

Opening and closing in morphological image processing

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World Journal of Advanced Research and Reviews, 2022, 14(03), 687–695

Publication history: Received on 14 May 2022; revised on 19 June 2022; accepted on 21 June 2022

Article DOI: <https://doi.org/10.30574/wjarr.2022.14.3.0576>

Abstract

Morphological Image Processing is a useful tool in digital image processing because it can rigorously quantify many features of the geometrical structure of a way that is consistent with human intuition and perception. Morphological processing may remove noise and clutter from images, as well as alter them according to the size and shape of the items of interest. Linear Image Processing is sometimes used instead of Morphological Image Processing since it changes the underlying geometric form of an image, although Morphological Image Processing does not lose the image's information.

Keywords: Morphological image processing; Erosion; Dilation; Opening; Closing

1. Introduction

The cornerstone of morphological image processing is the analysis of a two-valued picture in terms of a given geometric form known as a structuring element. The discipline of biology that deals with the form and structure of animals and plants is known as morphology.

A method for extracting essential properties from pictures that may be used in morphological processing for the representation and description of area forms that is particularly well-suited.

Morphological processing refers to operations that reduce an object to a more revealing shape by hitting or fitting it with structuring features. These structural components are shape primitives that have been created to represent a particular characteristic of the data or noise. Morphological transformations are performed on data by applying these structuring elements to it using various algebraic combinations. In forensics, morphological image processing methods are used on binary images.

2. Literature survey

Magnetic Resonance Imaging (MRI) is a form of brain imaging equipment that creates a detailed picture of the brain using a magnetic field and radio waves. Additionally, it also emits no harmful radiation into the environment. Mathematical morphological-image processing is used to increase the contrast of the MRI image. Because of the picture enhancement, doctors were able to make more accurate diagnosis. The image is not only brightened, but the skull is also removed utilising mathematical morphological-image processing. The opening operation will smooth the object image, break down the bridge, and remove small objects, whereas the closing operation will create small breaks and holes. The MRI image is improved at the end, and the skull stripping allows for a more accurate diagnosis.

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After locating the spots on the DNA microarray picture, the image must be strengthened and improved in quality so that the image's information can be extracted. As a result, this study employs mathematical morphological-image processing. Morphological opening and closure is a technique for improving image quality by manipulating the erosion and dilatation processes. In the opening phase, the picture is eroded and then dilates, whereas in the closing process, the image is eroded and then dilates. By reducing specific noise from the image, the threshold of the image can improve image quality. Pixels with a value less than or equal to the threshold value are set to zero, while pixels with a value greater than or equal to the threshold value are set to one.

Autonomous underwater vehicles (AUVs) were primarily utilised by scientists to research and comprehend the ocean ecosystem, particularly in the monitoring of plankton. The Visual Plankton Recorder (VPR) was created to record the images during the observation in order to do so. The Regions of Interest (ROIs) focusing on the area where the plankton' photos were predominantly located were saved in the memory as the visuals were recorded. One of the seven phases that the picture will go through is the morphological operation, or opening and closing procedure. The opening procedure in this case removes a small bit of noise, while the closure step reconnects the areas divided by small holes. Clear images of plankton may be detected by repeating the process, and the little amount of plankton can be identified by repeating the process.

3. Implementation

3.1. Fitting and Hitting

The Structuring Element is placed in all positions or potential locations in the binary image and compared to the pixel's surrounding neighbourhood.

A binary correction is similar to the morphological procedure. When the operation is logical rather than mathematical.

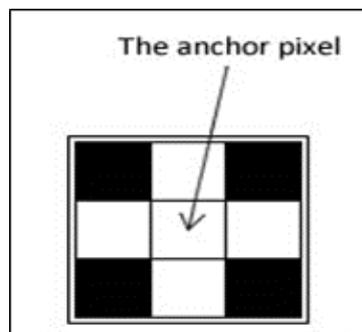


Figure 1 Structuring element

Let's say there are two 3x3 structural pieces

$$S1 = \begin{pmatrix} 1 & 1 & 1 \\ 0 & 1 & 0 \\ 1 & 1 & 1 \end{pmatrix}$$

$$S2 = \begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 0 & 1 & 0 \end{pmatrix}$$

A, B, and C are the three places in which the S1 and S2 structural components should be put in a particular picture.

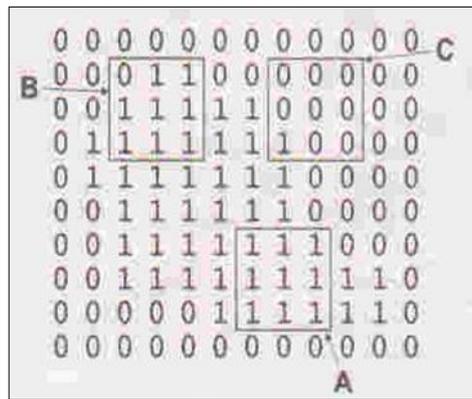


Figure 2 A, B and C are places in which S1 and S2 put in particular picture

A binary image was used to assess the fitting and hitting of Structuring Element S1 and S2.

3.2. Fit

The structuring element is said to FIT the image if each of its pixels is set to '1' and the matching picture pixel is likewise '1.'

Both S1 and S2 fit the image at 'A' in the example above (keep in mind that structural element pixels set to '0' are discarded when checking for a fit). S2 corresponds to the image at 'B,' but neither S1 nor S2 corresponds to the image at 'C.'

3.3. Hit

A structuring element is said to HIT an image if any of its pixels are set to '1'.The image pixel that corresponds to it is also a '1'. (We also ignore picture pixels whose corresponding structural element pixel is '0' in this case.)

S1 and S2 HIT the picture in neighbourhood 'A' in the example above. The same may be said for 'B'. In the 'C' neighbourhood, however, only S1 HITS the image.

In this notion, HITS stands for union, while FITS stands for intersection.

Furthermore, the set operations intersection and union can be replaced by the Boolean operators 'AND' and 'OR'

4. Erosion and dilation

4.1. Erosion

Objects shrink as a result of erosion. The structural element chosen determines the amount by which they shrink. Erosion shrinks an object's size by erasing or eroding the pixels on its edges.

The erosion of an image 'A' by a structural element 'B' is denoted by the letters AB.We place 'B' so that its origin is at picture pixel coordinate (x, y) and apply the rule to compute the erosion.

$$g(x, y) = \begin{cases} 1 & \text{if 'B' Fits 'A',} \\ 0 & \text{otherwise} \end{cases}$$

Repeat for all pixel or x and y coordinates. Erosion creates a new picture that emphasises all of the places in the input image where the origin of a structural element fits. The erosion procedure appears to remove a layer of pixels from an item, effectively diminishing it. Both the inner and outer margins of areas are degraded of pixels. As a result, erosion

will grow the holes enclosed by a single zone while also widening the spacing between them. Small extrusion on a region's limits will also be eliminated by erosion.

Erosion is defined as follows for binary images:

$$E(A, B) = A \ominus B$$

The picture is A, and the 3x3 structural element is B

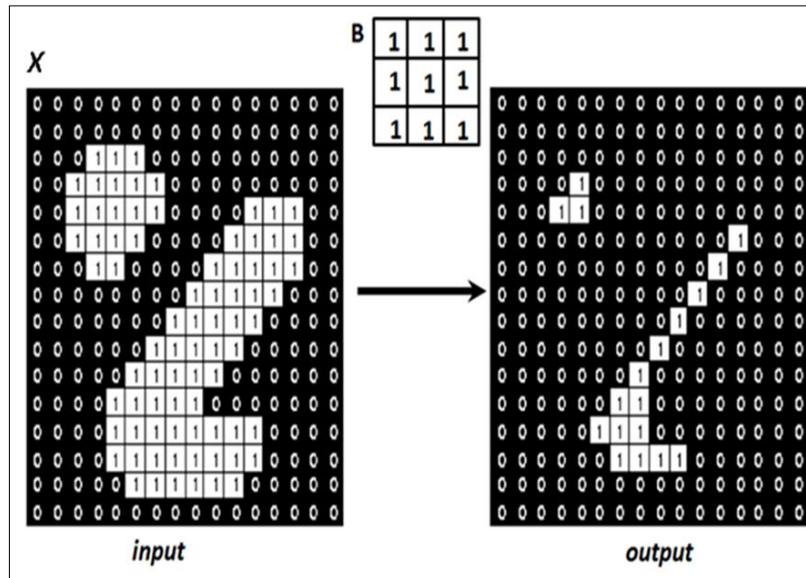


Figure 3 Erosion in a Binary image

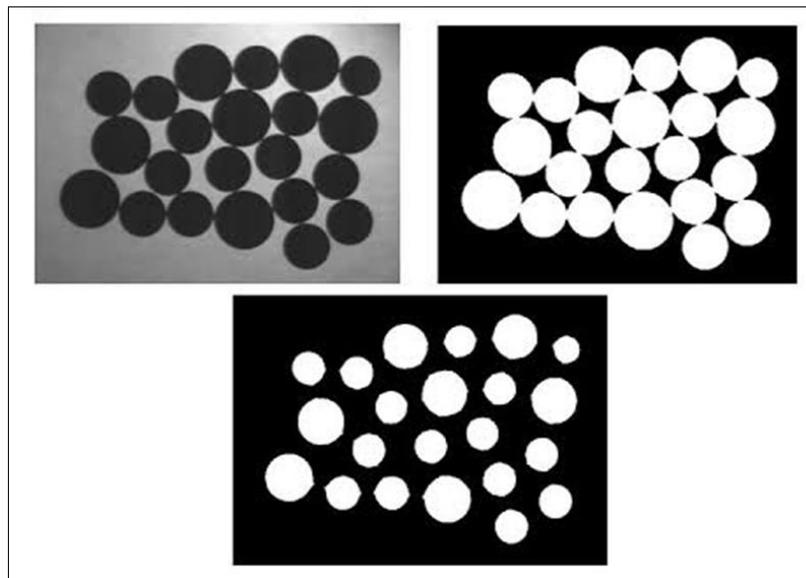


Figure 4 Separating the objects using erosion

4.2. Dilation

Dilation causes objects to dilate or expand in size. The volume and manner in which they expand is determined by the structural element used. By adding pixels to the margins of an item, dilation enlarges it.

AB represents the dilation of a picture 'A' by a structuring element 'B'. We locate 'B' so that its origin is at pixel location (x, y) and use the rule to compute the Dilation.

$$g(x, y) = \begin{cases} 1 & \text{if 'B' hits 'A'} \\ 0 & \text{otherwise} \end{cases}$$

Carry on with the process for all pixel coordinates. Dilation generates a new picture that depicts all of the places where the structuring element's origin HITS the input image. It does this by adding a pixel layer to an object, expanding it. Dilation will shrink the holes enclosed by a single area and make the gaps between various regions smaller by adding pixels to both the inner and outer bounds of regions. Any little encroachment into a region's borders will be filled by dilation. The form of the structural member, as well as its size, has an influence on dilation. Dilation is a morphological technique that may be used to both grayscale and binary pictures. It helps in grayscale picture extraction. It helps in the extraction of the images outside boundaries.

For binary images, the dilation operation is defined as follows:

$$D(A, B) = A \oplus B$$

The picture is A, and the 3x3 structural element is B

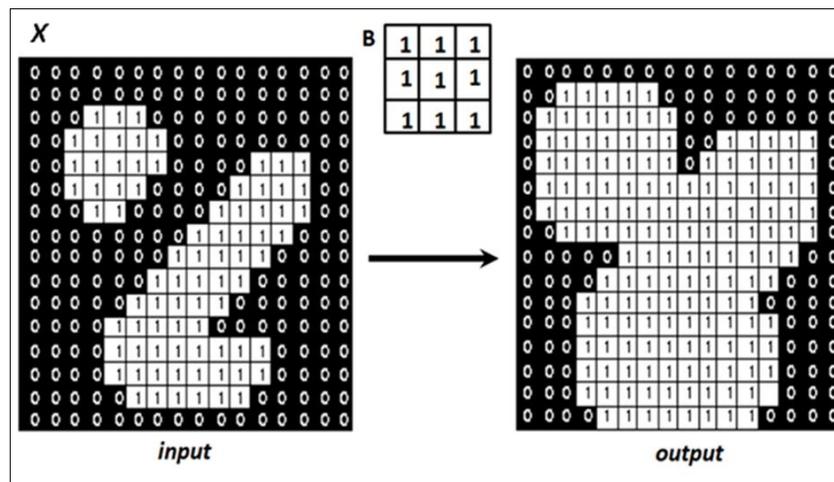


Figure 5 Dilation in Binary image



Figure 6 Combining the objects using Dilation

5. Opening and closing

5.1. Opening

It's a strong operator that creates by combining erosion and dilation. By opening the box, the items are separated. Dilation increases the size of a picture, whereas erosion decreases it. Opening an image smooths its contour, fractures narrow isthmuses, and eliminates thin protrusions in general.

AB stands for Erosion followed by Dilation, and it refers to the opening of an image 'A' by a structural element 'B.'

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

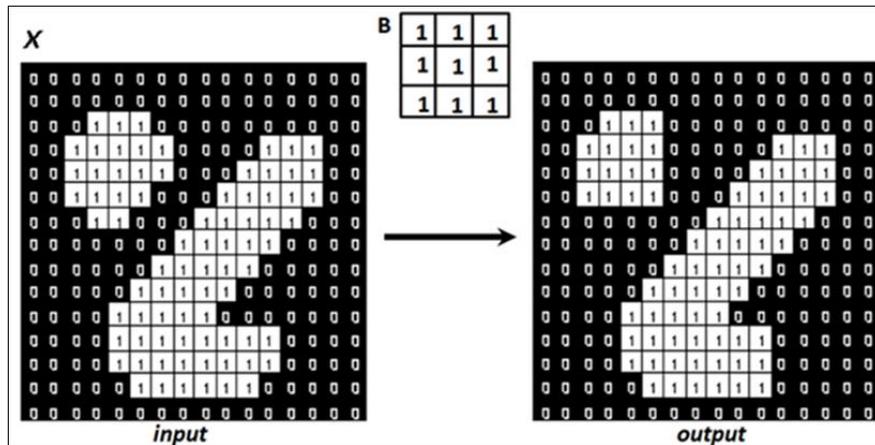


Figure 7 Opening operation in a Binary image

5.2. Closing

It produces a strong operator by combining erosion and dilation. Objects are brought together when they are closed. Closing, like opening, tends to smooth out contour areas, but it also fuses minor breaks and long thin gulfs, removes small holes, and fills in gaps. $A \bullet B$ is a dilatation followed by erosion that occurs when an image 'A' is closed by a structural element 'B.'

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

Closing is achieved by eroding a dilated picture. Closing puts fractured things together and fills in gaps in objects. Following the closure of one or more dilations, one erosion occurs.

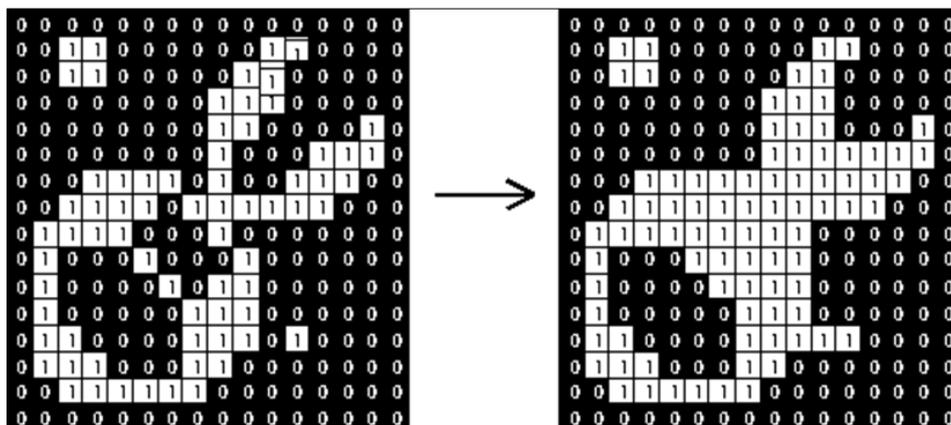


Figure 8 Closing operation in a Binary image

6. Results and analysis

6.1. Start Page

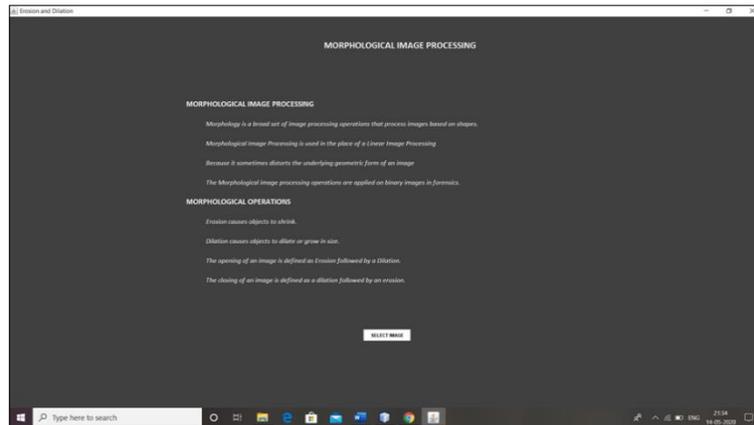


Figure 9 Morphological image processing done through selection of the image

6.2. Image Selection

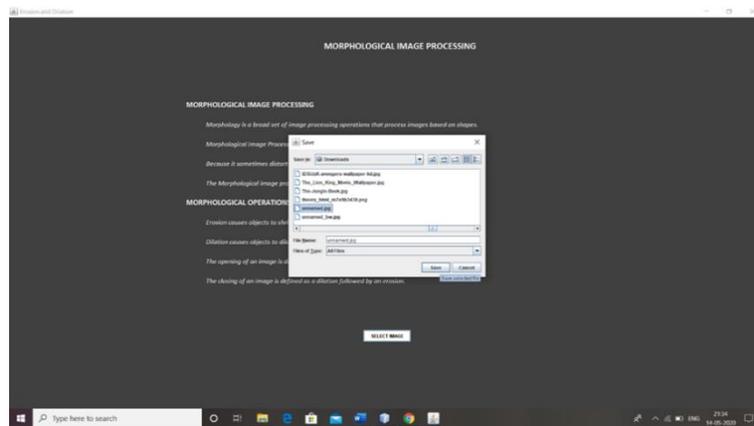


Figure 10 Image is selected from the storage

6.3. Accuracy Analysis

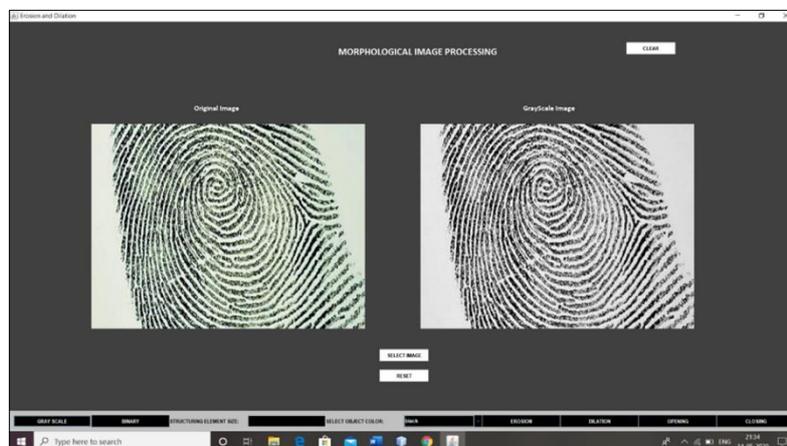


Figure 11 Conversion of original image into Gray Scale image

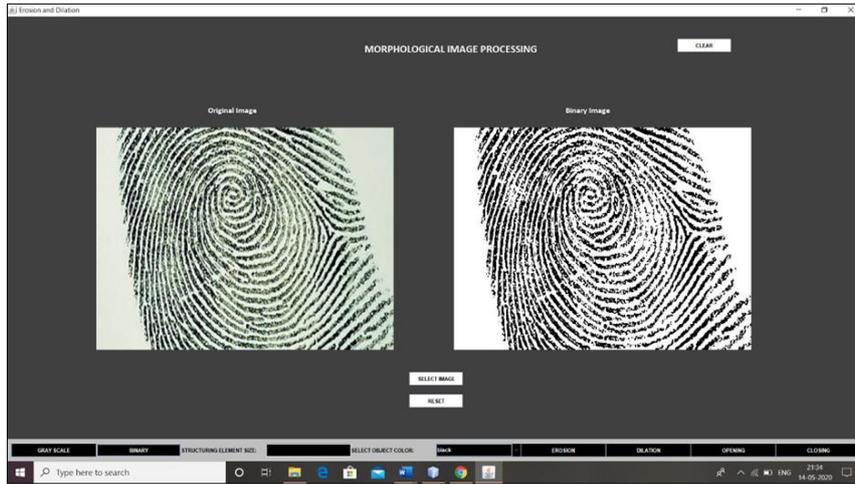


Figure 12 Conversion of original image into Binary image

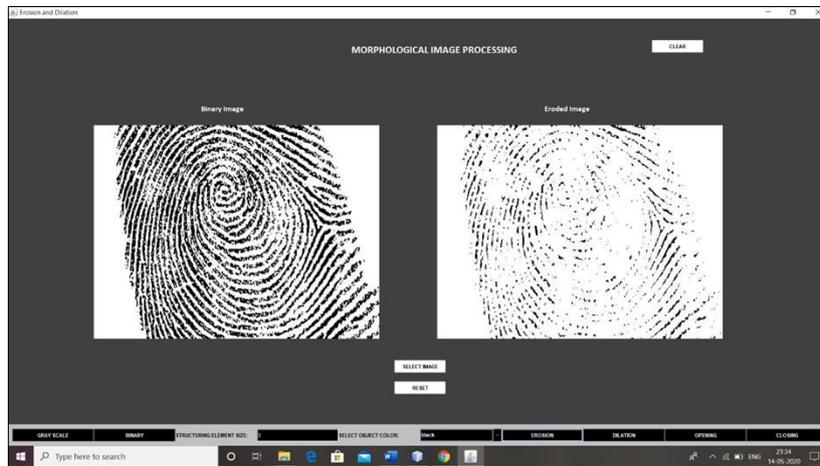


Figure 13 Erosion of the binary image

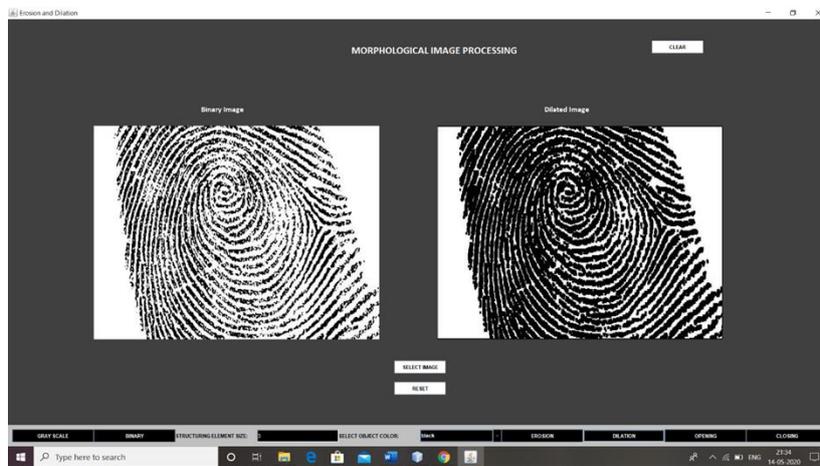


Figure 14 Dilation of binary image

7. Conclusion

In the beginning, the foreground is kept. The shutting preserves the background region. The approach of opening and closing in morphological image processing reduces picture noise.

Morphological processing may remove noise and clutter from images, as well as alter them according to the size and shape of the items of interest. Linear Image Processing is sometimes used instead of Morphological Image Processing since it changes the underlying geometric form of an image, although the information in the image is not lost during Morphological Image Processing.

Compliance with ethical standards

Acknowledgments

I would like to express my special thanks of gratitude to my guide Dr. Subhani Shaik and HOD Dr. Sunil Bhutada who gave me the golden opportunity to do this project on the topic Opening and Closing in Morphological Image Processing. It helped me in doing a lot of research and I came to know about a lot of new things related to this topic.

Disclosure of conflict of interest

No conflict of interest.

References

- [1] B. C. C. and L. V. L., "Morphology Based Enhancement and Skull Stripping of MRI Brain Images," in 2014 International Conference on Intelligent Computing Applications, 2014, pp. 254–257.
- [2] R. H. Sherrier and G. A. Johnson, "Regionally adaptive histogram equalization of the chest,"
- [3] IEEE Trans. Med. Imag., vol. MI-6, pp. 1–7, 1987.
- [4] N. J, M. S. S, and D. Pradeep, "A Fully Automatic Approach for Enhancement of Microarray Images," J. Autom. Control Eng., vol. 1, no. 4, pp. 285–289, 2013.
- [5] Y. Nagashima, Y. Matsumoto, H. Kondo, H. Yamazaki, and S. Gallager, "Development of a realtime plankton image archiver for AUVs," in 2014 IEEE/OES Autonomous Underwater Vehicles (AUV), 2014, pp. 1–6.
- [6] M. Lin, J. Xian, D. Gao, S. Wu, and J. Cai, "A chest silhouette recognition method based on digital image processing," in 2014 10th International Conference on Natural Computation (ICNC), 2014, no. 2011, pp. 862–867.
- [7] N. Li, L. Jia, and P. Zhang, "Detection and volume estimation of bubbles in blood circuit of hemodialysis by morphological image processing," in 2015 IEEE 7th International Conference on Cybernetics and Intelligent Systems (CIS) and IEEE Conference on Robotics, Automation and Mechatronics (RAM), 2015, vol. 58, no. 12, pp. 228–231.
- [8] C. R. González and E. Woods, Digital Image Processing. Englewood Cliffs, NJ: Prentice Hall, 1992.
- [9] F. Meyer and J. Serra, "Contrast and Activity Lattice," Signal Processing, vol. 16, pp. 303–317, 1989
- [10] B. Belean, R. Terebes, and A. Bot, "Low-complexity PDE-based approach for automatic microarray image processing," Med. Biol. Eng. Comput., vol. 53, no. 2, pp. 99–110, Feb. 2015.