 ISSN: 2454-4248
35 – 37

Performance Analysis of Iterative Thinning Methods using Zhang Suen and Stentiford Algorithm

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Abstract:Thinning is the most important technique used in image processing. Thinning is used to show the skeleton of the image by removing the pixel layer by layer. It is also known as skeletonization. This technique involves various algorithms, and the best working algorithm is Zhang Suen algorithm. The proposed algorithm focuses on the performance analysis to produce better results in terms thinning rate and PSNR values. The proposed algorithm uses a 3*3 neighbourhood of an image and starts its skeletonization method. The paper analysis the Zhang Suen and Stentiford algorithm and the accuracy of the thinned image has been calculated by the Thinning rate of the Thinned image. Matlab is the software used for the implementation of the algorithm.

Keywords:*Thinning, Skeletonization, Thinning Rate, PSNR.*

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I. INTRODUCTION

Thinning algorithms are developed to address a wide variety of problems in thinning. In digital image processing, thinning is a fundamental early pre-processing step usually applied in many computer vision applications. It can also be defined as act of identifying those pixels belonging to an object that are essential for communicating the object's shape. . At present, there are many thinning algorithm for binary images, e.g. classical thinning algorithm, Deutsch algorithm, Pavlidis asynchronous thinning algorithm, Stentiford thinning algorithm, the axial skeleton thinning algorithm, Zhang-Suen fast parallel thinning algorithm, etc. But Zhang-Suen thinning algorithm, finally refine the result to a single pixel. Performance measurement is carried out between Zhang – Suen's thinning algorithm and MATLAB command for image thinning in terms of Thinning Rate.

II. SKELETONIZATION TECHNIQUE

Skeletonization refers to the decomposition of pixels of an image until the skeleton is exposed.

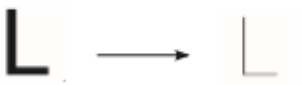

Fig. 1Skeletonization

Skeletonization consist of two algorithms
1. Iterative Thinning Algorithm
2. Non Iterative Thinning Algorithm

Iterative Thinning Algorithm:
This algorithm reduces the pixel layer by layer in an iterative process either in a sequential way or parallel way.

Non Iterative Thinning Algorithm:
Thins algorithm is just opposite to Iterative Thinning Algorithm. Where the pixel are not deleted Layer by Layer.

III. LITERATURE REVIEW

Lynda [1] In this paper proposes the directional approach used by ZS. The implementation is done by comparing two algorithms and the performance evaluation and experiments show that the hybrid approach algorithm is faster and produces better skeletons in terms of thinness and visual quality, solves the problem of loss of connectivity due to the complete removal 2 × 2 square incurred in ZS and adequately avoids excessive erosion. The ZS algorithm shows better results in terms of thinning rate, thinning speed, visual quality and connectivity preservation.

Sanket, Rahul [2] proposes most common thinning algorithms on printed Gujarati text and handwritten numerals. The main focus is in two types of algorithms: The first is serial thinning and second is parallel thinning. Skeletonized character reduces the complexity of the shape of the character. there are five algorithms used in this paper with different shapes like small,medium,bigger in size of a character the performance analysis is been concluded with different analysis . There are different algorithm is been worked in which LW works well. But in case of handwritten numerals ZS gives better results with a highest average result.

Padole [3] proposes two Iterative algorithms to thin a binary image. In first algorithm the binary image is thinned using two operations: subtraction and edge detection. In the Second algorithm it is based on deleting the pixels repeatedly until a single pixel width is obtained. But the result shows that this iterative thinning algorithm is time consuming as it is edge based thinning algorithm.

Jagna [4] proposes efficient image independent parallel thinning algorithm. The results are compared with other

standard thinning algorithms in terms of thinning time, thinning ratio, excessive erosion, connectivity, endpoint preservation, and visual quality. The examples shown in this paper is a heterogeneous image. This algorithm process the image in two-passes, in first pass of this algorithm, the entire image is thinned to two pixels thick and in second pass; the two pixel width image is further thinned to one pixel thick without any discontinuities in the resultant image.

Wei, Zhengchao [5] in this paper proposes the kind of practical refinement algorithm in Zhang-Suen fast parallel thinning algorithm. The Zhang-Suen fast parallel thinning algorithm expands by making the original algorithm based on good characteristics, increased the effect of noise weaken, the method of solving the Zhang-Suen refined after thinning algorithm line width for not only one pixel wide, and to except by the acute Angle at the line produced by redundancy line. By this method, the excellent characteristics of the original algorithm can be maintained and problems in the original algorithm can be solved.

Anil [6] in this paper Stentiford is been used with the Otsu thresholding method which determines the intensity margin set which the user sets. To simplify the margin determination Otsu method has played a vital role. The Stentiford algorithm is been used to mark out the boundaries of the object. The results obtained in this paper is been convincing for the threshold boundary.

Lynda, Basel [7] proposes a modified ZS thinning algorithm for implementation and also comparison of different existing algorithms is been used. Various image databases is been used for the results and performance evaluation. The MZS algorithm gives perfect connected thinned skeletons which are having single pixel width and does not affected by boundary noise in a short time. Moreover good visual quality is obtained in results which lead to best out performing Image Thinning Algorithm. This implementation algorithm used is done on a GPU using CUDA framework. Thus this application proposes MZS based GPU into fingerprint and retinal identification systems. The performance accuracy is also compared with other existing methods.

IV. ZHANG SUEN ALGORITHM

This Zhang Suen Algorithm is the fastest and simple algorithm to implement. This algorithm deletes pixels through iterations. This algorithm takes a binary image as input and reduces the pixels and gives the skeleton of the image in one pixel width. A single pixel width is displayed until certain conditions are satisfied.

1. The connectivity number should be one

2. It should have two black neighbours and not more than six.

3. At this step only one of Ii (I,j+1), I(i-1, j) and I(i, j-1) should be white.

4. At this step least one of I(I-1,j), I(i+1, J) and I(I,j-1) should be white.

The above steps should also be repeated for black pixels as the next iteration after performing the previous steps (1, 2) then following steps should be performed

At this step least one of I(i-1, j), I(I,j+1), and I(i,+1 j) should be white.

At this step least one of I(I, j+1), I(i+1, J) and I(I,j-1) should white.

The accuracy of the thinned image is been measured by the THINNING RATE.

THINNING RATE:

The degree in which an object is been completely thinned and can be measured in terms of thinning rate. The thinning rate is calculated by the total triangle count of the thinned image by the total triangle count of the original image. If the thinning rate=1 then the image is completely thinned, whereas if the thinning rate=0 the image is not thinned at all.

V. STENTIFORD THINNING ALGORITHM

The Image is been in the form of Template. The template is in the following order:

—T1 - from left to right and top to bottom;

—T2 - from bottom to top and from left to right;

—T3 - from right to left and from bottom to top;

—T4 - from top to bottom and from right to left.

The Stentiford Algorithm can be stated as the following steps:

1. The pixel location (i, j) matches the images in the template T1.All Pixels top of the image are been removed from leftto right and from top to bottom.

2. The central pixel is will not be the endpoint, and has connectivity number = 1, then mark that pixel for deletion.

3. Step 1 and 2 for all pixel locations matching T1 are to be repeated.

4. And steps 1-3 for the rest of the templates: T2, T3, and T4. are also to be repeated.

5. Finally the white pixels are set marked for deletion

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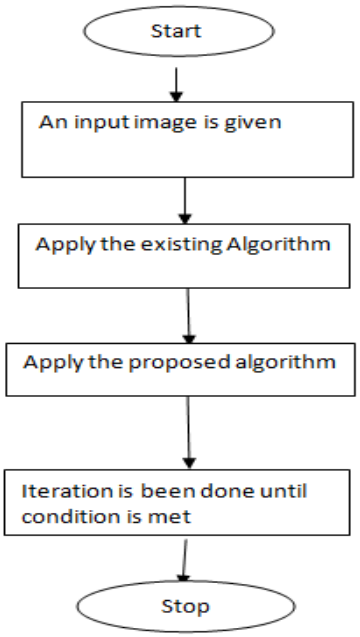
VI. PRPOSED METHOD



The binary image is been taken and two algorithm is been used in order to evaluate the perfect thinned image. The Connectivity Function is been used to show the processing in thinning of an image. This connectivity function has been used to perform the step by step pixel reduction process without lose connectivity and image erosion. This proposed method combines certain workflow of the existing algorithms. The Thinning Rate, PSNR value is been measured in which the measures are in the convincing way.

VII. EXPERIMENTAL RESULTS

The experiments are conducted in order to make a binary image in one pixel width. The one-pixel width, are considered as the thinning challenges criteria's in this research. Experimental results prove that the proposed method can thin both textual and non-textual binary image efficiently. We have been implemented both ZS and Stentiford Algorithm with a new method connectivity function in order to attain a perfection in Thinning the binary image in one pixel width.

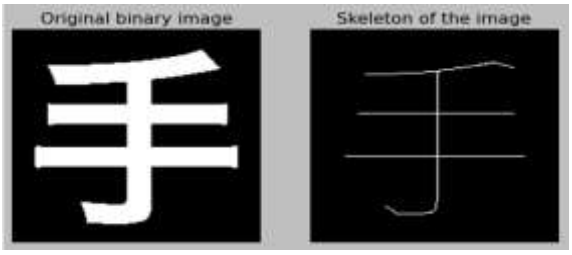


Fig. 2.Textual Thinning (a) Original image (b) Thinned Image

VIII. CONCLUSION

This paper proposes two algorithms with a new method connectivity function in which the accuracy is been convincing and the binary image is been thinned in a single pixel width without any loss in connection of the edge points. Thus this proposed algorithm can also been enhanced with different combination of Thinning Algorithms in order to attain the perfection without any lose connectivity and distortion of the binary image.

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