



A Method for Binary Image Thinning using Gradient and Watershed Algorithm

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Abstract- *Thinning is basically reducing a 'thick' digital object to 'thin' skeleton. Thinning is one of the most frequently used methods to know the geometrical feature of objects. For example, the tree structure of the bronchus is determined by using the thinned result of it. Image skeletonization can also apply on medical images for getting for refined causes of cancer or brain tumor.*

There are so many existing algorithms for getting a skeleton of an image. In this paper we purpose a method for skeletonization of an binary image in which we use gradient and watershed to extract what can be an image in actual and perform the skeletonization over the image to avoid higher intensity values. Implement the morphological dilation operator with thin parameter to retrieve the result image. We apply purposed method on some artificial images. Results of applying the purposed method on the variety of images will be shown. We calculate the time and PSNR values and also compare with some existing algorithms. The skeletonization implementation provided in the MATLAB Image Processing Toolbox.

Keywords: *Skeletonization, thresholding, morphological dilation*

I. INTRODUCTION

Thinning is an image processing operation in which binary valued image regions are reduced to lines that approximate the center skeletons of the regions. It is usually required that the lines of the thinned result are connected for each single image region, then these can be used to infer shape and topology in the original image. A common use of thinning is in the preprocessing stage to facilitate higher level analysis and recognition for such applications as Optical Character Recognition, diagram understanding, fingerprint analysis, and feature detection for computer vision. [5]

The skeleton of a binary image is an important representation for the shape analysis and is useful for many pattern recognition application. The skeleton of an object is a line connecting points midway between the boundaries[3]

Thinning techniques have been applied in many fields such as automated industrial inspection, pattern recognition, biological shape description and image coding etc. the main objective of thinning is to improve efficiency, to reduce transmission time.

The skeleton refer to the 'bone' of an image[5]. The first reported idea of skeleton as we know was given by Blum[1], where a skeleton is defined as a set of points at which the firefronts of "grassfires" started from the boundary meet.

Many thinning algorithms have been presented, all of them roughly classified into two class: one is sequential algorithm, other is parallel thinning.

The rest of the paper is organized as follows. In section II introduction to morphological dilation, section III introduction to skeletonization, section IV introduce purposed method and section V contain results and then conclusion.

II. MORPHOLOGY

Morphological techniques typically probe an image with a small template known as a structuring element (SE). The SE is small compared to the image and its size, zeros and ones in matrix define its shape. The SE is positioned at all possible locations in the image and it is compared with the corresponding neighborhood of pixels. By marking the locations where SE fits or hits the image information about the structure of the image can be obtained. The SE "fits" image if for each of its pixels that is set to 1 (foreground), the corresponding image pixel is also 1. For the 0 (background) pixels in SE corresponding image pixels values are irrelevant. The SE "hits" image if for any of its pixels that is set to 1, the corresponding image pixel is also 1. Image pixels for which the corresponding SE pixel is 0 are also ignored.[6]

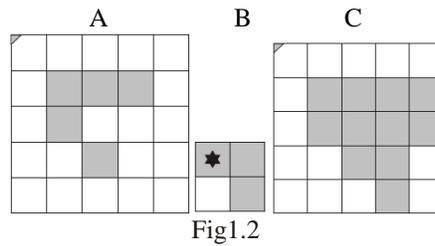


Figure 1.2 Binary Dilation (A - input picture, B - structuring element (SE), C - result)
 $D(A,B) = c \mid c = a + b, a \square \square A, b \square \square B$

In this operation SE probes image in all places where image pixels are 1 (gray color in figure 1.2) and saves all the 1 pixels from SE into the result image.

III. SKELETONIZATION

Binary skeletons can be retrieved by using the MATLAB function `bwmorph` with the operation set to 'skel' and the parameter N , the number of operations to be repeated, set to infinity, which means the operation will be repeatedly executed until the image does not change any more.

The skeleton obtained by this way is essentially a homotopic skeleton generated by a series of sequential thinning adopting the structuring element L from the Goly alphabet[2]. A morphological thinning / is defined as $X/B=X \setminus (X \times B)$

where \times is the hit-or-miss transformation.

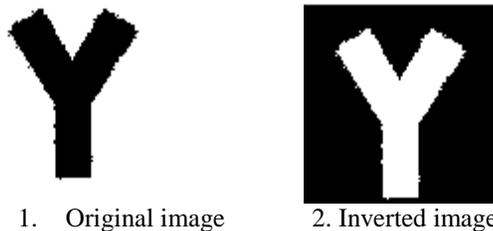
The `bwmorph` function uses eight calls to the MATLAB function `applylut`, eight logical NOTs and eight logical ANDs to perform one round of sequential thinning, and repeat the thinning until the operation no longer generate changes to the binary image[4]

IV. PURPOSED METHOD

- A. The steps of purposed method:
 1. Read the Source Image called `Img`
 2. Convert image to Black and White Image respective to some threshold value
 3. Fill the black areas of image with specific gradient.
 4. Implement the Curvelet to extract curvic structure of image
 5. Caculate the distance vector of each pixel of image respective to the curvelet image and generate a new distance vector image called `img1`
 6. Implement the Watershed algorithm on this `img1`
 7. Find the maximum intensity value from image
 8. Extract the edges having least intensity values and called it edge image `EImage`
 9. Perform the skeletonization over the image to avoid higher intensity values and keep low intensity edges from image
 10. Implement the morphological dialation operator with thin parameter to retrieve the result image
 11. Return the output image

V. RESULTS AND COMPARISON

The algorithm has been tested on a variety of images. In most cases the algorithm produced satisfactory results



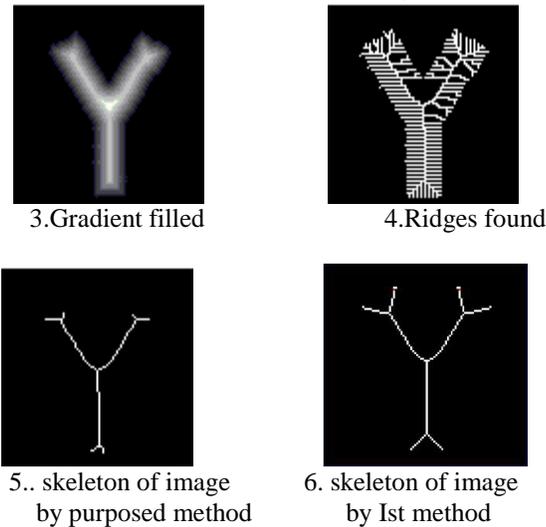


Fig 1.1

We compare with the Yoshito Mekada, Junichiro Toriwaki (Ist method) algorithm in Table 1.1 for **Y** alphabet

METHOD	PSNR VALUES	ELAPSED TIME (in milliseconds)
Purposed method	(gradient filled) 5.7123, 5.7103, 5.6961 (Ridges) 5.4568 (skeleton) 5.8988	5370.409
Ist method	11.7462	

Table1.1

In Table 1.2 shows the results after applying our method on two images air.gif and on star.bmp

VI. CONCLUSION

In this paper, we mentioned a method for image thinning using gradient and morphological dilation operator to find the resulted image. The method was applied to some artificial images. By the result, proposed method help to find what can be an image in actual by filling it with gradient like in star and airplane image after filling gradient an image look like an image. So we use it in satellite images to find what can be an image in actual.

References

- [1] H. Blum, "A transformation for extracting new descriptors of shape", Proc. Symp. on Models for the Perception of Speech and Visual Form, MIT Press, 1967, pp. 362-380.
- [2] M. J. E. Golay, "Hexagonal parallel pattern transformation", IEEE Trans. Computers, vol. C-18, no. 8, 1969, pp. 733-740.
- [3] M. Senthilnayagi, S. Veni, and K.A.Narayanam Kutty "Hexagonal Pixel Grid Modeling for Edge Detection and Design of Cellular Architecture for Binary Image Skeletonization" at 2006 IEEE
- [4] MATLAB Image Processing Toolbox User's Guide.
- [5] MR. R.M.NOORULLAH AND DR.A.DAMODARAM "INNOVATIVE THINNING AND GRADIENT ALGORITHM FOR EDGE FIELD AND CATEGORIZATION SKELETON ANALYSIS OF BINARY AND GREY TONE IMAGES" In Journal of Theoretical and Applied Information Technology
- [6] Peter TARÁBEK "MORPHOLOGY IMAGE PRE-PROCESSING FOR THINNING ALGORITHMS" Journal of Information, Control and Management Systems, Vol. 5, (2007), No.1
- [7] Tang Changqing (1990) Mathematical morphology and its application science publish house press Beijing

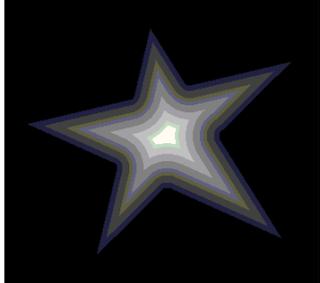
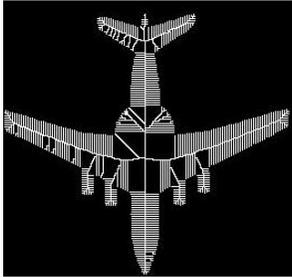
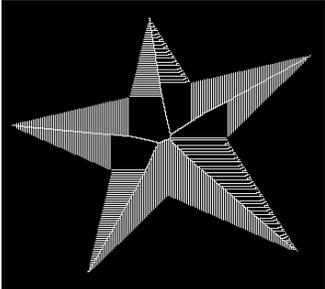
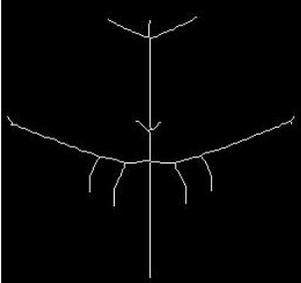
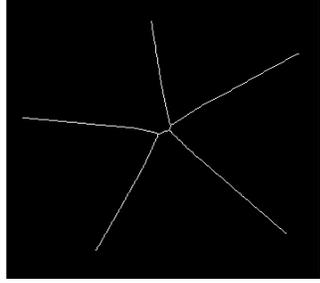
<p>1. Original image</p>	 <p>(Air.gif)</p>	 <p>(star.bmp)</p>
<p>2. After filling gradient</p>		
<p>3. Ridges found</p>		
<p>4. Skeletonization</p>		
<p>5. PSNR value</p>	<p>11.6026</p>	<p>10.3382</p>
<p>6. Elapsed time</p>	<p>2094.367 milisec</p>	<p>3312.283 milisec</p>

Table 1.2