MORPHOLOGICAL OPERATORS BASED ENHANCEMENT OF IMAGES

S.K.Khadar Basha[1], Dr.G.Chenchukrishnaiah[2]
[1]Research Scholar, VTU, Belagavi,Karnataka
[2]Professor & Dean, GKCE, Sullurpet Nellore
[1]Basha_skb@rediffmail.com, [2]Krishna.rakesh4@gmail.com

ABSTRACT

Image processing including image restoration and reconstruction, edge detection, image segmentation noise suppression, feature extraction, shaperecognition, image compression, texture analysis etc uses mathematical morphology. It is modulated from traditional morphology to soft mathematical morphology, fuzzy soft mathematical morphology and order morphology. This paper mainly deals with the enhancement of image using morphological operators such as erosion dilation opening and closing operation. The complete image processing is done using MATLAB simulation.

INTRODUCTION

Image enhancement provides a way to reconstruct damaged regions of an image. Image components are used for the description and representation of region or shape, such as skeletons, boundaries and the convex hull are extracted by Morphological image processing [1]. It can be used for thinning and pruning, filtering of images. It is constructed with operations on sets of pixels. Erosion and Dilation are the main morphological operations [4]. The objects are contracted in erosion operation with drawing away their boundaries. The images are stretched in dilation operation as small holes are filled and disjoint pixel objects will be connected to each other. These operations of erosion and dilation can be adapted for an application by the appropriate selection of the structuring element, which determines how the objects will be dilated or eroded exactly [5].

Morphology is a technique of image processing based on shape, region and form of objects. Morphological methods apply a structuring element to an input image, gives an output image of the same size. The value of each pixel in the input image is based on a comparison of the Corresponding pixel in the input image with its neighbors [7]. By choosing the size and shape of the Neighbor, morphological operator can be applied on that input image.

1. Structuring element- The structuring element is small images which are used to probe the original images. The structuring element can be binary image or a flat file that consists of coordinates values. Structuring element is mainly a small matrix of pixels, each with a value of zero or one which specifies the shape of element. Composite structuring elements are two structuring element that share a single common origin. The smallest square structuring element grid is 2×2. The dimensions of the matrix specify the size of the structuring element. Structuring element origin is usually one of its pixels.

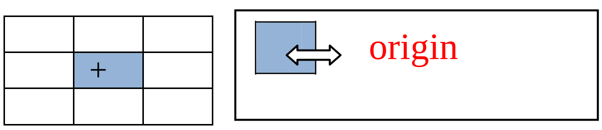


fig 1: Square structuring element of 3*3

2. Morphological Operations Dilation operation-

First, define A as the reference image and B is the structure image used to process image A. The dilation of an image A by a structuring element B (denoted A ⊕ B) produces a new binary image C = A ⊕ B with ones in all locations (a,b) of a structuring element's orIgin at which that structuring elementBhitstheteinputimageA,i.e.C(a,b)=1 ifBhitsAand0otherwise,repeatingforall pixel coordinates (a,b). Dilation mainly adds a layer of pixels to both the inner and outer boundaries of regions.

Image A and B are two set of pixels of original image and of structuring element. Dilation is defined by the equation:

$$A \oplus B = \{X \mid [(B^{\wedge})_x \cap A] \subseteq A\}$$

Among them, A is the input image, b is the structuring element and Bˆ is B rotated about the origin. The process of the structuring element B on the image A and moving it across the image in way like convolution is defined as dilation operation. The two main inputs for the dilation operation [6] i.e set of pixeles known as a structuring element and the image which is to bedilated.

The effect of the dilation on the input image A is determined by this structuring element B [8]. The following steps are the mathematical definition of dilation for binary images:

1. let L is the set of coordinates corresponding to the input binary image, and M is the set of cordinates for the structuringelement.
2. Suppose M_α denote the translation of M so that its origin is at α.
3. The dilation of L by structuring element M is simply the set of all points α such that the Intersectionof M_α with M isnon-empty.Dilation operation increases the size of object and also thickens the object by expanding the boundaries and small holes will befilled.

Characteristic of dilation operations-

- Dilation is commutative,i.e. $(A \oplus B) = (B \oplus A)$
- It isassociative,i.e. $(A \oplus B) \oplus C = A \oplus (B \oplus C)$
- It is distributive over unionset, i.e. $(A \oplus B) \oplus C$)=
- It is translationinvariant.
- Dilation operation iscomplementary.

original image dilated image with SE=4

Fig2: effect of dilation operation with SE=4

Erosion operation-

Erosion is another important operation of image morphology. The objective of this operator is to build an object smaller by removing its outer layer of pixels. Mainly the aim of image erosion is to contract the image in smaller size. In any image, if black pixels have white neighbors then all the pixels are made white. The erosion of a binary image A by a structuring element B (denoted A ⊖ B) produces a new binary image C= A ⊖ B with ones in all locations (a,b) of a structuring element's origin at which that structuring element B fits the input image A, i.e. C(a,b) = 1 is B fits Aand 0 otherwise, repeating for all pixel coordinates(a,b).

$$A \ominus B = \{X \mid (B)_x \subseteq A\}$$

This operation can be represented as-

Among them, A is the input image, B is the structuring element and Bˆ is B rotated about the origin.

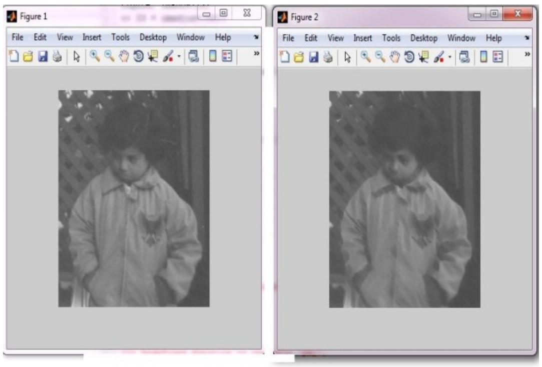
The main inputs needed for the erosion operator [9] are the image which is to be eroded and a structuring element. The exact effect of the erosion on the input image is determined by this structuring element.

The following steps provide the mathematical definition of erosion for binary images:

1. Let L is the set of coordinates of input binary image, and M is the set of coordinates for the Structuringelement.

2. suppose M_α denote the translation of M so that its origin is at α.

3.Then the erosion of L by M is simply the set of all points α suchthat $M_\alpha \subseteq L$



original image Eroded image

fig3: effect of erosion operation

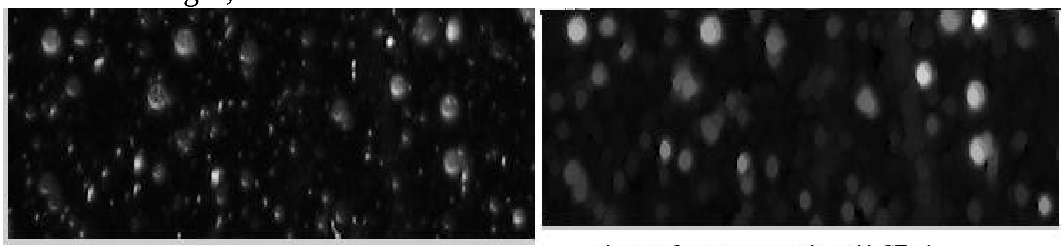
Operation of opening and closing –

Opening and closing is simply and extension of applications by utilizing the processes of erosion anddilation.Opening and closing operation are mainly useful for the morphological filtering of the images.

Opening:

The process of “opening” an image will likely smooth the edges, remove small holes from a reference image and break narrow block connectors. The opening of an image A by a structuring element B (denoted by A ∘ B) is an erosion followed by a dilation using the same structuring element A ∘ B =(A ⊖ B) ⊕ B

Input for opening operator are image to be opened say A and a structuring element, B.



original image image after open operation with SE=4

Fig4: effect of opening operation

Closing:

The process of “Closing” an image will also smooth edges but will fuse narrow blocks and fill in holes. Closing can fill holes in the regions while keeping the initial region sizes. The process of closing of image B by structuring element B(denoted by A● B)

$$A \bullet B = (A \oplus B) \ominus B$$

Opening and closing operation satisfies these Properties –

1) It satisfies the dualtransformation:

$$(A \bullet B) = A^c \circ B^\wedge \qquad (A \circ B)^c = (A^c \bullet B^\wedge)$$

2) Idempotenceproperty:

$$(A \bullet B) \bullet B) = A \bullet B$$

$$(A \circ B) \circ B) = A \circ B$$

Fig5: close operation effect on original image

3. SIMULATEDRESULTS

At matlab program we applied the 4 morphological operations as dilation, erosion, opening, closing for the enhancement of image so users can use any of the morphological operations needed, we added 2 types of SE (square , diamond) and a slider to modify dynamically the SE size. Dynamically change SE type through the pop-up menu, the experimental results foreach

Operation is shown in the following figure.

Figure (6) Effect of dilation on grayscale image with SE type = square

Figure (7) Effect of erosion on grayscale image with SE type = diamond

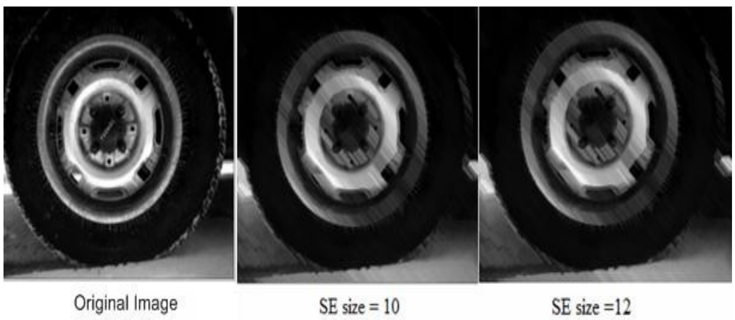


Figure (8) Effect of opening on grayscale image with SE type = square

Figure (9) Effect of closing on grayscale image with SE type = diamond

6. CONCLUSION

Image processing techniques which deal with the shape, region and features in an image are described by Morphological image processing. In this paper 4 morphological operations as dilation, erosion, opening and closing are implemented in matlab program with user interface in which changing the parameters of SE such as its size or type are simple to understand anduse.

REFRENCES

[1] R.C.Gonzales, R.E.Woods, "Digital Image Processing", 2-nd Edition, Prentice Hall,2002.

[2] J. Gil and R. Kimmel, "Efficient dilation, erosion, opening and closing algorithms in MathematicalMorphologyanditsApplicationstoImageandSignalProcessing"V,J.Goutsias, L. Vincent, and D. Bloomberg, Eds. Palo-Alto, USA, June 2000, pp. 301.310, Kluwer Academic Publishers.

[3] Z.Fang, M.Yulei, Z.Junpeng, "Medical Image Processing Based on Mathematical Morphology", The 2nd International Conference on Computer Application and System Modeling(2012).

[4] U.Scot.E, "Computer Vision and Image Processing", Prentice Hall, NJ, 1998, ISBN 0-13- 264599-8

[5] J. Gil and R. Kimmel, "Efficient dilation, erosion, opening, and closing algorithms", IEEE transactions on Pattern Analysis and Machine Intelligence, vol. 24, no. 12, pp. 1606.1617, December2002.

[6] H.Heijmans, "Morphological image operators", Advances in Electronics and Electron Physics.Academic Press, 1994.

[7] G.V.Tcheslavski, "Morphological Image Processing: Grayscale morphology", ELEN 4304/5365 DIP, Spring2010.

[8] R. Haralick, S. Sternberg, and X. Zhuang, "Image analysis using mathematical morphology", IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 9, no. 4, pp. 532.550, July 1987.

[9] L.Vincent, "Morphological area openings and closings for greyscale images", in Proc. Shape in Picture '92, NATO Workshop, Driebergen, The Netherlands, September 1992,Springer-Verlag.

[10] Serra.J, "Mathematical Morphology and Its Applications to Image Processing", Kluwer Academic Publishers, Boston (1994)