Early Diagnosis of Endometrium Cancer using Image Processing Techniques

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Abstract

According to GLOBOCAN 2020 estimates of cancer incidence and mortality, Endometrium cancer is the second leading cause of mortality in women after Breast cancer. However, it is also one of the treatable cancers if detected early. Radiologists read uterine ultrasound images manually, which is a difficult and confusing procedure that causes them to make mistakes and missing detecting malignancy. The focus of this paper is to look at the possibilities of detecting and classifying Endometrium cancer using image-processing techniques. To improve image detection, the quality of the input uterine ultrasound image was first enhanced during the preprocessing stage by removing noises and improving image contrast. Following that, a set of sequence techniques, thresholding image masking were used to remove of artifacts and labels form uterine ultrasound images. Filtering techniques are used to refine enhancement process, fussy logic is used to enhance edge detection, finally, k means and automatic thresholding were used for Uterine ultrasound image to obtain region of interest (ROIs) which is endometrium region, and the radiologist can as normal and abnormal. A MATLAB environment is used to examine the proposed approaches and the outperform results was achieved using Median Filter for a high quality Ultrasound 512X512 image size that affected by Salt and Pepper noise with 86.99% classification accuracy using peak signal-to-noise ratio (PSNR) metric.

ملخص—

وفقًا لتقديرات GLOBOCAN 2020 الخاصة بمعدلات الإصابة بالسرطان والوفيات، يعد سرطان بطانة الرحم السبب الرئيسي الثاني للوفيات لدى النساء بعد سرطان الثدي. ومع ذلك، فهو أيضًا أحد أنواع السرطان القابلة للعلاج إذا تم اكتشافه مبكرًا. يقرأ أخصائيو الأشعة صور الموجات فوق الصوتية للرحم يدويًا، وهو إجراء صعب ومربك يجعلهم يرتكبون الأخطاء ويفقدون اكتشاف الأورام الخبيثة. تركز هذه الورقة على النظر في إمكانيات اكتشاف وتصنيف سرطان بطانة الرحم باستخدام تقنيات معالجة الصور. لتحسين الكشف عن الصور، تم تحسين جودة صورة الموجات فوق الصوتية الرحمية المدخلة لأول مرة خلال مرحلة المعالجة المسبقة عن طريق إزالة الضوضاء وتحسين تباين الصورة. بعد ذلك، يتم استخدام مجموعة من تقنيات التسلسل وإخفاء الصورة لإزالة القطع الأثرية والملصقات من صور الموجات فوق الصوتية للرحم. تُستخدم تقنيات الترشيح لتحسين عملية التحسين، ويتم استخدام المنطق المتطلب لتعزيز اكتشاف الحواف، وأخيرًا، تم استخدام وسائل k والعتبة التلقائية لصورة الموجات فوق الصوتية للرحم للحصول على المنطقة محل الاهتمام (ROIs) وهي منطقة بطانة الرحم، ويمكن لأخصائي الأشعة كالمعتاد وغير طبيعي. تم استخدام بيئة MATLAB لفحص الأساليب المقترحة وتم تحقيق النتائج المتفوقة باستخدام Median Filter للحصول على صورة بالموجات فوق الصوتية عالية الجودة مقاس X512512 والتي تتأثر بضوضاء Salt and Pepper بدقة تصنيف تبلغ 86.99% باستخدام مقياس signal-to-noise ratio (PSNR).

Keywords— Early Diagnosis, Endometrium Cancer, Impulse noise, digital image, Gaussian, filters,* Uterine ultrasound, region of interest (ROIs)*, Fuzzy filter, Ultrasound images.

I. INTRODUCTION

Image processing is an important field in modern science and engineering that handles different aspects of images such as image analysis, enhancement and restoration [1]. Medical image processing has grown dramatically and is becoming an interdisciplinary research field that draws expertise from applied mathematics, computer sciences, engineering, telecommunication, statistics, physics, biology, and medicine. Medical imaging is a technique and procedure that provides visual representations of a body's internal organs or tissues for clinical study and medical intervention [2]. Therefore, it is widely applied to support physicians in establishing a diagnosis. When it comes to medical imaging, studying them is mostly reliant of what the radiologists can interpret from them visually, however, this consumes time, besides; it is usually subjective as it varies according to the experience of the radiologists. Due to the aforesaid considerations, the use of image processing techniques become a necessity, in order to facilitate analyzing and processing different medical image modalities like MRI, CT and ultrasound. Cancer is a disease where the body's cells proliferate uncontrollably. Uterine cancer occurs when cancer begins in the uterus. The uterus is a pear-shaped organ located in a woman's pelvic cavity [3]. Uterine cancer also named endometrium cancer, which is one of the most common malignant gynaecological cancers that prove to be a serious threat to women health. It is, however, largely preventable, and the treatment is dependent on the severity of the condition and availability of local resources at the time of diagnosis [1]–[4]. This research describes an effort to apply image-processing techniques to uterine ultrasound images in terms of improving their quality and help radiologists in both the screening and diagnosis phases, for detecting Endometrial Cancer. For women that may have gynaecologic problems, the utilization of ultrasound is usually one of the initial tests that are employed to examine the uterus, ovaries, and fallopian tubes [5]. To improve the quality of the Ultrasound images, image processing techniques and especially image enhancement are being used widely and more frequently. Examples of algorithms that are used include equalization, median filters, gamma correction, Gaussian filters, and morphological filters [6]. In this paper, the acquired ultrasound images will be filtered using a median filter and then segmented to obtain Region of Interest ROI.

In endometrium cancer, patients in early stages have a 91% 5-year survival chance. By contrast, patients in advanced stages have only 20% survival chance [7]. Therefore, early diagnosis of endometrial cancer is very important to reduce mortality rate of women, hence developing a high-performance image processing system for uterine ultrasound image segmentation, detection and classification of endometrium cancer is very important. It will help radiologists as well as physicians to perform best treatment because at early-stage the cancer is small and treatable. The most common problem with ultrasonic diagnosis procedure is speckle noise generated from the non-homogenous structure of the tissue, Speckle noise is a specific form of noise that degrades fine details and edge definitions in ultrasound images. A number of studies have been conducted in order to solve the speckle noise problem in ultrasound image. Thakur et al. in 2005 [20] were conducted comparative study of different noise reduction methods based on wavelet filter according to different threshold values applied to ultrasound images. The raw image is converted into a multi-scale wavelet field and the wavelet coefficients are processed in a soft-threshold method. The output image that is obtained from the inverse wavlet transformation of the threshold coefficients using the Donoho method becomes the denoised image. It has been observed that these noise reduction methods are effective in the sense that they preserve edge detail along with noise suppression [20]. Also, Damodaram et al. in 2012 in [21], were conducted one of very important denoised techniques to improve diagnostic information form ultrasound, the Wiener filtering technique was used to remove speckle noise from ultrasonic images of the liver. The search results of the algorithm was very useful for denoising [21].

Several different techniques can perform image segmentation. Ji and Shi in 2011 [22] were analyzed the weakness of a watershed segment method and proposed a new water flow image segmentation method based on morphological gradient reconstruction. In the proposed technique, morphological opening and closing operations are used to rearrange a gradient image, maintain important additions to details and noise of regional contours and avoid the common water flow separation phenomenon. It also overcomes the contour positioning of the region derived from traditional morphological opening and closing operations for the original image. Their simulations show that in terms of visual effects or eliminating too much segmentation, the position and contour of the area of noise and other properties [22]. In addition, Rawat and Gupta n 2018 [23] were proposed a technique that combines fuzzy C means and Darwinian particle swarm optimization (PSO). Among fuzzy-based clustering algorithms, the FCM algorithm is the most popular, but it can have a locally optimal solution because of a random centroid onset. To overcome such problems, they recommended optimization algorithms, such as PSO or other evolutionary algorithms. With the proposed method, lesion parts from different medical images can be segmented, and multiple images can be obtained with high accuracy by using FCM–Darwinian PSO to detect the outer lines of images. The search results of the method are evaluated by various parameters, such as sensitivity, specification, Jaccard index and dice coefficient [23]. Also, Saravanan and Sathiamoorthy in 2018 [24] were developed a computerized segmentation technique based on active contours without outline techniques for an effective PCOS classification of 3D ultrasound image. In this technique, the location and size of follicles are calculated automatically by combining information from local and global conditions under new probabilistic conditions. Then, the identified follicles are segmented via database-guide graphical cutting segmentation. Thereafter, a clustered marginal space learning method is used to identify the detected objects effectively. The proposed system is evaluated using 501 ovarian volumes consisting of a women’s left or right ovary with 8,108 available follicles. Their approach is the first to identify and segment ovarian follicles in a 3D ultrasound volume automatically [24].

Many researches has conducted the Endometrial cancer detection proplems, Snehal N. Patil et al., 2012 were discovered a model for CAD system helps the doctors as well as the radiologist to identify any suspicious nodules of cancers; this will then help increase the accuracy, sensitivity and efficiency of any diagnosis made by using it. This makes the CAD Systems extremely beneficial in detecting cancerous nodules. Thus, the process was implemented accordingly andthe work under Module 3 is in progress [25]. Also, Snehal R. Shinde et al., 2019 explored a system of Endometrial Cancer Diagnosis using CAD systems and found that they are useful in improving the present methods of diagnosis to obtain an accuracy of 87.5%. In addition, the proposed system proves to be the best system in analyzing the stage at which the cancer has spread as well as its features such as area and radius. It is therefore clear that Computer Aided Diagnostic (CAD) systems provide great benefit to process of detecting cancerous nodules. A study conducted by Xue Wang et al., 2022, where 85 cases of three-dimensional transvaginal ultrasound (3D TVUS) images were collected, with 75 of these cases had endometrial adhesion and the remaining ten samples had non-adhesion. In this study, the uterine ultrasound images were filtered first using block-matching and 3D filtering and speckle reducing anisotropic diffusion (SRAD). Both of the filtered images were then combines with original in order to construct a three channel images, which were then sent to 3D U-Net to detect endometrium segmentation. An evaluation of the performance of the segmentation models were then made using Dice similarity coefficient (DSC), Jaccard, sensitivity, and 95th percentile Harsdorf distance (HD95). Lastly, the endometrial centerline was extracted using medial axis transformation and based on this the endometrial thickness could be measured automatically. The study finished by concluding that the endometrium segmentation method proposed was able achieve 90.83% in Dice, 83.35% in Jaccard, 90.85% in sensitivity, and 12.75 mm in HD95 in the testing set. By taking the doctor's manual measurement as the gold standard an accuracy rate of 94.20% for the endometrial thickness measurements based on the segmentation results fall well within the marginal error rate the is deemed acceptable by clinical diagnosis [26].

The rest of this paper is organized as follows. In Section II, a brief Theoretical Background will be presented, the concepts of digital image processing is introduced in section III. Followed by experimentation of Endometrial cancer detection techniques and the performance metrics are discussed in sections IV, V respectively. Future work is suggested in section VI. Finally, the paper is concluded in section VII.

II. THEORETICAL BACKGROUND

A. Gynecological cancers

Endometrium cancer is typically a fatal disease with high mortality [4], unlike the experience of the Western world where endometrial cancer is considerably treatable and with lower mortality. Endometrium cancer is a heterogeneous disease, contains numerous distinct entities that have different biological features and clinical behavior including certain histological types. It can be categorized in several methods, including: based on its clinical features, its expression of tumor markers, and its histology type [10], [11].

The reproductive system of women consist of organs that are external and internal organs [12]. The external organs are located inside an area known as the vulva, which include the labia, the clitoris and the vaginal opening. As for the internal organs, they can be found within the pelvic cavity. The normal anatomy of the pelvis and reproductive organs is shown in Fig. 1 [13].

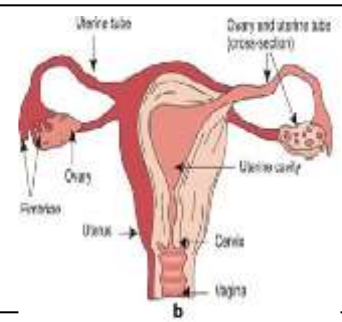

Fig. 1. Expanded view of the female reproductive organs

The Uterine cancer (endometrial cancer) arising from the innermost layer of the uterus, the endometrium, is called endometrial carcinoma. endometrial carcinoma is the most common type of gynecological cancers in females in developed countries and, if left without treatment, has high mortality and morbidity rates. To reduce the high morbidity and mortality rates, quick diagnosis and treatment is necessary. The endometrium, which lines the uterus and womb, is where the majority of uterine cancers develop. In these cases, the term "endometrial cancer" is frequently used [14].

The most common symptoms of uterine cancer are abnormal vaginal bleeding, this is especially observed with women who no longer experience periods (post-menopausal women) [17]. Abnormal bleeding can be Vaginal bleeding after the menopause, Bleeding that is unusually heavy or happens between periods, or Vaginal discharge , this can range from pink and watery to dark and foul smelling. Because of postmenopausal or irregular vaginal bleeding, 9 out of 10 uterine cancers (90 percent) are detected. This is reason for why uterine cancer can be detected at an early stage frequently. To diagnosis of uterine cancer,several tests can be performed in order to confirm the diagnosis and to determine if the cancer has spread from the womb. These tests include: Transvaginal Ultrasound, Hysteroscopy, Biopsy, CT Scan, and MRI Scan, more details are in [8].

B. Ultrasound imaging

Sonography procedure plays very important role in the detection of gynecological cancers and is used widely with clinical examinations but also for first-line imaging to give an accurate indication for more sophisticated diagnostic techniques or more invasive endoscopic procedures. It has been used for endometrial cancer detection in recent years because of the advantages of ultrasound (US) imaging such as no-radiation, sensitive to dense endometrial, low false positive rate, portable and cheap cost. Due to the nature of US imaging, the images always suffer from the poor quality caused by speckle noise, low contrast, blurred edge and shadow effect. It takes considerable effort for radiologists to extract the contours of lesions and the manual extraction is not reproducible.

Transvaginal ultrasonography (TVUS) is the first diagnostic tool that is used to identify the uterine cavity and the most convenient tool for detection and diagnosis of uterine lesions at a low cost. This device produces images of the uterus and endometrium at high resolutions due to how close the vaginal transducers are to the uterus [18]. The utilization of TVUS for the purpose of uterine imaging provides plenty of useful information, such as the length and thickness of as uterine and endometrial, the texture of endometrial and the uterine position e.g. versions, flexion…etc. These data are used to help allow the identification of any abnormalities. TVUS is also recommended for screening endometrium-related diseases among female patients. Fig 2 illustrates image samples from female patients with normal endometria, endometrial cancer, and endometrial polyps [19]. Nowadays, ultrasound imaging is very important diagnosis procedure in a medical image analysis.

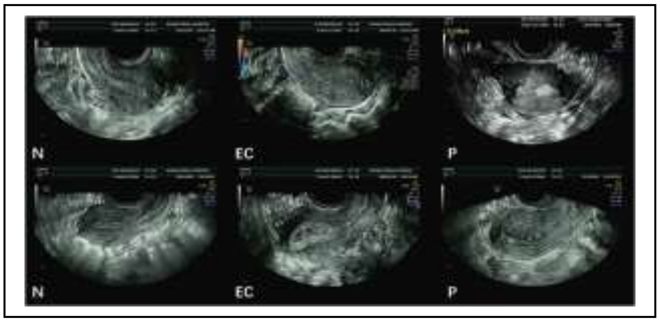

Fig. 2. TVUS images: N - normal endometrium, EC - endometrial cancer, P - endometrial polyps.

III. DIGITAL IMAGE PROCESSING

The process of image is used to perform certain operations on digital image with the goal of enhancing the output image or to obtain useful information from the original image. Recently, image processing is among rapidly growing technologies. It forms core research area within engineering, computer science and medical imaging disciplines. The methods of image processing can be analogue or digital image processing. Analogue image processing used for the hard copies such as printouts and photographs. Digital image processing techniques help in manipulation of the digital images by using computers [27].

A digital image is a numerical representation of a two-dimensional image, i.e., it is a discrete function. Discrete points known as pixels used to describe the digital image, the pixels arranged in a grid and each pixel has its position, represented by the space coordinates, and color. The color is discretized as well, with values that range from (0 to 255). In the case of digital grayscale images, a pixel with the value 0 represents a black pixel, the pixel with the value 255 represents white pixel, the RGB color model, which is a triplet of red, green, and blue color intensity values, can be used to represent colored images. More details for coordination system of the digital image are in [8],[9]and [27].

A. Noise in digital images

Digital image noise is random variation of brightness or color information in images, and is usually an aspect of electronic noise. This can be produced from multiple sources, such as the sensor and circuitry of the scanner or camera. The noise can also come from the film grin and is caused also by the unavoidable shot noise of an ideal photon detector. The noise produced is not desirable since it adds spurious and extraneous information. Image distortion is most pleasance problems in image processing. In digital images, there are many types of noise that an image can experience, such as Gaussian noise, Poisson noise, Speckle noise, Salt and Pepper noise and many more. For more details are in [8].

B. Image preprocessing

Image preprocessing refers to the initial processing of the raw image. The captured digital ultrasound images are transferred into a computer. These Digital images though displayed on the screen as pictures, they are digits, which are readable by the computer system, and are converted to tiny dots or pixel (image elements) representing the real objects. In some cases, preprocessing is done to enhance the image quality by containing undesired distortions referred to as noise or by the enhancement of important features of interest. Ultrasound images are extremely important in diagnose and treatment of patients. It shows different human body parts and tissues. A better ultrasound image is required for doctors to make accurate diagnoses and treatments [28]. Due of the complexity of ultrasound images, various types of tissues and anatomical structures involved, image enhancement techniques are needed for improving the visibility and detectability of the region of interest. Contrast enhancement techniques are widely used in various medical image-processing applications [19]. Among these techniques, histogram equalization (HE), global histogram equalization (GHE), local histogram equalization (LHE) also named as adaptive histogram equalization (AHE) and contrast limited adaptive histogram equalization (CLAHE) [27]. The normalized histogram is calculated using the probability density function (PDF) [29].

IV. IMAGE SEGMENTATION TECHNIQUES

The majority of image segmentation algorithms are classified into three categories: boundary based segmentation, region-based segmentation, and hybrid-based segmentation [30]. The first method splits an image using discontinuity by recognizing lines, edges, and isolated points based on abrupt changes in local attributes, The regions' boundaries are then determined. The second technique uses the homogeneity of spatially dense information such as texture, intensity, and color to create the segmentation result. The third technique is a hybrid of boundary-based and region-based segmentation. Existing segmentation methods typically separate objects from the background only, require prior knowledge of the data, and require user-specified input parameters, which may result in under- or over-segmentation. As a result, advancements in current techniques will allow for better image classification. Despite the extensive amount of research on the subject of image segmentation and the wide range of techniques applied, segmentation can be accomplished using different methods such as thresholding, edge-based segmentation, region-based segmentation, and energy-based segmentation. As a result, the following subsections start by discussing thresholding-based segmentation before moving on to the other three categories. There are several methods for image segmentation such as Thresholding-based image segmentation technique which is considered as a one of the beast segmentation methods because of its simplisty. Also, Edge-based image segmentation technique is widely used techniques in digital medical image processing. The Region-based image segmentation technique is very common method that split images into segments regions [31]. The most common techniques used in this method are region growing and region splitting. In addition, Region-growing techniques are rarly used due to its sensitivity to noise and its high computational complexity [31]. Region Splitting and Merging techniques is also used for image segmentation and suffers from complexity and high-compositionality. Finaly, clustering – based techniques are organizing data into groups called clusters; each cluster contains data that is more similar to one another than to others. In this work we use the previous mentioned segmentation techniques for medical image segmentation

V. EXPERIMENTATION OF ENDOMETRIAL CANCER DETECTION TECHNIQUES

A. Datadse

Ultrasound scanned uterus Image is used as Input. Uterine ultrasound images is used as input database. It is taken from National cancer institute - Sabratha hospital in Libya. This database is used for a first time in our work. Therefore, our results are superior and not comparable.

B. Development environments

The development of full-fledged segmentation system of Endometrium cancer detection by integrating image analysis techniques is an expensive task. Starting from image acquisition, we need high quality digital ultrasound machine, and also well established and controlled environment to take the images. In addition to this, image-processing techniques are resource intensive task. They need powerful computers with high processing speed, larger memory and hard disk space.

C. *Proposed methodology*

Uterine ultrasound images captured were transferred into a computer and converted to digital images. Digital images, though displayed on the screen as pictures, they were digits, which were readable by the computer and were converted to tiny dots or pixel (picture elements) representing the real objects. Image preprocessing was done to improve the quality by suppressing undesired distortions referred to as noise or by the enhancement of the important features of interest. For endometrium cancer detection, the Uterine ultrasound were collected in the first stage, after the image acquisition stage, preprocessing will be taken place. Next stage will be the image enhancement in which in the output image the finer details will be clearer than the original image, after that the image will be segmented to extract the endometrium region.

- **Phase 1: Acquisition ultrasound image form folder**

In this work we have used MATLAB R2021a that can be used to display, edit, process and analyze many formats and types of images. The ultrasound images captured were transferred into a computer and converted to digital image. Usually, the images that were obtained during image acquisition may not be suitable straight for identification and segmentation purposes because of certain factors, such as noise, lighting variations, poor resolutions of an image, unwanted background. The RGB image is converted into grayscale image. This conversion is done using the luminosity method, which relies on the contribution of each color of the three RGB colors. Using this method, the grayscale image is brighter since the colors are weighted according to their contribution in the RGB image not averagely. Fig. 3 shows an experimental result of converting the RGB scale to gray scale image

Fig. 3. Experimental results for ultrasound image acquisition. (a)Oriinal ultrasound image (b) Gray scale ultrasound image

- *Phase two: Image preprocessing and enhancement*

Image processing techniques improve the detection of the cancer by enhancing the quality of the images, therefore, the physicians diagnose properly. Moreover, using some techniques such as edge detection helps in detecting and segmenting the region of interest ROI, located in the uterine ultrasound image. Preprocessing includes steps like background removal, image type conversion, and unwanted artifacts and labels reduction from the Ultrasound image. Rreduction of the artifacts is a necessary step in improving the ultrasound imaging, Existing of artifacts (such as label, wedges and markers) causes failure of proper segmentation algorithms, in digital uterine ultrasound images artifacts and labels are the regions in Ultrasound image that contain brightest pixels. These regions must be removed before detection of region of interest so the segmentation techniques can be done efficiently. artifacts and labels located on the left or right top corner depending on the view of the image to eliminate the artifacts and an unwanted background (black pixels) in an ultrasound. Steps of this algorithm are in [8] and summarized as inthe following steps.

Firstly, the gray scale image (Gray Ultrasound Image) were converted into binary image by applying thresholding which a low-level image processing method to separate and enhance the region of interest to provide increased visual appearance of image. Then we filled up the remaining holes present in the image by removing some lighting remove the unwanted things in the image removing the written part in the image. Next, we multiply binary mask to image. Then we enhanced the output image by contrast that is based on the brightness or darkness of a pixel in relation to other pixels. Finally, we applied median filter as an image filtering technique. Fig. 4 shows the results of different filters applied Ultrasound images corrupted with various noises (Gaussian noise, salt & pepper noise, and Speckle Noise) for different image sizes (128X128, 256X256, and 512X512). We found that, the image quality of a de-noised image improves with increasing image size. Also the best visual results obtained for restoring a Gaussian noisy image, the Median Filter as shown in Fig. 4. Shows the Image preprocessing and enhancement steps.

Image binarization Filling Holes

Rempat ultrasound image Enhanced output image by contrast

Filtered uterine ultrasound image

Fig. 4. Image preprocessing and enhancement

- *Phase there: Image edge detection by fuzzy logic*

An edge detection algorithm for uterine ultrasound digital images is proposed in this work. Edge detection is one of the important and most difficult tasks in image processing and analysis. An edge is a boundary between two uniform regions. Edges can be detected by comparing the intensity of neighboring pixels. In image processing techniques, we can detect edges using filters including sobel, canny, prewitt and many others. Since uniform regions are not crisply defined, two neighboring pixels can have small differences in intensity and therefore do not always represent an edge. Instead, the intensity difference might represent a shading effect. The use of membership functions used by the fuzzy logic method for edge detection in image processing allows it to decide whether a pixel belongs to an edge or a uniform region and to what degree.

- *Phase four: Uterine ultrasound image segmentation*

Image segmentation is the technique of partitioning or pixel classification, which aims to segment objects or regions from the background. The segmentation process of uterine ultrasound image is extract endometrial region after input image use, main interest of image segmentation stage is to divide the uterine ultrasound image into regions and separate an area or region of interest (ROI) and isolate the endometrial region form uterine ultrasound image, we applied the K-means clustering technique and the Automatic thresholding segmentation technique detailed in [8] and Fig. 5. shows the results.

(a) K-Means Clustering from Ultrasound Image of uterine ultrasound (b) Automatic thresholding segmentation technique

(a) original enhanced image (b) the segmented endometrium region.

Fig. 5. Comparison between Original ultrasound image and segmented image

Our experimental results on uterine ultrasound images for segment endometrial region, enhancement techniques are used to improve the interpretability or perception of information in images for human viewers, or to provide enhanced input for other automated image processing techniques. The results in this work indicate that the proposed approach makes a better segmentation to detect endometrium cancer.

VI. PERFORMANCE METRICS

Image quality measurement is critical in many image-processing applications. In recent years, considerable effort has been focused in developing objective image quality measurements. MSE and PSNR are fundamental, simple to implement, and have low computational complexities.

A. Mean Squared Error (MSN)

Mean squared error (MSE) is one of the mathematically based metrics. It calculates the cumulative squared error between the original image and the distorted image. MSE is given as:

$$MSN = \frac{1}{MN}\sum_{y=0}^{M-1}\sum_{x-0}^{N-1}[E(x,y)]^2 \qquad (1)$$

where x and y indicate the pixel position, and M and N are the image width and height.

B. Peak Signal-to-Noise Ratio (PSNR)

The peak signal-to-noise ratio (PSNR) is a measure of the peak error between the compressed image and the original image. PSNR is given as:

$$PSNR = 20.\log 10\left(\frac{MAX_I}{\sqrt{MSE}}\right) \qquad (2)$$

Where MAXI is the maximum possible value of the image. The higher the PSNR, is the better the quality of the reproduction.

C. Mean of Absolute value of Errors (MAE)

Mean of the Square of Errors and MAE is the Mean of Absolute value of Errors. Here, errors represent the differences between the predicted values (values predicted by our regression model) and the actual values of a variable. They are calculated as follows:

$$MAE = \frac{|(y_I - y_p)|}{n} \qquad (3)$$

Where yi actual value yp, predicated value , n number of observation. Table 1 shows the overall PSNR, MAE, and MSE values for different image sizes. PSNR is the most important measurement, followed by MSE and MAE.

TABLE 1. ULTRASOUND IMAGE SIZE 512X512 PSNR, MAE, AND MSE

Ultrasound image size512x512			
Filter type	**Gaussian**		
	PSNR	MSE	MAE
Mean	80.45	24333	153
Median	79.9	94514	253
	Salt &Pepper		
	PSNR	MSE	MAE
Mean	80.1	24336	156
Median	86.99	94516	254
	Speckle		
Mean	80.46	24332	153
Median	80.14	94514	251

Peak signal-to-noise ratio (PSNR) was employed with first priority to illustrate the quantitative quality of the reconstructed image for various methods. When image size is increased with constant impulse noise density, PSNR increases, MSE and MAE decreases. This is due to the fact that ratio of image size to noise density increases with increase in image size and constant noise, therefore the output image is recovered. In ultrasound grey scale Image with three noises (Gaussian, Salt & Pepper and Speckle De-noised all noisy images by (Mean and Median) filters and conclude from the results that following de-noising, the median filter performs better than the Mean Filter for all Speckle and Gaussian noise. The performance of the Median filter after de-noising for all Salt & Pepper noise is better than Mean filter The image quality of de-noised image increases with the increase in image size for a constant impulse noise density.

VII. CONCLUSION

The object of this paper was to improve endometrial cancer detection using ultrasound image processing. the quality of the input uterine ultrasound image was first enhanced during the preprocessing stage by removing noises and improving image contrast. Thresholding image analysis mask was used to remove of artifacts and labels form uterine ultrasound images. Filtering techniques are used to refine enhancement process, fussy logic is used to enhance edge detection, finally, k means and automatic thresholding were used for Uterine ultrasound image to obtain region of interest (ROIs) which is endometrium region, and the radiologist can as normal and abnormal. the Median Filter outperform results that were achieved for a high quality Ultrasound 512X512 image size that affected by Salt and Pepper noise with 86.99% classification accuracy using peak signal-to-noise ratio (PSNR) metric.

VIII. FUTURE PERSPECTIVES

Future works are suggested for additional research and improvement on the current work by using another improvement technique to accomplish our goals. Also, applying a large local dataset images and test it on this proposed work for evaluation task. In addition, further establishment is needed to implement further algorithms using computer Aid diagnosis (CAD).

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