ENHANCEMENT OF Z-H ALGORITHM TO IMPROVE THINNING RATE: A REVIEW

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Abstract- Thinning of binary image processing is a fundamental and important technology. Most of the existing image thinning algorithms are based on processing the same picture multiple times, and deleting the edge points layer by layer. For an amount of information in the image, the image thinning processing is relatively slow. To address this problem, an improved thinning algorithm is proposed in this paper. In particular, this algorithm uses the depth of each point to find the deepest points, only considers the deepest points and its neighboring points to determine the point can be deleted. The thinning processing time is decreased, and the skeleton is smooth, clear and continuous.

Keywords: Binary image, thinning, depth of the edge.

INTRODUCTION

Image thinning is an important methods of feature extraction, which change multi-pixel wide lines in pictures into signal pixel wide lines that simplifies the expression of the image. The results of image thinning always be called ‘skeleton’. It is widely used in character recognition, fingerprint recognition and image understanding, etc. It improves the processing efficiency and reduces data redundancy [1].

Digital Image Processing (DIP) comprises of three words: digital, image & processing. Picture is a 2-dimensional function f(x, y), the amplitude of 'f' at any pair of coordinates (x, y) is called the intensity of the picture. If x, y and the amplitude values of f are discrete quantities, a digital picture is obtained. A digital picture contains finite number of elements called pixels, has a particular value & location [1].

One of the fundamental requirements is to represent the structural shape of digital images done by reducing it to a graph. This reduction can be complete by obtaining the skeleton of region using skeletonization also known as thinning.

SKELETONIZATION

Skeletonization is a process of removing skeletons from an object in the digital picture. It is operation that deletes pixels layer by layer until one pixel width skeleton is obtained. Skeletonization is a “pre-processing” procedure used in image analysis techniques [2]. It is the process of decreasing an object in a digital picture to the negligible size need for machine recognition of an object [2]. In this we produce an output by taking input as a binary picture, as shown in fig1 as a result:

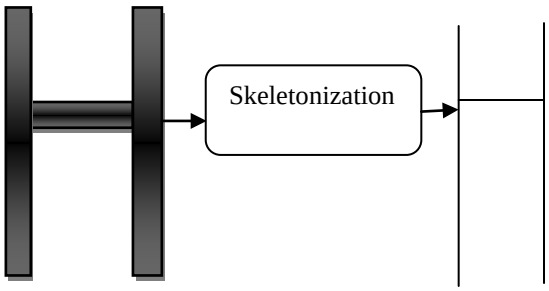

Fig 1: Concept of skeletonization [1]

Skeletonization is used in a wide variety of other applications like: Optical character recognition [2,5], Pattern recognition[3], Fingerprint classification[4], Biometric authentication[5], Signature verification[5], Medical imaging[4].

SKELETONIZATION ALGORITHMS

All the Skeletonization algorithms are separated into two parts:
1) Iterative thinning algorithm [3]
2) Non iterative thinning algorithm [3]

Iterative thinning algorithms delete successive layers on the boundary of the pattern until a skeleton remains. The deletion or retention of a pixel of an image would depend on the configuration of pixels in a local neighborhood containing ‘p’. Usually the neighborhood is a 3*3 area around the pixel. According to the way we examine pixels, iterative thinning algorithms can be classified as sequential or parallel. Iterative thinning algorithm creates a skeleton by examining and removing contour pixel through an iterative process in parallel and sequential way [3].In parallel thinning algorithms, pixels are removed on the basis of solution get from the past iteration. Therefore parallel thinning algorithm is suitable for implementation in parallel processors [3].

Non-iterative thinning is not based on analysis single pixels. Without study all the single pixel, these algorithms generate a certain median or centre line of a pattern to be thinned in one pass. Non pixel based methods include distance transforms, medial axis transforms, and determination of centre lines. Medial axis change often use gray-level picture where pixel

intensity express distance to the boundary of an object [3]. Distance transform based methods calculate the distance to the picture background for an object pixel and use this data to find which pixels is part of the skeleton.

Properties of Thinning Algorithms

- produce a thin or nearly thin skeleton;
- preserve the connectivity of the original pattern, which means that connected parts in the original pattern should stay connected in the skeleton;
- preserve the visual topology of the original pattern, which means that although the skeleton is a compact representation of the original pattern, it should deliver the same visual information;
- be robust against noise.

NEED OF SKELETONIZATION

It is a step in image processing applications like Pattern recognition [2], fingerprint classification [4] and optical character recognition [2,5] etc. There is always need for good skeletonization algorithms in reference to following parameters:

1. By reducing measurement of data [4].
2. By decreasing process time.
3. Evaluate of features such as junction-points, end-points and connection among the components is helpful in applications [4].
4. By repress an object just a skeleton, its meaningless parameters and noise can filtered out.
5. It is used for higher degree analysis[2,5,4].

APPLICATIONS OF SKELETONIZATION

Skeletonization is used for many image processing applications like:

1. Optical character recognition (OCR) [2,5]
2. Pattern recognition[3]
3. Fingerprint classification[4]
4. Biometric authentication[5]
5. Signature verification[5]
6. Medical imaging[4]

REQUIREMENT FOR THINNING ALGORITHMS

1. Skeleton should be one pixel thick.
2. Connectivity should be preserved.
3. Shape and position of the junction points should be preserved.
4. Skeleton should lie in the middle of a shape.
5. Skeleton should be immune to the noise (especially to boundary noise).
6. Excessive erosion should be prevented (length of lines and curves should be Preserved).

ZS ALGORITHM

A very popular and well-proved thinning algorithm is the ZS algorithm proposed by Zhang and Suen in 1984 [9]. It is an iterative parallel thinning algorithm working on 3 × 3 neighborhood as shown in figure

P8	P2	P3
P7	P1	P4
P6	P1	P5

Fig 2: ZS 3 × 3 Neighborhood.

It is a directional algorithm which consists of two subiterations: the first is aimed at deleting the South East boundary pixels and the North-West corner pixels while the second one is aimed at deleting the North-West boundary pixels and the South-East corner pixels that are the opposite orientations.

ZS parallel thinning algorithm performs sub-iterations step wise.

The first step

1) $2 \leq N(Pi) \leq 6$
2) $S(Pi) = 1$
3) $P2^* P4^* P6 = 0$
4) $P4 * P6^* P8 = 0$

The Second step

Conditions 3 and 4 in the first step are replaced with the following conditions.

3) $P2 * P4 * P8 = 0$
4) $P2 * P6 * P8 = 0$

REVIEW OF LITERATURE

Li *et al.* (2014): In this current picture diminishing calculations depend on preparing the same picture different times, and erasing the edge focuses layer by layer. In this depth point is use to determine the deepest point. The diminishing handling time is diminished, and the skeleton is smooth, clear and constant.

Abu-Ain *et al.* (2013): proposes a new skeletonization algorithm which combines sequential and parallel approaches which comes under iterative approach. The algorithm is conducted in three phases. First two phases used to remove the skeleton and the third is used for optimizing the skeleton into one-pixel width.

Padole and Pokle (2010): proposed two iterative algorithms for thinning binary pictures. In the initial algorithm, thinning of binary pictures is done by using: edge detection and subtraction. Second algorithm settled on repeatedly deleting the pixels until a one pixel wide pattern in a binary picture is obtained. Experimental solution proves that edge based iterative thinning algorithm is time consuming as compared to optimized Skeletonization algorithm.

Lam *et al.* (1992): had studied broad range of skeletonization algorithms on binary paradigm including pixel based deletion and non pixel settled deletion methods. Algorithms in these paper discuused relationships between the different skeletonization algorithms have also been explored. Various compactions have made between skeletons received from various skeletonization algorithms on the idea of subjective and objective criteria.

Chatbri and Kameyama (2014): introduced a framework for devising thinning algorithms vigorous against noise in sketch figure. The framework estimates the optimal filtering scale automatically and adaptively to the input image. Experimental result shows that this framework is robust against typical types of noise which exists in sketch images, mainly contour noise and scratch.

Rockett (2005): execute thinning of binary figure by iterate two sub-iterations: one removes the south-east boundary points and the north-west corner points while the other one removes the north-west boundary points and south-east corner points. Point deleting is done according to a specific set of rules. The two sub-iterations are repeated until no more points validate the deleting rules.

Guo and Hall (1989): have presented two algorithms which use two sub-iterations. These algorithm use two-sub iteration access: (1) alternatively deleting north and east and then south and west boundary pixels (2) alternately applying a thinning operator to one of two subfields. Both accesses create thin medial curves and second attain the fastest overall parallel thinning.

Jagna and Kamakshiprasad (2010): had describes new two parallel algorithms for the binary images. The algorithm makes the image to one pixel wide width and continues the connectivity of components. This algorithm also helps to preserve & neighbour connectivity in binary images. The proposed algorithm shows improved presentation in terms of connectivity and one pixel wide and produces high quality images than the previous Skeletonization algorithms.

CONCLUDING REMARKS

In this paper, ZS algorithms are studied to improve the picture quality by reducing thinning rate for static pixel values. various techniques and parameters for introduction, applications, need and algorithms for skeletonization, properties and requirements of thinning algorithms and ZS algorithm are discussed in this paper. Some studies done on improving the picture quality by reducing thinning rate by various researchers is also discussed. Some investigation will be carried out by applying enhancement procedures for ZH algorithms for dynamic pixel values in future.

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