Role of Mathematical Morphology in Digital Image Processing: A Review

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Abstract: *Image processing is a method to convert an image into digital form by performing operations on it for getting an enhanced image or to extract some useful information from it. It is a type of signal distribution in which input is image like video frame or photograph and output may be image or characteristics associated with that one. Usually this system includes treating images as two dimensional signals while applying already set signal processing methods to them. Mathematical morphology is also one of the important terms in image processing. It is a theory and technique for the analysis and processing of geometrical structures. This paper describes role of mathematical morphology in image processing.*

Keywords*: Mathematical Morphology, Dilation Erosion, opening, closing, Structuring element*.

1. Introduction

Mathematical morphology is a set theory approach, developed by J.Serra. Mathematical Morphology is a theory which provides a number of useful tools for image analysis. It is an approach to image analysis which is based on the assumption that an image consists of structures which may be handled by set theory. It refers to a branch of non-linear image processing and analysis that concentrates on the geometric structure within an image [1]. This technology is having significant role in many fields of image processing. It is used in segmentation of the image, which is having application in text extraction for image [text extraction] and also in automatic number plate recognition [nm]system , also used in image restoration process by deleting noise in binary image [2].

Some features of mathematical morphology which makes it highly useful in image processing system [3].

1) It deals with structuring element which is a shape, used to probe or interact with a given image. The structuring element is positioned at all possible locations in the image and it is compared with the corresponding neighborhood of pixels.
2) There exists a well-developed mathematical morphological operations which can be employed for representation and
3) Operations which can be employed for representation and optimization.
4) It is possible to express digital algorithms in terms of a very small class of primitive morphological operations.
5) There exist rigorous representations theorems by means of which one can obtain the expression of morphological filters in terms of the primitive morphological operations.

Dilation and Erosion are the main functions that are used in mathematical morphology operation. Dilation is used to increase the area of a component. It Adds pixels around the boundaries and fills interior holes. Erosion shrinks or thins object in a binary image. The manner or extent of shrinking is controlled by structuring elements

2. Role of Mathematical Morphology

2.1 Image Enhancement

Image enhancement is basically improving the interpretability or perception of information in images for human viewers and providing `better' input for other automated image processing techniques. The top-hat transform and bot-hat transform are used to improve the contrast of the images.[5] Then, the iterative threshold segment closing operation and opening operation are operated on the result respectively. In order to obtain high-quality minutiae, enhancement algorithm aims at [10].

- Strengthening genuine minutiae;
- Removing the patterns that produce spurious minutiae;
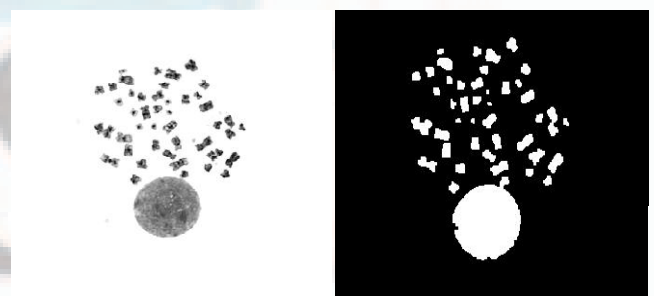- Retaining the physiological characteristics of palm print.

Figure 1: Result of the enhancement process (a) Original image (b) Result of enhancement.

2.2 Text Extraction for Image

Text in the image contains useful information which helps to acquire the overall idea behind the image. Character extraction from image is important in many applications. Extraction of text information present in scene images finds diverse applications, such as automatic annotation, indexing,

and structuring of images, document analysis, vehicle license plate extraction, technical paper analysis, and object oriented data compression. Mathematical morphology is used to perform the edge detection [4]. This algorithm is used to find out the connected component, in connected component set gray level value of each component is calculated , when components are found then labeling is done. After the selection process components whose variation is less than threshold value the text can be extracted. This method consists of four steps:

a) Edge extraction (pre processing).
b) Text candidate region formation (pre processing).
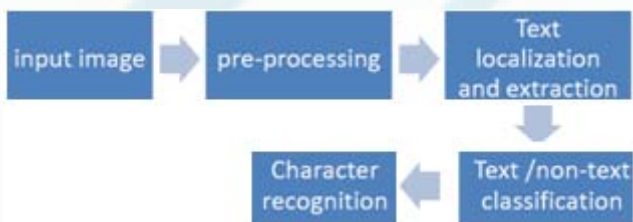c) Labeling of text candidate regions.
d) Elimination of non text region

Figure 2: Block diagram for text extraction form image

2.3 Image compression

Image compression is the representation of an image in digital form with as few bits as possible while maintaining an acceptable level of image quality [7] Mathematical morphological operations can used for purpose of image compression. The significance map is preprocessed using mathematical morphology operators to identify and create clusters of significant coefficients. Application of mathematical morphology self organizing feature map based image compression system to broad classes of images resulted in a satisfactory PSNR to the compression ratio.
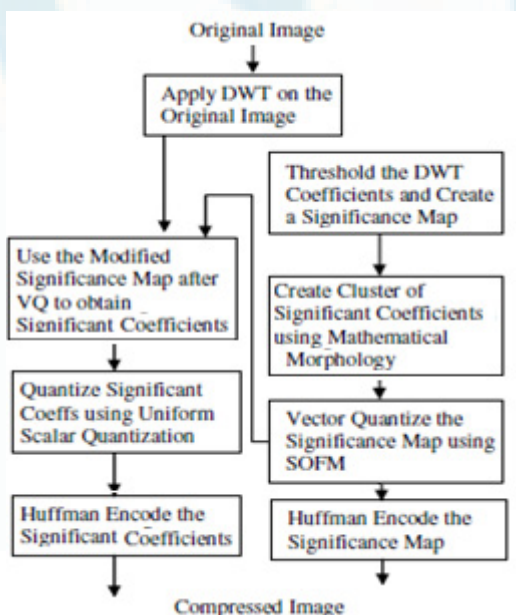

Figure 3: Block diagram of compression system [7]

2.4 Noise Detection

It is an application of mathematical morphology in image processing, by using this technique we can detect and can even remove the noise introduced in the binary image. [2]Morphological image processing emphasizes on geometry structure of an image. Which detects an image by use of a structuring element? Here fundamental operations of mathematical morphology dilatation, erosion, opening and closing are used. One of the simplest uses of erosion is for eliminating irrelevant detail (in terms of size) from an original image. It is helpful to eliminate these small noises and objects that are not interested in after segmentation. Dilation expands an image and erosion shrinks it. Based on the two operations, opening and closing are another two important smoothing operations

Figure 4: a) image with noise b) after opening c) after closing

2.5 Component Analysis

This is a very new concept which is used to recognize handwriting, by using mathematical morphology with different operators and structuring elements, it is possible to recognize the hand written digits [9]. This process can be used as the man machine interface, so by this concept one can directly operate machine with the hand writing despite typing because in some cases hand writing is more convenient than typing. Handwritten digit recognition can be classified into two categories: offline recognition and online recognition. In offline recognition we processes and recognizes the user input handwritten digit, based on images and later uses the geometry and temporal dynamics information of the user's input.

2.6 License Plate Recognition System

In this system one can automatically recognize the license plate number by using mathematical morphology [8]. First of all image of license plate is acquired with the help of camera then images are put into computer through video cards for pre processing [8]. Mainly there are three stages for the license plate recognition system.

(1) License plate detection
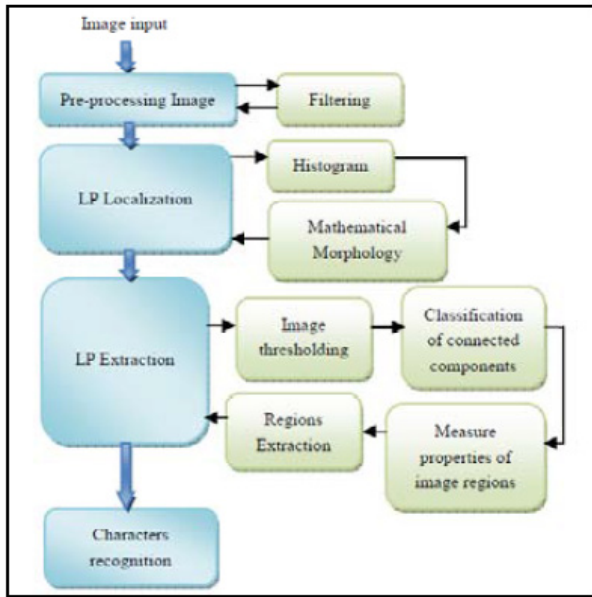(2) Character segmentation
(3) Optical character recognition (OCR).

Figure 5: License plate recognition system [8]

3. Conclusion

It has been concluded that mathematical morphology is having a significant importance in digital image processing. There are many applications of mathematical morphology in image processing such as image enhancement, image restoration, noise detection, component analysis and text extraction from image, these applications are fulfilled with the help of mathematical operators such as dilation, erosion, opening and closing.

References

[1] Robert M. Haralick, Stanley R. Sternberg,"Image analysis using Mathematical morphology", IEEE transactions on pattern analysis and machine intelligence, Vol. PAMI-9, No 2 (1987).

[2] Zhong Qiyuan , Huang Xianxiang ,Tan Lilong, Zhao Bing," A Method of Deleting Noise in A Binary Image Based on the Mathematical Morphology", IEEE Transactions on image processing, 1-4244-1135-1(2007).

[3] Wayne, Lin Wei-Cheng, "Mathematical morphology and its applications on image segmentation" , 978-1-4244(2004)

[4] Mohammad Shrif Uddin, Madeena Sultana,Tanzila Rahman and Umme Sayma Busra, "Extraction of texts from a scene image using morphology based approach", IEEE Transactions on image processing, 978-1-4673-1154/12(2012)

[5] Yan Wenzhong," Mathematical Morphology Based Enhancement for Chromosome Images", IEEE Transactions on image processing, 978-1-4244-2902-8(2009).

[6] M Rama Bai,"A New Approach for Border Extraction Using Morphological Methods", International Journal of Engineering Science and Technology, Vol. 2(8), pp.

[7] 3832-3837(2010).

[8] Dawei Qi, Yuanxiang Li, Lei Yu, "The Application of Mathematical Morphological Optimization Algorithm in Edge Detection of Defected Wood Image",

IEEE International Conference on Automation and Logistics Qingdao (2008).

[9] Hui Li, Pan Gao, Dongxiu Wang," Study on Mathematical Morphology Based Vehicle License Plate Location", IEEE Transactions on image processing, 978-1-4244- 4543-1(2009)

[10] G. Rama Mohan Babu, P. Srimaiyee, A. Srikrishna, "Text Extraction From Hetrogenous Images Using Mathematical Morphology", Journal of Theoretical and Applied Information Technology.

[11] Yan Zhen, GuangShun Shi, Lin Zhang, Wang YaJing Zhao,"Research Paper On Offline Palmprint Image Enhancement", IEEE Transactions on image processing, 1-4244-1437-7(2007).

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