# A NEW TOOL FOR MORPHOLOGICAL PROCESSING OF IMAGE

B. León García

Biomedical engineering, University CEU San Pablo, Madrid, Spain, b.leon4@usp.ceu.es

## Abstract

*The use of image processing techniques in biomedical engineering to enhance medical image quality and aid doctors in diagnosis and treatment planning is important. This study aims to develop a program that goes beyond the existing functions of MATLAB® by allowing users to process images and focus on specific areas of interest. The program offers options such as different sizes of the processing matrix and various operations (erosion, grow, hit/miss, and skeleton) for image analysis. This program's potential to assist doctors in diagnosing of patients and suggests future improvements of the program.*

## 1. Introduction

Biomedical engineers work with doctors, engineers give them the tools with which they can care for patients. Image processing allows us to improve the quality of medical images, to help doctors make a better diagnosis, biomedical engineers can remove noise from images and highlight important parts of the patient's body, as well as the planning of a surgical intervention since by image processing we can form 3D reconstructions that help the doctor to know how to operate and give them more security. In the case of a follow-up of treatments we can show more clearly the evolution of the patient's images. Also, in scientific research in medicine since we provide great options such as identifying disease patterns or studying biological parts. Consequently, in biomedical engineering, image processing is crucial to facilitate the study and work of doctors. After having carried out by means of some technique such as MRI, computed tomography, x-rays and radiography, images of the study area of interest are obtained, if we process these images, we will see them more clearly and clearly.

The objective of this study in image processing tool is to improve the processing in order to obtain better results and thus facilitate the diagnosis of doctors. The creation of a program to go a step further than the already existing functions of MATLAB® [1], that is, the program will allow you to process the images to look at other parts of the image and thus be able to analyse it more precisely.

With the morphological image processing functions of MATLAB®, images with a black background are analysed and the part in which the processing will be seen will be the light of the image.

In my program, the darker parts will undergo an apparent change, which can be very useful for the doctor depending on what is required for his study.

In my program you can process the images in different ways, either using different sizes of the processing matrix (matrix that walks through the image to process it) or a specific operation (chosen by the user, erosion, grow, hit/miss and skeleton) to perform that helps to better identify the components of the image for the study. With it you can focus on the dark parts of the image that correspond to the softest tissues such as cartilage, organs, gases or connective tissue.

With MATLAB® functions you cannot choose the size of the processing matrix, you can simply change the operation to be performed, this limits the doctor's analysis since there may be parts that cannot be appreciated.

## 2. Methods

Morphological image processing consists of traversing the image with a processing matrix and change some numbers depending on the operation needed.

### 2.1. Preconfiguration of the image

To process the image, it must be transformed into a binary matrix, made up of 0s and 1s. To focus on the dark part of the image, the program assigns 0 to dark colours (black), 1 to light colours (white) and -1 for indifference. In a nutshell, transform the image into an array of 0s and 1s.

To process the entire image, the program adds a frame according to the matrix size that is chosen, in this way the image is processed from beginning to end, instead of starting below the border.

In my program you have different options to choose.

You can choose the size of the processing matrix between 3x3, 5x5 and 7x7, as well as the operation to be performed.

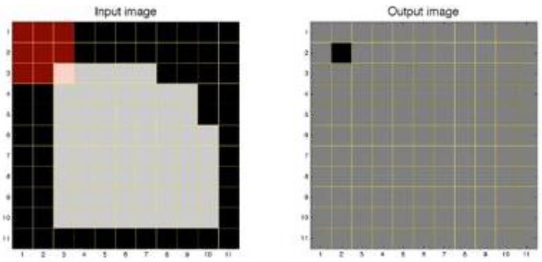


**Figure 1.** Red boxes represent how MATLAB® functions do. In my program you can choose the size of that matrix.

Therewith, the different operations from which the user can choose in my program are erosion, grow, hit/miss and skeleton.

### 2.2. Erosion

In morphological image processing it is the operation from which other morphological operations are based. The erosion operation usually uses a structuring element for reducing the shapes contained in the input image, make it smaller.[2]

In my program when the matrix finds a 0, in other words, the border of the dark drawing, it changes it to 1 to make a thinner drawing, thus the process is for eliminating the outer pixels of the darker drawing. [3]

### 2.3. Grow

It is also one of the basic operations based on erosion, as it does the opposite. The grow or dilatation operation uses a structuring element for expanding the shapes contained in the input image.[4]

It is confirmed that it is the opposite operation to erosion. So, when it finds the border, it changes it to 0 to make a bigger darker drawing, consequently the process add pixel to the drawing, making it bigger. [5]

### 2.4. Hit/miss

Hit-and-miss is a general binary morphological operation that can be used to look for particular patterns. Therefore, it is the basic operation of binary morphology. Almost all the other binary morphological operators can be derived from it. [6]

The matrix to traverse in this operation is the one that you introduce, with the size that you had chosen and the numbers you want (0, 1 or -1). It will change the pixel to black, 0 if the image matches with this matrix. In this way, when you have a specific pattern to analyse an image of a specific disease, you can process different images using the same pattern. [7]

### 2.5. Skeleton

A skeleton (or medial axis) is a representation of a shape or binary image, computed by means of the hit-or-miss transform, which preserve the shape's topology, as the previous opetarions. [8]

Accordingly, it is similar to hit/miss but the matrix it takes is the Golay's alphabet one and change the pixels to white, 1 instead of black. These matrixes work the same as the hit/miss matrix but instead of being entered by the user, these are used thanks to the binary Golay code that is a type of linear error-correcting code used in digital communications and following image processing. As seen in the image black squares represent the colour black (0s), the white ones white (1s) and the blue ones indifference (-1s). Therefore, we will obtain the skeleton of the drawing. It is to say, what supports the structure of the figure that we analyse. [9]

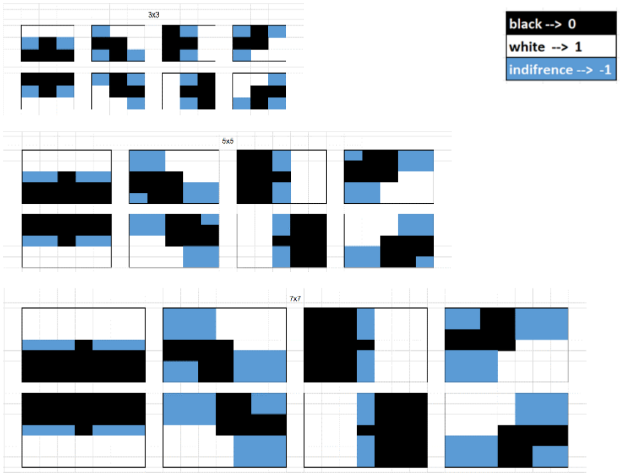


**Figure 2**. Golay's alphabet matrix

The source code of the developed program is available in a public repository, you can download it from GitHub, where you can see the full repository program. [10]

## 3. Results

In order to evaluate the algorithms used in this program for each of the operations we execute different test with some image, to see the results.

### 3.1. Erosion

In the following image erosion operation is performed with size 7x7, as we can see in the processed image the outline of the joint stands out more, in this way the doctor can detect some type of pathology.

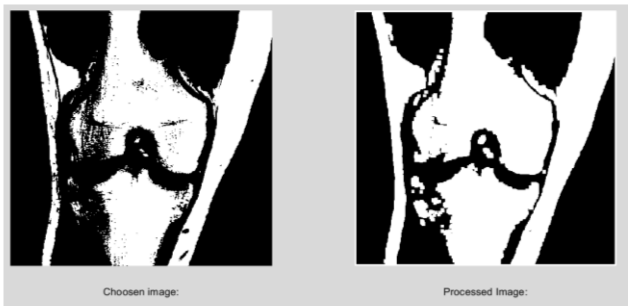


**Figure 3.** Erosion in 7x7

When using MATLAB®'s function we obtain this as a result, there is not a clear erosion of the image, and some noise is added to it.


**Figure 4.** Erosion in MATLAB®'s function

### 3.2. Grow

This time it is made grow operation with size 5x5. As in the previous image by making the outline of the joint larger, more visible, it will allow the doctor to make a better diagnosis.

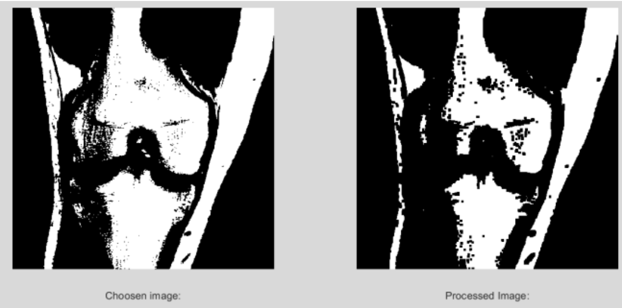


**Figure 4.** Grow in 5x5.

In grow operation of MATLAB® also add noise, the processed image is so blurry.

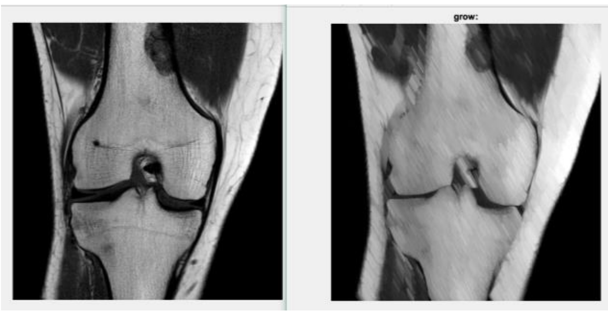


**Figure 5.** Grow in MATLAB®'s function.

### 3.3. Skeleton

When performing skeleton, we obtain the skeleton of the image. Here we can see how the skeleton of this hand palm is.

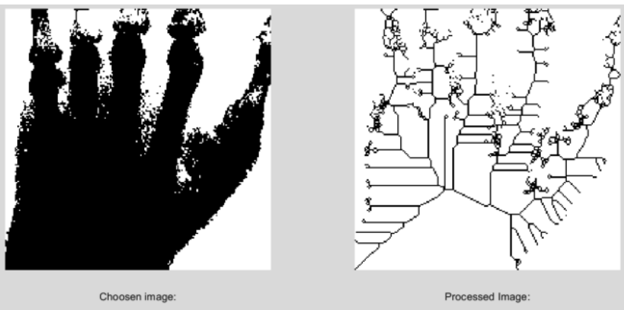


**Figure 6.** Skeleton in 3x3.

Definitely, in this operation MATLAB® adds a lot of noise, worsens the image until you can hardly see it.

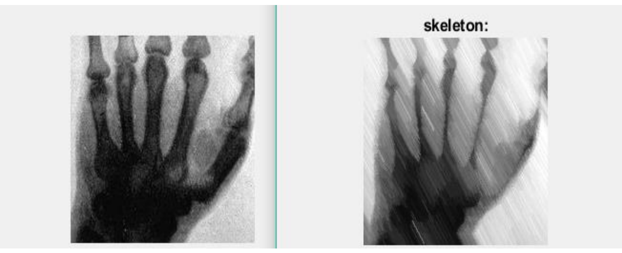


**Figure 7.** Skeleton in MATLAB®'s function.

### 3.4. Hit/Miss

In hit/miss you must introduce a processing matrix. After writing the matrix in table 1, we get this image. It depends on the processing matrix that you enter, you will be able to better appreciate some study points for the doctor.

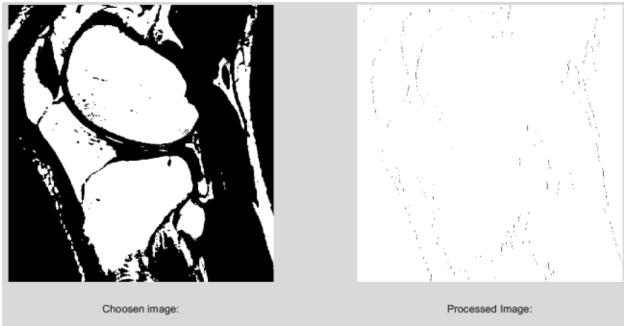


**Figure 8.** Hit/miss in 3x3.

| | | |
|---|---|---|
| 0 | 1 | -1 |
| 0 | 1 | -1 |
| 0 | 1 | -1 |

**Table 1.** Processing matrix used in hit/miss example.

Hit or miss in MATLAB® do not let you define de processing matrix, so the result is this. Also, a blurry image with lots of noise.

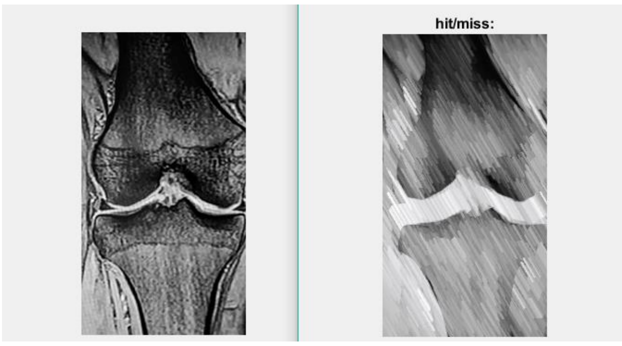


**Figure 10.** Hit/miss in MATLAB®'s function.

As you can see, all MATLAB® images are not well processed. The result is blurry and do not correspond with a clear operation with this type of images. The processed image appears with spots, dots and distorted but clearly the operation is not observed.

In erosion, it is not seen that it thins out; in grow, that it gets bigger; in skeleton, nothing similar to the skeleton of the figure and in hit/miss a change is not observed either.

## 4. Conclusions

This work presents a new toll for morphological image processing that simplifies the process and offers a wider selection of option that the ones that MATLAB®'s offered. With these images we can greatly help doctors when diagnosing or monitoring a patient's pathology.

As clearly seen, this type of images processed with MATLAB's functions do not provides more information, it really limits the information more.

The program gives you a wide range of options to process the image according to what the doctor wants to study and a grater configuration for the user in an easier and more effective way than MATLAB®. Therefore, it is a great tool for the field of biomedical engineering along with medicine and diagnostics.

The future view for my program is to create it in another type of programming language, a high-level one, be it Python or JavaScript, as these will show better results and will use less computer capacity and memory. Memory and processor are two fundamental parts in a computer since they play important roles such as performance and processing capacity.

Another way to improve the program would be to create a program along the same lines of this one but for 3D and 4D images [12]. By creating a program for 3D and 4D imaging, we can help doctors in an incredible way.

From several 2D images you can recreate the part you want from those in a 3D image. If you have a good program for 3D image processing, the doctor can present the problem of the patient has in an incredible way and even show it to the patient and said patient to see his problems.

## References


[1] Web page of MATLAB® morphological filtering operations https://es.mathworks.com/help/images/morphological-filtering.html

[2] Web page of erosion morphology in morphological image processing https://en.wikipedia.org/wiki/Erosion_(morphology)

[3] Web MATLAB®'s erosion. https://es.mathworks.com/help/images/ref/imerode.html

[4] Web page of dilation morphology in morphological image processing https://en.wikipedia.org/wiki/Dilation_(morphology)

[5] Web page of MATLAB®'s grow. https://es.mathworks.com/help/images/ref/imdilate.html

[6] Web page of MATLAB®'s hit/miss. https://es.mathworks.com/help/images/ref/bwhitmiss.html

[7] Web page of hit or miss transform. https://homepages.inf.ed.ac.uk/rbf/HIPR2/hitmiss.htm#:~:text=The%20hit%2Dand%2Dmiss%20transform,can%20be%20derived%20from%20it.

[8] Web page of skeleton morphology in morphological image processing https://en.wikipedia.org/wiki/Morphological_skeleton

[9] Web page of binary Golay's alphabet code. https://en.wikipedia.org/wiki/Binary_Golay_code

[10] Github page with full repository beatrizleongarcia/Image-Processing-Morphological-Assignment (github.com)

[11] Help when programming in MATLAB®. https://www.mathworks.com/help/matlab/

[12] Future possible program. https://www.academia.edu/26330842/Morphological_Operations_on_3D_and_4D_Images_From_Shape_Primitive_Detection_to_Skeletonization