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Follicle Detection in Ultrasound Images using Adaptive Clustering Algorithms and Empirical Mode Decomposition

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Abstract. Ultrasound Imaging is one of the techniques 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.Monitoring of follicle is important in human reproduction. This paper presents a method for follicle detection in ultrasound image of ovaries using Adaptive data clustering algorithms. The main requirements for any clustering algorithm are to initialize the value of K, i.e. the number of clusters. Estimating this K value is difficult task for given data. This paper presents adaptive data clustering algorithm which generates accurate segmentation results with simple operation and avoids the interactive input K (number of clusters) value for segmentation. The results represent adaptive data clustering algorithms are better than normal algorithms for clustering in ultrasound image segmentation. After segmentation, using the region properties of the image, the follicles in the ovary image are identified. The proposed algorithm is tested on sample ultrasound images of ovaries for identification of follicles and with the region properties, the ovaries are classified into categories, normal, cystic and polycystic ovary with its geometric properties.

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

I INTRODUCTION

PCOS (Polycystic Ovarian Syndrome) is disorder occur in females reproductive stage identified by formation of follicular cysts in the ovary. These follicular cysts are observed in ultrasound image which is obtained by scanning the ovary. The main cause of this disorder in females is due to menstrual problems, acne, endocrine abnormalities, hirsutism, obesity etc. [1]. The detection of ovarian follicle is done using ovary ultrasound images, which is a kind of object recognition problem with aim to identification of tumor by monitoring the growth and development of foetus. [2].

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Automating ovary image analysis mechanism will resolve problems that occur using manual analysis done by doctors. In this analysis, the doctors manually found the follicular cysts in ovary image. Based on the count and size, they judge the existence of PCOS in the body. In literature,
less work done in automating PSOC diagnosis [3,4]. In this paper, an algorithm for identification of follicles in ovarian images is presented using Adaptive data clustering algorithms. After identification of follicle in image, using region properties the classification of ovaries is done. The experiment results by proposed algorithm identifies the ovary images more accurately than manual segmentation.The ovary images used in this paper are taken from www.radiologyassist.nland www.e-ultrasonography.org. The flow diagram in analysing ovary images with existing methods in each stage [17] is shown in figure 1 and sample images are shown in figure 2 and figure 3. Section II presents filtering process, Section III presents Segmentation mechanism, Section IV presents Follicle identification mechanism, Section V experimental results and finally section VI conclusions

II NOISE REMOVAL USING BI-DIMENSIONAL EMPIRICAL MODE DECOMPOSITION

If the ultrasound image contains noise, the edge feature information will be affected. This edge information is primary source for extraction of ovary regions from ultrasound image. The noise in the ultrasound image is removed using nonlinear filter developed with Bi-dimensional empirical decomposition and wavelets. The decomposition process for getting IMFs on an image using BEMD [5] is shown in figure 4. The BEMD-DWT filtering process is as follows

a) Use 2-D EMD to generate IMFS.

b) Firstand second intrinsic mode functionsare high frequency components. These IMFsare denoised with DWT. This de-noised IMFs are represented using DNIMFs.

c) The denoised image RI is reconstructed by

$$RI = DNIMF1 + \sum_{i=2}^{k} IMF_i$$

The BEMD-DWT filtering mechanism is presented in figure 5.

III ADAPTIVE DATA CLUSTERING ALGORITHMS

In adaptive data clustering algorithms, the required K value is estimated using maximum connected domain algorithm [7].

Each time, the K value is compared to connected domain. If not equal, increment the K-Value until it matches. The adaptive k-means clustering algorithm is shown in figure 6. The same algorithm can be extended to K-medoids and FCM.

IV FOLLICLE IDENTIFICATION IN OVARY ULTRASOUND IMAGE

The main steps of the identification of follicles in ovary image are:

1. The ultrasound image is processed by BEMD based contrast enhancement algorithm,
2. Adaptive clustering algorithm to segment the contrast enhanced ovary image
3. Convert the segmented image into binary image and edges are extracted using BEMD by taking the first IMF and applying the thresholds on first IMF, the edge information is extracted.
4. Use imfill function to fill the holes. These holes denote follicles in ovary image.
5. Using the region properties, we can extract the features of follicles such as major axis length, minor axis length, area, centroids etc. With this features, the classification of ovaries as normal, polycystic and cystic ovary is done [10].

V. EXPERIMENTAL RESULTS

The proposed methodology is used to detect the follicles in ovary ultrasound images. Ovary images are found in websiteswww.radiologyinfo.com [8], www.ovaryresearch.com [9].The image 2 and image 2 is taken from dataset D1 with size 256*256 [10]. The qualitative analysis of the proposed method is shown in figure 7 compared with manual segmentation. Table 1presents comparative results of adaptive clustering algorithms on Ovary Image 1 using MSE [6].

VI. CONCLUSION

Monitoring the follicles in ultrasound images in terms of number, size, shape and position is important in human reproductive system. It is the basic requirement for infertility treatment. In this paper, a methodology of identification of follicles in ultrasound images is presented. The proposed method usesBEMD procedure to generate IMFs from the ultrasound image. Using wavelets for the first few IMFS, and then combining IMFs will generate a denoised image. After enhancement, the image is segmented using Adaptive k-means algorithm. 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, using the region properties of identified follicles.

Table 1: MSE values

Method / Ovary Image 1	Normal Clustering	Adaptive Clustering
K-means	95.8	94.5
K-medoids	94.2	93.2
Fuzzy c-means	90.2	89.6

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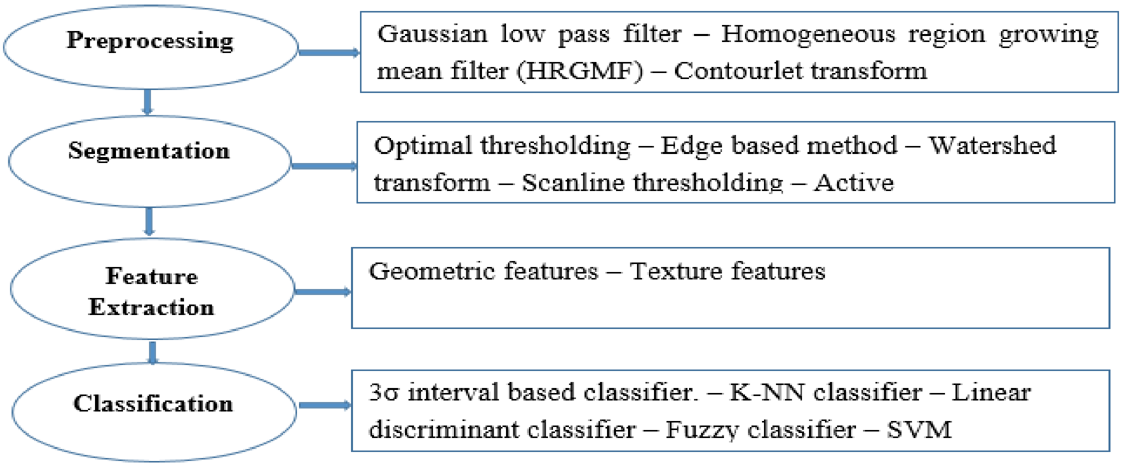

Fig 1: Ovary Image Analysis

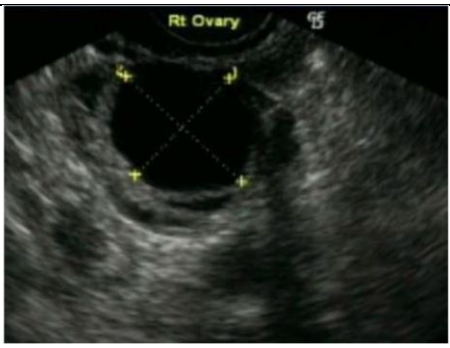

Fig2: Ovary Image2

Fig 3: Ovary Image 3

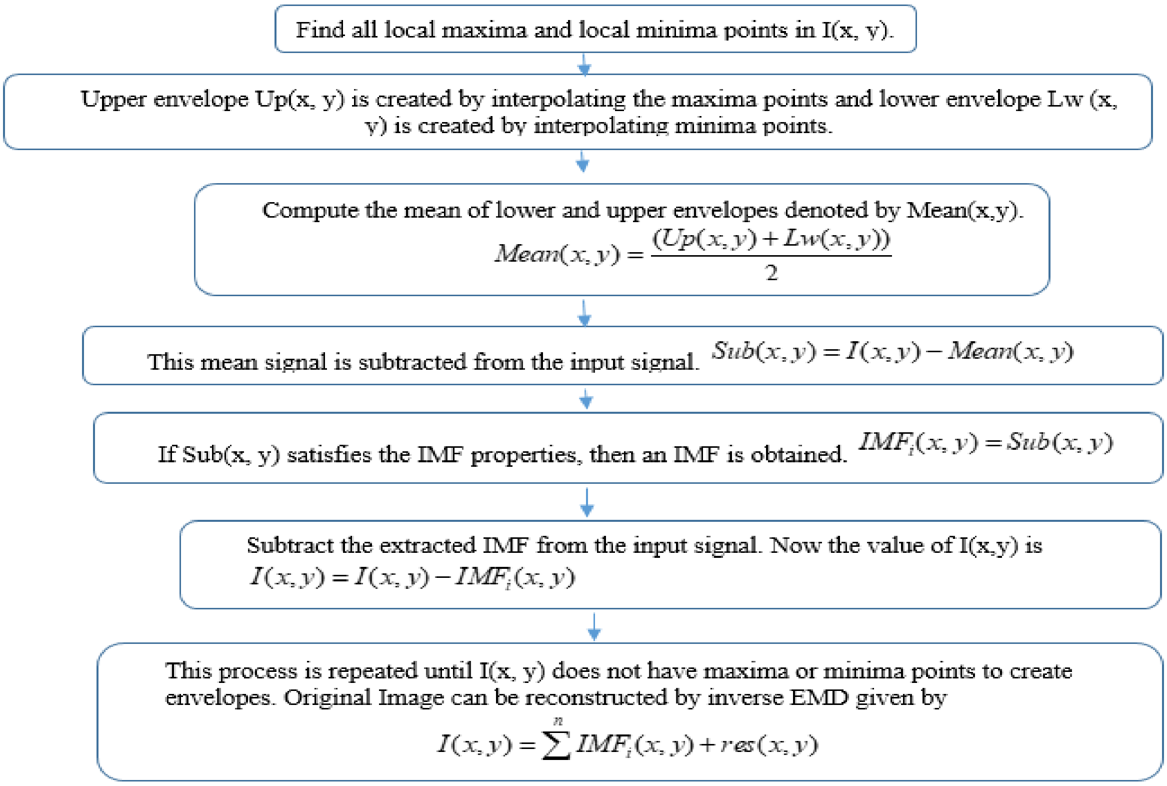

Fig 4: BEMD Decomposition Process

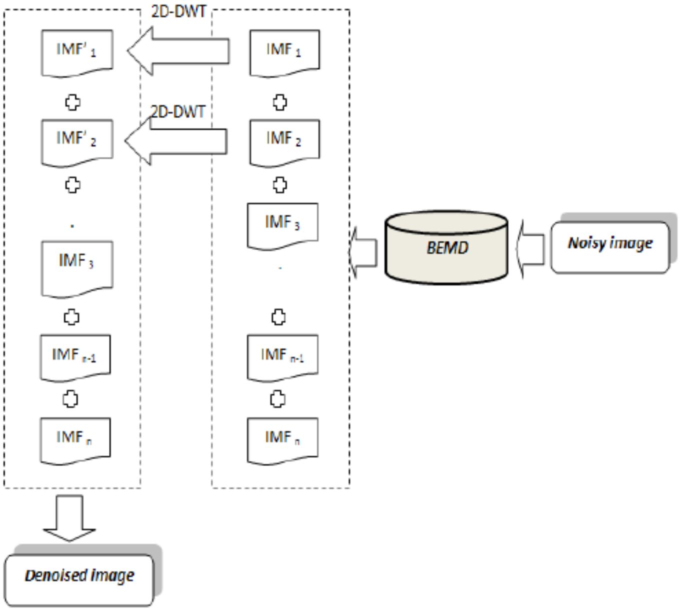

Fig 5: Denoising using BEMD + WAVELET

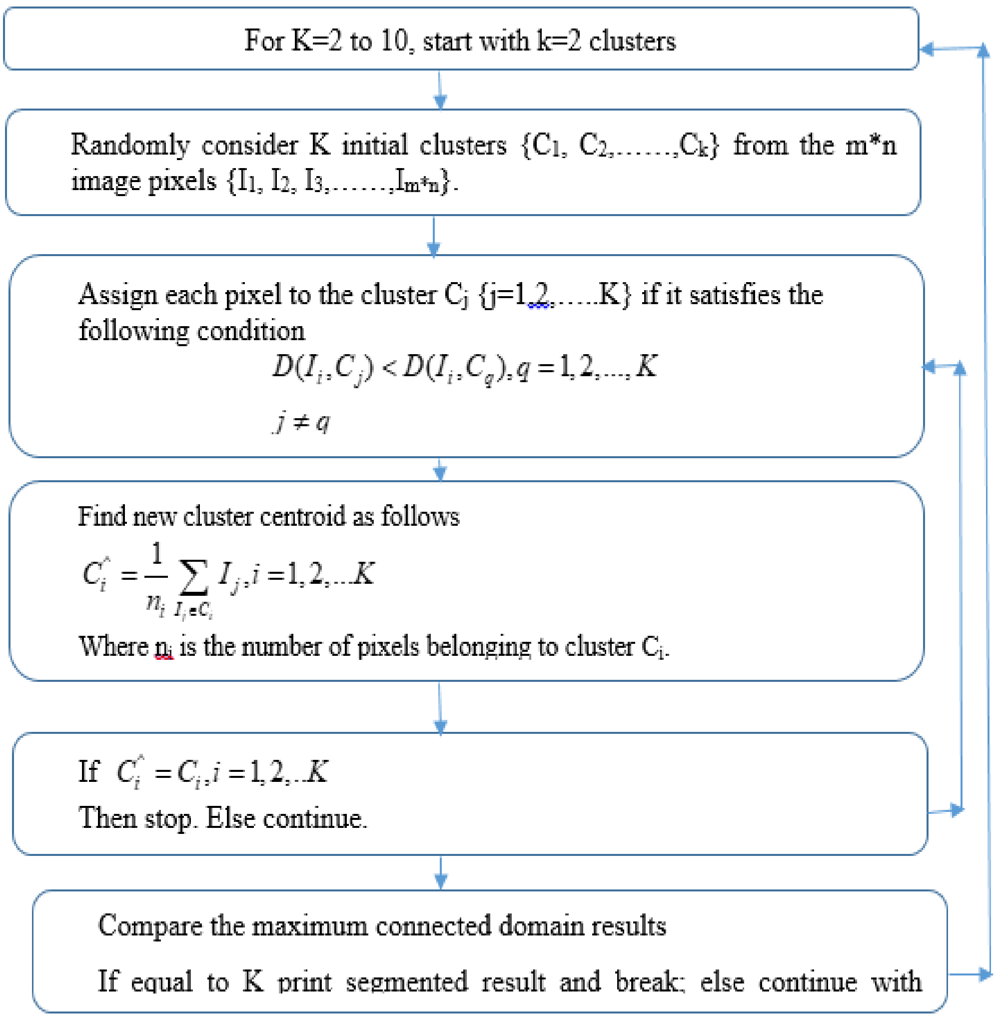

Figure 6: Adaptive K-means Clustering algorithm

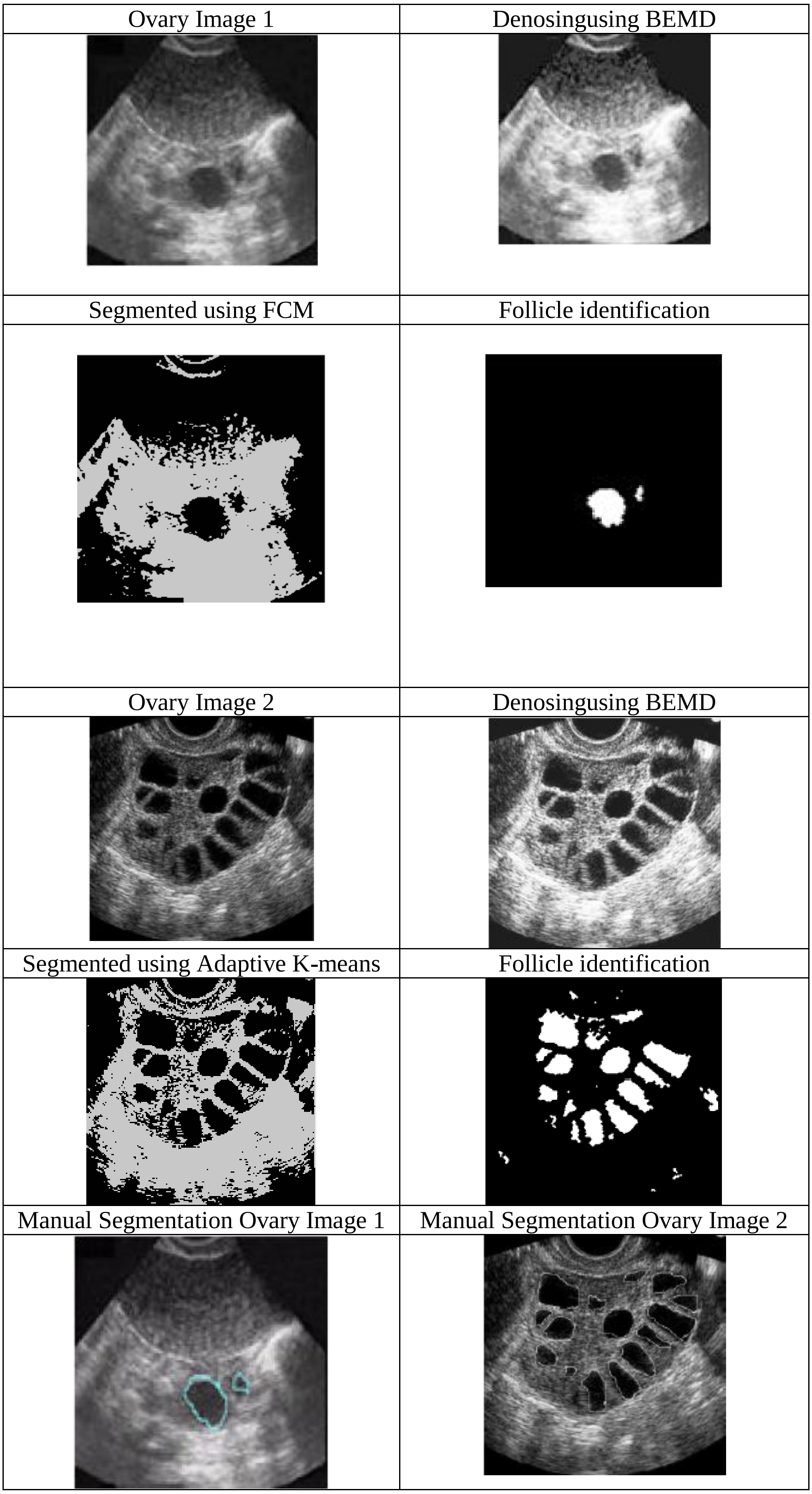

Fig7: Follicle detection in ovary ultrasound image