping to determine cells in the parameter space whose associated parameters are such that the defined primitive passes through the data point. The chosen cells are accumulated and after all the points in an image have been considered, local maxima in the accumulator correspond to the parameters of the specified shape.

The Hough Transforms methods, needs some the theories and methods such as segmentation, edge detection, Radon Transform.

The Hough transform has many applications, as most manufactured parts (and many anatomical parts investigated in medical imagery) contain feature boundaries which can be described by regular curves or straight lines. The main advantage of the Hough transform is that it is tolerant of gaps in feature boundary descriptions and is relatively unaffected by image noise.

The Hough technique is useful for computing a global description of features (where the number of solution classes need not be known a priori). One possibility is to use the Hough transform for template matching. This is applicable in cases where we have prior knowledge of the shape of the object we are trying to find, but do not know its location, orientation or even size. The problem is to parameterize the shape that we wish to identify in a way that can be easily identified. The Hough transform is very common in applications where the detection of straight lines is required. The advantage of using the simulation package for strait lines image detection: user friendly, littel knowledge in Hough Trnsform methods and technology, flaxablity to display many of images format, powerful to detect the lines in the image which effected by noise or unclear caputre image. Sometimes the stright line Hough Transform is efficient enough to detect features such as artificial curves, who also investigate its robustness in the case of occlusions.

The Hough Transform is explanations in this thesis will assume a basic familiarity with the algorithm, which explained in many computer vision books By achiving the HT method for line detection.

1.1 Objective of the thesis

Our aim is to achieve the intelligent machine vision inspection for the industrial application and research environment.

The objective of this thesis is to present an idea which utilize an line detection and recognition techniques in image processing as a support for camera application in industrial inspection environment.

The main idea is to provide the observe the capability of detection, where the image is affected and being captures in a condition and environment of noise, etc., in this case, other method are unable to extract the lines as accurate as can be Hough Transform.

1.2 Thesis organization

The thesis proposes a method for Hough Transform for line detection, using MATLAB codes as platform.

The theoretical aspect of the Hough Transform for line detection problem and solution is organized into five chapters. Chapter II gives an introduction to the subject by, special operation and transforms, computer vision examples, image processing steps, and finally review on Hough Transform for line detection with the difficulties. For the methods of object detection Chapter III, present of Hough transform methods and technology, introduction of the method used for object detection, Briefly description for Hough Transform, how it work, following steps segmentation, accumulators, detection, conclusion. Chapter IV, present of the methodology which has been used to achieve line detection and all the steps are used, with briefly contents of the program package such as filters, etc, mathematically and practically, supported by working principles flow chart to give briefly explanation to the user. Chapter V, result and discussion, where this result found from the experimental work by generation and the recognition software program, present the Hough Transform for line detection. Finally the conclusion for this research presented in Chapter VI.

CHAPTER II

LITERATURE REVIEW

Machine vision become popular in the early 1980s. At that time, much academic research was done to explore various algorithms or approaches that could improve the capability of vision systems to locate objects reliably. These early research had envisioned various approaches that could lead to enhance vision robustness, reliability, and speed. Unfortunately, due to the lack of general availability, and suitable computing platform, the industry had to rely first on easy to implement recognition techniques such as blob analysis and normalized gray scale correlation algorithms (Tuytaar *et al.*1998).

The performance limitation of these traditional algorithms have been much documented in the past. The rapid rise in computer processor speed is transforming the machine vision industry. Compared to traditional approaches, geometric object location (GOL) offers important advantages. Some of these are its robustness and insensitivity to nonlinear lighting and varying shading situations, part occlusions, background scene variation, low-contrast images, and poorly defined image edges (Illingworth and Kitter 1988).

2.1 Computer Vision

Computer-vision methods try to recognize objects and infer facts from digital images. Produced by either direct digital capture or by scanning photographic film, the images can then be represented by bi-dimensional arrays of pixels, Each pixel containing a number that describes a luminance value. The images are usually projections of the tri-dimensional world, from the perspective of the camera.

Computer-vision models and algorithms (Vishvijit 1993) are frequently based on presumed characteristics of the human vision. One of them is the hierarchical organization. This means that recognition of complex shapes is obtained by first recognizing elementary patterns, then recognizing more complex patterns based on their positional relationships.

Figure 2.1 illustrates the hierarchical model for computer vision, from image capture to file. The image processing start from image capturing by camera. The image then go through enhancement and clarification process. Only, after that the individual feature of each object can be measured. At template machine, decision Is making based on the knowledge available. The knowledge can be manually or automatically. The image can then be recognized. Come out to be fact.

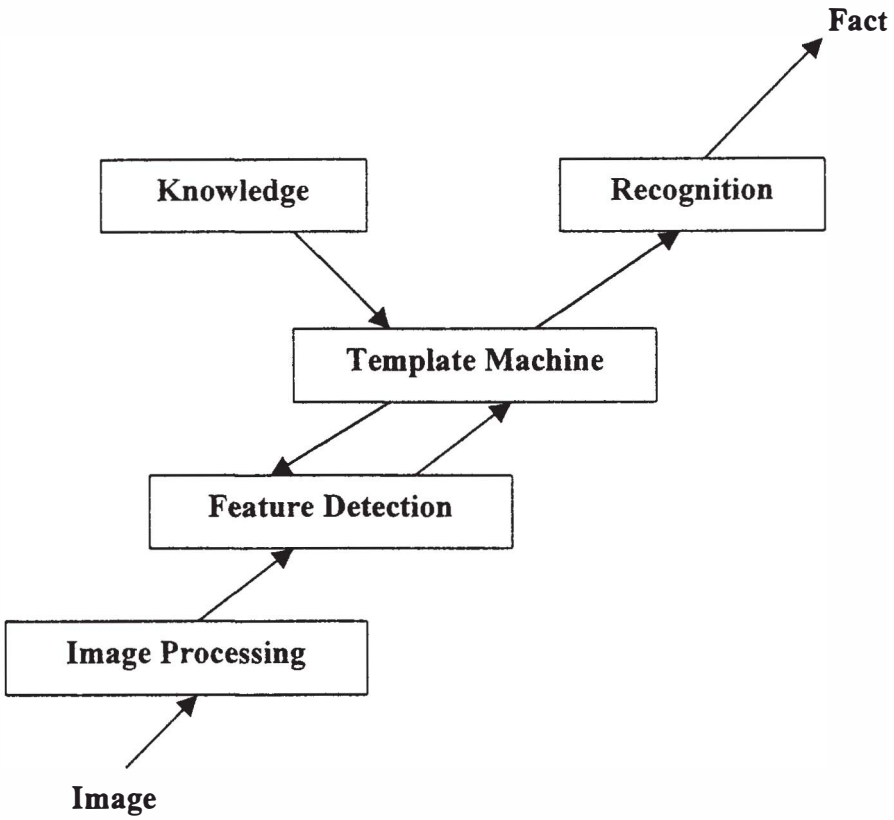

Figure 2.1: A hierarchical model for computer vision: from image data to facts.

2.2 Image Processing

Image enhancement, edge detection, and thresholding are commonly applied on digital images as a first step in extracting information. Linear and non-linear filtering are extensively used in these steps. An often-used technique is the neighborhood-based processing. Each pixel P*(i, j)* of the image has a set of neighbor pixels called structuring element or neighborhood, given by a selection function . A

new array Q is created where $Q(i, j)$ is assigned to $f(i, j)$ for every i and j, for some mapping function f illustrated in Figure 2.2., usually one easily computable.

The filter, given by the composite function is then an operator over the image space, returning a new image from the original one. This allows the cascading of filters until the information of interest is emphasized.

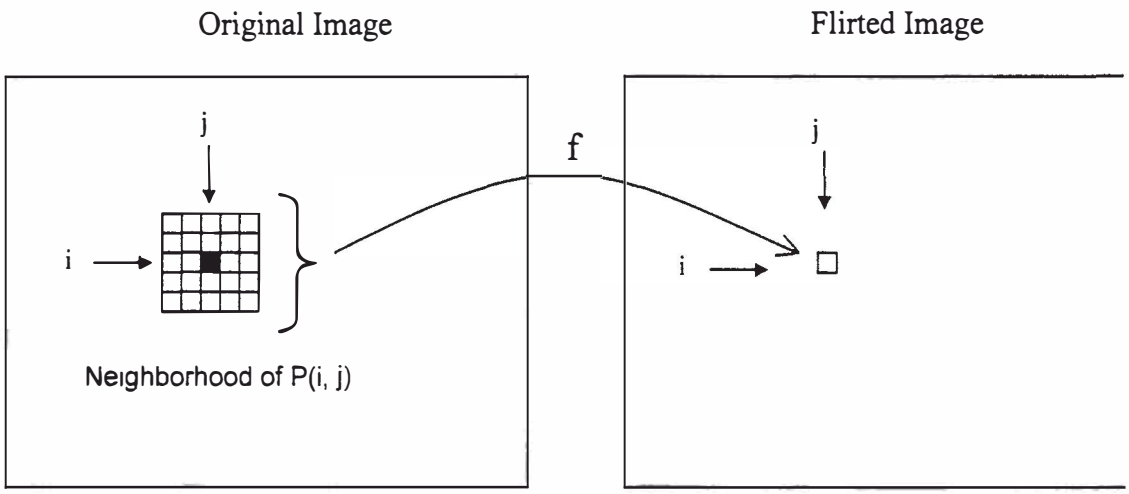

Figure 2.2: Image processing based on neighborhood mappings.

2.3 Image processing steps

Digital Image analysis consists of several steps. The first step is image acquisition-that is, to acquire a digital image. After a digital image has been obtained, the next step deals with preprocessing that image. Partitions an input image into its constituent parts or objects.

The next step is representation and description. Representation is the transformation of raw data into a descriptive form suitable for computer processing. Description deals with extracting features that result in some quantitative information of interest. Such descriptions are necessarily task specific.

The last step is recognition and interpretation. Recognition is the process that assigns a label to an object based on the information of the object. Interpretation assigns meaning to recognized objects. Image segmentation is an essential procedure in many applications of image processing. Image segmentation can be classified to boundary representation and regional representation. Each representation is identification of homogeneous regions or contours of local in homogeneity, respectively.

Segmentation algorithms (Gonzalez and Wood 1992) for monochrome images generally based on one of two basic properties of gray-level values: discontinuity and similarity. In the first category, the approach is to partition an image based on abrupt changes in gray level. The principal areas of interest within this category are detection of isolated points and detection of lines and edges in an image. The principal approaches in the first category are based on edge detection and boundary detection.

Basically, the idea in most edge detection techniques is the local derivative operator. The first derivative of the gray-level profile is positive at the leading edge