

Skeletonization of Image Patterns using Medial Axis Transform

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ABSTRACT

The skeleton of an image object is a powerful tool in order to reduce the storage space when working online. This enables the faster testing of image analysis algorithms. The medial axis of 2-D image patterns provides a conceptual design base, with transition to a detailed design occurring when the radius function is added to the medial axis or surface. To make such a design tool practicable, however, it is essential to be able to convert from an MAT format to a boundary representation of an object. The medial axis of an image pattern is the loci of all inscribed disks that touch two or more boundary points without crossing any of the boundaries. The medial axis transform (MAT) is a powerful representation for objects with inherent symmetry or near-symmetry.

In the proposed work, the medial axis transform has been extracted using the Euclidean distance transform based computation. The image pattern is prepared initially in binary form and then distance of each non-zero pixel to its closest zeroed pixel is computed. This process continues till the entire image pattern is scanned to its core.

I. INTRODUCTION

Skeletonized images (skeletons) are easier to process and they reduce processing time for the subsequent operations. It is a morphological operation that is used to remove selected foreground pixels from binary images. It is somewhat like erosion or opening. It is particularly useful for thinning and Medial Axis Transform. It is only applied to binary images, and produces another binary image as output.

A skeleton of an image can be thought of as a one-pixel thick line through the middle of an object which preserves the topology of that object. It is a fundamental preprocessing step in many image processing and pattern recognition algorithms. This operation makes use of a structuring

element. These elements are of the extended type meaning they can contain both ones and zeros.

II. BRIEF LITERATURE SURVEY

Mark Vincze, Bence Kovari [1] introduce the most common thinning methodologies and propose a method to evaluate their performance, especially in the field of signature recognition.

Khalid Sayeed, Marek Tabe, Dzki [2] states that the state of the art in the area of thinning methodologies, by giving descriptions of general ideas of the most significant algorithms with a comparison between them. Secondly,

Dr.P.Subashini, S.Jansi [3] states that the images interested in a scene can be characterized by structures composed of line or curve or arc patterns for shape analysis. It is used to compress the input data and expedite the extraction of image features.

Louisa Lam, Seong-Whan Lee [4] discusses the wide range of methodologies. It discusses the wide range of thinning algorithms including iterative deletion of pixels and non-pixel based methods whereas skeletonization algorithms based on medial axis and other distance transforms are also subjected.

Dr. Chi Quek, G.S.Ng, R. W. Zhou [5] discusses the thinning algorithm which uses flagmap and bitmap simultaneously to decide if a boundary pixel can be deleted as well as incorporation of smoothing templates to smooth the final skeleton.

Peter Tarabek [6] focuses on performance measurements of thinning algorithms used mainly for digitizing maps with road infrastructure.

Rafael.C.Gonzalez, Richard E. Woods, Steven I. Eddins [7] discusses the fundamental approach to various image processing techniques such as Image Compression,

Morphological Image Processing, Image segmentation, Image restoration etc using matlab.

Gulshan Goyal, Dr. Maitreyee Dutta, Er. Akshay Girdhar [8] states that the vectorization algorithms often used in pattern recognition tasks require one-pixel-wide lines as input the thinning process reduces such components to a thickness of one pixel or sometimes to a few pixels .

Peter Kardos, Gabor Nemeth, Kalman Palagyi [9] discusses that the sequential thinning algorithms use contour tracking: they scan border points and remove the actual one if it is not designated a skeletal point.

N.P. Khanyile, J.R. Tapamo, E. Dube [10] states that the performance of minutiae extraction relies heavily on the quality of skeletons used. A good fingerprint thinning algorithm can depress image noise and promote the robustness of the minutiae extraction algorithm which helps improve the overall performance of the system.

Ferid Bajramovic, Frank Mattern, Nicholas Butko, Joachim Denzler [11] discusses that there are several approaches to improve runtime and/or memory requirements of nearest neighbor methods:

Jacob Graves, Roger Mailler [12] states that a common technique used in studying the locomotion of the worm is to take video of the worm in motion and analyze it to extract relevant data

Liang-Jie Zhang, Shuxing Cheng, Carl K. Chang, and Qun Zhou [13] presents an analytic algorithm that is used to guide the architectural design of service exploration in a service registry. Service assets are proposed to be framed into a well-established categorical structure based on pattern recognition algorithm.

M.A. Comeau, E. Holbaek-Hanssen [14] states that the raster scanning systems make use of optical scanners as the primary mode of input. Instead of manually digitizing the data sources, the original map document is converted, by hardware, into an array of numbers representing the positional distribution of optical density within the image.

III. SKELETON EXTRACTION USING EUCLIDEAN DISTANCE TRANSFORM

The Euclidean distance transform is obtained by computing the distance of a zero pixel to the nearest non-zero pixel and arranging them in a matrix of size as that of the original image. This gives an image with maximum gray color intensities in the centre/core of the image. Below images show the Euclidean distance (ED) transform as computed in matlab:

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Fig. 1 Input Image Fig. 2 ED Transform

The medial axis transform (MAT) of an image is computed by calculating the Euclidean distance transform of the given input image pattern. The MAT is described as being the locus of the local maxima on the distance transform.

The maximum Euclidean distance is represented as maximum gray level intensity in the EDT image. The pixel coordinates of the maximum gray level intensity are extracted from the EDT image by converting the EDT image into row x column matrix. The row and column of the matrix gives the coordinates of the MAT line of the image pattern.

IV. PERFORMANCE EVALUATION PARAMETERS

Connectivity number (CN), Thinness Measurement (TM), Connectivity Measurement (CM), and sensitivity Measurements are computed from the skeleton in order to evaluate the quality of skeleton image. Results are tabulated in the table in result section.

V. RESULTS

Following images show the input image pattern and the corresponding MAT.

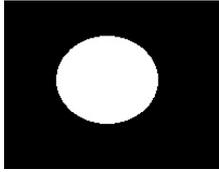


Fig. 3

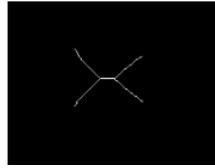


Fig. 4



Fig. 5

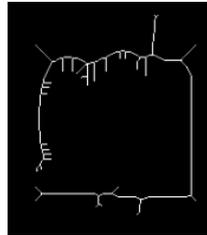


Fig. 6

Input Images – Fig. 1, 3 and 5

MAT Images – Fig. 2, 4 and 6

Following table shows the performance measure of the skeletonized image:

Image No.	CN	TM	CM	SM
Fig. 1	0.08169	514.00	0.002389	0.037180
Fig. 3	0.00760	1.00	0.000127	0.003708
Fig. 5	0.03760	40.00	0.000748	0.018120

CONCLUSION

The result table shows the results after implementing the discussed medial axis transform based skeletonization of image patterns. The Skeletonized images are shown above figures. Higher the thinness factor, better is the skeletonization or thinning. The discussed algorithm has been implemented on matlab version 7.5 and a text file is generated after every skeletonization. The performance parameters are normalized with respect to size of the image. This removes the ambiguity of the image if zoomed or compressed. Euclidean transform based medial axis transformation extraction of image patterns give a good speedy skeleton of image patterns. This serves good purpose in terms of computational speed as well.

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Author's Profile



The author¹ is pursuing her M.Tech. in ECE from DIET, Kharar, Punjab. Her field of interest is in image processing based research and applications.

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