Al-Kitab Journal for Pure Sciences
ISSN: 2617-1260 (print), 2617-8141(online)
www.kjps.isnra.org

Determination of Fetal sex by Fetal anatomy parameters using a Fuzzy C-Mean Cluster

Wafaa Ayoub Kissara*, Baydaa Flayyih Hassan
Middle Technical University, Technical College of management-Baghdad

Citation: Kissara W.A., Hassan B.F. Determination of Fetal sex by Fetal anatomy parameters using a Fuzzy C-Mean Cluster. Al-Kitab Journal for Pure Sciences (2021); 5(2): 9-25 .DOI: https://doi.org/10.32441/kjps.05.02.p2

Keyword
Medical image, feature extraction, median filt
winner filter, LBP, and DWT.

Article History

Received	15 Apr. 2021
Accepted	07 July. 2021
Available online	27 Dec. 2021

Abstract:

This paper proposes a new approach to determining the sex of the fetus using the measurement of dimensions of the head. The research attempted to use one of the techniques of fuzzy logic in the field of medicine, and here it was dealt with the visual properties designed to mix the properties of fuzzy logic (FL) and feature images. The results that some traits cannot give good results such as the results obtained from the local binary pattern (LBP) algorithm and the power and superiority of the results of hybrid filters because the ultrasound images have a special color spectrum. The results also showed the ability of the fuzzy logic proposed by using the characteristics derived from the hybrid filter to deal with the study of images and to achieve a better diagnosis of the gender of the fetus through measuring the dimensions of the head.

Keywords: Medical image, feature extraction, median filter, winner filter, LBP, and DWT.

Corresponding Author: wa747371@gmail.com *

تحديد جنس الجنين من خلال معلمات تشريح الجنين باستخدام خوارزمية العنقدة الضبابية سي-*M*

وفاء ايوب كسارة، بيداء فليح حسن

الجامعة التقنية الوسطى/الكلية التقنية الإدارية

wa747371@gmail.com, baydaa@mtu.edu.iq

الخلاصة:

تقترح هذه الورقة مقاربة جديدة لتحديد جنس الجنين باستخدام قياس أبعاد الرأس. حاول البحث استخدام إحدى تقنيات المنطق الضبابي في مجال الطب، وهنا تم تناول الخصائص البصرية المصممة لخلط خصائص المنطق الضبابي (FL) والصور المميزة. النتائج التي تفيد بأن بعض السمات لا يمكن أن تعطي نتائج جيدة مثل النتائج التي تم الحصول عليها من خوارزمية النمط الثنائي المحلي (LBP) وقوة وتفوق نتائج المرشحات الهجينة لأن صور الموجات فوق الصوتية لها طيف لوني خاص. كما أظهرت النتائج قدرة المنطق الضبابي المقترح باستخدام الخصائص المشتقة من المرشح الهجين للتعامل مع دراسة الصور ولتحقيق تشخيص أفضل لجنس الجنين من خلال قياس أبعاد الرأس.

الكلمات المفتاحية: الصورة الطبية، واستخراج الميزات، والمرشح المتوسط، والمرشح الفائز، وLBP و DWT.

Introduction:

This section deals with the importance and objectives of the research and the determinants of research, ie, the obstacles faced by the researcher, the research community and the research sample. The study also addressed the use of one of the techniques of Fuzzy Logic, an algorithm (FCM) with an attempt to include how to manage the various features that were extracted to images of ultrasound, where Fuzzy logic is one of the most important fields of knowledge in the field of informatics, which was still a concern for many researchers, it helps support decision-making in general and medical decision in particular. The purpose of adopting FL is due to the difficulties encountered by classical logic in dealing with images. In these circumstances, logic techniques Blurry is effective and of great importance medical image processing, ie, dealing with inaccurate information and knowledge and thinking about decision making, because medical images are often ambiguous and uncertain. **[1] [2]** The focus on the ultrasound image of the fetal head is due to the fact that ultrasound images of this type of image are widely used because it is relatively safe, economical, adaptable and convertible. **[3]** As a result, our research in an attempt to manage and distinguish the images of medical ultrasound by extracting the precise properties of each element of this data and employing these properties in the field of logic and the research was based on extracting the fabric features of each element and making it a database. Features that best describe the tissue features of the ultrasound image, which are used to determine the fetal classification.

It is known that the visual properties represent a set of features that reflect the images of the ultrasound of the dimensions of the head of the fetus (Bi-Parietal Diameter) through which the sex of the fetus is identified with the other factors related to the relationship. The adoption of the FCMC algorithm, based on the visual features derived from the image collection,

contributes to the appropriate decision and experience to determine the gender of the fetus. It also included the most important filters that were used and included the proposed algorithm for research in terms of the most important models of the cluster. It also included analysis of the results of the application of the proposed system and compared with the approved systems for the management of images ultrasound to observe the most important features and avoid the most important defects. The last section included the main conclusions and recommendations of the study **[2].**

The problem of research includes the mixing of data on the medical side, especially images, because of its common characteristics in terms of form and different qualities, making it difficult and sometimes impossible to manage, classify and place such data within a logic that is a challenge that can create many problems. The aim of this study was to determine the sex of the fetus by possible gender-related measurements in the ultrasound of Bi-Parietal Diameter (BPD) and FL in uncomplicated pregnancies. The age of pregnancy was determined and determined by ultrasound (US). The cases were taken between (15) and (40) weeks of pregnancy To research the management of ultrasound images by investing the properties and features that can be obtained from these images and the use of these properties to obtain the appropriate classification of this type of images, which is difficult and complex tasks that require extensive experience, for the purpose of investment information that The design of a system to detect and diagnose the sex of the fetus by measuring the dimensions of the head is not a smooth task as it faces many problems and difficulties, which can be summarized as follows:

1. The complexity of obtaining the official approvals required to obtain the data, as well as the difficulty or lack of understanding of the bodies responsible for the concept of identifying sex through the head of the fetus and to obtain knowledge of them, which hinders the reasons for requesting data.

2. The complexity of the uterine tissues and the similarity of the head of the fetus sometimes lead to difficulty of discrimination.

The Karkh maternity hospital was selected as a private hospital for obstetrics and antenatal care. The examination of the pregnant mother was conducted in order to provide the sonar equipment and a free source of medical images for educational purposes. A large number of pictures related to the study were included. Research (91) Image of the fetal head (BPD) of the ultrasound device (US) during the second trimester and the third trimester of pregnancy, the images are distributed between 52 images of the head of the fetus male and (39) a picture of the head of the fetus female. [researcher]

Literature review

Many studies have included the use of fuzzy logic techniques to improve data management and overcome ambiguities. These techniques include the algorithm (FCM). These studies include:

Ajwad, A. A. (2012). “Noise reduction of ultrasound image using wiener filtering and haar wavelet transform techniques”. Noise reduction of the medical image is an important task to improve the medical image quality that may be helpful in medical diagnosis. The proposed system performed into two steps: First; application of Wiener filtering technique as a preprocessing step to reduce the amount of noise present in ultrasound image of human kidney, Second; implementation of Haar wavelet transform for denoising the resulting image from the first step.The results of noise isolation of ultrasound image after implementation of Wiener

filtering and wavelet transform were presented. also, some statistical results of these images were recorded [4].

• (Ajwad, A. A) adopted a special study on "noise reduction" by Wiener Ultrasound image using a wavelet filter wavelet filter ". In this research, the use of the Weiner filter and wavelet conversion to reduce the accompanying ultrasound of ultrasound images (Vatamanu OA1, Ionescu M, Mihalay GI) were conducted by the researchers. (LBP) by using a localized binary pattern operator to provide the classification and retrieval technology applied to ultrasound medical images, based on variations of the local LBP algorithm [5].

• The Researcher"(Seyyid Ahmed Medjahed) adopted a Comparative study method of extracting features in image classification." This research Blood comparison protocol several techniques for extracting features in the context of image classification are used for both binary and multi-category labels. The aim of this research is to demonstrate the technique of extracting the relevant feature that improves the rate of classification accuracy [6].

• The two researchers (Murat Alparslan Gungor and Irfan karagoz) special paper on the "Effects of the intermediate filter in different sizes of the image window". The median filter is performed with a different window and the sizes are evaluated by the image quality scale and the quality comparison [7].

• The researcher (Jalenamary, F, & Nirmala, M. A) and others undertook a special paper to discuss the "Improved approach to the FCM algorithm for image retrieval". This proposed work is used to retrieve images based on similarity. And works to help the doctor in decision-making [8].

The researcher (0GNJEN MAGUD) conducted a special discussion of the discussion. "Reduce the noise of ultrasound image spots by the appropriate media filter". In this paper, a medium-adjusted candidate with a modified window size is proposed to remove stain noise from medical ultrasound images [9].

Methods

1 Medical Images

Medical images are one of the diagnostic tool's foundations. They contain a lot of information about the patient and the disease. [10] Medical imaging refers to the techniques and processes used to create images of the human body (or parts thereof) for different clinical purposes such as medical procedures and imaging. The imaging method is an imaging system that uses a particular technique. [11]

2 Ultrasound images

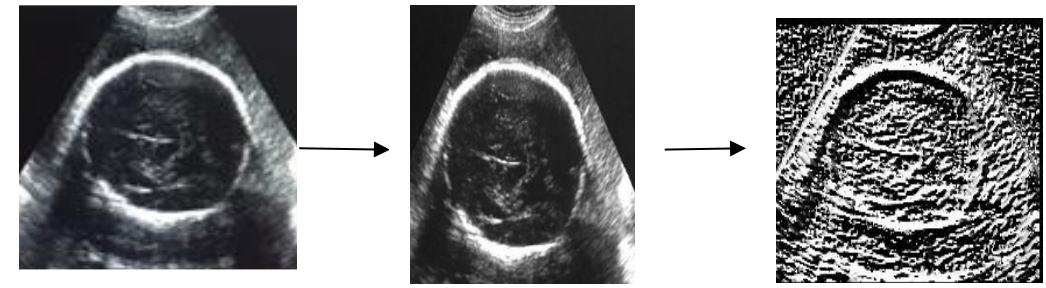
Is a useful and flexible method that is widely used in the medical field and often provides an additional or unique description of the tissue. Unlike X-ray waves, electromagnetic waves such as non-ionizing ultrasound do not use ionizing radiation (as used in X-rays), and on this basis there is no radiation exposure to the patient. It is therefore safe [12] [11].

3 Fetal Anatomical Parameters:

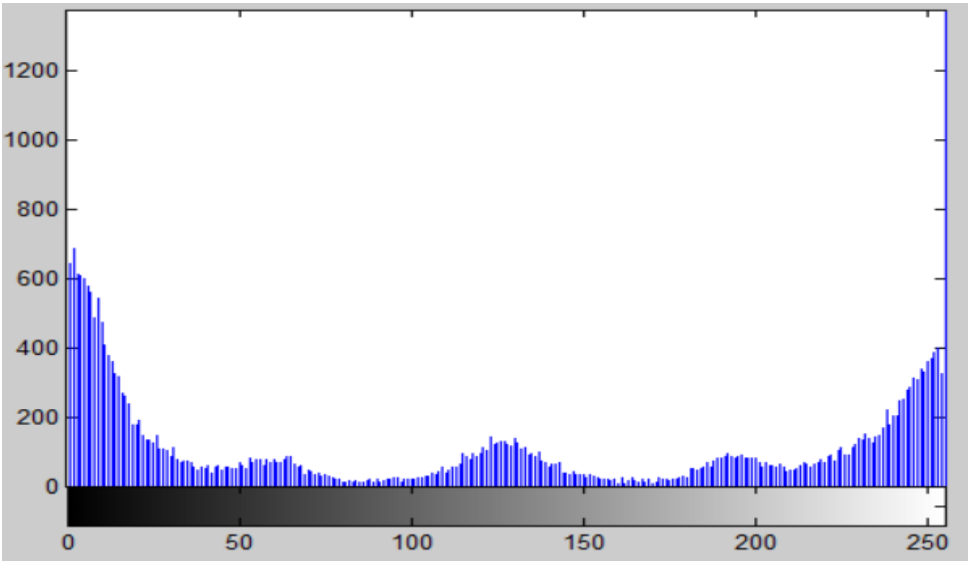
The knowledge of fetal growth using the ultrasound imaging system involves many of the fetal anatomical parameters used. like the femoral (FL) length and (BPD) [13][14].

Algorithm Local Binary pattern

The LBP is a binary pattern algorithm that is executed ، the basic algorithm idea can be described as two-parent surface textures The native operator classifies pixels of the image by specifying the 3 x 3 (LBP) of each pixel with the value of the center and the result is a binary number As an LBP as classification or fragmentation properties by applying a summation of the probability of fabric pattern in the histogram. The reason for the failure of the local binary pattern (LBP) in the classification is because it is influenced by the contour, which is often a "high contrast". **[15]**



a. original image **Image after conversion to gray b.** **image LBP .c**

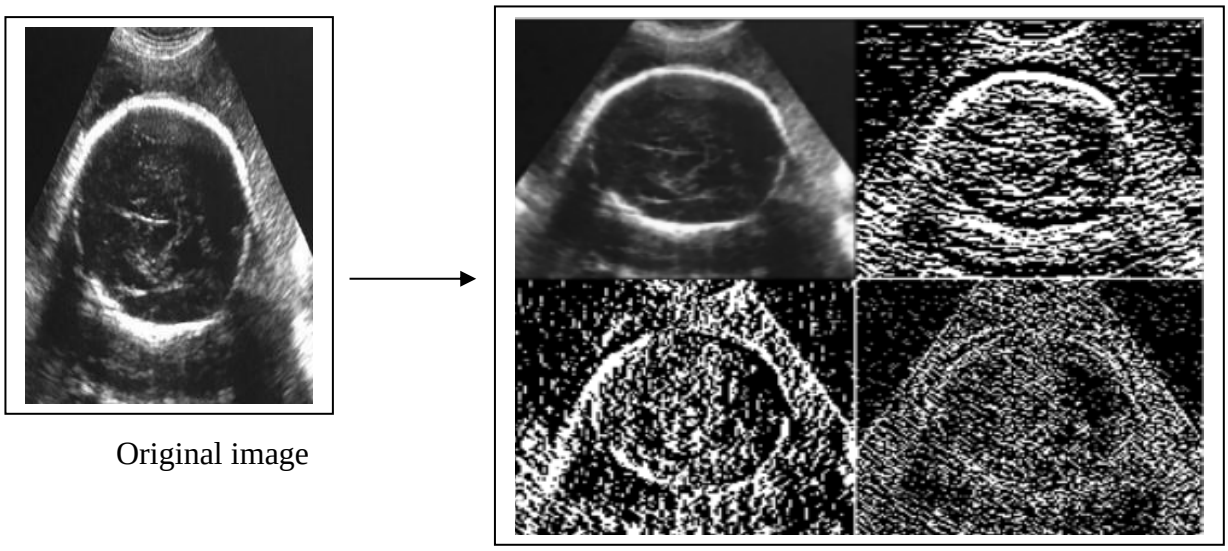


d. LBP Histogram

Fig1. shows the sequence of the local-style binary (LBP) algorithm

Discrete Wavelet Transform

It is an easy-to-implement transform in which wavelets are sampled separately and it is important to use DWT rather than Fourier transform because this transform uses a variable-width window instead of using a fixed-width window, and the window display is changed to obtain different frequency information Along the wavelength, as well as the time it takes to calculate a DWT conversion is very low because it is very fast compared to a Fourier transform that takes more time, the conversion depends mainly on the wavelet matrix, which can be calculated more quickly than the Fourier matrix. You can also use the DWT method to hide information **[16] [17]**.



Original image

Fig2.shows the level of analysis of the wavelet transform conversion of the ultrasound image

The process of converting wavelets is a simple idea. The original image is divided into 4 new sub-images. Each sub-image is (1/4) from the original image by analyzing each image in different frequency bands with varying degrees of accuracy (DWT). Each image is decomposed by two levels using the separate wavelet conversion at each level. (HH, HL, LH) and Details (LL) Transactions Rounding The sub picture appears in the upper right, lower left, and lower right as an approximation of the original image because it contains high frequency components of the original image. As for the upper left sub-picture, it appears as the original image and looks smoother with the lower frequency components of the original image. **[18] [16]**

1. Noise removal

Biomedical images are usually affected by different types of noise. And unwanted data that may reduce the contrast or deterioration of the shape or size of the objects in the image and their clarity and noise affects all coherent imaging systems including medical ultrasound. To remove this noise without destroying the required information is often a great challenge. Image data is usually noisy. Image noise occurs for many reasons, including incomplete tools, lighting variations, image transformations to digital format or other causes, resulting in poor image quality and problems with data acquisition. Effective noise reduction technology is necessary to compensate for data corruption. The ultrasound image quality has generally deteriorated due to noise **[19] [20]**.

2. Speckle noise

Noise is the most widespread and inherent noise in the ultrasound image and is in the form of granules that affect image quality and deteriorate, making detection and recognition more difficult and the noise of spots in images. Is an obstacle to the extraction of effective parameters and also affects the edges and fine details that limit the accuracy of the contrast and make the diagnosis more difficult and produces this type of noise from the interference of the return wave at the power adapter slot. **[22] [21]**

3. Median filter

Nonlinear digital filtering, mostly used for removal and reduce This method is effective and very widely used in digital image processing because it maintains sharp edges when noise is

removed. [23] It is used to remove the noise of "spots" from an ultrasound image. And is done Calculate the median by sorting all pixel values from surrounding neighborhoods in the numerical system and then replacing pixels corresponding to the pixel value The medium also provides simplicity of implementation and effectively eliminates noise when compared with other filters as well as maintains sharp edges. Especially for ultrasound images, this filter is very important. [24]

Unsorted vector is (1 ,0 ,5 ,0 ,8 ,29 ,0 ,7, 14)

sorted vector are (0, 0, 0, 1, 5, 7, 8, 14, 29)

Median value is 5

1	0	0
0	8	7
5	29	14

Fig3. shows how to calculate the mean value of the median filter

(A) (B)

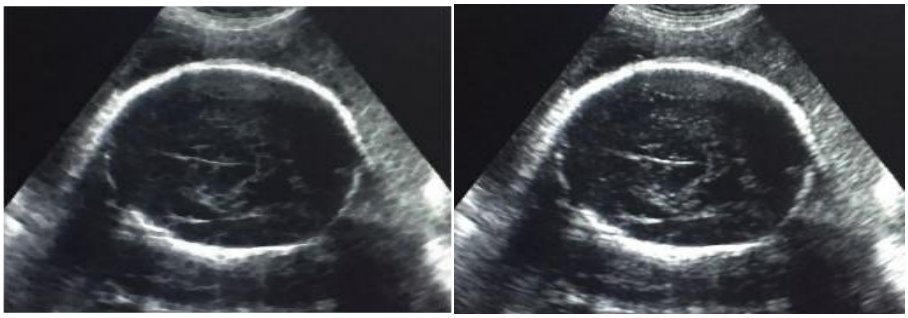


Figure (4) shows the implementation of the median filter

(A) The original image before the implementation of the mediator filter (B) filtered image after the implementation of the mediator filter

It is noted in Fig4. that the images contain a higher percentage of noise than the image (B) resulting in the results as:

4. Wiener Filter

The Winner Filter is from optimal linear filters involving a linear rating is the reduction of the wiener for the required signal. The main purpose of the filter is the amount of noise in the image. This filter may be used, and this filter is based on a statistical approach. (Smoothing) also by softening and is one of the most important techniques to remove camouflage in pictures. This works on all candidate units by applying the pixel mean and will be calculated by estimating the local mean around each pixel to find the value of the central window. (Variance) and contrast **[25].**

5. Feature extraction

Extract feature is the most important step in image classification. It helps to extract the attribute of the image as perfect as possible. [26] and that Extraction Features It extracts visual information from the image and saves properties oriented in the database features. In the form

of a characteristic value for each pixel of the resources used to describe a wide range of data, especially if there is a need to store and analyze a large number such as images in medical applications or image retrieval systems. **[6] [15]**

6. Texture: Analysis Based Feature Extraction

Texture analysis is of great importance in many areas of computer image analysis to perform classification or detection operations based on local spatial patterns of edges or color. It is often attributed to human cognition and is widely used in digital image analysis. Can be used to extract features in imaging and medical classification. The method of selecting image extraction is very important (Texture analysis) for the success of textile classification. There are many ways to derive statistical attributes based on fabric. Such as methods based on statistical methods **[26].**

Statistical Methods

Statistical features are derived from different categories, such as the method of statistical features of the first and second degrees. The features of statistical fabric are useful for classifying and retrieving similar images. These fabric features provide information about the distribution properties of the density level of image **[27].**

1. First order statistical features

One of the simplest ways to describe the texture of a picture is because it provides a good description of the texture in the picture. Which the main features extracted from Mean, Variance (histogram) Deviation, Skewness, and Kurtosis **[28].**

1. Second order features

The tissue attributes are extracted from the common presence matrix and the mathematical equations are given the textile profiles as follows: **[29]**

Table (1). shows statistical characteristics of the second type.

First order statistical features	Function
entropy	$entropy = -\sum_{i=0}^{L-1} P(z_i) Log_2 [P(z_i)] \dots [64]$
Correlation	$\text{Correlation} = \sum_i \sum_j \frac{(i-\mu_x).(j-\mu_y)p(i,j)}{\sigma_x.\sigma_y} \dots [66]$
Energy	$\text{Energy} = \sum_i \sum_j \lvert P(i,j)\rvert^2 \dots [66]$
Homogeneity	$\text{Homogeneity} = \sum_i \sum_j \frac{P(i,j)}{1+\lvert i-j\rvert} \dots [67]$
Contrast	$\text{Contrast} = \sum_i \sum_j \lvert i-j\rvert^2 P(i,j) \dots [67]$

Fuzzy C – Mean cluster

Is a repetitive algorithm found on fuzzy clusters? The associated fuzzy, which best represents the data structure and uses the blurry membership concept, is often abbreviated by FCMC. it was The FCM algorithm (Bezdek)is proposed as a clustering method that allows one part of to be associated with data to two or more sets, which assigns to each data a membership value within each group and therefore may belong to the specified data into more than one group. Among all Fuzzy methods, it is the most common given its application of "Fuzzy c - Means Clustering" is still the most spread for its practical succeed in the academic environments that the clustering algorithm has the ability to discover the basic skeletons of data which are used in many engineering and scientific fields for example medical images and search for biological date **[31][30]**.

Proposed methods

In the image initialization phase, the processing processes carried out to obtain the best results This phase involves color conversion, image resizing, noise reduction, and image quality enhancement and Accurate details can be detected correctly. Using the local binary pattern algorithm, the native LBP operator classifies image pixels by specifying Neighborhoods are 3 x 3 parities per pixel with the center value, the result is a binary number, The reason for the failure of the local binary pattern (LBP) in the classification because it is affected by the neighborhoods that are often (Height Contrast). DWT When applying this Transform the image will be divided into four parts. The rounding and detail coefficients will be obtained, and the approximation coefficients will be one and the three detail parameters ie Horizontal, Vertical and Diagonal. And the third stage extraction feature (Feature extraction) and this stage is used as an input to the classification stage It is known that the visual properties represent a set of features that reflect the images of dimensions of the head of the fetus (Bi - Parietal Diameter) Which are triggered by The second part of the system includes a node or so-called aggregation of data by employing an algorithm (FCM) data classification and access to solutions that help in the decision-making process This algorithm works by assigning membership to each point of data corresponding to the cluster center based on the distance between the center of the cluster and the data point. The data closest to the center of the mass has more membership towards a given mass center, and the sum of the membership of each data point must be equal to one. After each repetition, membership and assembly centers are updated. The adoption of the FCMC algorithm, based on the visual features derived from the image collection, contributes to the appropriate decision and experience to determine the fetal sex.

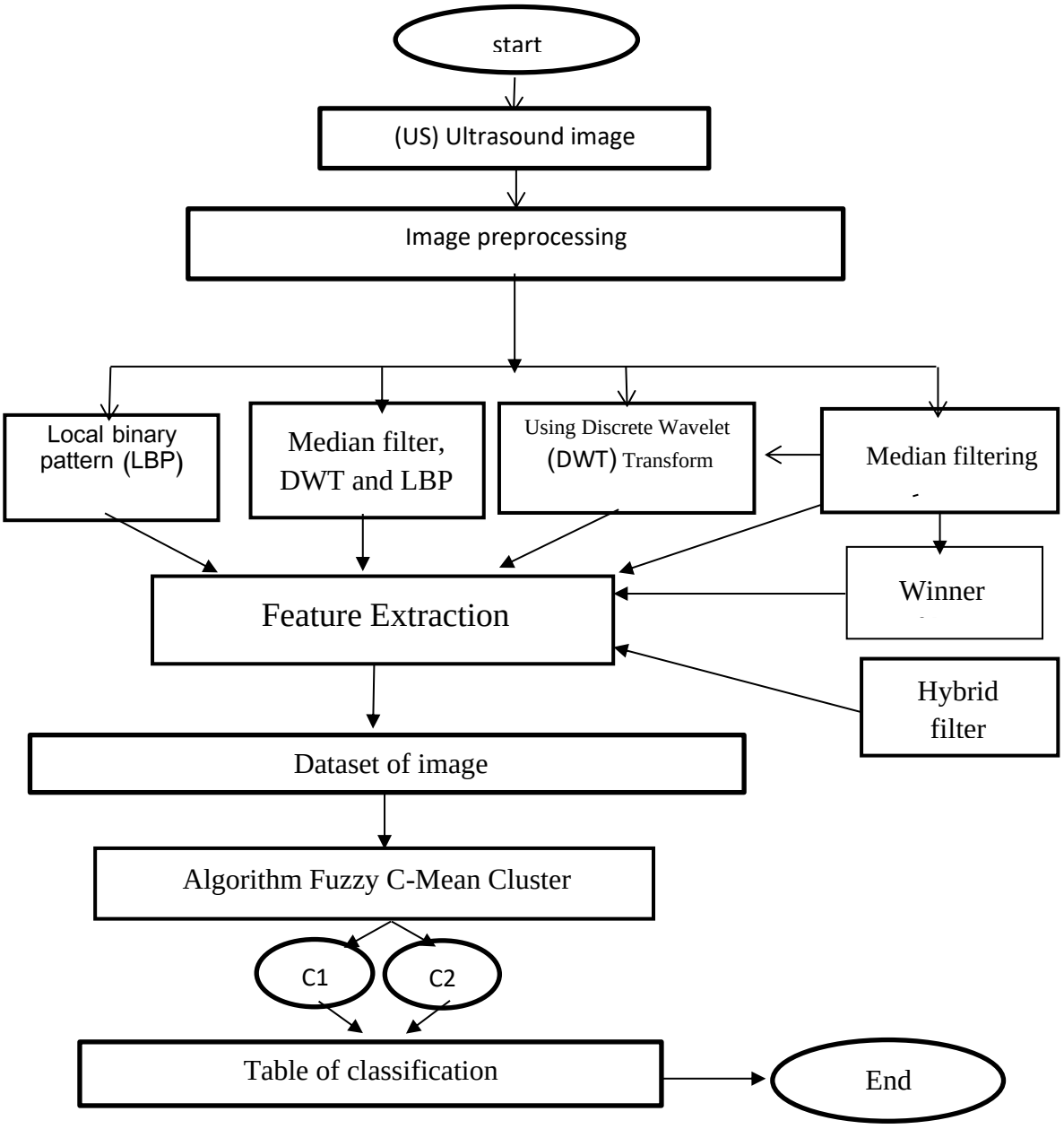


Fig5.The Proposed System.

Hybrid Filter

The proposed filter is a combination of a non-linear filter and a linear filter. When we arrange these filters in a series, we will get the desired output. First, we remove the noise using the Median filter and then pass the result to the Winner Filter. The proposed filter produces better results for noise reduction, preservation of structures and key details. The purpose of using the Hybrid Filter is to improve the results. Note that the median filter is used to maintain the edges of the image for smoothing. The filter is used because it fits in with the local variation and the performance of the smoothing feature extraction.

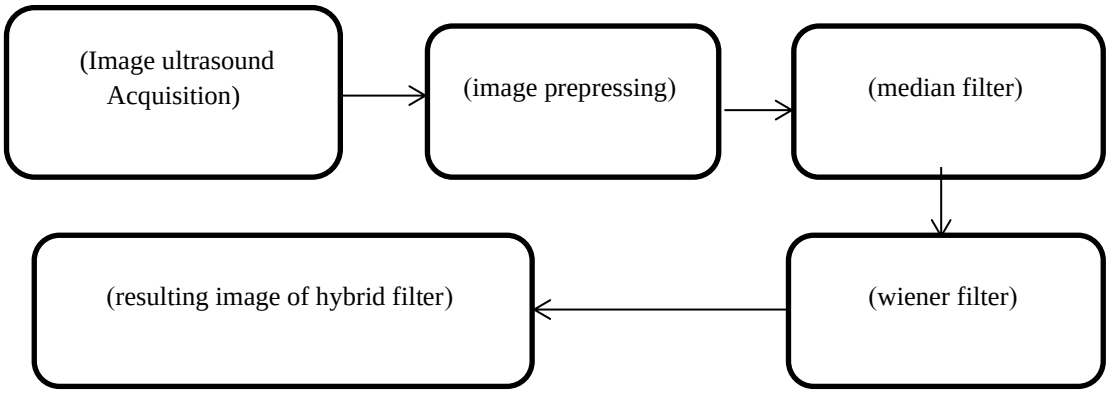


Fig6. shows how to implement the Hybrid Filter

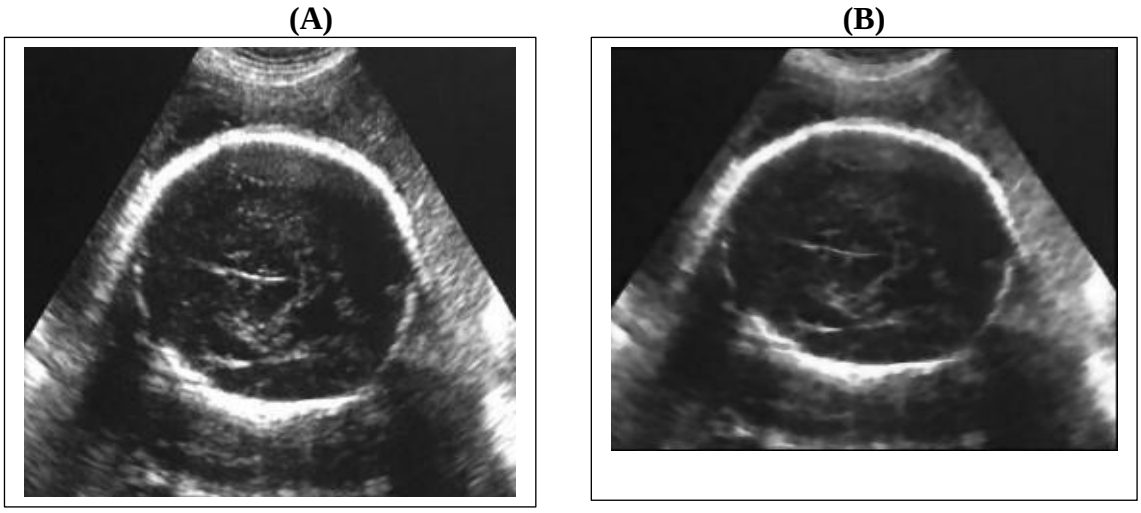


Fig7. shows the implementation of the Hybrid Filter

(A) The original image before the implementation of the Hybrid Filter (B) filtered image after the implementation of the Hybrid Filter

Results and Discussions

In this section, the results of the implementation of the algorithm used in the classification of the fetal sex determination system will show the ultrasound images of the number of clusters equal to (2) The dimensions of the head of the embryo are distributed (50) images of the head of male embryos (image of the head of female embryos. The lower forms show the results of the Median Filter cluster algorithm after applying them to the features resulting from FCMC (Median filter, DW and median filter, Hybrid Filter, LBP, DWT and Median Filter and LBP). The C# program was used to apply filters and transformations, and the MATLAB program to apply the fuzzy logic algorithm and extract statistical properties.

(O) represents the elements (Cluster1) and the (x) symbol represents the elements (Cluster2) where cluster1 represents the images of the female embryos and cluster2 represents the images of the male embryos.

Figure (8) shows the results of the classification of the FCM algorithm to cluster1, which compiles the results of the images (BPD) of the female embryos (female).

As shown by the results of the diagram: The cluster1 consists of (39) images which are classified to (24) in correct form and it is indicated by the green color and (15) of them classified in wrong way that why it is indicated by the sign (⬬) With a health rating of

$$\frac{24}{39} * 100\% = 0.6153846154$$

C1 =39
- 24 =True
- 15 =false

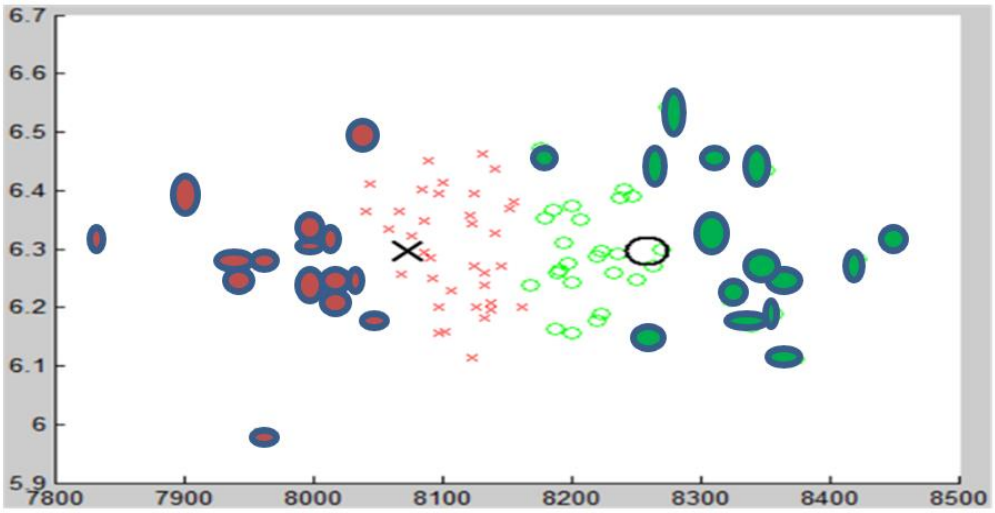


Fig8. shows the results of the clustering algorithm of the FCMC after applied to the image properties resulting from the LBP algorithm.

As well as shown by the results of the diagram: The cluster2 consists of (52) images which are classified to (37) in correct form and it is indicated by the red color and (15) of them classified in wrong way that why it is indicated by the sign (⬬) With a health Proportion:

$$\frac{37}{52} * 100\% = 0.71153846$$

C2 =52
- 37=true
- 15=false

Figure (9) shows the results of the classification of the FCM algorithm to cluster1, which compiles the results of the images (BPD) of the female embryos (female).

as shown by the results of the diagram: The cluster1 consists of (46) images which are classified to (43) in correct form and it is indicated by the green color and (3) of them classified in wrong way that why it is indicated by the sign (⬬) With a health rating of

$$\frac{43}{46} * 100\% = 0.9347826087$$

C2 =46
- 43 =true
- 3=false

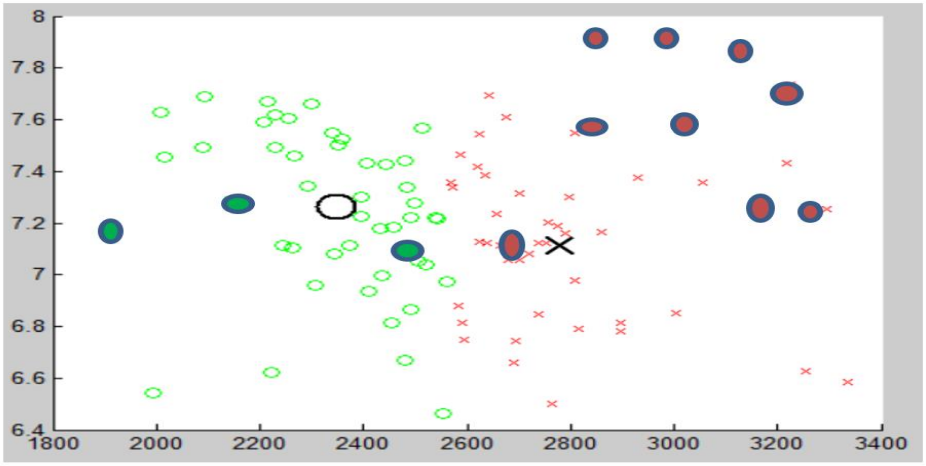


Fig9. shows the results of the FCMC's clustering algorithm after applying to the features images resulting from the application of the median filter with the intermittent wavelet conversion (DWT)

As well as shown by the results of the diagram: The cluster2 consists of (45) images which are classified to (36) in correct form and it is indicated by the red color and (9) of them classified in wrong way that why it is indicated by the sign ( ) With a health rating of:

$\frac{36}{45} * 100\% = 0.8$

C1=45 { 36 =true

9 =false

Figure (10) shows the results of the classification of the FCM algorithm to cluster1, which compiles the results of the images (BPD) of the female embryos (female).

as shown by the results of the diagram: The cluster1 consists of (46) images which are classified to (37) in correct form and it is indicated by the green color and (9) of them classified in wrong way that why it is indicated by the sign ( ) With a health rating of

$\frac{47}{52} * 100\% = 0.9038461538$.

C1=46 { 37=true

9=false

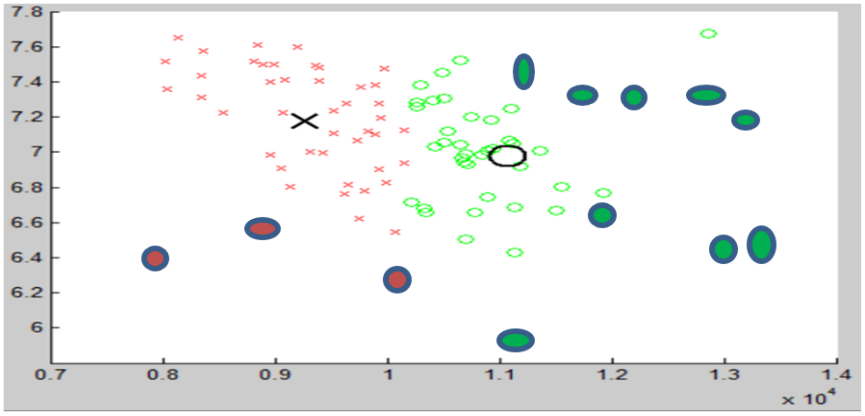


Fig10. shows the results of the clustering algorithm for the FCMC after applying it to the features resulting from the Median Filter.

As well as shown by the results of the diagram: The cluster2 consists of (45) images which are classified to (42) in correct form and it is indicated by the red color and (3) of them classified in wrong way that why it is indicated by the sign ( ) With a health rating of:

$\frac{42}{45} * 100\% = 0.93333333$.

C2=45 { 42=true ; 3=false

Figure (11) shows the results of the classification of the FCM algorithm to cluster1, which compiles the results of the images (BPD) of the female embryos (female).

As shown by the results of the diagram: The cluster1 consists of (52) images which are classified to (47) in correct form and it is indicated by the green color and (5) of them classified in wrong way that why it is indicated by the sign ( ) With a health rating of

$\frac{47}{52} * 100\% = 0.9038461538$.

C1=52 { 47=true ; 5=false

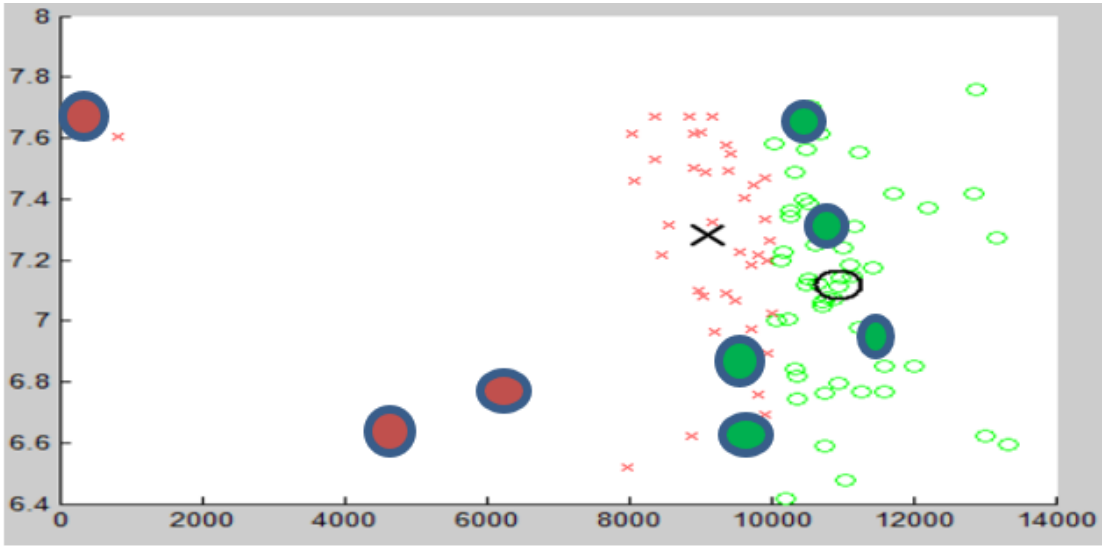


Fig11. shows the results of the application of the clustering algorithm for FCMC on the image characteristics of the hybrid filter.

As well as shown by the results of the diagram: The cluster2 consists of (39) images which are classified to (36) in correct form and it is indicated by the red color and (3) of them classified in wrong way that why it is indicated by the sign ( ) With a health rating of:

$\frac{36}{39} * 100\% = 0.9230769231.$

C2=39 { 36=true ; 3=false

The results showed that the best method of classification was obtained from the application of the hybrid filter resulting from the application of the median filter with the wiener filter. The total error in both Claster1 and Claster2 was lower than the results of the other tables. When using the median filter, the results were fairly good. When applying the intermittent wavelet conversion with the median filter, the results were incorrect as required and when using the local binary mode LBP), we note that it failed in the classification because it is affected by the contours that are often (Height Contrast) and when applied the worst results were obtained, as in the following table:

Table (2). The results of the cluster algorithm test for the FC-M

Name of Technique	Cluster1	Cluster2	Result
LBP	0.4423076923	0.71153846	1.15384615
median filter	0.8043478261	0.93333333	1.7376811561
median filter with DWT	0.8	0.9347826087	1.734782609
Hybrid filter	0.9038461538	0.9230769231	1.8269230769

Conclusion and Recommendations

The study proved that the features extracted from the images give good results in determining the sex of the fetus by contrast and entropy parameters, some of which were included in the classification. The best diagnostic scores were obtained from the results of the hybrid filter images, while the results of the LBP algorithm were not able to give the correct classification. The best classification results were obtained through the application of the FCM algorithm when the number of clusters was two, where the gender of the fetus was easily determined.

It is recommended to take other types of images (ultrasound) such as femur (FL) images, use Fourier transform and other transformations as well as adopt from other algorithms such as SIFT algorithm and other appropriate data algorithms, adopt prediction methods, reduce dimensions in classification, medical images, and classify images The fetus is divided into three categories from the fetal head, with ascites fetuses containing congenital abnormalities and used to assist the doctor in the diagnosis and identification of appropriate factors and treatment of the condition. The fuzzy neural network classification of fuzzy information mining algorithms can be used to compare with search results.

Reference

[1] Garrido, A. (2012)." A brief history of fuzzy logic". BRAIN. Broad Research in Artificial Intelligence and Neuroscience, 3(1), 71-77.

[2] Ponce-Cruz, P., & Ramírez-Figueroa, F. D. (2010). "Fuzzy logic." Intelligent Control Systems with LabVIEW™, 9-46.

[3] Rani, P., & Verma, R. (2015) .”A Review on Ultrasound Image Segmentation Techniques”.

[4] Ajwad, A. A. (2012). "Noise reduction of ultrasound image using wiener filtering and haar wavelet transform techniques". Diyala Journal of Medicine, 2(1), 91-100.

[5] IONESCU, O. A. V., & MIHALAŞ, G. I. (2013)." Analysis and classification of ultrasound medical images using the Local Binary Pattern operator". Informatics, Management and Technology in Healthcare, 190, 175.

[6] Medjahed, S. A. (2015). "A comparative study of feature extraction methods in images classification". International Journal of Image, Graphics and Signal Processing, 7(3), 16.

[7] Gungor, M. A., & Karagoz, I., (2016, October) "The effects of the median filter with different window sizes for ultrasound image" , In Computer and Communications (ICCC), 2016 2nd IEEE International Conference on (pp. 549-552). IEEE

[8] Jalenamary, F., & Nirmala, M. A. "(2016)AN ENHANCED FUZZY C-MEANS CLUSTERING APPROACH FOR CONTENT BASED IMAGE RETRIEVAL".

[9] MAGUD, O., TUBA, E., & BACANIN, N. (2017)." Medical Ultrasound Image Speckle Noise Reduction by Adaptive Median Filter".

[10] Gleich, B. (2013). "Principles and applications of magnetic particle imaging" . Springer Science & Business Media.

[11] Dougherty, G. (2009). "Digital image processing for medical applications" . Cambridge University Press.

[12] Kaur, K. (2013). "Digital image processing in ultrasound images" . International Journal on Recent and Innovation Trends in Computing and Communication, 1(4), 388-393.

[13] Hobbins, J. C. (2008). "Obstetric ultrasound: artistry in practice ". John Wiley & Sons.

[14] Lutz, H., & Buscarini, E. (Eds.). (2011). "Manual of diagnostic ultrasound (Vol. 2). World Health Organization".

[15] Goswami.,P .(2016) "Texture Based Feature Extraction and Object Tracking " , Department of Electrical and Computer Engineering The University of Arizona .

[16] Attlas, N., & Gupta, S., (2014) "Reduction of speckle noise in ultrasound images using various filtering techniques and discrete wavelet transform: comparative analysis " ,International Journal of Research (IJR), 1(6), 112-117.

[17] Mohanty, A. K., Beberta, S., & Lenka, S. K. (2011). Classifying benign and malignant mass using GLCM and GLRLM based texture features from mammogram. International Journal of Engineering Research and Applications (IJERA), 1(3), 687-693.

[18] Kurniawan, A., Purboyo, T. W., & Prasasti, A. L., (2017)."Implementation of Image Compression Using Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT)", International Journal of Applied Engineering Research, 12(23), 13951-13958.

[19] Seetha, R., & Baboo, S. S(2016) . "Analysis of Enhancement Techniques for Medical Images" . International Journal of Control Theory and Application.

[20] Boyat, A. K., & Joshi, B. K. (2015). A review paper: noise models in digital image processing. arXiv preprint arXiv:1505.03489.

[21] Benzarti, F., & Amiri, H. (2013). "Speckle noise reduction in medical ultrasound images". arXiv preprint arXiv:1305.1344.

[22] Gomes, M. I. (2011)." Advanced Computational Methodologies for Fetus Face".

[23] Patidar, P., Gupta, M., Srivastava, S., & Nagawat, A. K. (2010). "Image de-noising by various filters for different noise". International journal of computer applications, 9(4).

[24] Gungor, M. A., & Karagoz, I., (2016, October) "The effects of the median filter with different window sizes for ultrasound image" , In Computer and Communications (ICCC), 2016 2nd IEEE International Conference on (pp. 549-552). IEEE

[25] Abuazoum, M. S. (2012)." Efficient analysis of medical image de-noising for MRI and ultrasound images" . (Doctoral dissertation, Universiti Tun Hussein Onn Malaysia).

[26] ping Tian, D. (2013)." A review on image feature extraction and representation techniques" . International Journal of Multimedia and Ubiquitous Engineering, 8(4), 385-396.

[27] Ahmadv, A., & Daliri, M. R. (2016). "A review on texture analysis methods in biomedical image processing" . OMICS J Radiol.

[28] Malik, F., & Baharudin, B. (2013). "The statistical quantized histogram texture features analysis for image retrieval based on median and laplacian filters in the dct domain" . The International Arab Journal of Information Technology, 10(6), 1-9.

[29] Kale, S. D., & Punwatkar, K. M., (2013) " Texture analysis of ultrasound medical images for diagnosis of thyroid nodule using support vector machine" , IJCSMC, 2, 71-77.

[30] László LEFKOVITS ,Cluj-Napoca, Romania & David ICLANZAN (2020). "A review on suppressed fuzzy c-meansclustering models" . Acta Univ. Sapientiae Informatica 12, 2 (2020) 302–324

[31] Tran Dinh Khang ,Manh-Kien Tran and Michael Fowler (2021). "A Novel Semi-Supervised Fuzzy C-Means Clustering Algorithm Using Multiple Fuzzification Coefficients" . Algorithms 2021, 14, 258.