

# ULTRASOUND IMAGE SEGMENTATION FOR DETECTING FOLLICLE IN OVARIES USING MORPHOLOGICAL OPERATION AND EXTRACTION METHODS

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## Abstract

There are three different types of ovaries in women such as normal ovary, cyst ovary and Polycystic ovary syndrome (PCOS). The normal ovary consists of 8-10 follicle with size 2mm to 28mm. If the number of follicles more than 9 with size less than 9mm, it is classified as Polycystic ovary syndrome (PCOS). Follicles can be detected through ultrasound images. Ultrasound images produce noises resulting in segmentation images cannot be perform properly. Therefore, to detect the follicles in the ovary is by using morphological operations with feature extraction. In this paper, the method of detecting the follicles is described which involves segmentation of follicles from ultrasound images using morphological method consists of erosion, open and dilation. Therefore, the number of follicles is counted and can save time for the doctor who has spent a lot of time to manually counting the follicles.

**Keywords:** Women; Polycystic Ovary Syndrome; Ovaries; Ultrasound Image; Image Processing.

## INTRODUCTION

Polycystic ovary syndrome (PCOS) is a hormonal disorder common among women of reproductive age. The ovaries may develop numerous small collections of fluid (follicles) and fail to regularly release eggs. PCO Syndrome causes individuals to gain weight, irregular menstrual cycles, acne breakouts because of excess androgen. PCO syndrome also can leads to infertility, depression, anxiety and eating disorders. Early diagnosis and treatment along with weight loss may reduce the risk of long-term complications such as diabetes and heart disease. During ultrasonographic examination of the ovary of a PCOS patient, many times small follicles overlap, which may vary the counting that in turn, can result in wrong diagnosis. Moreover, this approach is operator biased (P.Mehrotra 2011). Therefore, in this paper a procedure is proposed which would significantly increase the efficiency, quality and statistical significance of generating data.

First image enhancement techniques are used to improve the contrast of the image. Then to suppress noise, average filtering is done. Then thresholding is done for segmenting the follicles. Moreover, by using edge detecting systems and different morphological operators, follicles were retrieved and counted (S.Wild 2000).

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## METHODOLOGY

The proposed methodology will overcome the shortcomings of manual tracking method, improves the accuracy, and save time. This methodology uses fully MATLAB to detect follicles in the ovaries. Feature extraction is one of the methods to extract the data and information of the objects in the image. Figure 3.1 shown step by step to detect follicles in the ovaries through flowchart.

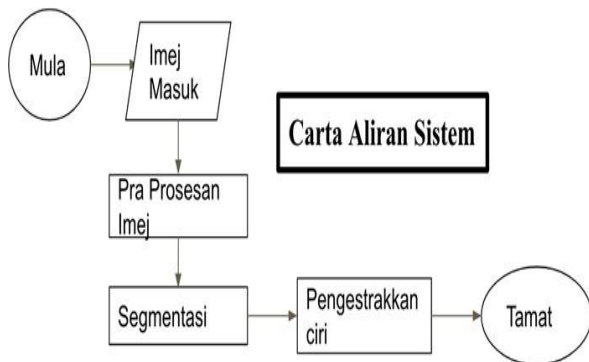


FIGURE 3.1. Flow Chart System

### Image Enhancement



FIGURE 3.2. Ultrasound Image of Ovary

Figure 3.2 shown follicles with dense stroma and blood vessels. To avoid error while detecting the follicles, preprocessing image need to be done because of the presence of the noise while acquisition. Contrast stretching to improve the contrast and filtering to remove the noise that presence in the image.

### Histogram Equalization

This method normally used to increase global contrast in various image especially when image data used is described as closed contrast value. Through this adaptation, intensity can be better distributed to the histogram. Indirectly, low contrasts areas get high contrasts. Histogram equalization can be achieved by spread value intensity frequently. This method works in images that have foreground and background that both can be dark or bright.

### Filtering

Filtering is a method to remove noises and improves visual quality of an image. Besides that, presence of noise can make edge detection method get a false result. A moving

average filter smoothest data with replacing each point with average neighboring data points defined within the span. This process such as low pass filter with the response of the smoothing data through differential equations.

### Image Segmentation

Image segmentation is a system that very interesting in image processing. Segmentation subdivides image into objects and region (Mahmood et al., 2012). Therefore, feature of interest is follicles that need to be segment in ovary image which include dense stroma and blood vessels. Principle of this method can be used to separates image into same region based on a set of predefined value of threshold T and then extract the objects.

### Threshold Image

Threshold image is binary image that can be used as mask image to another images. Pixel in threshold image showed in the middle of image as image binary (black/white) and original image showed masked in the left image (grey/color). Inputs are low and high threshold value at the beginning and image file name or image matrix. Threshold image returns the threshold value and the final color of the band used is to selects threshold. Image can be used integer types and floating-point types.

### Feature Extraction

Feature extractions can be used in every concept of machine algorithm (Mustaza et al., 2022). The feature can be extracted to differentiate within the image. Feature extractions is low stage operation of image processing. This method normally done by the first operation on the image and examined every pixel to see if any features were present on the pixels.

### Morphological Operation

Morphological operation is one of the easier operations based on the shape of the image. These operations normally used in binary image. Two basic operation of morphological is erosion and dilation.

### Erosion

Basic erosion is to remove boundary of foreground of the objects and reduces the features of the images. It is defined in Equation (1)

$$A \ominus B = \{z \in E \mid B_z \subseteq A\} \quad (1)$$

### Dilation

Basic dilation is to increase the region of the objects and to highlight features of the objects. It is defined in Equation (2)

$$A \oplus B = \{z \mid (\hat{B})_z \cap A \neq \emptyset\} \quad (2)$$

### Opening

Combination of erosion and dilation frequently used to perform image processing operation. For example, definition open morphological operation is erosion followed by dilation using the same structure for both operations. It is defined in Equation (3)

$$A \circ B = (A \ominus B) \oplus B \quad (3)$$

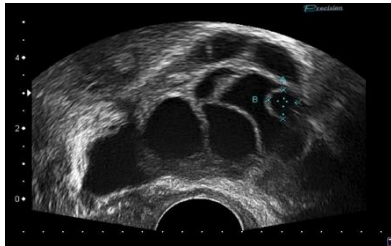
Edge Detection

Edge detection method is one of the techniques to find boundary of the objects in the image. It is function as to detect non continuously lighting.

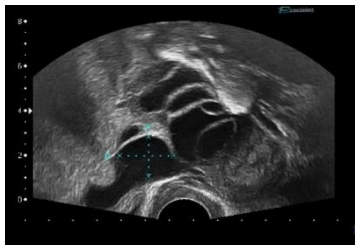
RESULTS AND DISCUSSION

Figure 4.1 until Figure 4.7 shown below are the results that obtained based on Chapter III.

MATLAB software was fully used to try the proposed methodology. Figure 4.1 is the original image of PCO patients that need to be process, Figure 4.2 is histogram equalization and Figure 4.3 is filtering to enhance the image to be process. Figure 4.4 is threshold image and extraction. Figure 4.5 until Figure 4.7 are morphology operations consist of erosion, dilation and opening. Lastly, Figure 4.8 is edge detection.



a) Image 1

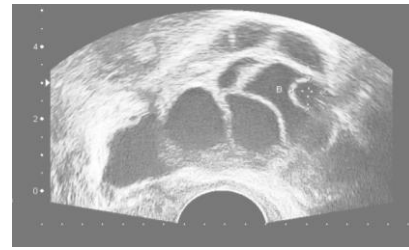


b) Image 2

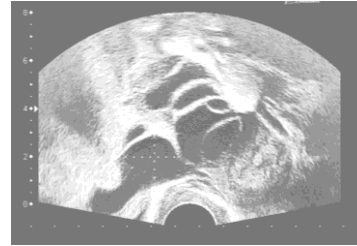


c) Image 3

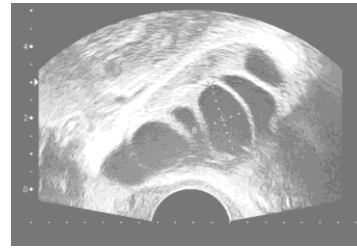
FIGURE 4.1. Original Image of PCO (a) Image 1 (b) Image 2 (c) Image 3



a) Image 1

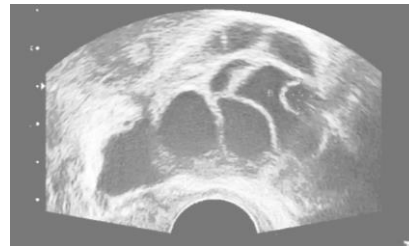


b) Image 2

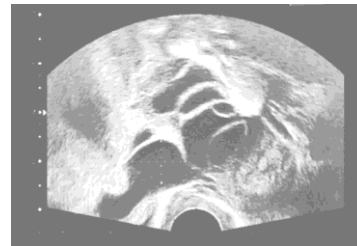


c) Image 3

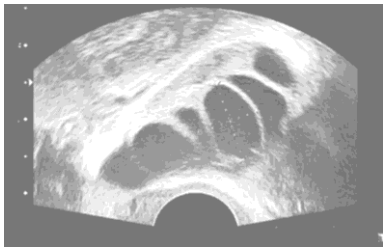
FIGURE 4.2. Histogram Equalization (a) Image 1 (b) Image 2 (c) Image 3



a) Image 1



b) Image 2

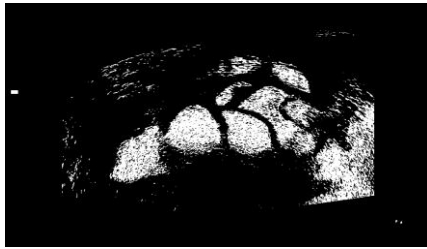


c) Image 3



b) Image 2

FIGURE 4.3. Filtering (a) Image 1 (b) Image 2 (c) Image 3



a) Image 1



c) Image 3

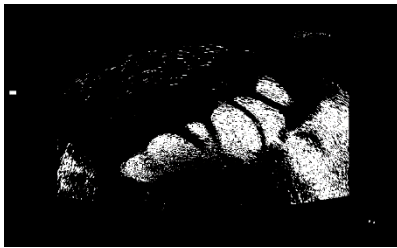
FIGURE 4.5. Dilation (a) Image 1 (b) Image 2 (c) Image 3



b) Image 2



a) Image 1



c) Image 3

FIGURE 4.4. Threshold Image and Extraction (a) Image 1 (b) Image 2 (c) Image 3



a) Image 1



b) Image 2



c) Image 3

FIGURE 4.6. Erosion (a) Image 1 (b) Image 2 (c) Image 3



a) Image 1



b) Image 2

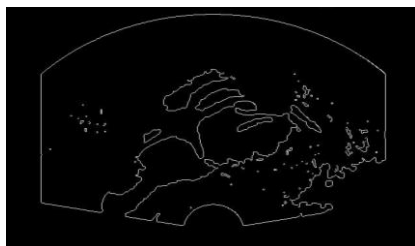


c) Image 3

FIGURE 4.7. Opening (a) Image 1 (b) Image 2 (c) Image 3



a) Image 1



b) Image 2



c) Image 3

FIGURE 4.8. Edge Detection (a) Image 1 (b) Image 2 (c) Image 3

Through this method, the results showed that the size of the follicle inside the ovary met the characteristics of a PCO patient. Ovarian polycystic syndrome can be detected if the follicle number is greater than 12 or the follicle size is approximately 9mm-10mm. However, manual and automatic calculations have a very large variation gap. The proposed method is more efficient in detecting follicles than using the manual method of the ultrasound image. In addition, many overlapping follicles cannot be seen with the naked eye.

In addition, the difference between the morphological method and the proposed method with the addition of extraction to the threshold image enables the follicle to extract the follicle from the segmentation image. The follicles can be detected more clearly, and segmentation can be done better.

#### Analysis Methodology

The method can be analyzed through Peak to Noise Ratio and Mean Squared Error. Peak to noise ratio (PSNR) and average square error (MSE) were used to compare the square error between the original and the reconstructed image. There is a relationship between PSNR and MSE. The higher PSNR values indicate better image quality. Structural Similarity Index (SSIM) is analysis method to identify the similarity between two images. Table 4.1, Table 4.2 and Table 4.3 are the results of PSNR, MSE and SSIM of 3 different ultrasound images of PCO patients performed using the proposed method. Comparison is made between the original and the segmented image. Although the high PSNR proves that the image is quality, in some cases it is not good quality. Therefore, careful action must be taken in the validity of the metric. It is valid if used to compare results from the same codec or similar content.

TABLE 4.1. Results of PSNR

Methodology	Image 1	Image 2	Image 3
Morphology	22.8801	22.9684	22.8421
Morphology and Extraction	23.0077	23.0951	22.9201

TABLE 4.2. Result of MSE

Methodology	Image 1	Image 2	Image 3
Morphology	322.7570	322.7947	325.9254
Morphology and Extraction	320.9503	312.0464	320.6368

The PSNR block calculates the ratio of peak signal to sound in decibels through two images. Ratio is used to determine the quality of the measurement between the original image and the compressed image. Through Table 4.1, the difference in PSNR values for the three pictures is because of the quality of the image. If the PSNR value is increase, the compressed image quality will be increase. PSNR and MSE are used to compare compressed image quality. The average square error represents the cumulative square error between the compressed image and the original image. If the MSE value decreases, the lower the error as shown in Table 4.2. The relationship between PSNR and MSE is inversely proportional. Figure 4.1 and 4.2 shows the relationship between PSNR and MSE. Through this figure can show the higher the PSNR value, the lower the MSE value.

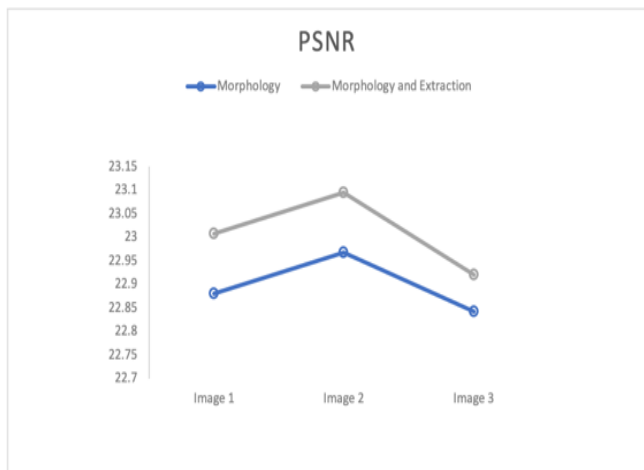


FIGURE 4.9. Result of PSNR

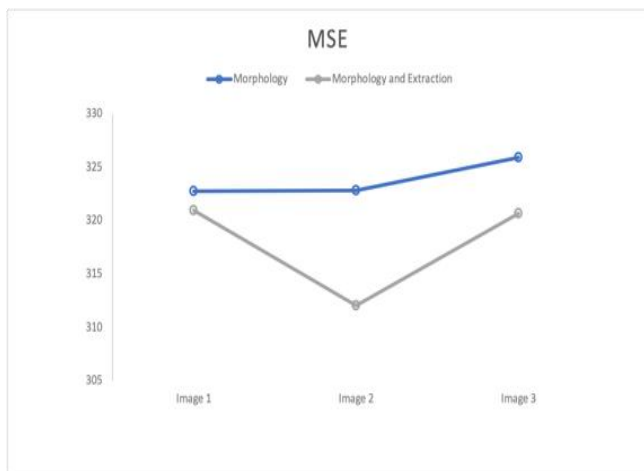


FIGURE 4.10. Result of MSE



FIGURE 4.11. Result of SSIM

While the structural similarity index can be analyzed when the SSIM value of the image approaching the value of one has better quality. When the SSIM value approaches the zero value the lower the image quality. Table 4.3 and Figure 4.3 show the SSIM values for morphological methods and proposed methods.

Through the analysis that has been conducted, morphological and extraction methods have better image quality than morphological methods alone.

TABLE 4.3. Result of SSIM

Methodology	Image 1	Image 2	Image 3
<b>Morphology</b>	0.81921	0.90804	0.84650
<b>Morphology and Extraction</b>	0.95725	0.97638	0.96349

## CONCLUSION

PCO Syndrome is one of the diseases that disrupts women's ovulation (Nazarudin et al., 2020; Azli et al., 2022). This disruption is due to the formation of follicle size in the ovary. In addition, ultrasound imaging is one of the cheap and good techniques for follicle detection in the ovaries. The overall quality of an ultrasound image is the final product of a combination of various factors from the imaging system and the performance of the operator. Ultrasound imaging is a cheap and effective technique for identifying follicle sizes. Therefore, various studies have been carried out to ascertain the size of follicles within the ovaries such as neural network convolution method, clustering method, follicle recognition method and particle swarm optimization method.

Currently, doctors make a diagnosis by manually calculating the number of follicles in the ovary to determine whether or not the patient has PCO syndrome. As a result, the manual method results in lower efficiency, longer durations and variable problems. Therefore, as discussed in Chapter III, morphological and extraction methods have been used to make this project a success. This method is an operation based on the shape of an object, so the follicles that they want

to detect can be easily calculated even if they overlap with each other.

In conclusion, the success of this project could benefit physicians in calculating the number of follicles in the ovary to determine whether or not patients have PCO syndrome.

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