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A Practical Approach of Parallel Thinning Algorithm on Numeral Patterns Using Matlab Simulation

Komal Bishnoi[1], Preeti Gupta[2]

M.Tech, CSE, JCDV, Sirsa, India [1]

Asst Professor (CSE), JCDM College of Engineering, Sirsa, India [2]

Abstract: Digital image processing deals with manipulation of digital images through a digital computer. It is a subfield of signals and systems but focus particularly on images. DIP focuses on developing a computer system that is able to perform processing on an image. The input of that system is a digital image and the system process that image using efficient algorithms, and gives an image as an output. A number of image processing and pattern recognition application demand that are raw digitized binary pattern array be normalized, so that the constituent components of that array are of uniform thickness. The Thinning process reduces such components to a thickness of one pixel or sometimes to a few pixels. The thin-line representations of elongated patterns would be more amiable to extraction of critical features such as end-points, junction-points, and connection among the components. This Paper has been proposed and implemented the thinning algorithm. The thinning equation has been optimized in the algorithm. The algorithm has been analyzed on the basis of connectivity and convergence to unit width. The Performance parameters PSNR and errors has been analyzed and compared with the Morphology algorithm and shows the higher PSNR values and represented in the forms of graphs.

Keywords: Image Processing, Thinning, Computer Vision.

I. INTRODUCTION

Digital image processing deals with manipulation of digital images through a digital computer. It is a subfield of signals and systems but focus particularly on images. DIP focuses on developing a computer system that is able to perform processing on an image. The input of that system is a digital image and the system process that image using efficient algorithms, and gives an image as an output. The most common example is Adobe Photoshop. It is one of the widely used applications for processing digital images. Skeletonization is a process for reducing foreground regions in a binary image to a skeletal remnant that largely preserves the extent and connectivity of the original region while throwing away most of the original foreground pixels.

To see how this works, imagine that the foreground regions in the input binary image are made of some uniform slow-burning material.

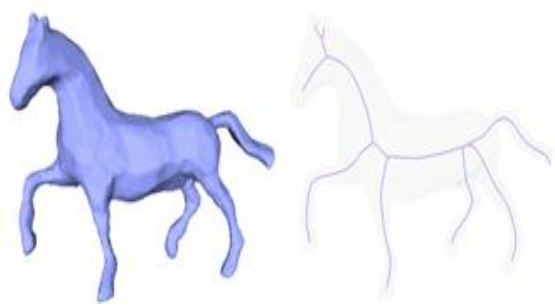

Figure 1: Image Skeletonization

Light fires simultaneously at all points along the boundary of this region and watch the fire move into the interior. At points where the fire traveling from two different boundaries meets itself, the fire will extinguish itself and the points at which this happens form the so called "quench line". This line is the skeleton. Under this definition it is clear that thinning produces a sort of skeleton.

Skeletonization is the result of the thinning process, which peeling the contour of the text until reaches most medial one pixel width. Goodness of the thinning method is measured by how much the skeleton extracted preserve the topology of the shape without any interrupt. Skeletonization is used in pre-processing phase for several applications such as writer identification, script identification, optical character recognition OCR. Skeletonization is divided into two main approaches; iterative and non-iterative. Iterative techniques, the peeling contour process iteratively parallel or sequentially; in the parallel way the whole unwanted pixels are erased after identify the whole wanted pixels. Whereas in sequential techniques; In non-iterative approach the skeleton is extracted direct without examine each pixel individually, but these techniques are difficult to implement and slow as well. Even most of traditional problem for thinning concepts; there are some algorithms suffer from these traditional problems such as one pixel width of the skeleton and skeleton connectivity as well.Thinning plays an important role in image process and computer vision.

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It's a vital pre-processing step in several applications like document analysis, compression, information compression, fingerprint classification, and pattern recognition. Dilution method transforms an input binary image into skeletons with nearly skinny lines, curves and arcs. The main objective of dilution is to preserve the necessary info like form, size and topological properties thereby simplifying the later process steps like extracting options from patterns.

Recognition of line objects is complex problem that can be solved in many ways. It consists of more phases depending on approach. Each phase affects next so it is important to obtain good results after the first ones. Pre-processing is the first step in all methods. It modifies input raster to enhanced important information and wipe out those that can cause future problems (like noise). In the next step we usually use some type of thinning to create skeleton. This process is often called Skeletonization or medial axis transformation. Skeleton represents original objects by the set of lines that can correctly describe the main features like shape and connectivity. There are many approaches on how to create skeleton with different results. Accuracy of results heavily depends on input quality and characteristics. This paper focuses on the pre-processing phase, which is essential for many image processing tasks including line objects recognition.

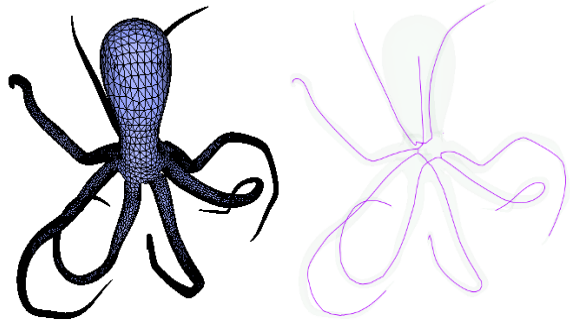

Figure 2: Image Thinning

digital image is defined as a two-dimensional object with a finite set of intensity values whose elements are referred as picture elements (pixels). Images whose possible intensity values are only black (foreground) represented as 1 and white (background) represented as 0 are referred as binary images. Representation of English alphabet "T" as a binary image is illustrated.

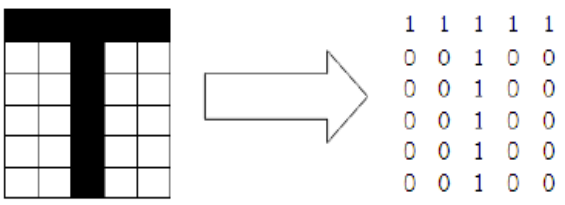

Figure 3: Image Binary Representation

Thinning is a process by which a one-pixel-width representation (or the skeleton) of an object is obtained, by preserving the connectedness of the object and its end points. Thinning algorithms should also preserve topological and geometric properties of the original object as much as possible. This includes connectedness of components, no spurious endpoints, and no excessive erosion of the original object. Thinning algorithms can be classified as one of two broad categories:

1) Iterative thinning algorithms
2) Non-iterative thinning algorithms.

In general, iterative thinning algorithms perform pixel-bypixel operations until a suitable skeleton is obtained. Non iterative thinning methods use sequential pixel scan of an image. Iterative thinning algorithms delete successive layers on the edges of a pattern until a skeleton remains. Usually the pixels of an image are considered consecutively and a choice is made to either delete or keep the pixel. The criterion for this choice is a set of "rules" based on the pixels in the neighborhood around the current pixel. Usually the neighborhood is a 3*3 area around the pixel.

II. LITERATURE REVIEW

Document image ana-lysis and recognition (DIAR) techniques are a primary application of pattern recognition. DIAR techniques aim to extract information from document images to enhance knowledge. There are two categories of DIAR applications: textual applications and graphical applications. Textual applications deal with the text body in a document image. They include tasks related to text processing and text recognition. Text processing represents several applications such as text skew detection and correction, text extraction, text skeleton, layout analysis and text segmentation. A new iterative thinning algorithm is proposed. The method consists of three stages. First two stages conceder to extract the skeleton and the third is conceder for optimizing the skeleton into one-pixel width. The experiments are conducted into multi class chosen from Set of MPEG-7 Shape Dataset classes to evaluate the proposed method. The visual experiments prove the high-quality performance for shape binary images. The superior tails and the topology problem are highly achieved [1].

Today, recognition of line characteristic connectivity-preserving objects is an important task in image processing. This paper briefly describes binary morphology and its applications that are important for thinning algorithms. The main purpose of binary morphology in this process is to deal with problem of preventing future errors and irregularities in process of creating skeleton, which is an important step towards recognizing line objects. There are many approaches about image pre-processing that can be used, but this work proposes to use binary morphology because of its versatility and relatively fast execution. In addition it is based on fundamentals that can be used in many other ways including creating skeleton itself. The most important thing in the binary morphology is to find good combination of binary operations with adequate number of repetition. This is not an easy task and it heavily depends on size of the objects in input and its characteristics.

In the case of 2D binary images, we considered the 3x3 neighborhood of the candidate pixel. We used the difference in the local Euler number before and after removing the candidate pixel and as well as the difference

in the boundary length as a criteria for determining whether a given pixel belongs to the skeleton or not. While the Euler number is used for determining the topological criteria, the difference in the boundary length is used to determine the geometric criteria. Using these criteria, we got the expected results for our test bodies (rectangles and squares) and also for a sample 2D image. In other words, we arrived at a topology preserving sequential thinning algorithm which preserves the topology and geometry of the original image
and gives different skeletons depending on the values in the boundary length difference. All the possible adjacency pairs (4,8), (8,4), (6.1,6.1), (6.2,6.2) were considered and expected results obtained [3].

Author has been assimilated the knowledge about image thinning. A critical step in fingerprint recognition is to skeletonize the fingerprint image for minutiae extraction. This process is referred to as "thinning" in image processing. Thinning is the main preprocessing stage in the fingerprint recognition process. The speed and reliability of the thinning process are important for the whole fingerprint identification system. To accelerate the thinning process, an improved fast thinning algorithm is proposed and implemented in MATLAB and on FPGA. In this paper, an improved fast thinning algorithm is proposed for thinning fingerprint images. The algorithm is implemented both in Matlab and on FPGA. Experimental results show that the algorithm is more efficient than the referred algorithm. Fingerprint recognition process consists of series of image enhancement and minutiae extraction processes. Out of seven processes only two processes namely image binarization and image thinning are presented. Further the remaining five processes can be implemented and finally an attempt can be made to integrate all seven processes into one which completes the finger print recognition process [4].

This works proposes a thinning algorithm suitable for offline handwritten Tamil character recognition. The proposed method is a modification of post processing step in Stentiford Thinning (ST) algorithm. In ST algorithm, for the removal of spurious line segments, a set of matrices are defined, which remove only vertical and horizontal line segment. We defined eight more matrices such that unwanted line segment in all the direction are removed. The visual quality of the thinned output given by the proposed algorithm is found to be better than given by a set of prominent thinning algorithms. Further we carried out character recognition experiments using character images thinned with the proposed algorithm. The results show that there is increasing recognition accuracy in comparison to the result obtained when thinning is performed with other prominent algorithms.Thinning is a most important technique for achieving efficient HCR system. This work proposes a new thinning algorithm for offline handwritten Tamil character recognition. The proposed thinning algorithm is implemented and applied on a set of handwritten character images. The performance of the algorithm is analyzed in terms of image shapes, execution time and classification performance. In comparison with the performance of a set of six prominent thinning algorithms, the proposed method gives better performance [5].

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. 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 [6].

This research article paper discusses the enhancement of a fingerprint impression with the help of anisotropic filter. The main aim of this paper is to discuss a fingerprint recognition system by extracting the minutiae of a fingerprint impression after applying the thinning and the minutiae extraction algorithm. The result provides better fingerprint impression with higher matching accuracy.

From the study and analysis of matching fingerprint impressions after enhancing the poor quality fingerprint impression and after obtaining the result of binarization, thinning and minutiae extraction process, we have come to the conclusion that it helps in providing an efficient output with higher accuracy [7].

As we know that image thinning plays an important role in image processing, It is also equally important to propose an efficient image thinning algorithm with an objective, to minimize the amount of information to be processed by preserving the important information required to preserve the topological and geometrical properties of the thinned image, thereby enhancing the later processing procedure. This can be achieved by an efficient image independent thinning algorithm. 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.

Author has proposed an efficient image independent parallel thinning algorithm. Implementation of this algorithm has been carried out and we have also compared its results with other standard thinning algorithms in terms of thinning time, thinning ratio, excessive erosion, connectivity, endpoint preservation, and visual quality. Results indicate that the proposed algorithm is efficient. The robustness of the proposed thinning algorithm has been established across heterogeneous image examples [8].

III.OBJECTIVES

The Objectives has already been mentioned in the review paper which demonstrated the objectives and techniques of research work. This paper has been explained the implemented work and MALAB simulation tool has been used for practical work. There are many goals of the of the Image Thinning technique. In this paper we have been explained the main objectives which are as follows:

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a. Identify the Existing Techniques of Image Thinning Algorithm.
b. Understanding the Steps of the Algorithm.
c. Research on algorithm of the Image Thinning.
d. To Study on improvement Steps of parallel thinning algorithm.
e. Implement the Proposed Approach in Simulation Tool.
f. To visualize and compare the performance of given alternative algorithm in terms of information loss and skeleton.
g. Generate Results.

Problem Statement

The different parallel Thinning algorithms give different results in terms of maintaining the connectivity and generating the spurious branches. Analysis of these parallel thinning algorithms prompted the development and testing of a ”hybrid” algorithm consisting of both the distance and peeling approaches.

In the “hybrid” algorithm the distance algorithm would be used to locate the approximate “centerline” and remove the bulk of unwanted pixels in a fixed number of passes. Peeling algorithm would be used to remove remaining extraneous pixels.
When we implement the discussed alternative parallel Thinning algorithm we observe that it provides better connectivity of pixels in the thinned image for almost all the test images. In the proposed algorithm we apply the single template in each pass and the output of each pass is passed onto the next pass, the connectivity and one- pixel width is guaranteed.

The reduction of image can eliminate some counter distortions while maintaining significant topological and geometric properties.

In more practical terms, thin-line representations of elongated patterns would be more suitable for extraction of critical features such as end-points, junction-points, and connection among the components. The vectorization algorithms often used in pattern recognition tasks also require one-pixel-wide lines as input.

IV. PROPOSED METHODOLOGY

a. Study the Image Thinning Concepts in Images and analyze the techniques.
b. Study the steps of existing algorithms.
c. Research on these Techniques for identification of issues.
d. Apply Improved Concept to work with Algorithm.
e. Implemented the Parallel Thinning Technique and iterating the thinning algorithm until convergence.
f. Development of new proposed efficient technique, improved the performance parameters such as PSNR or MSE and compared with the morphological operators.
g. Implementation in MATLAB Language.
h. Generated Results and Graphs.

Flow Chart:

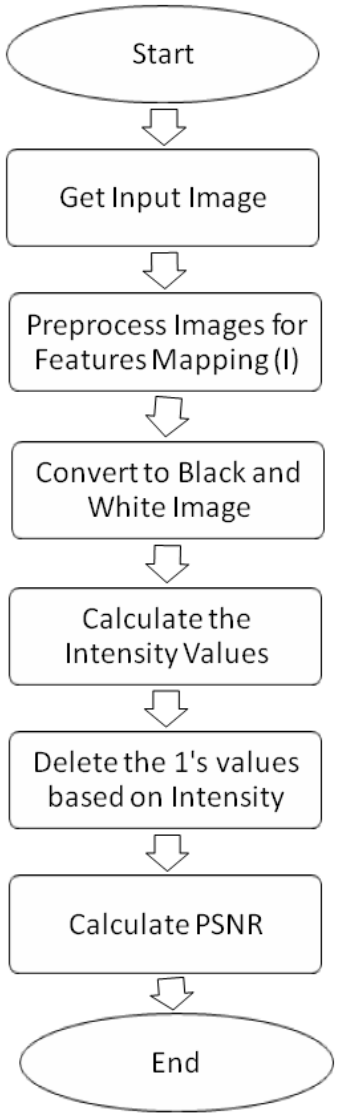

Figure 4: Flow Charts of Proposed Techniques

V. ALGORITHM

Algorithm is used for solving the problem step by step which can be implemented with help of programming in any language.
1. Start
2. Get Input and Thick Images (I)
3. Pre-process Images for Features Mapping (I)
4. Generate Black and White Image of Image Set (I)
5. Read the Input Images using imread Method
6. Get the Image Rows and Columns Values
7. Calculate the Intensity Values
8. Generate the output values in forms of 0’s and 1’s.
9. Delete the intensity based 1’s values for thinning the images
10. Write the Images bytes to Images
11. Compare with Morphological Operators
12. Generate the PSNR values of Existing Technique and Modified Technique.
13. Generated the Comparison Graphs
14. Stop

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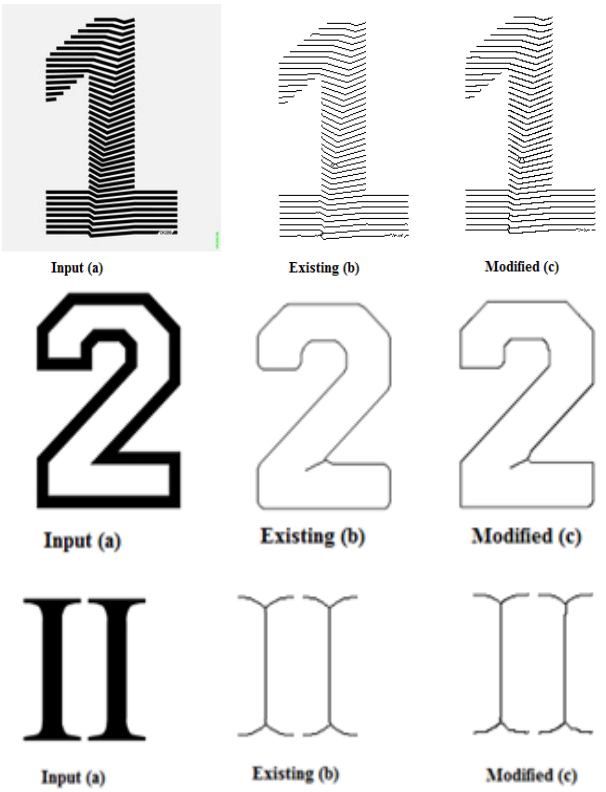
VI. RESULTS & DISCUSSIONS

The algorithm functionality has been tested on the numerals of different types. The three types of numerals has been taken for input and the results has been generated with the morphological operators and modified technique and then compared by the existing results images as well as the PSNR values.



In the above images, the input (a) represents to the input images; existing (b) means the results generated with the morphological operators and modified (c) represented to the output results generated by the enhance algorithm.

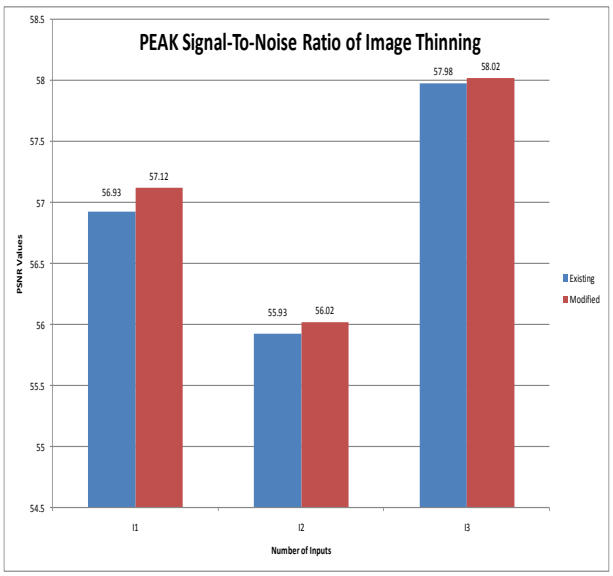


Figure 5: PSNR of Image Thinning Algorithms

The PSNR values of the algorithms have been compared in the graphs.

VII. CONCLUSION AND FUTURE WORK

This Paper has been implemented the Image Thinning Concept and algorithm that has been used to generate the skeleton of an image and generated the performance parameter such as PSNR and MSE. The Results values are then compared with the Morphological operators in terms of accuracy, connectivity and performance parameters. The algorithm shows the accuracy than the existing technique of image thinning.

In future the research can be on image thinning of compressed images. The compressed images quality improvement can be more specific in future.

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