Design and manufacture of Skeletonization Applications

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ABSTRACT

The development of image processing technology is well developed today, such as object recognition in an images. Algorithm to obtain accurate results in object recognition continues to be developed. One example is the handwriting recognition application. This application is usually used to archive records or documents from physical form such as a notebook or a letter in the form of files digital. One of the initial process in image processing is image segmentation, and one of the methods used is skeletonizaton.

This Skeletonization uses Discrete Local Symmetry. The process begins by setting the active contour of the image. From the active contour triangulation process is done. And from the process the symmetry points are defined. Skeletonization process is then performed using point symmetry obtained.

The results show that the size of an image greatly affect the outcome of the process of skeletonization using Discrete Local Symmetry. Discrete Local Symmetry methods suitable for ribbon-like shaped objects.

Keywords

Image Processing, Skeletonization, Discrete Local Symmetry.

1. INTRODUCTION

The development of image processing technologies are developing at present, including the introduction of objects on the image. Algorithm to obtain accurate results in object recognition continue to be developed. One example is the handwriting recognition applications. This application is usually used to archive records or documents from physical form as notes and letters into book form of a digital file.

Pengenalan obyek pada citra membutuhkan beberapa tahap dalam proses pengolahan citra salah satunya adalah proses segmentasi citra. Banyak metode yang dapat digunakan dalam proses segmentasi citra, salah satunya adalah *Skeletonization.* Proses *skeletonization* digunakan karena hasil yang diberikan berupa kerangka citra yang masih mempunyai karakteristik topologi dan bentuk asli dari citra tersebut. Dimana hasil kerangka citra dapat digunakan lebih lanjut dalam aplikasi pengolahan citra seperti aplikasi pengenalan pola, pengenalan tulisan maupun pengenalan sidik jari[2]

Many existing skeletonization methods being developed. One example is using the method of thinning skeletonization. But the method that is mentioned to have weaknesses where the result of that process is affected by noise. So the result order obtained do not comply with the characteristics and the original form of the image. In addition, the size of the image also affect the length of time the process because the number of pixels the skeletonization will in the process more and more. To overcome these problems, a skeletonization method developed robust against noise using the method of Discrete Local Symmetry.[4]

2. *SKELETONIZATION*

Skeletonization is one of image processing which has enough global functions. Skeletonization is widely developed because the framework has a good structure and still have the characteristic shape of the image making it suitable for use in image processing applications, one of which is pattern recognition.

Many methods can be used in the process of using operators such as skeletonization morphologi e.g. thinning and (called pruning). And some other methods like using level sets, curve evolution, constrained delaunay triangulation [3] and distance transform.

In general the method in the skeletonization can be divided into two pixel-based and non-pixel-based. In pixel-based method used is usually thinning or distance transforms. While in a non-pixel-based, only the contours of the pixels of an object that is used to process the skeletonization. [4]

Method of non-pixel-based usually has a faster processing time than the pixel-based because fewer processed data. To get an order of an object using contours, discrete local symmetry of the object should be obtained accurately. Discrete local symmetry can be calculated from the pixel of the objects contour. Techniques for identifying discrete local symmetry matching used in low resolution image or medium, this is because in the high resolution image, all the pixels of the image contours used in the calculations. [4]

2.1 Discrete Local Symmetry

Discrete local symmetry (DSL) describes a symmetry between the contour of the pixels of an image with contour segments between two adjacent contour pixels. The concept was developed to obtain a the symmetry between the contour pixel and contour segment that showed a series of contour pixel [5]. A contour is divided into a series of segments with the linearization process where two ends of each contour segments connected by straight line segments.

It is assumed that no straight line segments intersect each other at interior points. Thus, the contours of the shape of the picture can be indicated with a planar straight line graph G (V, E) where ends of E and vertices V is a straight line segment and the end of the contour. A vertex v ∈ V and point e ∈ E form a generalized Discrete Local Symmetry (gDLS) if loop in the triangle formed by a T v and e there was no tip from the vertices of G which is visible from all other vertices of t. and T is contained in the object in the original image. Two dots are visible from every segment of the line that connects them not intersect with point e ' ∈ e. A gDLS will be DSL if in the main

segment of the contour, there are only two and only 2 contours pixels.

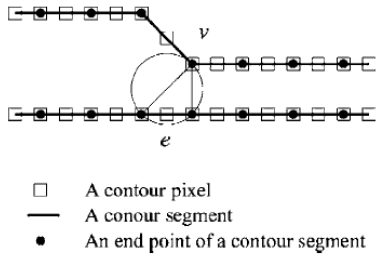

Figure 1. Metode Discrete Local Symmetry.

2.2 Contour Pixel

Contour Pixel is the set of pixels that form the boundary edges of the Contour can be open or closed [1]. Regional boundaries are useful to describe the shape of the object in the image analysis stage. Contours can be divided into two, namely, closed contour and open contour. Close contour is contour with the boundaries that surround an area, and open contour can be line or part of the boundaries of the area.

3. SYSTEM DESIGN

The software system developed for the process of Skeletonization method using Discrete Local Symmetry is composed of five main processes. The first is the process of processed imagery grayscaling, where from the image will be transformed into the image of colored grayish. The second is the process of thresholding the image results from the images obtained so grayscaling consisting only of black and white. This is done to help the next process to get accurate results. Then proceed with the process of with Edge Detection. In this process the pixels of the image of the contour is obtained.

The fourth process is the process of Triangulation, where contour pixel Edge Detection result of the process divided into triangles. The last process is the search axis of symmetry derived from the process of Triangulation process results and Skeletonization are displayed.

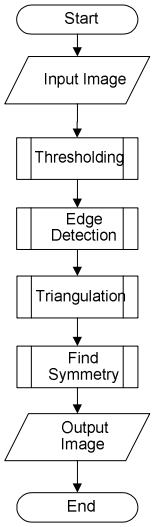

Figure 2. The Main Process Flowchart.

3.1 *Triangulation*

The process of Triangulation is the main process in the method of Discrete Local Symmetry. On the process of triangulation is the result of the process of Edge Detection will be divided into active contour which would have made the point to draw a triangle. Description of the process in general are shown in Figure 3.

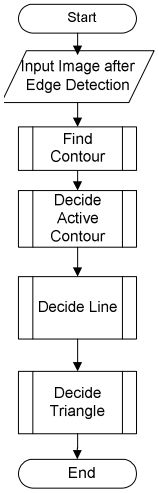

Figure 3. *Flowchart Triangulation*.

4. IMPLEMENTATION AND TESTING

In this section it will be shown the test results using the method of Discrete Skeletonization application Local Symmetry. The test will be divided into four parts, namely the validation test, test on paper, test on the image and test the thickness.

4.1 Test Validation

In this section the results of the use of the application in the validation test. To test the validity of apikasi made use image by comparing image desired results with images thickened. From the results of the validation test the original image and the result still has the same basic shape

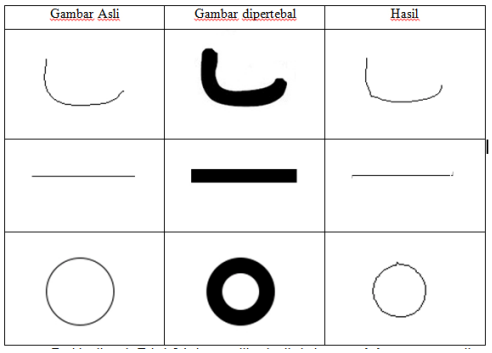

Figure 4. Validation Test Results

4.2 Test on Writing

In this chapter will sub compared the results with the other 2 methods of application which is thinning and Distance Transform of writing.

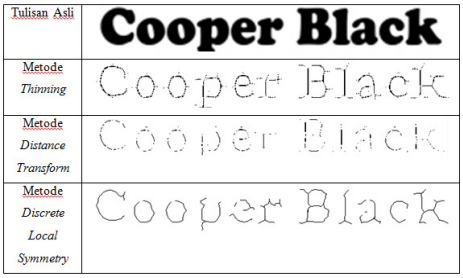

Figure 5. Results of test on Writing the alphabet

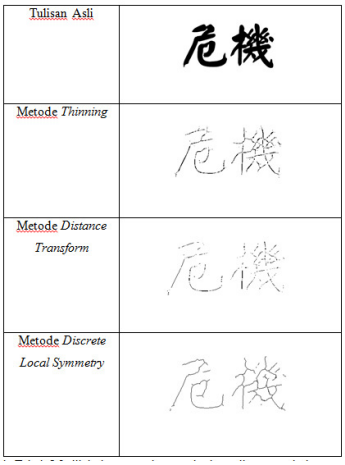

Figure 6. Test results on Chinese Writing

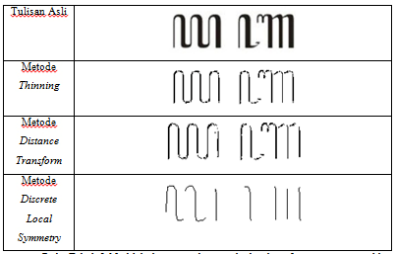

Figure 7. Results of test on Writing Java

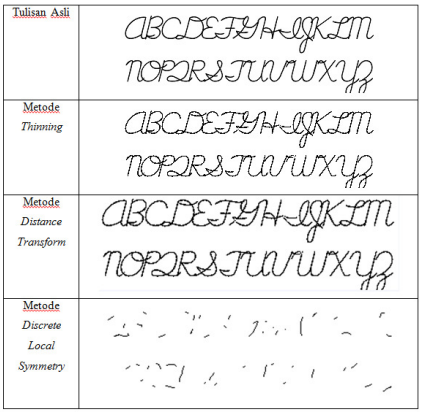

Figure 8. Test result on Handwriting

From the test results in Figure 5 and Figure 6 shows that the basic form of writing is still legible, but drop out in some parts of the letter. In Figure 7 a thin piece of writing to be lost so that the basic form of writing changed. Whereas in Figure 8 results out of shape. Loss of yield due skeletonization posts are too thin.

4.3 Test in Figure

In this section the results will be compared with two other methods of application are thinning and Distance Transform on the image.

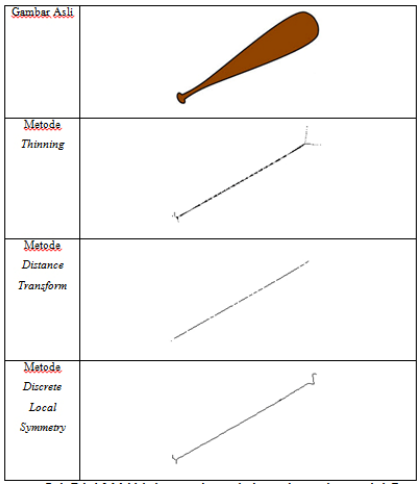

Figure 9. Test Results in Figure Sticks

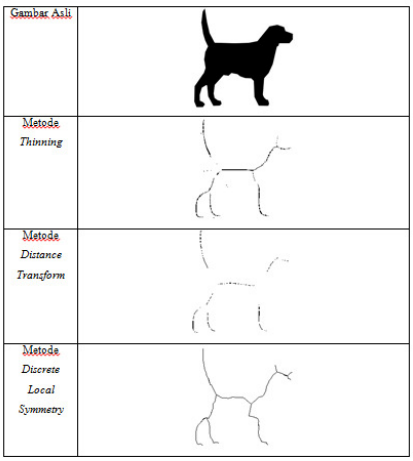

Figure 10. Test results on the image of the dog

From testing on a stick and the silhouette of a dog, the skeleton of the method of Discrete Local Symmetry still has the same basic form with the original image.

4.4 Thickness Test

On the sub chapter applications will be tested against the thickness of various sizes in units of pixels.

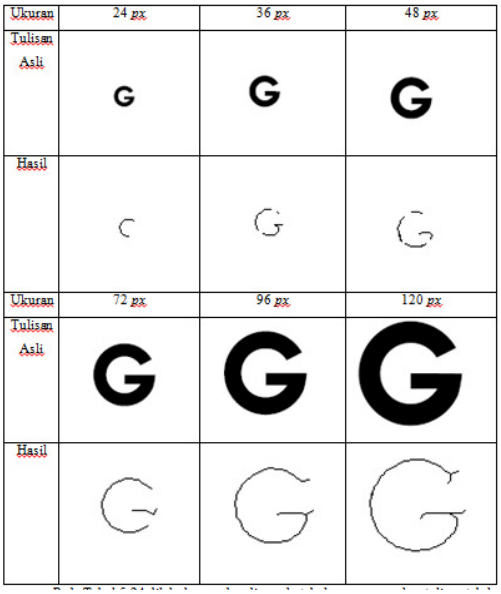

Figure 11. Test Results Thickness in letter

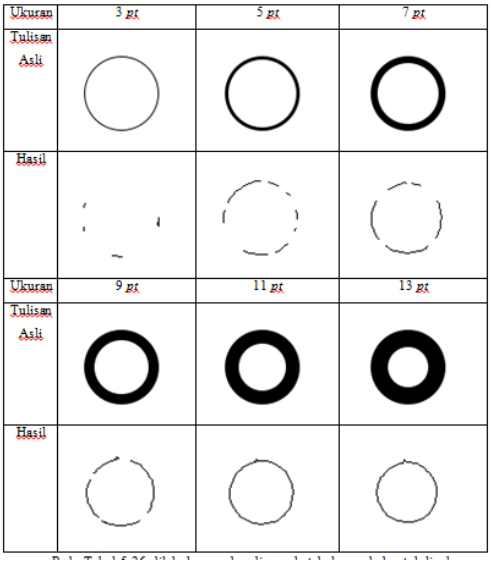

Figure 12. Test Results The thickness of the image circle

From the test against the thickness of this proves that the method is weak against the thin image. In Figure 11 the new form of writing seen in size 36 pixel 12 Pictures while on the basic forms of the new circle is visible on the thickness of the 5 points, although the results are not perfect.

5. CONCLUSION AND ADVISE

5.1 Conclusion

Based on the test results can be concluded as follows:

- Through testing we can conclude that different active contour placement in an image affect the outcome of the Local Discrete Symmetry method. This is because the placement of which is based on active contour pixels to make the results of different triangulation process. This can be seen in which the thickness of the test results of the skeleton of the letter G in Figure 11 should be the same.
- Based on the test results thickness Local Discrete Symmetry method is not suitable for thin images because it can eliminate the basic form or interruption of the skeleton of the image results.
- From the test results Local Discrete Symmetry method is more suitable for ribbon-shaped objects like such in writing and written Mandarin alphabet.

5.2 Advise

The few things that can serve as suggestions in the process of further development, among others:

- Development of applications in order to process the skeleton for the posts with a small size.
- Development of algorithms in order to find the midpoint of an image accurate.
- Development of algorithms in order to avoid breaking the result of skeletonization process.

6. REFERENCES

[1] Munir, Rinaldi (2005). Kontur dan Representasinya,141. Retrieved April 26, 2013, from http://informatika.stei.itb.ac.id/~rinaldi.munir/Buku/Pengolahan%20Citra%20Digital/Bab-9_Kontur%20dan%20Representasinya.pdf

[2] Zhao, F., Tang, X.(2007). "*Preprocessing and postprocessing for skeleton-based fingerprint", Pattern Recognition, vol 40 (pp. 1270 – 1281). HongKong: Elsevier*

[3] Zou, J.J., Yan, H. (2001). *Skeletonization of Ribbon-Like Shapes Based on Regularity and Singularity Analyses. School of Engineering and Industrial Design University of Western Sydney, Australia.*

[4] Zou, J.J. (2003). *A Fast Skeletonization Method. School of Engineering and Industrial Design University of Western Sydney, Australia.*

[5] Zou, J.J. (2006). "*Efficient Skeletonisation Based on Generalised Discrete Local Symmetries*", *Optical Engineering, vol.* 45*, no*. 7, *article number* 077205, pp. 077205-1 –077205-7.