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AN ENHANCED IMAGE BIOMEDICAL CLASSIFICATION BY MORPHOLOGY ALGORITHM

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Abstract

Image Processing morphology is an important tool in digital image processing based on human intuition and perception. Morphology based on the geometry, which emphasizes the geometry of the image. Morphology of the process is mainly used to remove the imperfections that exist in the form of an image. No exception in the field of medicine / medical, often obtained results rontgent or scanning the resulting images do not have the accuracy of the expected image quality. This is because factors of body movement or instrument (not focusing) so that the resulting image blur and distorted. One method is to enhance this image by using morphology method. With operations erosion and dilation as well as a combination of both in the process of opening and closing, the morphology of high level / complex projects could be implemented. The key to success lies in the selection process of the morphology of mathematical operations and the choice of structured elements. Even the selection of filters and methods of transformation in this process is often not used. In a study obtained optimal results for the distorted image with SNR 19.891 dB, reduction bits 2.206, and Gain 13.27 dB.

Keywords: morphology, enhanced image, erosion, dilation, structured elements

1. Introduction

Modern digital technology has made it possible to manipulate multi-dimensional signals with systems that range from simple digital circuits to advanced parallel computers. An image defined in the 'real world' is considered to be a function of two real variables, for example: $a(x,y)$ with a as the amplitude (e.g. brightness) of the image at the real coordinate position (x,y).

An image may be considered to contain sub-images sometimes referred to as regions of interest (ROI) or simply regions. An image is digitized to convert it to a form which can be stored in a computer's memory or on some form of storage media such as a hard disk or DVD-ROM. This digitization procedure can be done by a scanner or by a video camera connected to a frame grabber board in a computer. Once the image has been digitized, it can be operated upon by various image processing operations. Image processing operations can be roughly divided into three major categories:

- ✓ Image compression, involves reducing the amount of memory needed to store a digital image
- ✓ Image enhancement , Image defects which could be caused by the digitization process or by faults in the imaging set up
- ✓ Restoration, compensate for or undo defect which degrade an image.

Morphology is a technique or process used for image processing (image) based on the principle of mathematical morphology [1]. In image processing, the expected result is based on the shape or structure of the original image [2]. Meanwhile, Chris Solomon and Toby Breckon further said that the morphology of the process is always closely related to neighborhoods which are formed from blocks of one and zero binary values [3]. Furthermore, the morphology of an image is a collection of non-linear operations related to the shape or morphology of an image [4]. In practice, binary systems are often used in the process of morphology, namely the bit 1 or known as the foreground and background bits of 0 or by changing certain parts of the foreground into the background and vice versa to change some background to the foreground area. Change foreground and background area is closely related to three things: the image, the morphology of the type of operation, and arrangement of elements (structured element) image. There are three basic operations in morphology operations, namely: operations AND, OR, and NOT.

Tab 1. Morphology of the basic operation

P	Q	AND	OR	NOT
0	0	0	0	1
0	1	0	1	1
1	0	0	1	0
1	1	1	1	0

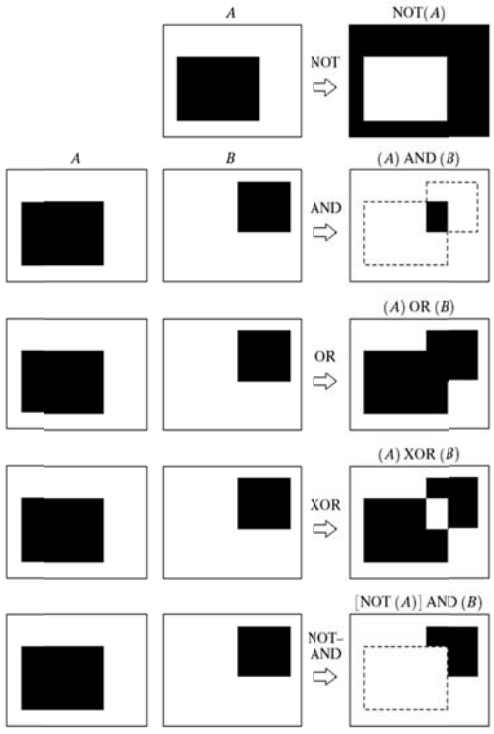

Fig 1. Some operations in the morphology of binary logic. Binary black and white representing the number 1 represents 0.

In binary morphology, an image was viewed as a subset of Euclidean space R^d or grid Z^d integer to the value of the dimension *d*. Benefits of using the morphology of which is to eliminate the existing noise. Getting to know the characters form an image, and used to improve image quality. In the form of 2D, the morphology of the process used for the extraction of the characters in the image. As for 3D, this process is used in the medical field. One is to get objects from a collection of objects together in the cardiac surgical, neuro surgical and functional MRI for mind [5]. The process is also used in the morphology of the police to fingerprint identification in order to clarify the flow pattern existing hand lines.

2. Study References

According to Luc Vincent [7] stated that combination between morphological gray scale and sequential technique result in a hybrid grayscale reconstruction algorithms which is an order of magnitude faster than any previously known algorithm.

Marian M. Choy and Jesse S. Jin [8] stated that assessment of cardiac function using imaging techniques requires accurate identification of borders. Combination between morphological images with a second derivative operator that is Laplican of Gaussian can reduce noise and increase contrast of the image.

Karol Mikula, Tobias Preuber, and Martin Rumpf [9] stated that using morphological multi-scale method for image sequence processing will give result denoise the whole sequence while retaining geometric features such s spatial edges and highly accelerated motions.

L. Vincent [10] gives an efficient algorithm for the implementation of morphological operations with random structure elements, assuming a chain code encoding of the binary objects.

The types of operations to transform an input image $a[m,n]$ into an output image $b[m,n]$ can be classified into three categories:

- ✓ Point: the output value at a specific coordinate is dependent only on the input value at that same coordinate
- ✓ Local: the output value is dependent on the input values in the neighborhood of that same coordinate
- ✓ Global: the output value is dependent on all the values in the input image

To obtain the third form, the image on the sample is can be classified two forms of structured element or neighborhoods pixels:

- ✓ Rectangular sampling
- ✓ Hexagonal sampling

Local operations produce an output pixel value $b[m=m_o,n=n_o]$ based upon the pixel values in the neighborhood of $a[m=m_o ,n=n_o]$. Some of the most common neighborhoods are the 4-connected neighborhood and the 8-connected neighborhood. Operations that are fundamental to digital image processing can be divided into four categories:

- ✓ Operations based on the image histogram
- ✓ On simple mathematics
- ✓ On convolution
- ✓ On mathematical morphology

An arrangement of elements (*structuring element*) is a block array is 0 or 1 or rectangular, the block row, column or block.

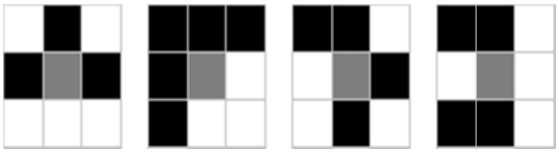

Fig 2. Examples of structure elements and the central structuring element pixel are drawn in the gray.

In the figure 2, the central structuring element is in the middle of the block when the block is odd dimension (e.g., 3 x 3, or 5 x 5). As for the block dimension is even, the central structuring element is on the left side closest to the middle of the block (e.g., block of 4 x 3 and 4 x 4 then the central structuring element in the [2.2]).

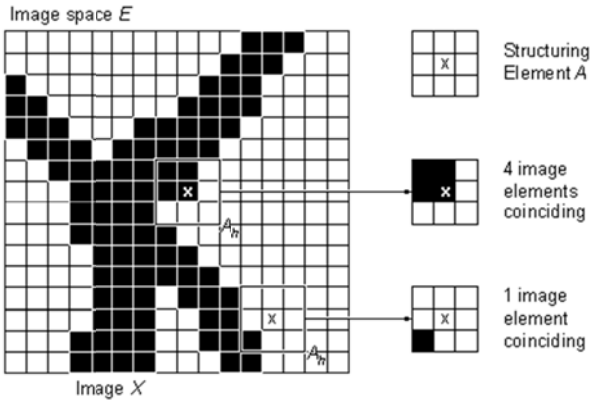

Fig 3. Structuring elements that is fill the area of origin in a row, one after another.

Structuring element is a common form used in the morphology of the image as a convolution kernel that is often used in linear filters process an image [4]. When the structuring element is placed in a binary image, each pixel by pixel interlaced image neighborhood of origin.

2.1 Dilation and Erosion

Dilation process in the morphology of identical image is can do by adding pixels in the original scope of the image, by placing one by one after the central structuring element for each pixel background. If any pixel neighborhood foreground pixel (value 1), the background changed to the foreground pixels. Notation for dilation is expressed as follows.

$$g(x, y) = f(x, y) \oplus SE \tag{1}$$

The process of erosion is the process of removing pixels within the object image by putting the central structuring element one by one in the foreground pixels (value 1). If there is a neighborhood pixel value background pixels (value 0), then the value is in the foreground to the background change. Notation for erosion is expressed as follows.

$$g(x, y) = f(x, y) \Theta SE \tag{2}$$

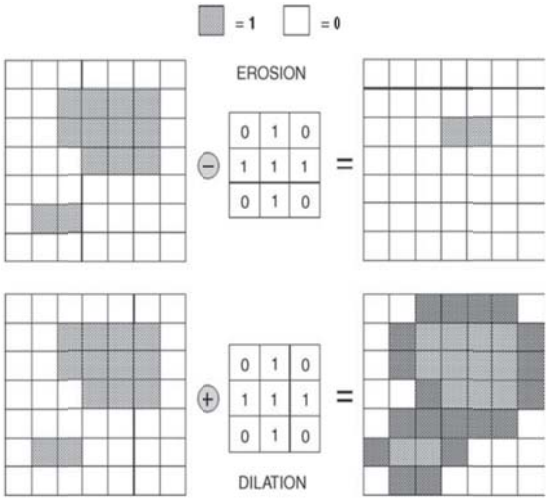

Fig 4. The original image is covered by a block arrangement of the elements one by one.

The pixel value will only be worth it as the central structuring element of appropriate value (in this case the value of cross -1) with values other than the center to zero. While in the process of dilation, the origin pixel has a value equal to the block arrangement of elements of the pixel value their neighborhood turn into such a block structuring element. With the erosion process resulting in shrinking the size of the image object so that it can be used to separate objects that mutually coupled to each other. While the dilation will increase its size so it can thicken the object image and connect the object to flatten the edge of the object is lost or damaged.

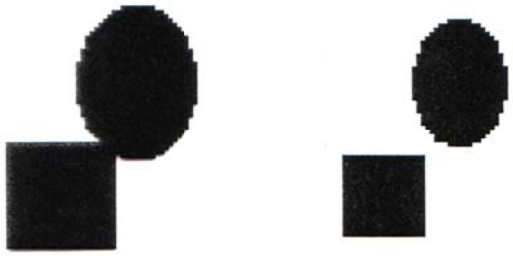

Fig 5. The process of erosion can be used to separate objects that bond together.

Fig 6. Dilation process is used to connect the fragmented object.

2.2 Opening and Closing

Opening the morphology is the process using erosion and then the process continued with the dilation using structuring elements the same, which can be expressed by the following notation.

$$f(x,y) \circ SE = (f(x,y) \Theta SE) \oplus SE \tag{3}$$

Opening widely used for the process of removing small objects in an image but still retain their original shape.

Fig 7. Opening the process used to separate objects as well as to smooth the image

While closing is the process of morphology by performing a dilation operation followed by erosion operation using the same structuring element. Written with the following notation:

$$f(x,y) \bullet SE = (f(x,y) \oplus SE) \Theta SE \tag{4}$$

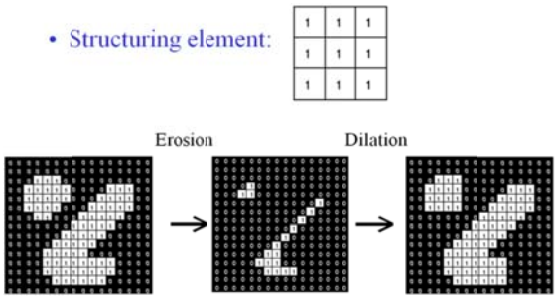

Fig 8. Example of a 3x3 structuring element with a binary 1
is used for the process of erosion and dilation.

Closing method is used when you want to close the gap with the object retains its original shape.

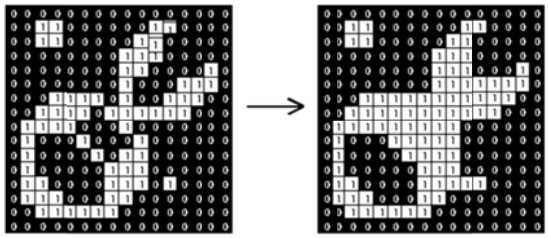

Fig 9. Closing process is used to fill the empty part of an object.

2.3 Boundary extraction

The process to get the boundary edge image objects or known by the boundary extraction process can be done by first doing the process of erosion with a small block structuring element, and then the result is reduced by the image origin. Boundary extraction Notation is written as follows.

$$\beta(A) = A - (A \ominus B) \tag{5}$$

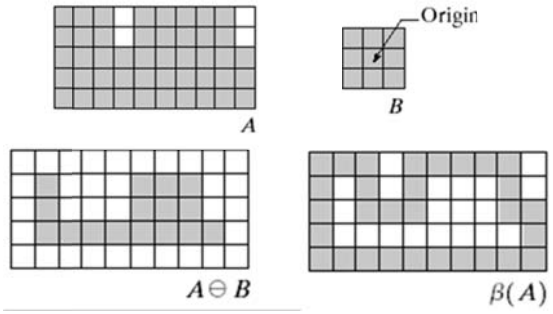

Fig 10. Boundary process extraction

Fig 11. Using a structuring element of 3 x 3 box shape in the process of boundary extraction is obtained images extracted boundary

2.4 Morphology in Matlab

For some of the basic process of morphology can be implemented with the help of Matlab software from MathWorks Inc. (www.mathworks.com), listed in the following table.

Tab 2. Matlab function in the process morphology

Operation	Matlab Function	Information
Erosion	imerode	$A \ominus B$
Dilation	imdilate	$A \oplus B$
Opening	imopen	$A \circ B = (A \ominus B) \oplus B$
Closing	imclose	$A \blacksquare B = (A \oplus B) \ominus B$

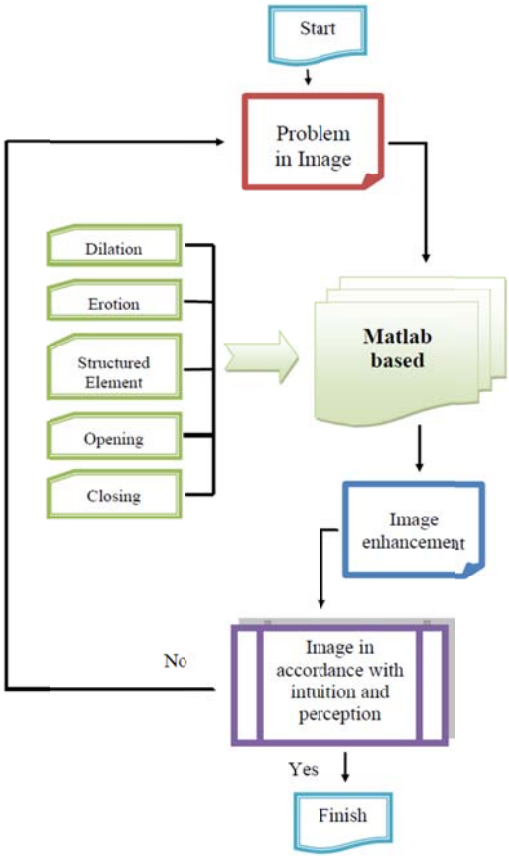

Fig 12. Flow chart of research process with the morphology of algorithms to improve image quality in medical field

In this study using a variety of medical image or collecting medical imagery, especially imagery associated with: bones, joints, skull, heart (gray scale). Both images are obtained in perfect condition and have been distorted because of movement by lens or by patients and then the perfect image is used as a reference.

Creating a collection based algorithm in Matlab programming, primarily determines the choice of a variety of structured elements with different variations that are used to compare with each other so that the obtained image with the optimal shape in terms of eye.

Creating program for each type of morphology which is commonly used to improve image quality, there is dilation, erosion, opening and closing as well as mixing between the four components.

Combining all of the algorithms and programs in the morphology of a whole project based MATLAB programming in order to facilitate the research of several sources of medical images.

The results of the medical image that has been improved with the method morphology compared with the existing of perfect image and then made a conclusion.

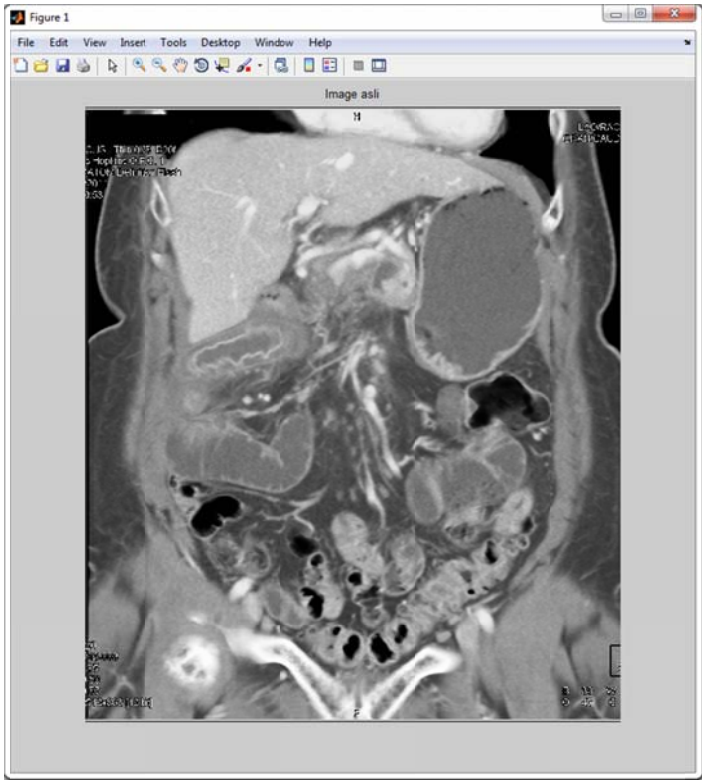

Fig 13. One of the original Colon.jpg image is used for research.

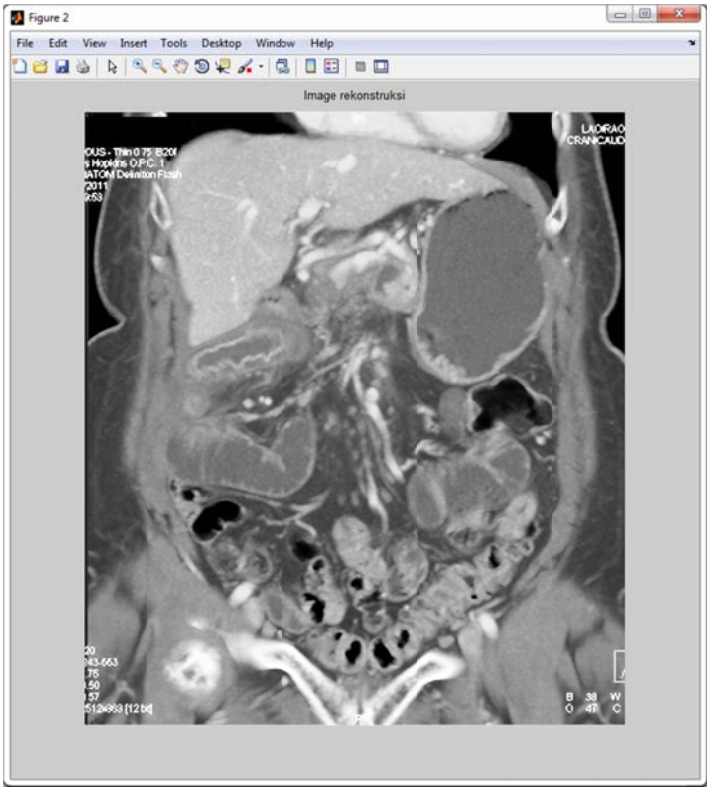

Fig 14. Reconstruction Colon.jpg with the process dilate
by using structured element in Matlab [0 1 0; 1 1 1;0 1 0]

Fig 15. Reconstruction Lung.jpg with the process erode
by using structured element in Matlab [0 1 0; 1 1 1; 0 1 0]

Fig 16. Reconstruction Lung.jpg with the process erode by using structured element in Matlab `[1 0 0 1 0 0 1; 0 1 0 1 0 1 0; 1 1 1 1 1 1 1; 0 1 0 1 1 0 0; 1 0 0 1 0 0 1]`

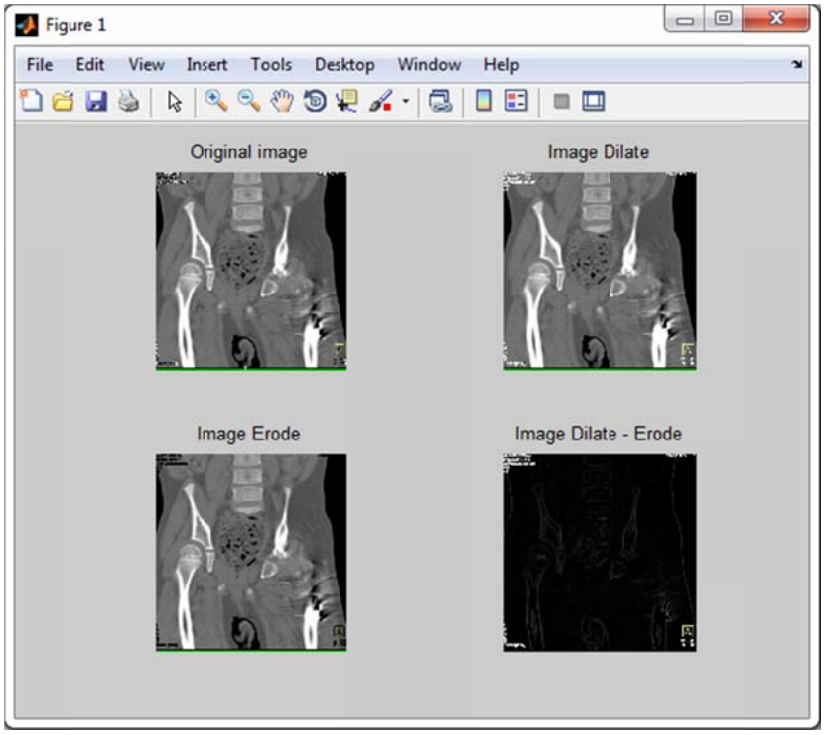

Fig 17. Image Pediatric.jpg with mix process between *dilate* and *erode* using *structured element* `[0 1 0; 1 1 1; 0 1 0]`

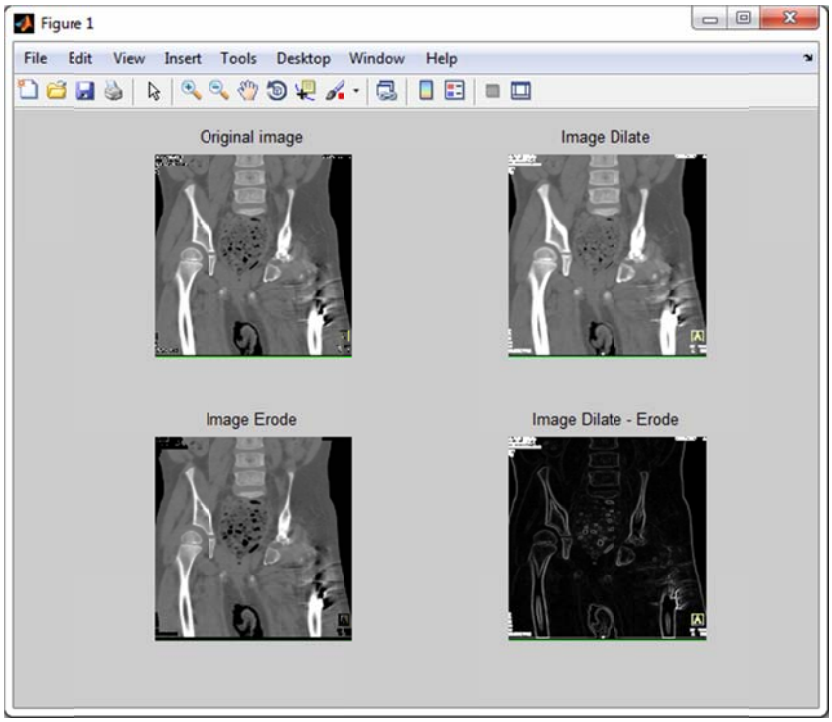

Fig 18. Image Pediatric.jpg with mix process between *dilate* and *erode* using *structured element* `[1 0 0 1 0 0 1; 0 1 0 1 0 1 0; 1 1 1 1 1 1 1; 0 1 0 1 1 0 0; 1 0 0 1 0 0 1]`

Tab 3. The amount of Gain, number bits on reduction process, and SNR

Image	Gain (dB)	Reduction Bit (bits)	SNR (dB)
Adrenal.jpg	13.47	2.24	18.88
Cardiac.jpg	14.28	2.37	20.18
Chest.jpg	12.32	2.05	17.02
Colon.jpg	11.27	1.87	17.08
Esophagus.jpg	10.43	1.773	16.56
Gastrointestinal.jpg	15.63	2.60	22.90
Genitourinary.jpg	16.52	2.74	26.27
Kidney.jpg	7.74	1.28	14.58
Liver.jpg	15.94	2.65	29.48
Lung.png	14.22	2.36	21.60
Musculoskeletal.jpg	18.21	3.02	22.09
Pancreas.jpg	9.88	1.64	16.46
Pediatric.jpg	11.65	1.94	17.03
Spleen.jpg	14.22	2.36	18.35
$\sum$ / μ	185.78 / 13.27	30.893 / 2.2066	278.48 / 19.891

3. References

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