Diagnostic Tool for PCOS Classification

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Abstract— **Poly Cystic Ovarian Syndrome (PCOS) is a common disease of the endocrine gland and is otherwise called as Stein-Leventhal syndrome. Generally about 5% to 10% of women at the reproductive age are affected by this disease. The real cause of the disease is not exactly known, but the onset of the disease is characterized by the excessive secretion of insulin resistance androgen. There are many different methods to diagnose this condition. The most effective method is the pelvic ultrasound, which confirms the presence of multiple small cysts in the periphery of the ovaries. The ultrasound scan image gives us the visualization of the follicles. Actually there are about three types of ovaries in women. They are classified based on the number and the size of the follicles as normal ovary, cystic ovary and polycystic ovary. If the numbers of follicles are 12 or more than 12 and the diameter is more than 2-9 mm, it is being classified as polycystic ovary. In the conventional method, the follicles are counted manually by a medical expert and verified by the second person. Therefore, it is operator biased. Also, there may be a possibility of overlapping of follicles during the ultrasonographic examination process which lead to the wrong diagnosis. This led to the development of automatic detection and counting of follicle in the ovarian ultrasound image. This method makes use of the image processing techniques to pre-process and segment the region of interest. The algorithm works in such a way that it automatically detects and counts the number of follicles based on the size of the follicles in the image. Finally, the ovary is classified as PCOS present/PCOS absent. This PCOS diagnostic tool would save time a physician who has to spend time in manual tracing of follicles.**

Keywords— **PCOS, Ultrasound, Diagnostic tool, Image processing, Classification**

I. Introduction

There are three types of ovaries and is classified as normal ovary, cystic ovary and polycystic ovary. Poly Cystic Ovarian Syndrome or PCOS is a complex hormonal condition affecting up to around 1 in every 10 women at their reproductive age. The diagnosis of PCOS is made if a woman has infrequent or absence of ovulation. PCOS is characterized by clinical/biochemical signs of androgen excess. The other methods to confirm the presence of multiple follicles is the ultrasonography, which is widely used in the diagnosis of diseases due to its low cost, portability, and low risk to patients [1]. The scanned image of the ovary is used for the study of its morphology, abnormalities, ovulation monitoring for its growth and function. This scan helps the physician determine the formation, maturity of the egg and ovulation. [2]. The number of follicles are counted manually by the medical expert and is verified by a second person. There are possibilities of overlapping of follicles which may lead to wrong counting and in turn result in wrong diagnosis[4]. Having considered these limitations of the existing method, a new method of diagnostic tool for automatic counting and classification of follicles have been developed.

II. Materials and Methods

A. Materials

The type of probe and frequency of the ultrasound wave emitted determines the quality of the image. The higher the ultrasonic frequency the lesser will be the depth of penetration due to attenuation. The highest frequency, 6 MHz is used to image pelvic organs with a satisfactory resolution [3].

Probes with arrays of piezoelectric elements arranged either in a curvilinear or convex sector shape is developed to provide a better fit on the abdomen. It also offers a wider view field than with the linear-array configuration.

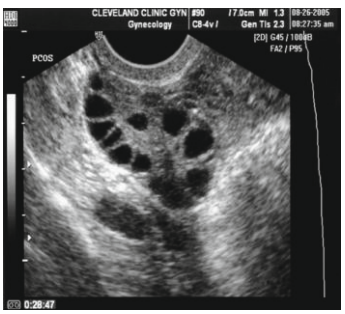

Fig. 1 Poly cystic ovarian ultrasound image

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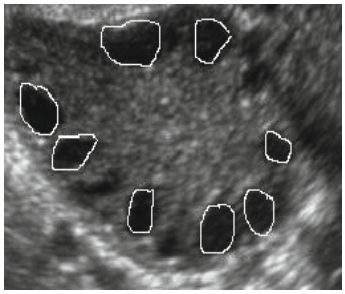

Fig. 2 Manually traced Poly Cystic Ovaries

The Fig. 1 is the PCOS ultrasound image and Fig.2 is the manually traced PCOS ultrasound image by a medical expert which is normally considered as the ground truth.

B. Methodology

The automatic classification of ovaries using the proposed method will not only overcome the shortcomings of manual tracing method but also improves the accuracy and reduces the time to process the image. This method will reduce the inter-observer variability. The method makes use of MATLAB 7 software to process the images. The databases of ultrasound images consisting of normal and polycystic ovarian ultrasound images were collected. The procedure of automatic classification of polycystic ovarian ultrasonographic images was performed on DICOM (Digital Imaging and Communications in Medicine) and JPEG (Joint Photographic Experts Group) images.

The ultrasound ovarian image obtained from the ultrasound imaging modality is given as input to the proposed automatic ovary classification system. The input image is preprocessed so that it can be used efficiently for further processing steps. Preprocessing steps include histogram equalization and filtering. The preprocessed image is then subjected to the threshold to segment the image. Morphological operations are carried out on the segmented image to enhance the boundaries of the image. Edges of the ultrasound images are detected using canny operator. As a result of the above-mentioned steps, the processed image consists of the outer boundary of the follicles in the ovary. The preprocessed image is superimposed on the original image in order to check whether all the ovaries are taken into consideration for counting or not.

Then finally the follicles are checked for the prescribed value of diameter. If the numbers of follicles are 12 or more than 12 and the diameter is more than 2-9 mm, it is being classified as polycystic ovary.

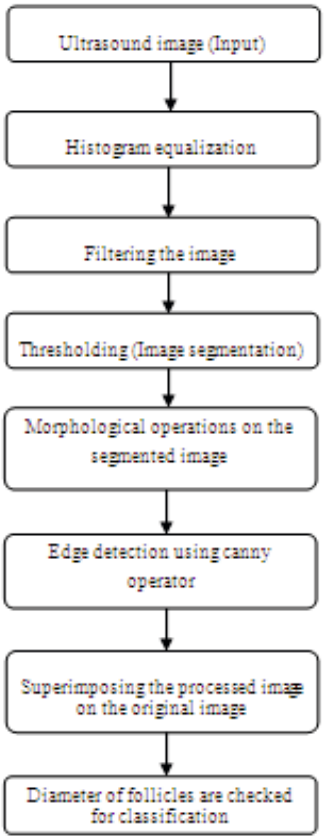

Fig. 3 Flow diagram of the classification of PCOS

The flow diagram of the proposed methodology for the classification of PCOS is shown in Fig. 3.

C. Description of the methodology

Histogram equalization is a method to adjust image intensities to enhance the global contrast. In other words, the intensity values of the image are spread over the entire range. The resultant image after histogram equalization contains uniform intensity distribution [5].

Filtering removes noise and improves the visual quality of the image. Sometimes, due to the presence of noise the edge detecting methods may give false results. A moving average filter smoothes the data by replacing each data point with the average of the neighboring data points defined within the span.

Segmentation subdivides image into its constituent objects or regions. The follicles are to be segmented from the rest of the ovarian image, which contains the dense stroma and blood vessels. The segmentation method partition the image into its regions that are similar according to a set of predefined threshold value T and then extracting the objects. Thus the follicles are extracted.

The morphological operations such as opening and dilation are carried out on the segmented image to get the edges of the follicles [6].

The image obtained after morphological operation is subjected to canny edge detection operation to extract the region of interest.

Thus obtained image is subjected to the classification by feeding the criteria of number of follicles and the size of the follicles to the algorithm. Thus the classification is done.

III. Results and Discussion

The proposed method is implemented on the PCOS ultrasound images and classification of ovaries is done. The Fig.3 shows the results of the process of classification.

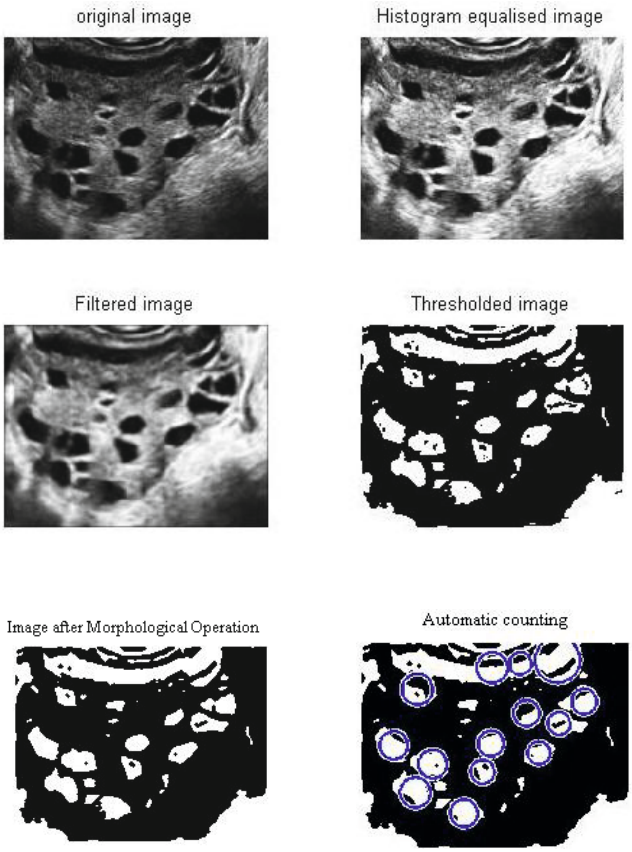

Fig.4 Results of the proposed method

Table.1 Classification Results of Ground truth Vs. Proposed method

Sl. No	Number of follicles (manual)	Classification Result	Number of follicles (proposed)	Classification Result
1.	9	Absent	15	Present
2.	11	Absent	14	Present
3.	13	Present	16	Present
4.	7	Absent	8	Absent
5.	11	Absent	17	Present
6.	12	Present	13	Present
7.	4	Absent	7	Absent

The results in Table.1 show the efficiency in the detection and classification of the proposed diagnostic tool for PCOS. The proposed method is efficient in detecting and counting the follicles as compared to the manual method in all the ultrasound images of ovaries. It is because many follicles overlap or cannot be seen with the naked eyes. Therefore, the number of follicles detected by the proposed algorithm is high in number. The correlation coefficient is 0.9.

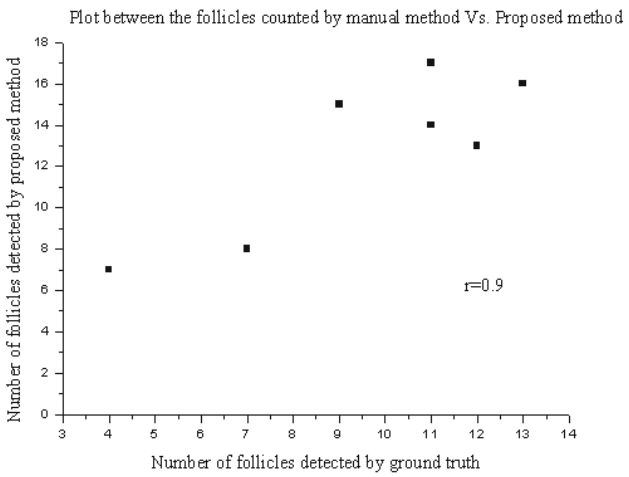

Fig.5 Plot between manual Vs. Proposed method

The average recognition rate of the manual method is 78%[7]. The average recognition rate of the proposed method is 88%.

IV. Conclusion

The proposed diagnostic tool for PCOS is very efficient in detecting and counting follicles from ultrasound images using image processing techniques.

Conflict of Interest

"The authors declare that they have no conflict of interest".

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