ISSN (Online) 2249 - 054 X

International Journal of Computing and Corporate Research

Specialized and Refereed Journal for Research Scholars, Academicians, Engineers and Scientists

http://www.ijccr.com

VOLUME 2 ISSUE 1 JANUARY 2012

# MATHEMATICAL MORPHOLOGY AN APPROACH TO IMAGE PROCESSING AND ANALYSIS

*Divya Sobti*

*M.Tech Student*

*Guru Nanak Dev Engg College Ludhiana*

*Gunjan*

*Assistant Professor (CSE)*

*Guru Nanak Dev Engg College Ludhiana*

**Abstract**

This paper presents the application of mathematical morphology to image processing and discusses its various operations. Quite often a recorded image suffers from a common degradation like poor contrast. There are standard techniques like histogram stretching, histogram equalization for improving the poor contrast of the degraded image. A few variations of histogram equalization technique e.g. histogram modification also serve the purpose. The application of mathematical morphology to image processing and analysis has initiated a new approach for solving a number of problems in the related field. Mathematical

ISSN (Online) 2249 - 054 X

International Journal of Computing and Corporate Research

Specialized and Refereed Journal for Research Scholars, Academicians, Engineers and Scientists

http://www.ijccr.com

VOLUME 2 ISSUE 1 JANUARY 2012

morphology is based on set theoretic concepts of shape. In morphology objects present in an image are treated as sets. The identification of objects and object features through their shape makes mathematical morphology become an obvious approach for various machine vision and recognition processes.

**Keywords:** Morphological Operations, Dilation, Erosion, Opening, Closing, Noise, Filter.

## 1. Introduction

Digital images are prone to a variety of types of noise. There are several ways that noise can be introduced into an image, depending on how the image is created. For example: If the image is scanned from a photograph made on film, the film grain is a source of noise. Noise can also be the result of damage to the film, or be introduced by the scanner itself. If the image is acquired directly in a digital format, the mechanism for gathering the data (such as a CCD detector) can introduce noise. Electronic transmission of image data can introduce noise. [1].Image noise elimination (reduction) [5] is the process of removing noise from the image.

Noise reduction techniques are conceptually very similar regardless of the signal being processed, however a priori knowledge of the characteristics of an expected signal can mean the implementations of these techniques vary greatly depending on the type of signal. In practice a lot of methods are used to eliminate the noise from the image and a lot of filters are used. There are standard techniques like histogram stretching, histogram equalization for improving the poor contrast of the degraded image. A few variations of histogram equalization technique e.g. histogram modification also serve the purpose.

The speciality of conventional histogram equalization technique is that it treats the image globally. However, there is a need for devising a context-sensitive technique based on local contrast variation since the image characteristics differ considerably from one region to another in the same image and also the local histogram does not necessarily follow the global

ISSN (Online) 2249 - 054 X
International Journal of Computing and Corporate Research
Specialized and Refereed Journal for Research Scholars, Academicians, Engineers and Scientists

http://www.ijccr.com

VOLUME 2 ISSUE 1 JANUARY 2012

histogram. A numerous modifications of histogram equalization (or modification) are suggested based on adapting the same over a sub region of the image. Contrast stretching methods using local statistics are also reported.

Image enhancement is an ad-hoc process of improving the visual quality of a degraded image subject to a pre-requisite quality for subsequent application specific processing. An enhancement technique performing is thus highly context sensitive and a given enhancement technique suitable for enhancing biomedical images may not be identically efficient in enhancing satellite images. There exist two broad categories of image enhancement techniques viz. The spatial domain techniques and the frequency domain techniques.

The application of mathematical morphology to image processing and analysis has initiated a new approach for solving a number of problems in the related field. This approach is based on set theoretic concepts of shape. In morphology objects present in an image are treated as sets. The identification of objects and object features through their shape makes mathematical morphology become an obvious approach for various machine vision and recognition processes. The technique usually adopted for improving the visual quality of such degraded images is broadly termed as image enhancement. [4]

**2. Hardware implementation of morphological processors**

These include Golay logic processor , Leitz Texture Analysis System TAS , the CLIP processor arrays ,and the Delft Image Processor DIP. The entension of concepts of morphological operations like dilation and erosion ( also known as Minkowski addition and subtraction respectively ) of binary images to arena of gray level images has proved to be reasonably efficient. Natural extension of morphologic transformations from binary image processing to gray scale processing using max and min operations is done by Sternberg [30] and Haralick . A number of researchers in various fields of image processing use morphologic techniques. Peleg and Rosenfield use it to generalize medial axis transform,

ISSN (Online) 2249 - 054 X

International Journal of Computing and Corporate Research

Specialized and Refereed Journal for Research Scholars, Academicians, Engineers and Scientists

http://www.ijccr.com

VOLUME 2 ISSUE 1 JANUARY 2012

Peleg et.al. use it to measure changes in texture properties as a function of resolution, Werman and Peleg used it for feature extraction, Lee et.al. [3] and Chanda et.al. [1] have employed gray scale morphology for edge detection.

### 3.Morphological Image Processing

Morphological image processing consists of a set of operations that transform images according to rules of set theory. It was originally developed for binary images and later extended to grayscale images. It was primarily developed in the 60's by French mathematicians Jean Serra and Georges Matheron. The basic idea in binary morphology is to probe an image with a simple, pre-defined shape, called the **structured element**, drawing conclusions on how this shape fits or misses the shapes in the image. The value of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbors. By choosing the size and shape of the neighborhood, we can construct a morphological operation that is sensitive to specific shapes in the input image. [2] Dilation and erosion are two fundamental morphological operations. Dilation adds pixels to the boundaries of objects in an image, while erosion removes pixels on object boundaries. The number of pixels added or removed from the objects in an image depends on the size and shape of the structuring element used to process the image. Dilation and erosion are often used in combination to implement image processing operations. For example, the definition of a morphological opening of an image is erosion followed by dilation, using the same structuring element for both operations. The related operation, morphological closing of an image, is the reverse: it consists of dilation followed by erosion with the same structuring element.[2] Morphological operations has been widely used to process binary and gray scale images, with morphological techniques being applied to noise reduction, image enhancement, and feature detection.[7].

#### 3.1 Morphological Operations

The four basic operations of mathematical morphology are:

ISSN (Online) 2249 - 054 X
International Journal of Computing and Corporate Research
Specialized and Refereed Journal for Research Scholars, Academicians, Engineers and Scientists

http://www.ijccr.com

VOLUME 2 ISSUE 1 JANUARY 2012

Erosion: shrink objects

Dilation: grow objects

Opening: erosion followed by dilation (disconnect parts)

Closing: dilation followed by erosion (remove holes) [6]

### 3.1.1 Erosion

The fundamental operation of mathematical morphology is erosion. All mathematical morphology depends on this notion [8]. The erosion of an input image A by a structuring element B is defined as follows:

$A \ominus B = \{x : B + x \subseteq A\}$

This means that in order to perform the erosion of A by B we translate B by x so that this lies inside A. The set of all points x satisfying this condition constitutes $A \ominus B$. The erosion of an image can also be found by intersecting all translates of the input image by the reflection of the structuring element:

$A \ominus B = \cap\{A + b : b \in -B\}$

### 3.1.2 Dilation

The dual operation to erosion is dilation. Dilation of an input image A by a structuring element B is defined as follows:

$A \oplus B = \cup \{B + a : a \in A\}$

This means that in order to perform the dilation of A by B we first translate B by all points of A. The union of these translations constitutes $A \oplus B$.

### 3.1.3 Opening

A secondary operation of great importance in mathematical morphology is the opening operation. Opening of an input image A by a structuring element B is defined as follows:

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

An equivalent definition for opening is:

$A \circ B = \cup\{B + x : B + x \subseteq A\}$

ISSN (Online) 2249 - 054 X

International Journal of Computing and Corporate Research

Specialized and Refereed Journal for Research Scholars, Academicians, Engineers and Scientists

http://www.ijccr.com

VOLUME 2 ISSUE 1 JANUARY 2012

This means that in order to open A by B we first translate B by x so that this lies inside A. The union of these translations constitutes A o B. For instance, the opening of a triangle A by a disk B (the origin coincides with the centre of the disk) is the triangle A with rounded corners. In general, opening by a disk rounds or eliminates all peaks extending into the image background.

**3.1.4 Closing**

The other important secondary operation is *closing.* Closing of an input image A by a structuring element B is defined as follows:

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

For instance, closing a triangle A by a disk B (the origin is on the centre of the disk) yields the same triangle A. In this case A • B = A and we say that A is *B-close*. In general, closing by a disk rounds or eliminates all cavities extending into the image foreground.

Other important math morphology operators are (mostly can be written as combinations of the basic operators):

**Thinning :** reduce thick lines to thin, 1 pixel wide lines (repeated erosion)

**Thickening :** opposite of thinning, produce wider lines (repeated dilation)

**Skeleton :** generates a skeleton, a central line equidistant to the boundary of the shape

**Prunning :** remove dangling lines, spurs

**Watershed :** image segmentation.[9]

ISSN (Online) 2249 - 054 X
International Journal of Computing and Corporate Research
Specialized and Refereed Journal for Research Scholars, Academicians, Engineers and Scientists

http://www.ijccr.com

VOLUME 2 ISSUE 1 JANUARY 2012

### 3.1.5 Example, Random Image

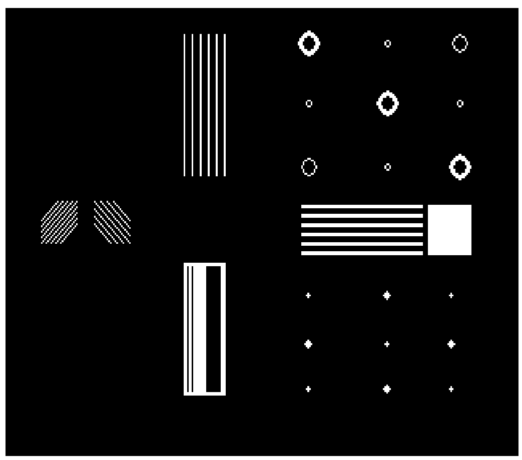

Fig 1(a):Random Image

Fig1(b):Erosion

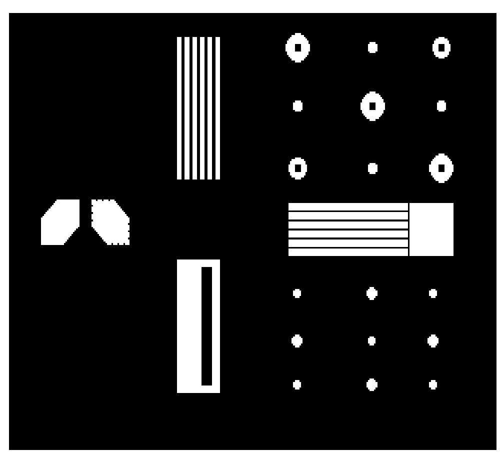

Fig1(c):Dilation

ISSN (Online) 2249 - 054 X
International Journal of Computing and Corporate Research
Specialized and Refereed Journal for Research Scholars, Academicians, Engineers and Scientists

http://www.ijccr.com

VOLUME 2 ISSUE 1 JANUARY 2012

Fig1(d):Opening

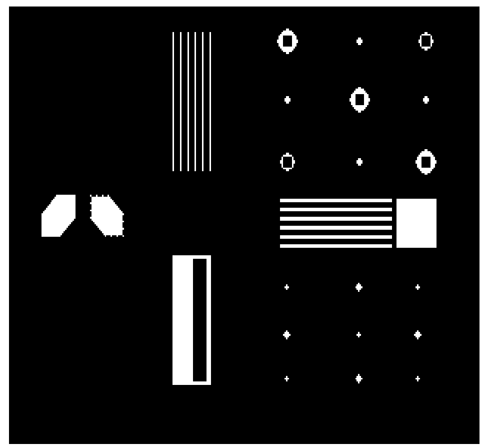

Fig 1(e):Closing

**4. References**

[1] B. Chanda, M. K. Kundu, and Y. V. Padmaja. "a multi-scale morphologic edge detector". Pattern Recognition, Vol.31:1469{1478, 1998}.

[2] Morphological operations (Image processing Toolbox user's guide).

[3] J. S. J. Lee, R. M. Haralick, and L.G.Shapiro. Morphologic edge detection. IEEE Trans. On Robotics and Automation, RA-3:140-156, 1987.

[4] S. Mukhopadhyay and B. Chanda: Local Contrast Enhancement of Grayscale Images using Multiscale Morphology.

[5] http://en.wikipedia.org/wiki/Noise_reduction.

[6]Waheeb Abu Ulbeh, Akram Moustafa, Ziad A. Alqadi :Gray Image Reconstruction.

[7] R. C. Gonzalez and B. A. Fittes. Gray-level transformations for interactive image enhancement. Mechanism and Machine Theory, 12:111-122, 1977.

[8] R. C. Gonzalez and P. Wintz. Digital Image Processing, 2nd ed. Addison-Wesley, Reading, MA,1987.

ISSN (Online) 2249 - 054 X

International Journal of Computing and Corporate Research

Specialized and Refereed Journal for Research Scholars, Academicians, Engineers and Scientists

http://www.ijccr.com

VOLUME 2 ISSUE 1 JANUARY 2012

[9] Alexandre Cunha:A brief introduction to image processing:Center for Advanced Computing Research California Institute of Technology Methods of Computational Science 2009