www.ijemr.net ISSN (ONLINE): 2250-0758, ISSN (PRINT): 2394-6962

Vandana Publications
IJEMR

Volume-8, Issue-4, August 2018
International Journal of Engineering and Management Research
Page Number: 163-167
DOI: doi.org/10.31033/ijemr.8.4.20

Follicle Detection in Digital Ultrasound Images using Bi-Dimensional Empirical Mode Decomposition and Mathematical Morphology

M.Jayanthi Rao[1] and Dr. R.Kiran Kumar[2]
[1]Research Scholar, Department of Computer Science & Engineering, SISTAM Engineering College, Srikakulam, INDIA
[2]Assistant Professor, Department of Computer Science, Krishna University, Machilipatnam, INDIA

[1]Corresponding Author: harikiran.jhk@gmail.com

ABSTRACT

Ultrasound Imaging is one of the technique used to study inside human body with images generated using high frequency sounds waves. The applications of ultrasound images include examination of human body parts such as Kidney, Liver, Heart and Ovaries. This paper mainly concentrates on ultrasound images of ovaries. The detection of follicles in ultrasound images of ovaries is concerned with the follicle monitoring during the diagnostic process of infertility treatment of patients. Monitoring of follicle is important in human reproduction. This paper presents a method for follicle detection in ultrasound images using Bi-dimensional Empirical Mode Decomposition and Mathematical morphology. The proposed algorithm is tested on sample ultrasound images of ovaries for identification of follicles and classifies the ovary into three categories, normal ovary, cystic ovary and polycystic ovary. The experiment results are compared qualitatively with inferences drawn by medical expert manually and this data can be used to classify the ovary images.

Keywords-- Ovarian Classification, Image Processing, Histogram Equalization, Bi-dimensional Empirical Mode Decomposition

I. INTRODUCTION

PCOS (Polycystic Ovarian Syndrome) is one of the common disorder seen in females of reproductive age. The disorder is characterized by the formation of many follicular cysts in the ovary. The main cause of this disorder in females is due to menstrual problems, hirsutism, endocrine abnormalities, acne, obesity etc [1]. The detection of ovarian follicle is done using ultrasound images of ovaries. Object recognition in an ultrasound image is a challenging task which includes the detection of follicles in ovary, growth of the foetus, monitoring of proper development of the foetus and presence of tumor [2]. Now a days the diagnosis performed by doctors is to manually count the number of follicular cysts in the ovary, which is used to judge whether PCOS exists or not. This manual counting may lead to problems of variability, reproducibility and low efficiency. Automating this mechanism will resolve these problems. In literature, less work done in automating PSOC diagnosis.

In case of normal ovary, under influence of right levels of hormones FSH and LH (i.e. Follicle Stimulating Hormone and Luteinizing Hormone), only one follicle grows in size to about 20 mm in diameter, matures and becomes ready for ovulation. In PCOS affected ovary, due to reduced levels of FSH and LH and high levels of prolactine, follicles fail to grow and attain maturity. Thus, in ultrasound image of PCOS affected ovary, large number of small follicles (typically 12 or more and about 2-9 mm in diameter) can be seen distributed along the periphery of the ovary, classically described as 'necklace formation [3]. Moreover, the ovarian volume in such patients is typically increased over 10 cm^3. Figure 1 shows ultrasound image of normal ovary showing only one follicle ready for ovulation. Whereas, figure 2 shows numerous small follicles present along the periphery of the ovary [4]. In this paper, an algorithm for identification of follicles in ovarian images is presented using bi-dimensional empirical mode decomposition and mathematical morphology. The experiment results are compared with inferences drawn by medical expert manually and classify the ovary images more accurately than manual segmentation.

The paper is organized as follows: Section II presents Empirical Mode Decomposition, Section III presents, Identification of follicles in Ovary Ultrasound Images, Section IV presents Experimental results, and finally Section V reports conclusion.

	
Figure 1: Normal Ovary	Figure 2: PCOS affected Ovary

II. BI-DIMENSIONAL EMPIRICAL MODE DECOMPOSITION

The EMD proposed by Dr. Norden Huang [5], was a technique for analyzing nonlinear and non-stationary signals. It serves as an alternative to methods such as wavelet analysis and short-time Fourier transform. It decomposes any complicated signal into a finite and often small number of Bi-dimensional Intrinsic Mode Functions (IMF). The IMF is symmetric with respect to local zero mean and satisfies the following two conditions.

1. The number of extrema and the number of zero crossings must either be equal or differ by one.
2. At any point, the mean value of the envelope defined by local maxima and local minima is zero, indicating the function is locally symmetric.

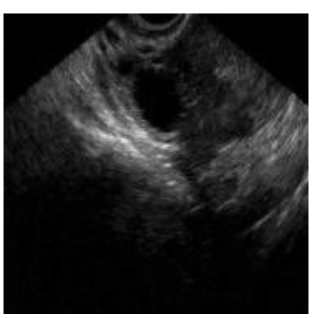
The decomposition method in EMD is called Shifting Process [6]. The shifting process of the two- dimensional signal such as image can be adapted from the one-dimensional signal as follows.

1. Let $I_{original}$ is defined as an image to be decomposed. Let j=1 (index number of IMF), I= $I_{original}$ (the residue).
2. Identify the local maxima and local minima points in I.
3. By using interpolation, create the upper envelope E_{up} of local maxima and the lower envelope E_{lw} of local minima.
4. Compute the mean of the upper envelope and lower envelope.
   $E_{mean}= [E_{up} + E_{lw}]/2$
5. $I_{imf} = I- E_{mean}$.
6. Repeat steps 2-5 until I_{imf} can be considered as an IMF.
7. $IMF(j)= I_{imf}$, $j=j+1$, $I = I- I_{imf}$,
8. Repeat steps 2-7 until all the standard deviation of two consecutive IMFs is less than a predefined threshold or the number of extrema in I is less than two.

The first few IMFs obtained from BEMD contain the high frequency components which correspond to salient features in original image and the residue represents low frequency component in the image. The original image can be recovered by inverse BEMD as follows [7]:

$$I = RES+ \sum_{j} IMF(j)$$

The BEMD process and IMFs of the ovary ultrasound image are shown in figure 3 and figure 4.

Ultrasound Ovary Image	Ultrasound Ovary Image (Contrast Enhanced)
	

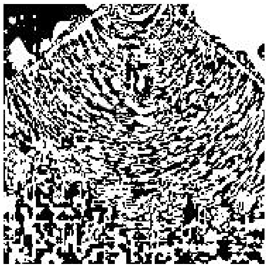
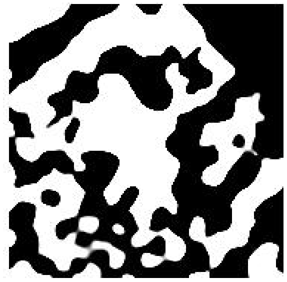
IMF1	IMF2	IMF3	IMF4
			

Figure 4: IMF of ultrasound image

III. FOLLICLE IDENTIFICATION IN OVARY ULTRASOUND IMAGE

The main steps of the edge detection using BEMD are summed up as follows:

1. The ultrasound image is processed by Bi Histogram Equalization [8], then an image with sharper contrast is obtained.
2. Apply BEMD to get the first IMF.
3. Suitable thresholds T_1 and T_2 are chosen to convert the gray level values of the first IMF image into black and white image so that the edge image can be extracted.

$$I(x,y) = \begin{cases} 0 & T_1 \leq IMF(x,y) \leq T_2 \\ 1 & \text{else} \end{cases}$$

4. The obtained edge image has thick edge lines and isolated pixels.
5. Perform Mathematical Morphology operations on the resulting image to remove isolated pixels and to replace thick lines with thin lines.
6. Use imfill function to fill the holes. These holes denote follicles in ovary image.

IV. EXPERIMENTAL RESULTS

In this section, the proposed method is used to detect the follicles in ovary ultrasound images. Ovary images are obtained from the publicly available websites www.radiologyinfo.com, www.ovaryresearch.com [9]. The image1 and image2 is taken from dataset D1 with size 256*256. The qualitative analysis of the proposed method is shown in figure 4 compared with manual segmentation.

V. CONCLUSION

The information about the status of female reproductive system is important for problems related to fertility and family planning. The ultrasound imaging is an effective tool in infertility treatment. Monitoring the follicles in ultrasound images in terms of number, size, shape and position is important in human reproductive system. In this paper, a methodology of identification of follicles in ultrasound images is presented. The proposed method uses Bi-dimensional empirical mode decomposition procedure, to extract first intrinsic mode function IMF1 and from IMF1 using thresholds edge information is extracted. By using region properties, the follicle regions in the ultrasound image is identified. This proposed method is compared qualitatively with manual segmentation. In future this follicle information is used to classify the ovary images into three classes, normal ovary, cystic ovary and polycystic ovary.

ISSN (ONLINE): 2250-0758, ISSN (PRINT): 2394-6962

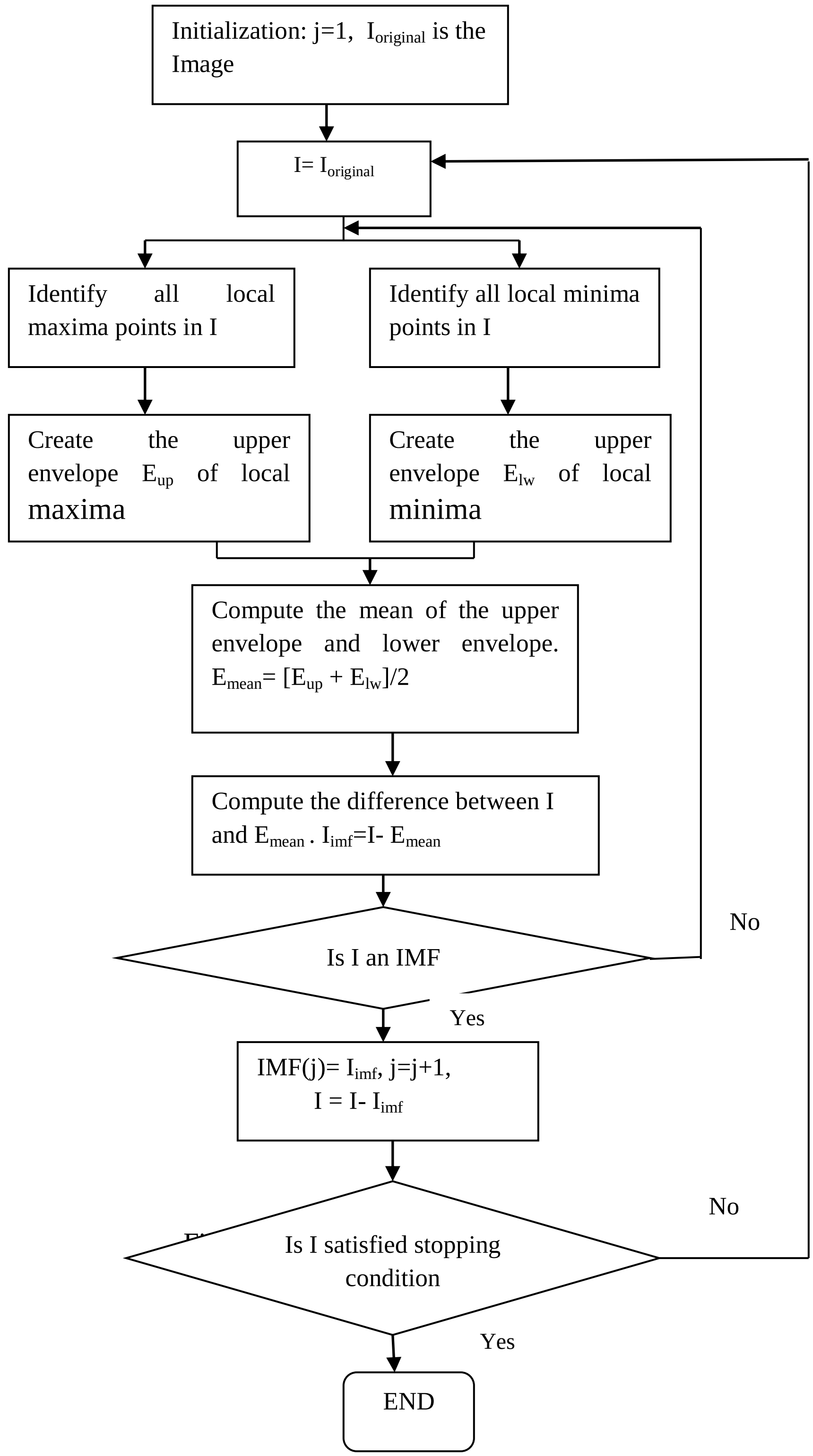


Figure 3: BEMD Process

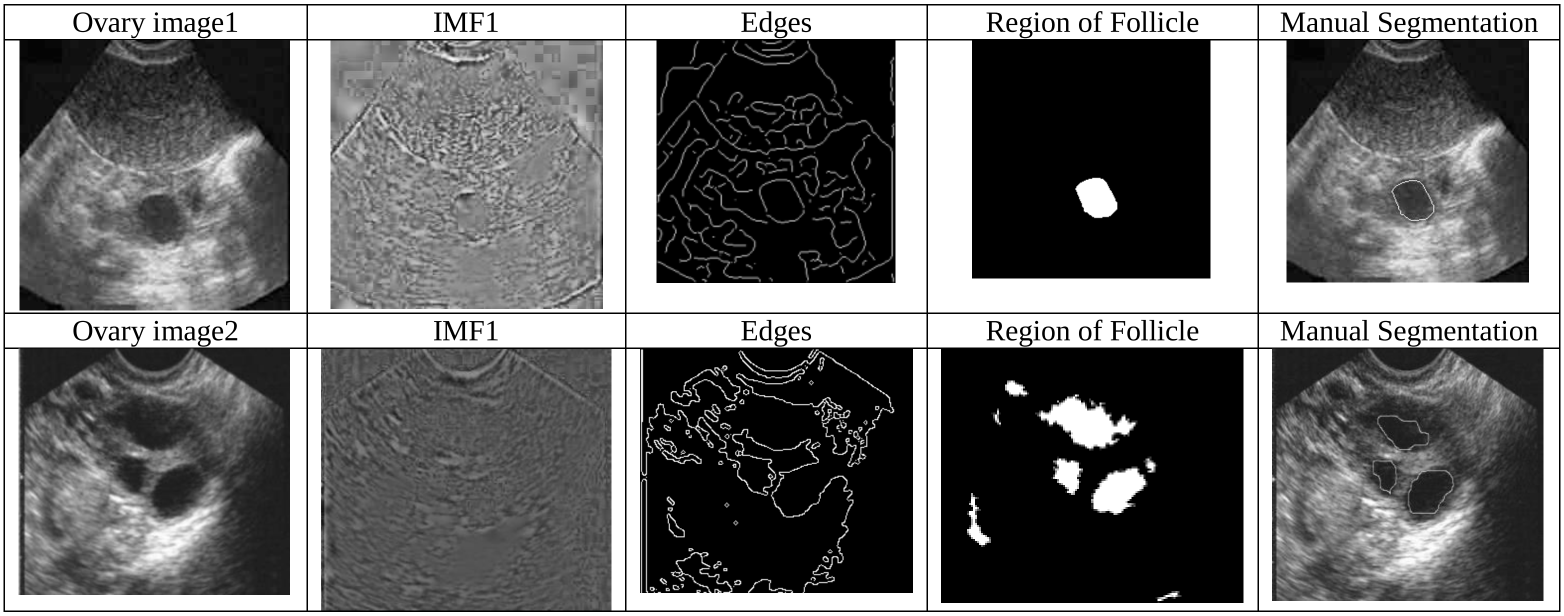


Figure 4: Follicle detection in ovary ultrasound image

REFERENCES

[1] Yinhui Deng, Yuanyuan Wang, & Ping Chen. (2008). Automated detection of polycystic ovary syndrome from ultrasound images. *30th Annual International IEEE EMBS Conference*, 4772-4776.

[2] Kiruthika.V & M.M.Ramya. (2014). Automated segmentation of ovarian follicle using k-menas clustering. *5th International Conference on Signal and Image Processing*, 137-142.

[3] Palak Mehrotra, Chandana Chakraborthy, & Biswanath Ghoshdastidar. (2011). Automated ovarian follicle recognition for polycystic ovary syndrome. *Proceedings of International conference on Image Information processing*.

[4] Sharvari S.Deshpande & Asmita Wakankar. (2014). Automated dectection of Polycystic Ovarian Syndrome using Follicle recognition. *Proceedings of International Conference on Advanced Communication Control and Computing Technologies*, 1341-1347.

[5] B. Saichandana, J. Harikiran, Dr. K.Srinivas, & Dr. R.KiranKumar. (2016). Application of BEMD and Hierarchical Image Fusion in Hyperspectral Image Classification. *International Journal of Computer Science and Information Security, 14*(5), 437-445.

[6] J.Harikiran, et.al. (2015). Multiple feature fuzzy C-means clustering algorithm for segmentation of microarray image. *IAES International Journal of Electrical and Computer Engineering, 5*(5), 1045-1053.

[7] J.Harikiran, et.al. (2012). Fuzzy C-means with Bi-dimensional empirical mode decomposition for segmentation of microarray image. *International Journal of Computer Science Issues, 9*(5), 273-279.

[8] J.Harikiran, B.Saichandana, Dr. P.V.Lakshmi, & Dr. R.Kiran Kumar. (2012). Spot edge detection in microarray images using bi-dimensional empirical mode decomposition. *C3IT, AOT-WestBengal University, Proceedings in Elsevier Procedia Technology, 4*, 19-25.

[9] P.S.Hiremath & Jyothi R.Tegnoor. (2013). Follicle detection and ovarian classification in digital ultrasound images of ovaries. *INTECH*, 167-199. http://dx.doi.org/10.5772/56518.