PROTOCOL OF AUTOMATED POLYCYSTIC OVARY SYNDROME(PCOS) DIAGNOSIS USING FOLLICLE RECOGNITION

Kishan S, Dhanush V D Upadya, H S Nagabharan, Ganesh S, Radhika A D

[1] *Kishan S, Student, Department of Computer Science and Engineering, Vidyavardhaka College of Engineering, Karnataka, India*
[2] *Dhanush V D Upadya, Student, Department of Computer Science and Engineering, Vidyavardhaka College of Engineering, Karnataka, India*
[3] *H S Nagabharan, Student, Department of Computer Science and Engineering, Vidyavardhaka College of Engineering, Karnataka, India*
[4] *Ganesh S, Student, Department of Computer Science and Engineering, Vidyavardhaka College of Engineering, Karnataka, India*
[5] *Radhika A D, Assistant Professor, Department of Computer Science and Engineering, Vidyavardhaka College of Engineering, Karnataka, India*

ABSTRACT

Polycystic ovaries cause infertility in women because the development of follicles is inhibited, resulting in a large number of follicles (PCO). PCO identification is still done by a gynecologist manually, counting the number and size of follicles in the ovaries, which takes a long time and requires a high level of precision. PCO can be discovered in general by calculating stereo-logy or extracting and classifying features. PCOS is detected in this study using a follicle count extracted from ultra sound images using the K-Means clustering technique. A decision tree classifier with greater than 90% accuracy is used to perform the classification.

Keyword: - *Gaussian Smoothing, K-Means Clustering, Connected Component Analysis, Decision Tree Classifier.*

1. INTRODUCTION

Fertility is one of the aspects that can affect a family's stability. Infertility is a disorder that affects both men and women's reproductive systems. Inhibition of the follicular maturation process can interfere with ovulation in women, resulting in polycystic ovaries (PCO). PCO symptoms can be identified early with a hormone test. Due to the high cost of such tests, many people opt for ultrasonography (USG), which creates an ultrasound image like the one seen in Figure 1. A woman has PCOS if she has two of the three symptoms: (1) ovulation failure, (2) increased androgen hormones, or (3) the appearance of polycystic ovaries, according to the Rotterdam conference [1]. In the existence of polycystic ovaries, it can be indicated if there are twelve or more follicles 2-9 mm in diameter, or if the ovarian volume grows by more than 10cm3 [2]. The number and size of follicles in the ovaries are manually counted by a clinician as part of the ultrasound examination. However, evaluating whether or not a patient has polycystic ovary syndrome takes time and requires a high level of accuracy.

Under the influence of the hormones FSH and LH, only one follicle in a typical ovary grows to roughly 20 mm in diameter, matures, and is ready for ovulation (i.e. Follicle Stimulating Hormone and Luteinizing Hormone). Follicles in PCOS-affected ovaries fail to grow and mature due to low FSH and LH levels and high prolactin levels.

A significant number of small follicles (typically 12 or more, with a diameter of 2-9 mm) can be seen distributed along the ovary's periphery in an ultrasound scan of a PCOS-affected ovary, a phenomenon described as 'necklace formation'[6]. Furthermore, these patients' ovarian capacity is frequently greater than 10 cm3 [3]. An ultrasound image of a normal ovary with only one ovulating follicle is shown in Figure 1.

2. LITERATURE SURVEY

2.1 Soni et al. [4] developed a method for deleting or eliminating duplicate data and improving accuracy by performing segmentation before to CNN. Segmentation is the process of splitting data or images in order to retrieve the specific information required.

2.2 Blankenstein et al. [5] emphasized the use of transvaginal ultrasound in the management of ovulation with medications like Clomid and gonadotropins to improve fertility. Based on the Cochrane Database, there is no evidence from randomized trials that cycle monitoring with ultrasound and serum estradiol is more effective than cycle tracking with ultrasound alone in terms of live birth and pregnancy rates.

2.3 On the basis of ultrasound image processing, Govindjee et al. [6] used morphological features to classify PCOS. The ovary's follicles can be imaged using ultrasound to provide vital information about the ovary, such as the type of cyst, the number of follicles, and the size of the follicles' reaction to hormonal imbalance. Image segmentation provides additional information in the image's region of interest and clearly distinguishes the object from the backdrop. However, due to the difficulty of performing segmentation on ultrasound pictures due to noise, detection of follicles can be made simple and effective by combining image preprocessing with morphological processes. The fuzzy logic method is used to classify ovarian cysts. Parekh et al. [7] suggested a fuzzy logic-based segmentation approach for follicular segmentation.

2.4 Sheikh et al. [8] presented ultrasonic imaging methods. Follicles in the ovary and ovarian regenerative tissues cells are automatically recognized using these approaches. The mean shift clustering approach is used to segment and classify images using Canny edge detection.

2.5 To identify ultrasound images, Bedy Purnama et al. apply three machine learning approaches: NN-LVQ, KNN utilizing Euclidian distance, and SVM. Low pass filter, histogram average, binarization, morphology, and edge detection were used to preprocess the ultrasound image. [12] Before moving on to classification, the image's feature was manually retrieved using Gabor Wavelet. When using SVM, the best result is 82.55 percent, and when using KNN with k=5, the best result is 78.81 %.

The majority of studies use morphological methods to classify and segment the follicular region, or they use a classifier directly to ultrasound pictures without segmentation, according to the literature. It's also worth noting that classification accuracy has dropped to 78 percent. As a result, developing an effective technique for segmenting follicular regions is critical. As a result, a semi-automated method for diagnosing PCOS is devised in the proposed methodology.

3. METHODOLOGY

An input image is first preprocessed using Gaussian smoothing, after which the preprocessed image is sent through K-Means clustering. Furthermore, the appropriate cluster for follicle identification is determined by taking into account a cluster input from the user. Finally, a decision tree classifier is used to classify the ultrasound pictures based on the count of follicular areas. The block diagram for PCOS detection utilising ultra sound images is shown in Figure 1.

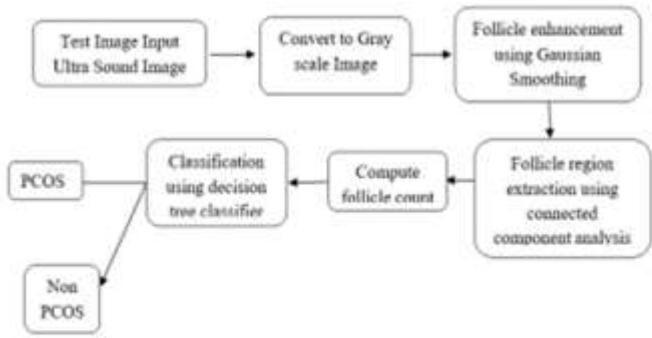

Fig -1: Workflow of proposed system

3.1 Gaussian Smoothing

Gaussian filtering with a 3x3 kernel is used to transform the input image to grayscale for grainy noise reduction. Gaussian smoothing had the effect of suppressing grainy noisy patterns in the image. Gaussian smoothing is a symmetric filter which is isotropic defined by (1)

$$g(x,y)=\frac{1}{2\pi\sigma^2}e^{-\frac{x^2+y^2}{2\sigma^2}} \quad (1)$$

Where x is the horizontal axis distance from the origin, y is the vertical axis distance from the origin, and g(x, y) is the Gaussian distribution's standard deviation, and is the smoothened image obtained using the Gaussian smoothing filter. After that, the smoothed image is forwarded to K-Means clustering for segmentation.

3.2 K-Means Clustering

K-means clustering is one of the most basic and often used unsupervised machine learning algorithms. Unsupervised algorithms, on the other hand, infer from datasets only on the basis of input vectors, rather than referring to known, or labelled, outcomes. "The goal of K-means is to group similar data points together and find underlying patterns," explains AndreyBu, who has over 5 years of machine learning experience and now teaches others how to do the same.
A cluster is a collection of data elements that have been grouped together based on their shared characteristics.

A goal number, k, will determine the number of centroids necessary in the dataset. A centroid, which could be fictional or real, represents the cluster's center. By lowering the in-cluster sum of squares, each data point is assigned to one of the clusters. To put it another way, the K-means algorithm finds k centroids and then assigns each data point to the cluster with the fewest centroids. The 'means' in K-means refers to the data's average or centroid calculation.

3.3 Connected Component Analysis

Components interconnected Labeling separates a picture into components based on pixel connectedness, which means that all pixels in a connected component have similar pixel intensities and are connected in some way. Following the discovery of all of the groups, each pixel is assigned a grey level or a color(color labelling) depending on which component it belongs to.

Many automated image analysis applications rely on the extraction and identification of multiple disconnected and related components in a picture.

Algorithm for Connected Component Analysis:

1. The size of the image matrix is used to initialize the connected-component matrix.

2. For each recognized object in the image, a mark is created and increased.
3. The number of objects is counted using a counter.
4. For the full image, a row-major scan is started.
5. If an object pixel is found, the procedures below are repeated while (Index!=0).
    a. In Image, set the appropriate pixel to 0.
    b. All the nearby pixels of the currently set pixels are updated in a vector (Index).
    c. Only unique pixels are kept, while duplicate pixels are eliminated.
    d. In the connected-component matrix, mark the pixels indicated by Index.
6. Move the marker to a new location in the image.

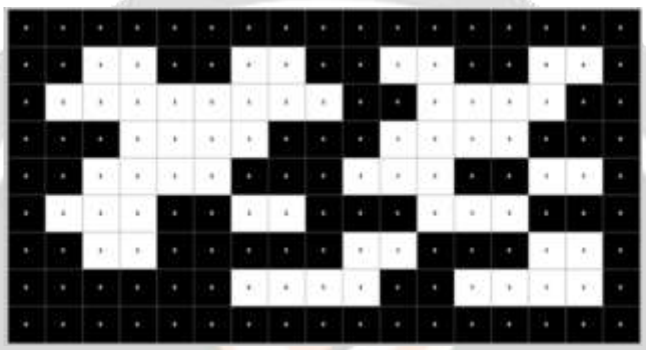

Fig -2: Example of image after Connected Component Analysis.

3.4 Decision Tree Classifier

In the categorization process, there are two steps: learning and prediction. The model is created using the training data gathered during the learning process. In the prediction step, the model is used to forecast the response for given data. One of the most basic and often used classification systems is the Decision Tree. It can be used to address classification and regression difficulties.

In this study, the classification decision tree is developed as shown in Figure 3.

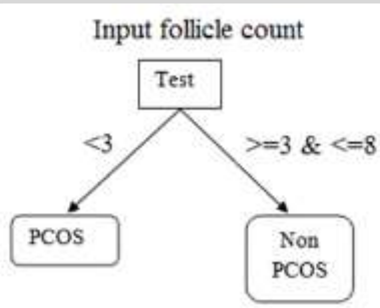

Fig -3: Decision tree classifier for PCOS classification

4. CONCLUSION

This research proposes an effective way for identifying a PCOS patient in order to save doctors' time. The automatic detection of PCOS in its early stages has been implemented. For better image quality, image preprocessing (grey scaling and Gaussian Smoothing) is performed. K-means Clustering is used to binarize and segment the image. A decision tree is used to classify the data. Because K-Means form tighter clusters and it is computationally faster than other segmentation techniques, this model can assist doctors in recognizing disease much more quickly, allowing patients to receive early treatment.

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