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A Review Paper on Thinning of Image Using Zhang and Suen Algorithm and Neural Network

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Abstract: *This review paper provides a concise survey on different techniques for thinning and their comparison in image processing. Thinning is one of the fundamental requirements is to represent the structural shape of digital images. This can be done by reducing it to a graph. This process may be completed by obtaining the skeleton of the particular region of the image or the full image using skeletonization of the image also known as thinning. Skeletonization is the process of extracting skeletons from an object in a digital image. Skeletonization has been used in a wide variety of other applications like Optical character recognition, Pattern recognition, Fingerprint classification, Biometric authentication, Signature verification, Medical imaging. It proposes the new algorithm using Zhang and Suen algorithm also neural network based on various factors like PSNR, MSE, execution time and thinning rate. There are different techniques for thinning of the image like iterative, non-iterative etc.*

Keywords: *Thinning, Skeletonization, Image Processing, Zhang and Suen, Neural Networks, Thinning rate, Thinning speed.*

I. Introduction

An image consists of a set of points or picture elements stored as an array of numbers in a computer [6]. Image processing is the study of any algorithm that takes an image as input and returns an image as output. Output includes image display and printing of the image, image editing and manipulation, image enhancement, feature detection and image compression. Skeletonization is the process of extracting skeletons from an object in a digital image. It is morphological operation that deletes black foreground pixels iteratively layer by layer until one-pixel width skeleton is obtained. Skeletonization is essentially a "pre-processing" step used in many image analysis techniques.[8,9] Thinning is the process of reducing any image into a digital image to the minimum size that is essential for machine recognition thinning process of that object [10].This process is usually applied to binary images which consist of black and white pixels which are also known as foreground and background pixels. It takes input a binary image and produces another binary image as output. With the use of neural networks, we can perform thinning invariant under arbitrary rotations. Skeletonization has been used in a wide variety of other applications like Optical character recognition (OCR) [2], Pattern recognition, Fingerprint- classification, Biometric authentication, Signature verification, Medical imaging. Skeletonization reduce the amount of data required to be processed as it takes less time and extraction of critical features such as end-points and connection among the components is helpful in many applications [4].By reducing an object to only a skeleton, unimportant features and image noise can be filtered out.

II. Literature Review

This review paper provides a survey on different skeletonization techniques which are given in previous papers.

In [1] the author proposes a new thinning algorithm which combines sequential and parallel approaches. And these approaches come under iterative approach. The thinning algorithm is comprised of three stages. And the first and second stage is used to extract the skeleton of the input image and the last step is used for optimizing the skeleton into one-pixel width. And the experimental result shows that the proposed skeletonization algorithm produces better, effective results than the previous thinning algorithms.

In [2] the author proposes two new iterative thinning algorithms for thinning images. Input image must be a binary image. The first thinning algorithm of binary images is done using two operations first is edge detection and second is subtraction. The second thinning algorithm is based on peeling the pixels until a skeleton of the image is obtained from the binary image as input. The results show that edge based and subtraction based iterative thinning algorithm is time- consuming as compared to optimized Skeletonization algorithm.

In [3] the author introduced a new technique for making thinning algorithms robust against noise in sketch images and also having fast computation time. The framework estimates the optimal filtering scale

automatically and adaptively to the input image. Experimental results showed that this framework is robust against typical types of noise which exists in sketch images, mainly contour noise and scratch.

In [4] the author proposes an algorithm based on morphological operators with the use of hypergraph and also describes its application like Biometric authentication, Signature verification for thinning algorithms. These operators are used prevent errors and irregularities in the skeleton. These operators using hypergraph such as dilation, erosion etc. is a new approach of thinning in image processing and these operators act as a filter for the removal of the noise and also remove the errors from the images.

In [5] the author proposes an algorithm which is combining two thinning approaches that is parallel and sequential which are further categorized under iterative approach. This is widely used approach for thinning of the image. The result of thinning of image is giving much better results when comparing with other thinning techniques. This method is applicable for any shape with any rotation.

In [6] the author briefly, describes an open CV based java platform using Zhang and Suen thinning algorithm. It describes that the proposed implementation for the thinning of the image with the existing implementations of Zhang and Suen thinning algorithm using Matlab platform, C++ and it compares the performance parameters like computation time for the skeleton of the image, thinning rate, removal of noise with others. This experimental results achieved by openCV based java platform. It is faster in terms of computation time and better removal of noise from the image when compared to Matlab and C++.

Review on skeletonization with neural network

In [7] the author proposes a new approach that is feed forward neural network approach for simulation of Zhang-Suen algorithm. There are number of parameters are chosen based on experimentation like values of MSE, PSNR, and Execution time. Performance graphs have been plotted also for comparing with existing approaches. It is proved that experimental technique using feed-forward neural networks is better in terms of PSNR, MSE in comparison to the existing technique. Results also show that using neural networks technique the algorithm takes less execution time for skeletonization of any type of image. Future work will be related to the use of back-propagation using neural networks, algorithm takes less execution time, thinning rate for performing skeletonization.

III. Technique

Zhen Suen algorithm

It is very popular and well proved algorithm for thinning of an image. This algorithm was proposed by Zhang and Suen in 1984. In base paper Zhang and Suen technique is used to thin black and white pixels because this algorithm works on binary images. [11] A new hybrid thinning algorithm is proposed using Zhang and Suen algorithm to produce a new thinning algorithm for better results. [12]

[A] Existing Work:

Step for the process of thinning of the image in the base paper are:

[a] Image Acquisition:

Images are acquired with the help of digital camera or it is process of acquiring the image from any source. This is the first step because without image acquiring process, there will be no processing of the image.

[b] Image Pre-processing:

Image pre-processing techniques are applied to remove noises and other unwanted objects from the images .[10] It includes shade correction, removing artifacts, image clipping, image smoothing, image enhancement formatting, and filtering, binarization and edge detection. In thinning noise removal and binarization of image is the second step. [9]

[c] Hybrid Thinning Algorithm:

A new hybrid thinning algorithm using Zhang and Suen technique. This technique work on the binary images and binary image to be processed and it produces better skeletons with less computation time. It propose a new thinning algorithm which combines the directional approach used by Zhang and Suen algorithm and the subfield approach in order to produce a new hybrid thinning algorithm which is more efficient, produces better thinner results (skeleton thickness is equal to one), better PSNR, MSE, visual quality than the ZS algorithm and it also solves the ZS's loss of connectivity problem in2×2squares. [12]

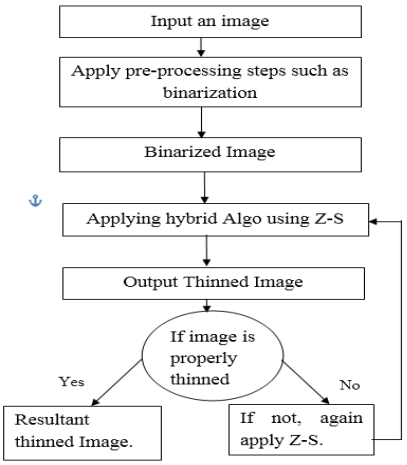

Fig1. Steps for the Thinning of the image

[d] Results:

The results of applying the proposed hybrid algorithm on a variety of binary images and comparison with Zhang and Suen algorithm show better results in terms of thinning rate, thinning speed, connectivity preservation and visual quality .[12]

[B] Proposed Work:

Step for the process of thinning of the image in the proposed work:

[a] Neural Network Approach:

The neural network is one of the approaches to implementing the existing thinning algorithms using neural networks. Here we are proposing a new method for thinning of the image using neural networks. The thinning problem has required two tasks that must be implemented on the image: (a) removing the thick pixels off or deleting or peeling the pixels off (b) stopping the deleting or peeling pixels process when the pixel size of the image reduces to exactly one. [1] The first task can be achieved easily. The main difficulty arises in the second task because the stopping decision of peeling the pixels must be done automatically. This decision can be achieved by using a real-time cellular neural network by training the neural network for thinning purpose. Most of the thinning approaches may suffer from noise sensitivity. Use of neural networks, we can perform thinning invariant under arbitrary rotations. [8]

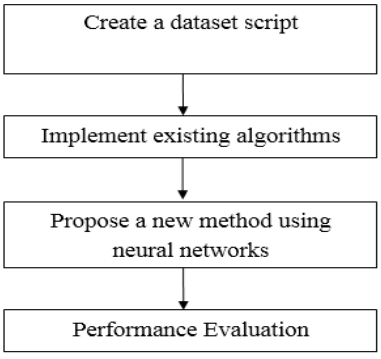

Fig 2. Proposed Methodology

[b] Evaluating Performance:

To evaluation the process of existing thinning algorithms and new proposed method for skeletonization using neural networks, are factors on the basis of some performance measures:

i. **Execution Time**: The time taken to obtain the output skeletons for a particular image is improved than the previous algorithms. We can say that the output of this skeletons image is better than the preceding algorithms.

ii. **Thinning Rate:** The degree at which an object is completely thinned, it can be measured in terms of thinning rate.

IV. Comparison Table

Author	Year	Description	Outcome
Abu-Ain W,et al. [1]	2013	The iterative algorithm is implemented.	Better thinning rate.
Padole G.V, Pokle S. B[2]	2010	Iterative thinning using edge-detection and subtraction.	Time- consuming as compared to optimized thinning technique.
Chatbriet al.[3]	2014	Thinning algorithms robust against noise in sketch images.	Robust against typical types of noise which exists in sketch images. Mainly contour noise and scratch.
Prakash, R. P.[4]	2015	A thinning algorithm using hypergraph- based morphological operators.	Noise free skeletonize-d image.
Abu-Ain, W., Abdullah [5]	2015	Parallel and sequential approach under new iterative thinning algorithm are proposed. Algorithm using Feed Forward Neural Networks.	This method is applicable for any shape with any rotation.
Saudagar, Abdul Khader Saudagar, Abdul Khader Jilani [6]	2016	OpenCV based implementation of thinning using java platform.	Better result obtained from other implementation.
Luthra, Ritika[7]	2013	Simulation of Zhang and Suen	Forward neural networks are better in terms of PSNR, MSE.

V. Conclusion

Thinning can be done with the help of image processing and various thinning approach. Neural network approach with Zhang and Suen algorithm is also one of the way. This paper reviewed various techniques which have been already used. It shows good results in terms of thinning rate, thinning speed, visual quality and connectivity preservation. But there are still some chances for the improvements in the existing techniques and having the better result in terms of PSNR, MSE, execution time and thinning rate.

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