A Systematic Review of DICOM Compressed Medical Ultrasound Image Restoration Techniques

Ryan Kamal Said Ahemed[1]; Zeinab Adam Mustafa[2]; Banazier Ahmed Abrahim[3]; Musab Elkheir Salih[4]

[1;2;3;4]Sudan University of Science and Technology,
College of Engineering Biomedical Engineering Department

Publication Date 2025/08/14

Abstract: The use of DICOM for storing and transmitting medical images is essential for medical diagnosis, but this causes image degradation due to compression artifacts. Ultrasound image restoration plays a vital role in restoring image quality for precise diagnosis and treatment strategy planning. This paper presents a systematic review of three groups of DICOM compressed ultrasound image restoration techniques (contrast restoration, de blocking and deburring), focusing on methods to improve contrast, reduce blocking artifacts, and recover blurry details. The adopted techniques are already used in ordinary ultrasound image degradation restoration, but in this study they were modified and then applied to medical DICOM compressed ultrasound images, to test whether they are effective in compression artifact restoration or not. In this study, adaptive histogram equalization and contrast stretching was used to restore contrast loss, for blocking artifacts, Winner filtering, median filtering, bilateral filtering, and total variation filtering are evaluated for their effectiveness in preserving edge information while mitigating unwanted artifacts. Additionally, de-blurring techniques, including Blind Deconvolution, Winner filtering, and Lucy-Richardson Deconvolution, are assessed for their ability to reverse the effects of motion or defocus blur. The performance of these restoration methods is compared based on quantitative measures (MSE, SNR, PSNR, SSIM and QI) and qualitative results, highlighting their strengths and limitations. Our findings demonstrate that a combination of these techniques can significantly improve the quality of DICOM compressed medical ultrasound images, contributing to more reliable diagnostic outcomes.

Keywords: *Degradations, Contrast Restoration, Total Variation Filtering, Blind Deconvolution, Lucy-Richardson Deconvolution, DICOM, Lossy JEPG Compression.*

How to Cite: Ryan Kamal Said Ahemed; Zeinab Adam Mustafa; Banazier Ahmed Abrahim; Musab Elkheir Salih (2025) A Systematic Review of DICOM Compressed Medical Ultrasound Image Restoration Techniques. *International Journal of Innovative Science and Research Technology*,10(8), 296-309.
https://doi.org/10.38124/ijisrt/25aug206

I. INTRODUCTION

Ultrasound imaging is a widely used medical diagnostic tool due to its non-invasive nature, real-time imaging capabilities, and relatively low cost. However, like all imaging modalities, ultrasound images are often subjected to various degradations such as blocking, ringing, blurring, and low contrast problems, which can hinder accurate interpretation and diagnosis [1]. Degradation stems from many sources such like equipment limitation, environmental factors motion artifacts and compression artifacts in case of using Picture archiving and communication systems (PACs) [2].

PACs are widely used nowadays, to communicate medical ultrasound images, using the most popular medical communicating template Digital Imaging and Communications in Medicine (DICOM) that relies on lossy and lossless compression .Therefor DICOM compression artifacts arises from this compression. This results in presence of medical compressed ultrasound images with compression degradation [3, 4]. All the previous studies focused only on modification of the used compression templates (DICOM) to solve the compression artifacts, by enhancing the template capabilities. In this study, the problem of the compression artifacts have been addressed with different sight, by focusing on restoring of the DICOM compression artifacts ,not by enhancing DICOM capabilities. This study provides a systematic review for DICOM lossy compressed medical ultrasound images restoration techniques ,by performing programming modification for the preexisting ultrasound images restoration methods, those utilized to rehabilitate diminished ultrasound images, to be suitable for significantly restoring DICOM compressed medical

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug206

ultrasound degraded images , and examining their effectiveness, advantages, and limitations, by comparing the performance of these methods using specific types of image quality metrics, this study aims to illuminate the most promising methods for restoring the quality of medical ultrasound images those were DICOM compressed, thereby contributing to more reliable and accurate medical diagnoses.

II. LOSSY JEPG COMPRESSION IN DICOM

Joint Photographic Experts Group (JPEG) is one of the most commonly utilized image compression formats. The JPEG format employs lossy compression, resulting that certain data from the original image is eliminated. During compression. The main goal of JPEG compression is to minimize the file size while ensuring satisfactory image quality. [5]. JEPG works with the following steps:

- Transform the image from **RGB** to **YCbCr** color space,

Where:

Y = Luma (brightness or grayscale information)

Cb = Blue-difference chroma (how blue the color is compared to luma)

Cr = Red-difference chroma (how red the color is compared to luma).

- Apply chroma subsampling (if used) to reduce chrominance resolution.
- Segment the image into 8x8 sections.
- Implement the Discrete Cosine Transform (DCT) on every block.
- Quantize the coefficients of the DCT to reduce precision and discard less important information.
- Reorder the coefficients using a zigzag scan.
- Apply run-length encoding to compress sequences of zeros.
- Apply Huffman coding (or other entropy coding techniques) to further compress the data.
- Save the compressed data in a file format that includes header information, such as the quantization tables, Huffman tables, and other metadata.

(DICOM) is the standard format for storing and transmitting medical images, such as those produced by magnetic resonance imaging (MRI), computer tomography (CT) scans, X-rays, and ultrasounds. DICOM supports both lossless compression (such as, Run-Length Encoding (RLE) and lossy compression techniques (such as, JPEG2000 or JPEG). In this study a DICOM template, which is RadiAnt DICOM Viewer 64xbit was used to generate compressed image for creating a degraded image with different artifacts (low contrast, blocking artifacts, and blurring artifacts). Low contrast and blocking artifacts were resulted from the same degree of compression, but since the degree of compression directly affects the amount of blurring in an image, a higher degree of compression was added to gain the blurred degraded image, and that is obviously in the different between the degraded image in case of low contrast and blocking artifacts, and the degraded image in case of blurring artifact.

III. DICOM COMPRESSED MEDICAL ULTRASOUND IMAGE DEGRADATION AND RESTORATION

DICOM compressing degradation in medical ultrasound image is the problem of presence of degraded details within the image, or missing of wanted details in the image due to compressing of medical ultrasound image using a DICOM template. Degradation could be in many forms such like contrast losing artifacts, blocking artifacts and blurring artifacts. While restoration is restoring the original image from degraded images using specific algorithm. Restoration has many techniques each one the outcome is contingent upon the specific type of degradation present in the image. [6].

A. DICOM Compressed Medical Ultrasound Image Degradation:

Medical ultrasound images may be compromised by various elements, lead to in a low-quality image; there are three popular types of DICOM compressed medical ultrasound image degradations, resulted from DICOM lossy compression, those types of degradations were handled on this study, and they are: contrast-losing artifacts, blocking artifacts and blurring artifacts. On this paper, a demonstration of these three degradation phenomena is carried out, relating each artifact with the suitable modification of the pre-existing restoration technique.

The selection of each restoration method depends on the techniques that degradation work with. Therefore, to relate each degradation with the suitable modified restoration technique, firstly a demonstration of the DICOM compressing artifact must be done, and then followed with demonstration of the modified restoration techniques. This paper concludes three types of artifacts arises from DICOM compression:

➢ *Contrast Loss:*

Contrast loss arises when the contrast between the brightest and darkest areas of an image is diminished. These artifacts can occur on medical ultrasound images due to various factors during image processing, compression, or other manipulations. In this paper, concern is given to contrast loss due of compression. However; contrast loss artifact that is resulted from lossy compression in DICOM, is the most common type, which has drawback of loss of contrast, especially in areas with fine gradients or subtle color variations. When data is discarded during compression, contrast in these regions can be diminished, and that is resulted from high compression [7]. In this study contrast restoration techniques, such as histogram equalization and contrast stretching, are

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug206

modified and applied to restore contrast loss in medical ultrasound images.

- *Blocking Artifacts:*

Compression is used in medical image to minimize the dimensions of the image so it can be stored or transmitted, but it may lead to the loss of significant visual information and blockiness [8]. In medical images, blocking refer to visible distortions or flaws that occur when an image is compressed or processed, particularly when the image is divided into small blocks for efficient storage or transmission. These artifacts are often visible as blocky patterns or sudden changes in color or brightness, especially at lower compression levels [9]. Algorithms (such as JPEG) segment the image into small blocks (typically 8x8 pixels) for compression. When these blocks are compressed individually and information is discarded, it can result in noticeable edges or jagged patterns between them [10]. DICOM compressed ultrasound images, those went through lossy compression, suffer from these blocking artifacts. In this study, techniques includes Wiener filtering, median filtering, bilateral filtering, and total variation filtering, were modified to handle the blocking of medical ultrasound images.

- *Blurring Artifact:*

The main cause of formation of blurred image is losing the sharpness in the formed image due to many factors [11]; one of these factor is lossy compression (DICOM compression), which causes blurring in two ways: the first one because of compression algorithms itself; when algorithms like JPEG, with high compression rates is applied, losing of fine details occurs, often resulting in blurred areas in the image. This is because compression reduces the quantity of data preserved results in intricate textures, and edges to become soft or smeared [12]. The second way of lossy compression blurring is quantization; during compression, quantization errors can cause loss of high-frequency details, which leads to blur in sharp edges or fine textures. De blurring is the operation for removing blur and restore high quality image [13].In this paper the used De-burring techniques are Blind Deconvolution, Wiener filtering, and Lucy-Richardson Deconvolution.

B. DICOM Compressed Medical Ultrasound Image Restoration Techniques:

Medical ultrasound images restoration is a wide spreaded study that aims to derive a good quality image. Many algorithms has been derived for restoring compressed image; targeting specific points of view, but when applying these algorithms in medical ultrasound images specific consideration must be taken in account; that because medical details are sensitive to interpolation procedures ,which all the used restoration techniques depend on them . In this paper, the proposed restoring technique for each artifact was explained, and that after modifying the pre-existing ordinary restoration algorithms, to fit DICOM compressed medical ultrasound image. Here is the proposed technique for each mentioned artifact:

- *Contrast Loss Restoration Techniques:*

Many ultrasound contrast improvement algorithms have been reported in the literature, but experiences remain an open issue in this area. In the first place, contrast restoration in medical ultrasound images are driven through using of hybrid techniques to reduce time and complexity [14]. One of algorithms that concerns with this, is a coherence diffusion with automatic edge stopping function, this technique overcome the inherent problem of threshold, and fitting precisely the data, but it has drawback of high complexity and low speed [15], and that was the major reason for suppression this technique from this paper. Generally, the techniques those are used to restore contrast can be categorized as two types: firstly, histogram transformation, this is the easiest and least expensive technique, but it has the cons of, if the statistics of the image undergo changes, direct mapping may not significantly restore the contrast. Secondly, histogram modification, which a unique instance of the initial case. Where the gray scale is modified to produce an image with a designated histogram. In this paper, the hybrid technique of Contrast restoration based on adaptive histogram equalization and contrast stretching is used to restore medical DICOM compressed ultrasound image.

This technique combine the advantages of adaptive histogram equalization those are improving local contrast, handling of non-uniform lighting, restoring small features and preservation of brightness, with the advantages of the contrast stretching which are: simplicity and high speed, easy to implement and works well on well-contrasted images [16].

- *Blocking Artifact Restoration Techniques:*

Compression may entail either the complete retention of information (lossless) or the minimization of data while safeguarding essential information. [17]. Reducing the effects of compression artifacts in ultrasound image is on of ultrasound image restoration field of research concerns with restoring ultrasound image after compression. The most parameters these are affected by blocking are spatial resolution. Recent studies in ultrasound image restoration focuses on this area and try to restore the compressed image with optimum spatial resolution [18]. Super-resolution algorithms are used to restore low-resolution images. Interpolation-based, deep learning based, and sparse-coding-based algorithms are applied for low-resolution image restoration [19], but these techniques have disadvantages of too much parameter selection and low speed. In this paper four techniques were used for de-blocking DICOM compressed medical ultrasound images , they are: De blocked image based on wiener filtering making benefit of its optimal noise reduction and preservation of image details, de blocking image based on median filtering making benefit of its edge preservation and simplicity and low computational complexity, de blocking image based on bilateral filtering making benefit of its adaptability to different image characteristics , and de blocking image based on total variation filtering making benefit of its edge preservation and de-noising without blurring details. In addition, comparison between these techniques was done basing on image quality metrics, ending up with the best performance filter.

- *Blurring Artifact Restoration Techniques:*

There are many techniques those are used in ultrasound blurring restoration, such as: inverse filtering and regularized de-blurring, the first method attempts to reverse the effects of

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug206

blurring, but unfortunately it is not sensitive to some kind of blurring, it works well just when the blurring function is known and can be accurately estimated. The second method adds constraints to ensure the solution does not amplify blurred details too much. These drawbacks of the two algorithms are the reasons for suppression these algorithms from this paper. Another algorithm is Blind Deconvolution, which try to estimate both the blurred image and the blur function simultaneously.

This is more complex but can be highly effective in medical images [20]. Many other algorithms is available but the mentioned are the top in dealing with lossy compression blurring. In this paper, three techniques were tested: de blurring based on blind deconvolution making benefits of its recovery of missing information, de blurring based on winner filter benefits of its adaptive filtering and de blurring based on Lucy Richardson deconvolution benefits of its flexibility in handling different types of blur while preservation of image details.

IV. CHALLENGES WITH DICOM COMPRESSED MEDICAL ULTRASOUND IMAGE RESTORATION TECHNIQUES

From the previous sections, the most common challenges with ultrasound image restoration techniques that having high computational complexity, which will lead to need of high capacity for processing, storing and retrieval, also having low computational speed which will increase the time required for processing, storing and retrieval , having low contrast resolution which will lead to loss of image details those are needed in diagnosis process, and having low image quality, by the mean of low image metrics index. These reasons were the significant reasons for ignoring algorithms with these drawbacks. Each algorithm has its pros and cons, and the field still accepting further studies. In this study, the chosen, modified and tested techniques are working on removing the compression artifacts, with maintaining the simplicity, high speed and good quality image, making them the best techniques for each artifact restoration.

V. METHODOLOGY

In this paper, from the previous studies a numerous restoration techniques were reviewed and compared to each other on the principle of the used algorithms for image restoration, the used compression method was image quality metrics, then three groups of restoration techniques (contrast restoration,deblocking and debluring) were chosen to deal with medical DICOM compressed ultrasound image restoration, and according to the concluded review of the image quality matric for each algorithm of these studies; firstly 10 medical ultrasound reference clear images were gathered from different organs in the human body (liver, spleen, pancreas, gall bladder, adrenal gland, appendix, breast, bone, muscle, uterus).

Then these images were compressed with different degrees, using RadiAnt DICOM Viewer 64xbit software, which is a lossy compression template, creating a degraded images with three different artifacts (low contrast image, blocked image and blurred image), in the case of the contrast loss and blocking artifact the compression was done only one time ,but in case of blurring; compression was performed four time to have the desired degraded image. , After that 8 restoration techniques were applied for the 10 images, to restore different types of degradation, then certain image quality metrics were employed to assess the quality of each algorithm, and they are: mean square error (MSE), signal to noise ratio (SNR), peak signal to noise ratio (PSNR),structure similarity index (SSIM) and quality index (QI) were used as quality metrics to compare the results of those techniques.

The image metrics was chosen according to the used ones in the literature review at the end, the average values for each image quality metric for each one of the applied techniques was done, and that through the 10 used images. The resulted average was written in the tables (1, 2 and 3). Each best result in image quality metric was bolded .The work was grouped in three categories to resolve the restoration dilemma, each group concluded with the best technique of the used techniques. The first group discussed low contrast restoration, and has one hybrid technique for contrast restoration, which is Contrast restoration based on adaptive histogram equalization and Contrast Stretching. The second group have four techniques to restore blocking artifact, which are: De blocked image based on wiener filtering, De blocking image based on median filtering, De blocking image based on bilateral filtering and De blocking image based on total variation (TV) filtering. The third group concern with restoration of blurred images, which has three techniques: De blurring based on Blind Deconvolution, De blurring based on Winner filter and De blurring based on Lucy Richardson Deconvolution. All the applied algorithms were carried out using MATLAB R2022a software. All that is illustrated at Figure (1).

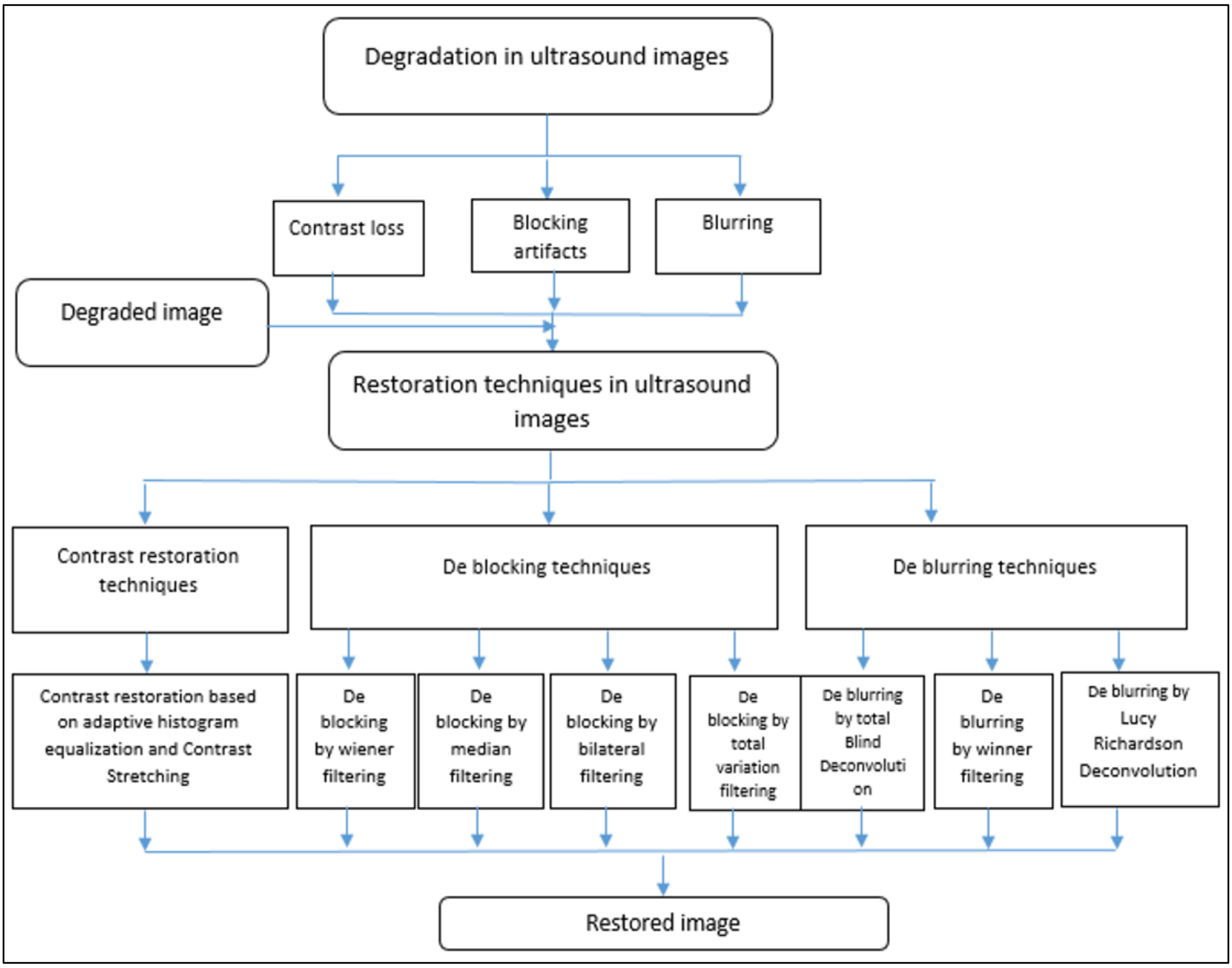


Fig 1 Degradation in DICOM Compressed Ultrasound and their Proposed Restoration Techniques

VI. IMAGE QUALITY METRICS

As it previously mentioned, the proposed modified restoration algorithms were applied to 10 images from different body organ, image quality metrics were calculated for each one, and finally the average values were calculated for the used image quality metrics. Tables (1 to 3) denote the average quality metrics for each technique.

Table 1 Average Image Quality Metrics for Contrast Restoration Techniques

Average	**MSE**	**SNR**	**PSNR**	**SSIM**	**QI**
Contrast restoration based on adaptive histogram equalization and Contrast Stretching	1.007837	12.1093	21.1845	0.5358	0.5915

Table 2 Average Image Quality Metrics for DE Blocking Techniques

Average	**MSE**	**SNR**	**PSNR**	**SSIM**	**QI**
De blocked image based on winner filtering	0.587380	13.7699	23.4780	0.9472	0.7815
De blocking image based on median filtering	0.477100	11.4720	19.2015	0.6564	0.6891
De blocking image based on bilateral filtering	0.448849	13.7791	24.1668	**0.9951**	0.7646
De blocking image based on total variation filtering	**0.446481**	**14.1795**	**24.2511**	0.9861	**0.7885**

Table 3 Average Image Quality Metrics for De-blurring Techniques

Average	**MSE**	**SNR**	**PSNR**	**SSIM**	**QI**
De blurring based on Blind Deconvolution	1.141604	9.3863	16.4546	0.6486	0.6892
De blurring based on Lucy Richardson Deconvolution.	1.566041	9.6801	17.1504	0.6466	**0.6779**
De blurring based on Winner filter	**1.042773**	**10.8201**	**18.1403**	**0.6635**	0.6682

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug206

➢ *Here is the Explanation for the used Image Quality Metrics:*

- *MSE:*

Lower MSE values suggest an improvement in image quality. Since the difference between the original and processed image is reduced [21], the mathematical formula for the adopted MSE in this research is:

Let:

I(i,j) : be the value of pixel I at (i,j) position in the original image.

K(i,j): be the value of pixel K at the same position in the processed image.

The image size be M×N

$$\text{MSE} = \frac{1}{MN}\sum_{i=0}^{M-1}\sum_{j=0}^{N-1}[I(i,j) - K(i,j)]^2$$

In table (1), for Contrast Restoration Techniques it is noticeable that the applied technique has an acceptable value for MSE when compared with the MSE values in literature review. In table (2), in DE blocking Techniques, the best MSE was brought up with total variation filtering. In table (3), the best MSE in De-blurring Techniques was for winner filter.

- *SNR:*

A higher SNR means less noise in the processed image, the mathematical formula for the adopted SNR is:

Let:

I(i,j) : be the value of pixel I at (i,j) position in the original image.

K(i,j) : be the value of pixel K at the same position in the processed image.

The image size be M×N

$$SNR = \frac{\sum_{i=0}^{M-1}\sum_{j=0}^{N-1} I(i,j)^2}{\sum_{i=0}^{M-1}\sum_{j=0}^{N-1}[I(i,j) - K(i,j)]^2}$$

In table (1), for Contrast Restoration Techniques it is noticeable that the applied technique has an acceptable value for SNR when compared with the SNR values in literature review. In table (2), in DE blocking Techniques, the best SNR was brought up with total variation filtering. In table (3), the best SNR in De-blurring Techniques was for winner filter.

- *PSNR:*

A higher PSNR indicates better quality. It is often used to measure how close the processed image is to the original one, the mathematical formula for the adopted PSNR is:

Let:

I(i,j) : be the value of pixel I at (i,j) position in the original image.

K(i,j) : be the value of pixel K at the same position in the processed image.

The image size be M×N

MSE: Mean Squared Error between the two images

MAXi =Maximum pixel value of the image (e.g., 255 for 8-bit images)

$$PSNR = 10\ \log_{10}\left(\frac{MAXi}{MSE}\right)$$

In table (1), for Contrast Restoration Techniques it is noticeable that the applied technique has an acceptable value for PSNR when compared with the PSNR values in literature review. In table (2), in DE blocking Techniques, the best PSNR was brought up with total variation filtering. In table (3), the best PSNR in De-blurring Techniques was for winner filter.

- *SSIM:*

The metric assesses the structural resemblance between the original images and those that have been processed. Higher SSIM values indicate better perceptual quality, the mathematical formula for the adopted SSIM is:

Let:

μ_x: mean of image patch x.

μ_y: mean of image patch y.

σ_x^2: variance of x.

σ_y^2: variance of y.

σ_{xy}: covariance of x and y.

$C1=(K_1L)^2$, $C2=(K_2L)^2C$: small constants to stabilize the division

L: dynamic range of pixel values (e.g., 255 for 8-bit images)

Typical values: $K_1=0.01, K_2 = 0.03$.

$$\text{SSIM}(x,y) = \frac{(2\mu x\mu y + C1)(2\sigma xy + C2)}{(\mu x^2 + \mu y^2 + C1)(\sigma x^2 + \sigma y^2 + C2)}$$

In table (1), for Contrast Restoration Techniques it is noticeable that the applied technique has an acceptable value for SSIM when compared with the SSIM values in literature review. In table (2), in DE blocking Techniques, the best SSIM was brought up with bilateral filtering. In table (3), the best SSIM in De-blurring Techniques was for winner filter [21].

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug206

- *QI:*

QI typically combines several factors, and like the other metrics, a higher value suggests better quality, the mathematical formula for the adopted QI is:

Let:

x: original image patch (or image)

y: distorted image patch (or image)

μ_x: mean of image x

μ_y: mean of image y

σ_x^2: variance of x

σ_y^2: variance of y

σ_{xy}: covariance of x and y

$$QI(x,y) = \frac{4\,\mu x\,\mu y\,\sigma xy}{(\mu x^2 + \mu y^2)(\sigma x^2 + \sigma y^2)}$$

In table (1), for Contrast Restoration Techniques it is noticeable that the applied technique has an acceptable value for QI when compared with the QI values in literature review. In table (2), in DE blocking Techniques, the best QI was brought up with total variation filtering. In table (3), the best QI in De-blurring Techniques was for Lucy Richardson Deconvolution.

In addition, statistical plots for the image quality metrics were performed to show the behavior of each algorithms compared to others, figure (2, 3) denote the statistical plots.

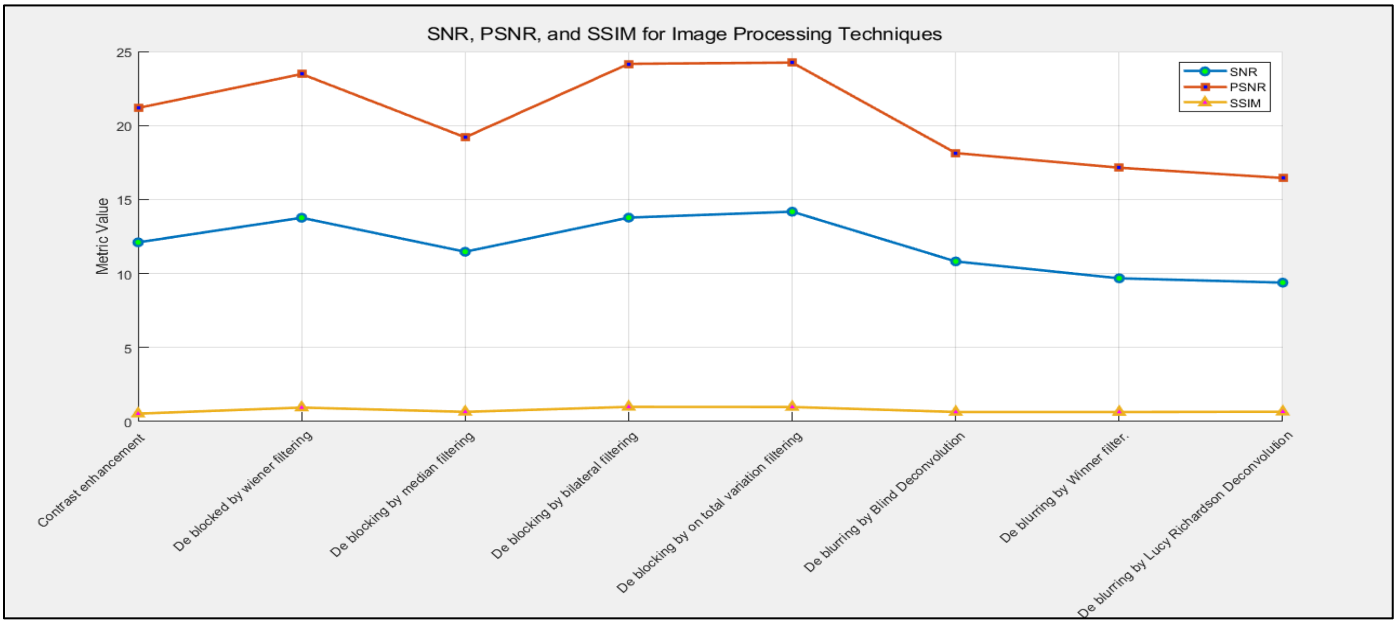


Fig 2 Statistical Plot for SNR, PSNR and SSIM for Image Restoration Techniques Respectively

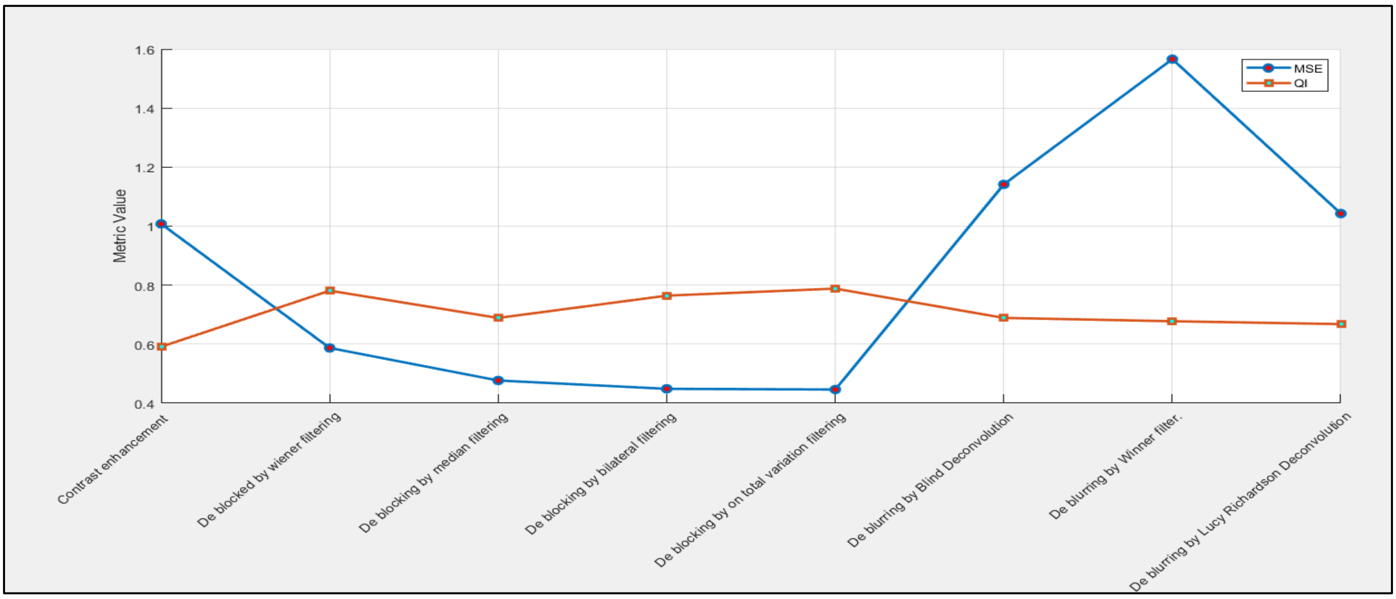


Fig 3 Statistical plot for MSE and QI for Image Restoration Techniques Respectively

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug206

VII. RESULTS

The results were arranged starting with the clear reference image, and then the DICOM compressed degraded one, then the results of the applied restoration techniques.

The restoration techniques were used in 10 ultrasound images, but to compare the visual results, only five images were introduced in the paper.

A. Contrast Restoration Based on Adaptive Histogram Equalization and Contrast Stretching:

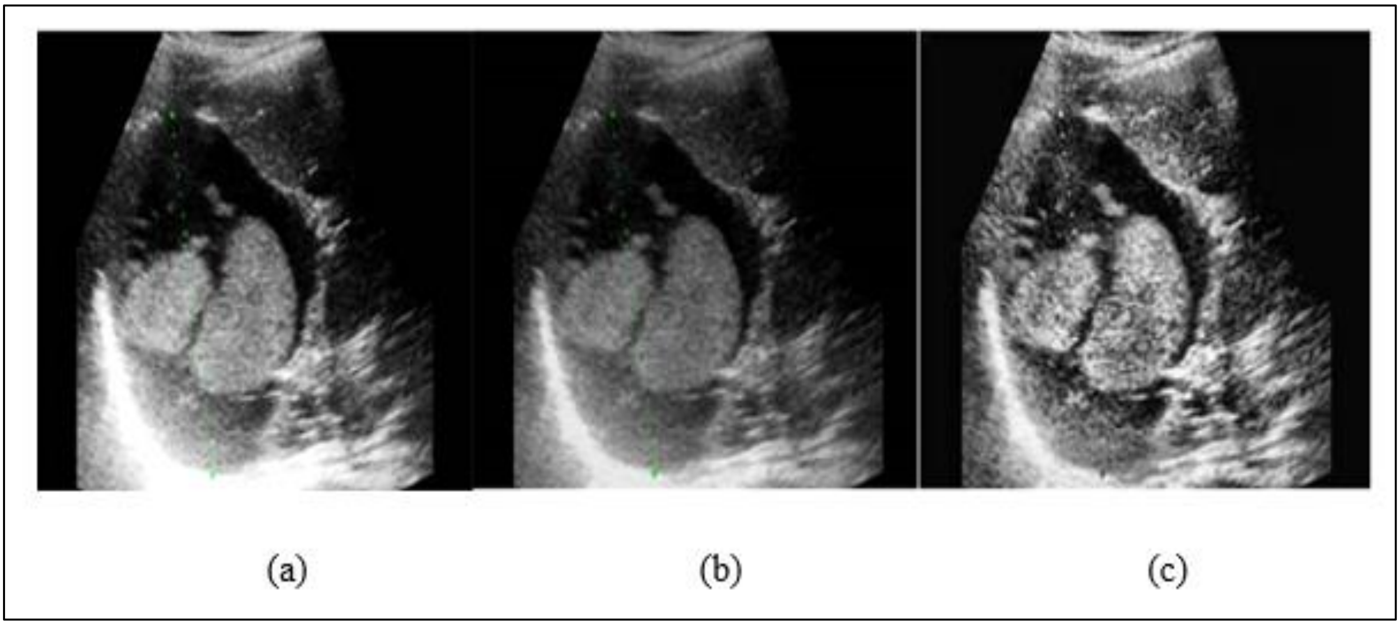


Fig 4 (a) Reference Clear Image (b) Degraded Image for Liver with Low Contrast, (c) Restored Image using Contrast Restoration Based on Adaptive Histogram Equalization and Contrast Stretching.

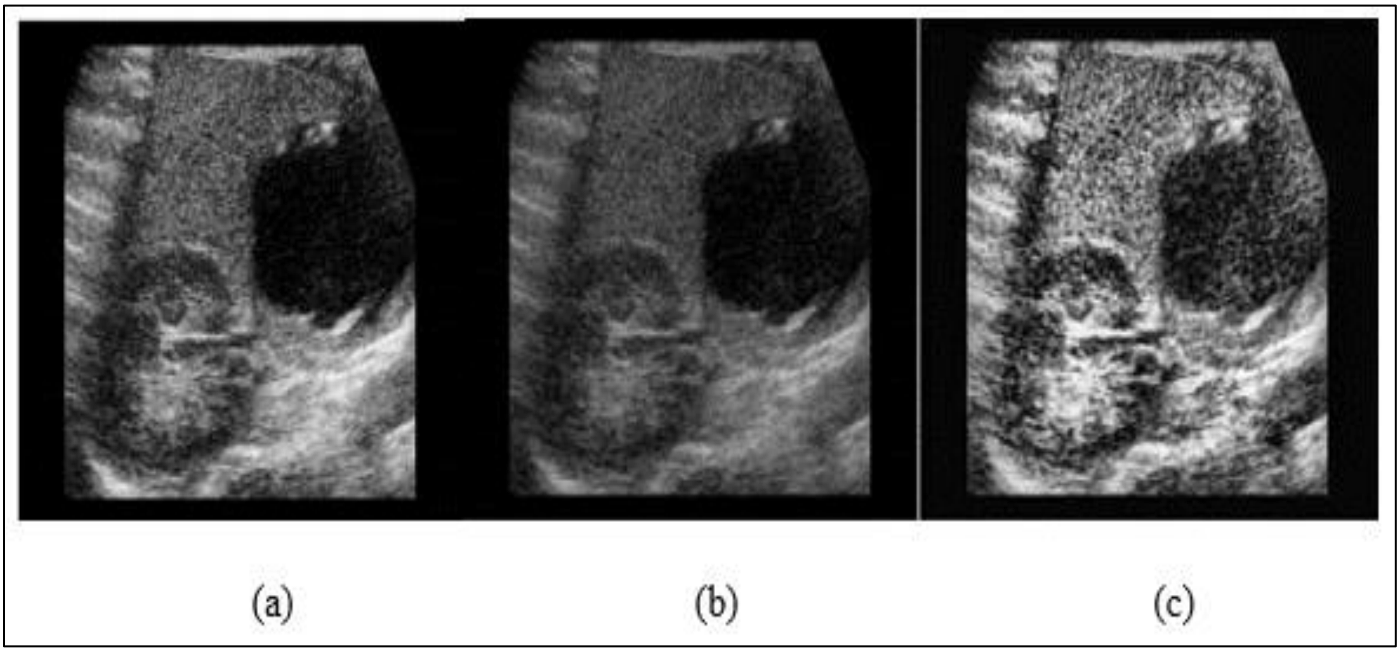
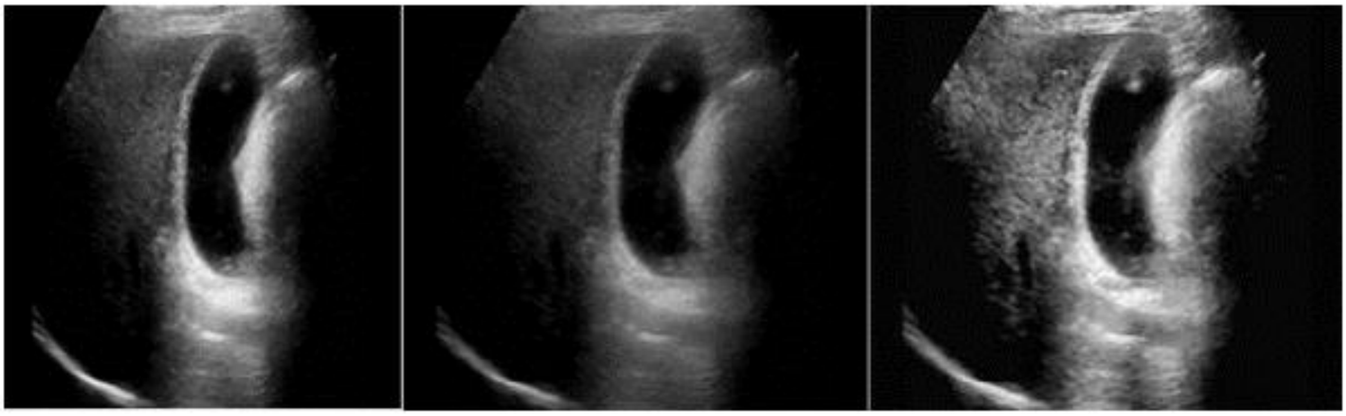
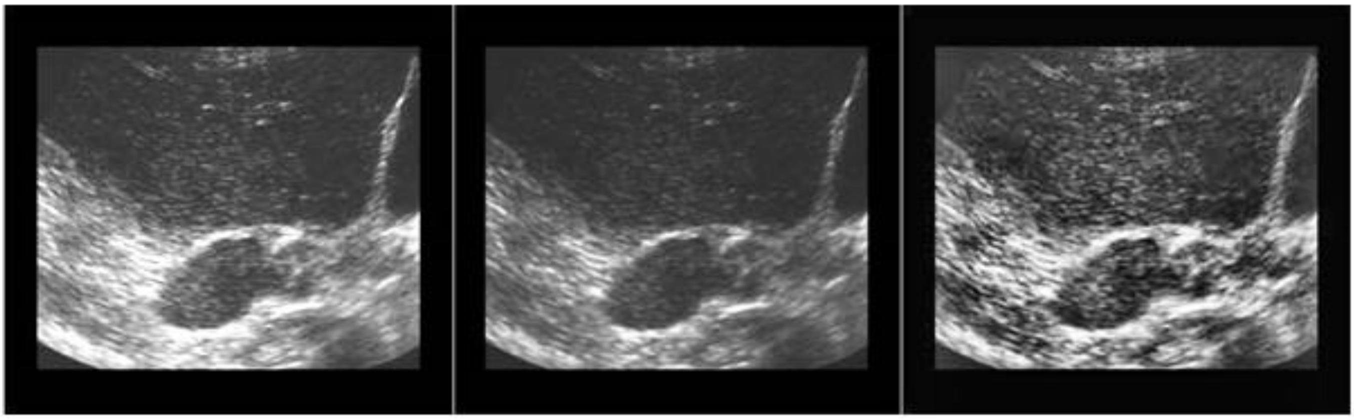


Fig 5 (a) Reference Clear Image (b) Degraded Image for Spleen with Low Contrast, (c) Restored Image using Contrast Restoration Based on Adaptive Histogram Equalization and Contrast Stretching.



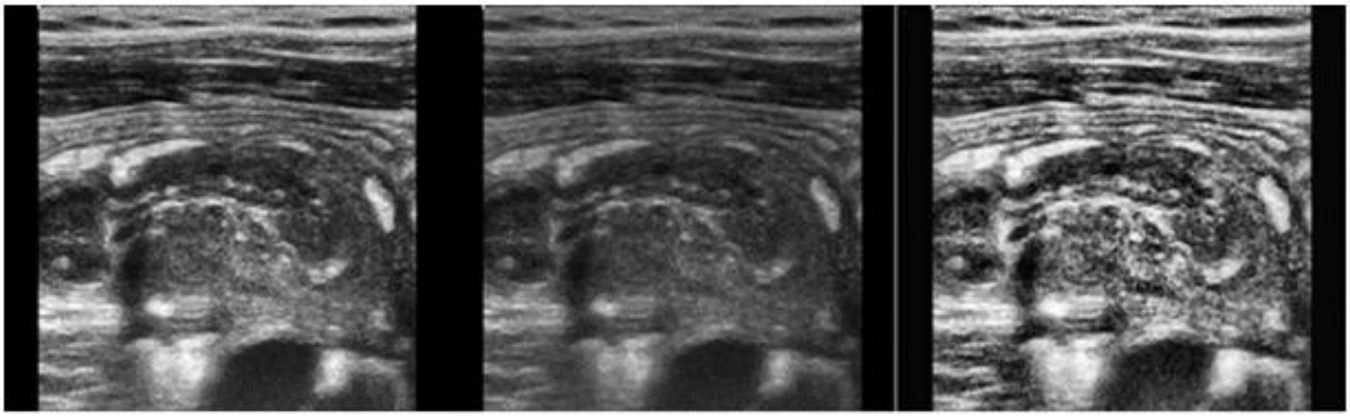
(a) (b) (c)

Fig 6 (a) Reference Clear Image (b) Degraded Image for Gall Bladder with Low Contrast, (c) Restored Image using Contrast Restoration Based on Adaptive Histogram Equalization and Contrast Stretching.



(a) (b) (c)

Fig 7 (a) Reference Clear Image (b) Degraded Image for Adrenal with Low Contrast, (c) Restored Image using Contrast Restoration Based on Adaptive Histogram Equalization and Contrast Stretching.



(a) (b) (c)

Fig 8 (a) Reference Clear Image (b) Degraded Image for Appendix with Low Contrast, (c) Restored Image using Contrast Restoration Based on Adaptive Histogram Equalization and Contrast Stretching.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug206

B. De-Blocked Images Using Wiener, Median, Bilateral, and Total Variation Filtering:

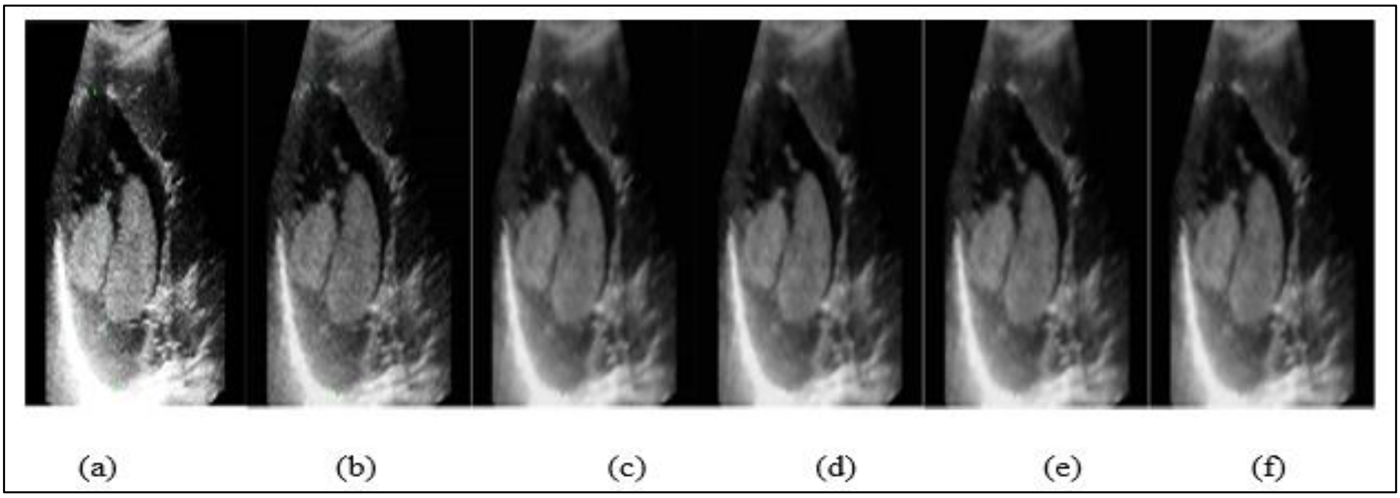


Fig 9 (a) Reference Clear Image (b) Degraded Image for Liver with Blocking Artifacts, (c) Restored Image using Winner Filter, (d) Restored Image using Median Filter, (e) Restored Image using Bilateral Filter, (f) Restored Image using TV Filter.

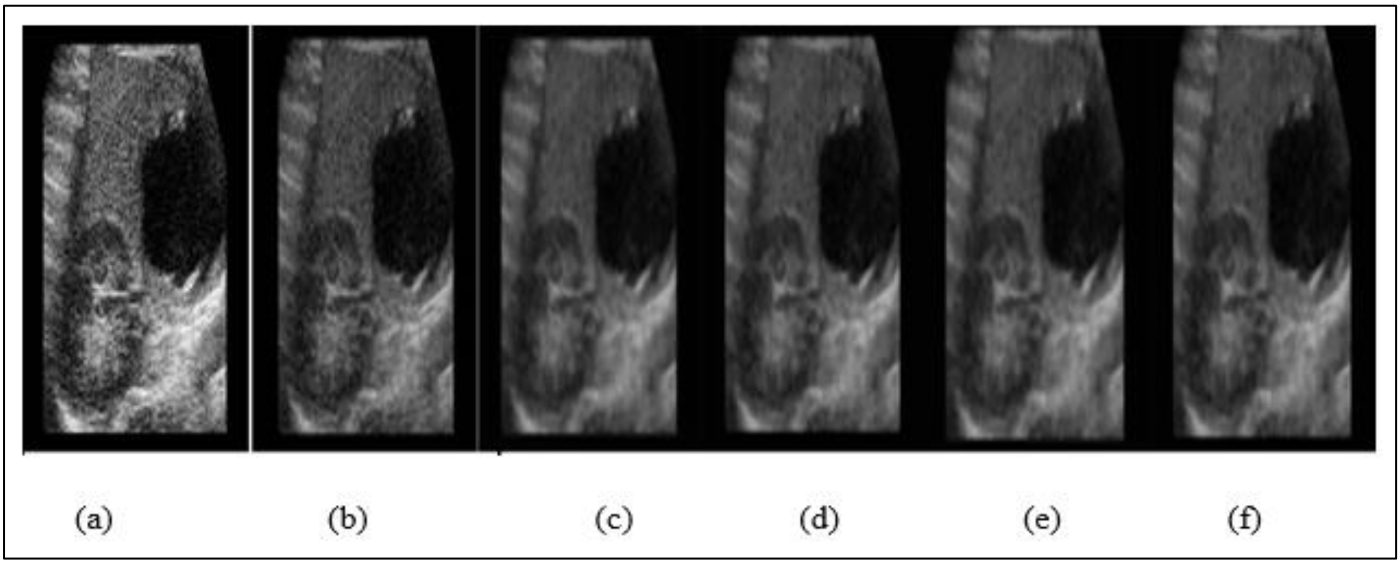


Fig 10 (a) Reference Clear Image (b) Degraded Image for Pancreas with Blocking Artifacts, (c) Restored Image using Winner Filter, (d) Restored Image using Median Filter, (e) Restored Image using Bilateral Filter, (f) Restored Image using TV Filter.

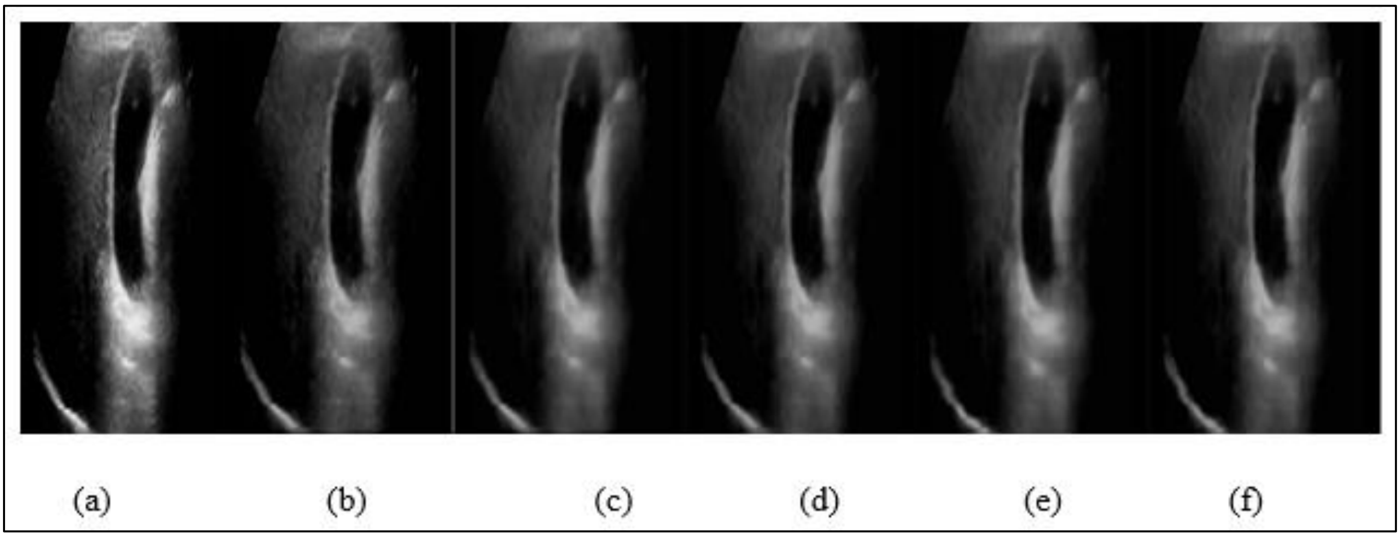
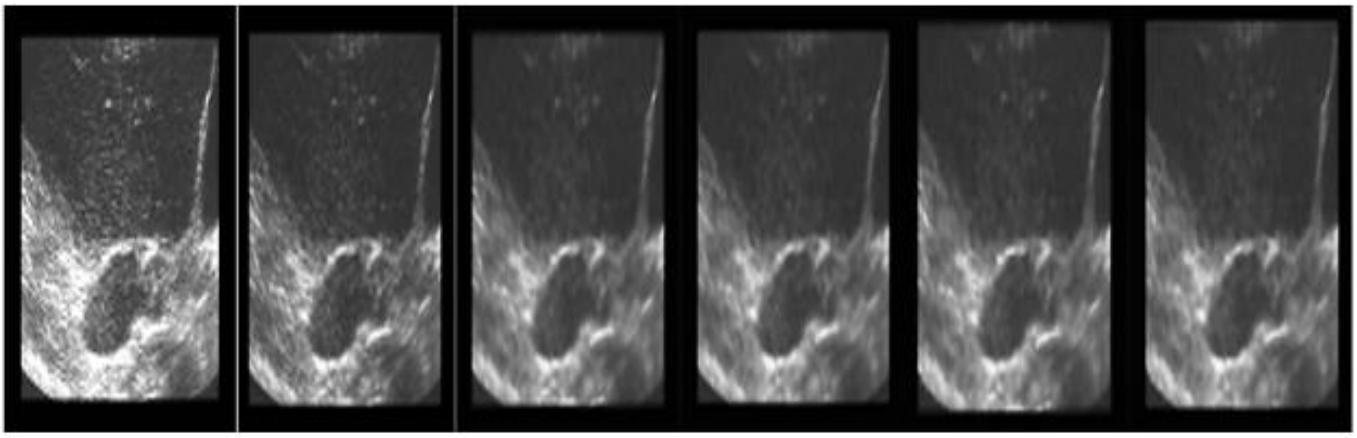


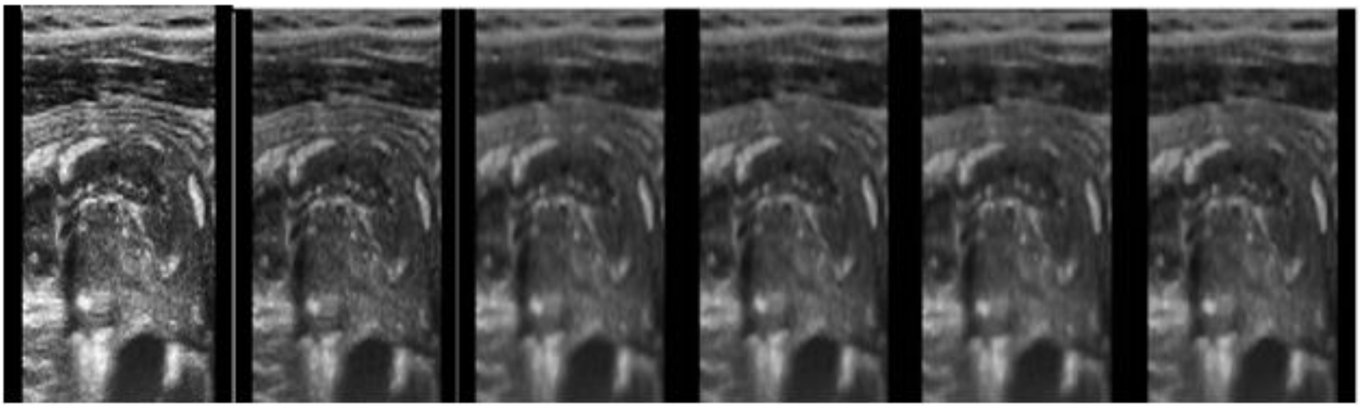
Fig 11 (a) Reference Clear Image (b) Degraded Image for Gall Bladder with Blocking Artifacts, (c) Restored Image using Winner Filter, (d) Restored Image using Median Filter, (e) Restored Image using Bilateral Filter, (f) Restored Image using TV Filter.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug206



(a) (b) (c) (d) (e) (f)

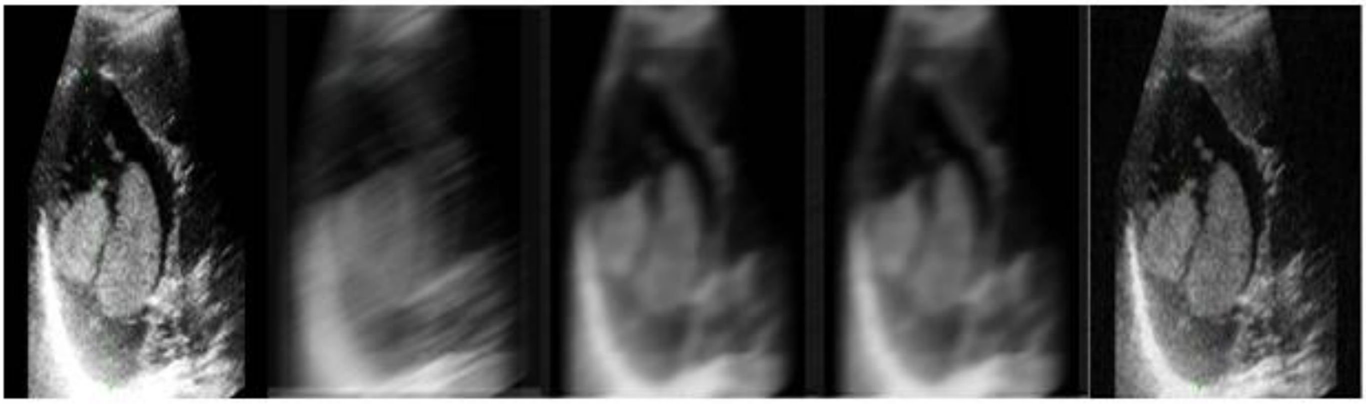
Fig 12 (a) Reference Clear Image, (b) Degraded Image for Adrenal with Blocking Artifacts, (c) Restored Image using Winner Filter, (d) Restored Image using Median Filter, (e) Restored Image using Bilateral Filter, (f) Restored Image using TV Filter.



(a) (b) (c) (d) (e) (f)

Fig 13 (a) Reference Clear Image, (b) Degraded Image for Appendix with Blocking Artifacts, (c) Restored Image using Winner Filter, (d) Restored Image using Median Filter, (e) Restored Image using Bilateral Filter, (f) Restored Image using TV Filter.

C. De Blurring Based on Blind Deconvolution, Winner Filter and Lucy Richardson Deconvolution:



(a) (b) (c) (d) (e)

Fig 14 (a) Reference Clear Image, (b) Degraded Image for Liver with Blurring Artifacts, (c) Restored Image using Blind Deconvolution, (d) Restored Image using Lucy Richardson Deconvolution, (e) Restored Image using Winner Filter.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug206

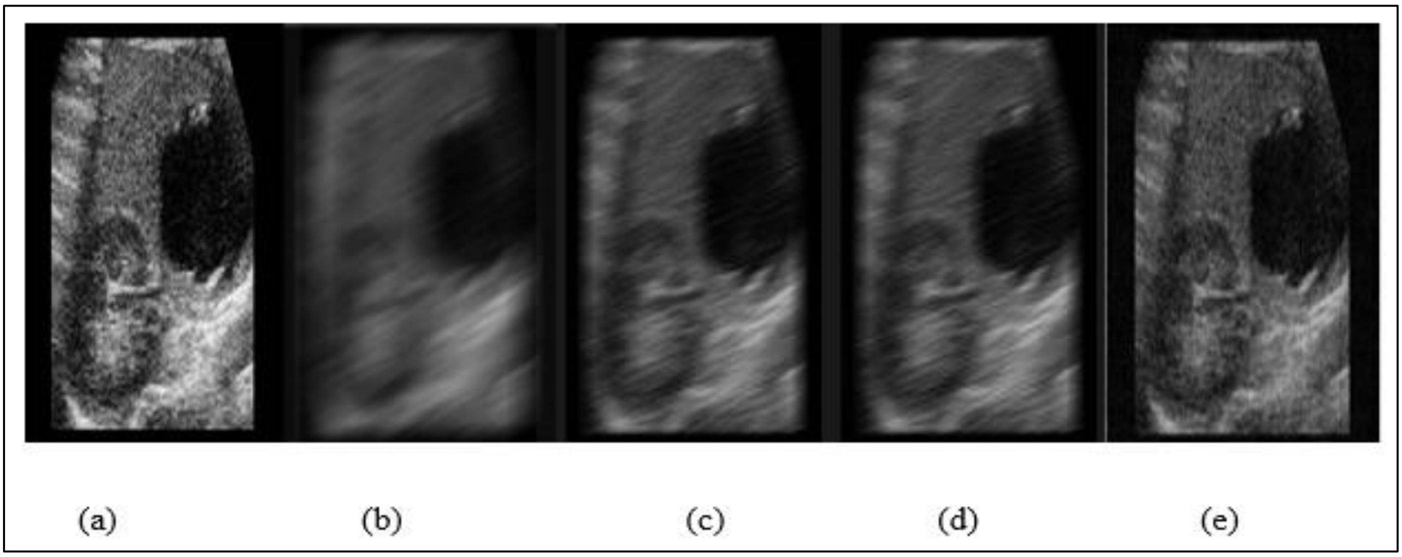


Fig 15 (a) Reference Clear Image, (b) Degraded Image for Pancreas with Blurring Artifacts, (c) Restored Image using Blind Deconvolution, (d) Restored Image using Lucy Richardson Deconvolution, (e) Restored Image using Winner Filter.

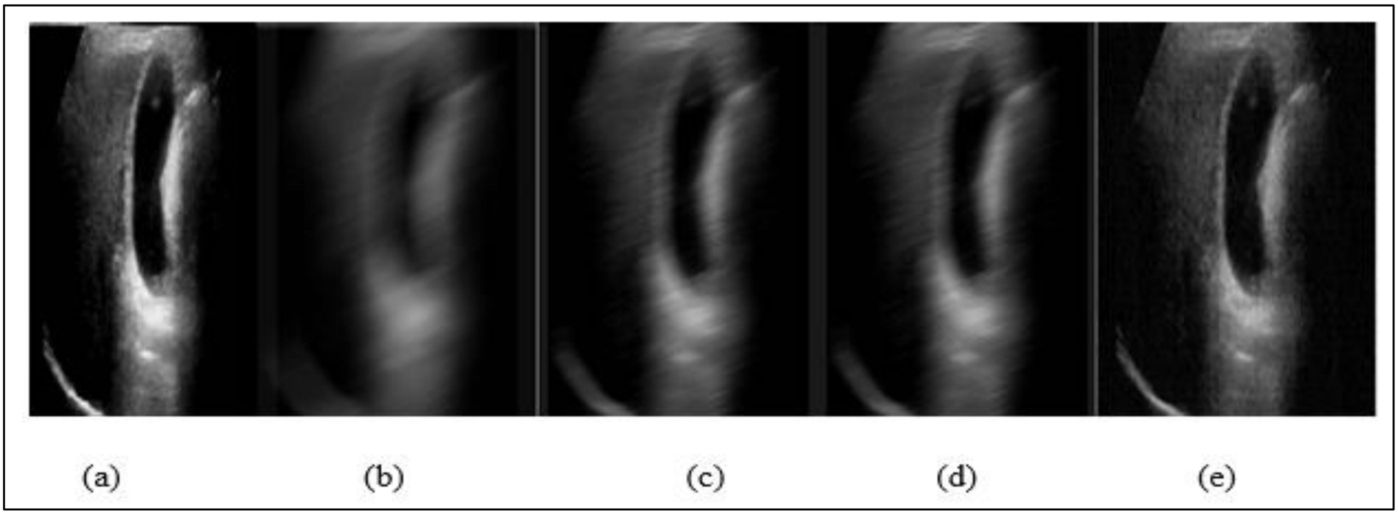


Fig 16 (a) Reference Clear Image, (b) Degraded Image for Gall Bladder with Blurring Artifacts, (c) Restored Image using Blind Deconvolution, (d) Restored Image using Lucy Richardson Deconvolution, (e) Restored Image using Winner Filter.

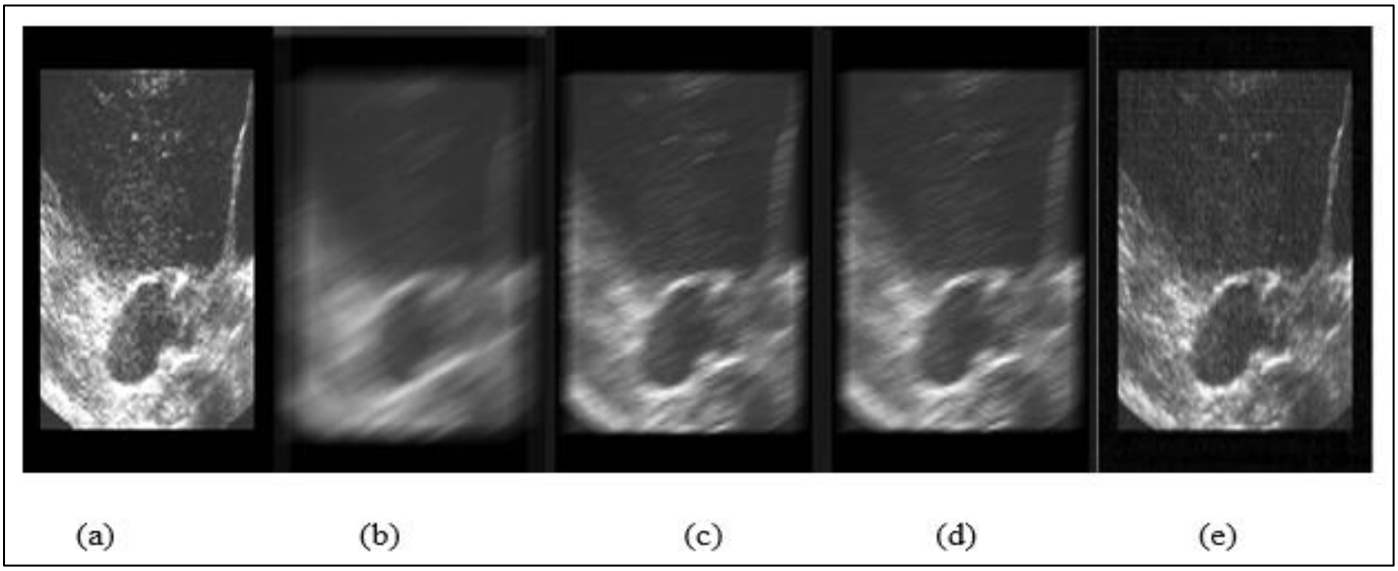


Fig 17 (a) Reference Clear Image, (b) Degraded Image for Adrenal with Blurring Artifacts, (c) Restored Image using Blind Deconvolution, (d) Restored Image using Lucy Richardson Deconvolution, (e) Restored Image using Winner Filter.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug206

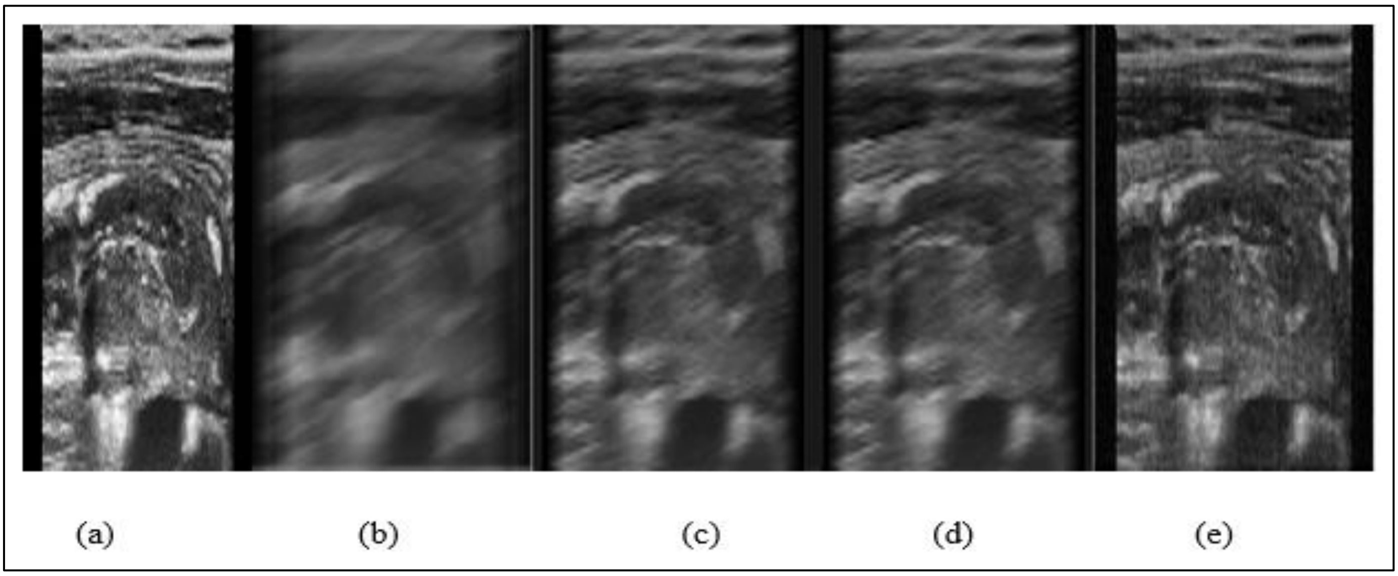


Fig 18 (a) Reference Clear Image, (b) Degraded Image for Appendix with Blurring Artifacts, (c) Restored Image using Blind Deconvolution, (d) Restored Image using Lucy Richardson Deconvolution, (e) Restored Image using Winner Filter.

VIII. DISCUSSION

Qualitatively, it seems that the low contrast images had been restored with PSNR of (21.1845) by using Contrast restoration based on adaptive histogram equalization and Contrast Stretching; this is clear in the results quantitatively and qualitatively , when comparison takes place between the reference clear image and the restored one; however, on the other hand, the restored image losing some of details, this also can be noticed from the results in table (1), where high MSE (1.007837) is presented.

In Blocking artifacts, the best performance technique was found is TV filter followed by bilateral filtering, that is clear when going through images in figures (9 to13), However, it is crucial to mention that TV filter slower with 244 second than bilateral filter and that because it has a longer algorithm and more iterations. From the identical figures, and in the third position, winner filter takes a part for removing block artifacts, but it has drawback of loss of high frequency information and that was clear, because it has the highest MSE value (0.587380) among all de-blocking techniques. Median filter take the worst place because of its bad results of the softening of boundaries and the loss of intricate details. Also from the results, it seems that in removing blocking artifact, the De-blocked image based on total variation filtering has the lowest MSE (0.446481), the highest PSNR value (24.2511),and highest SNR (14.1795) which suggests it is the best at preserving image quality among the method listed. De-blocked image based on bilateral filtering also has the highest SSIM value (0.9951), which indicates it is the most perceptually similar to the original image. De-blocked image based on total variation filtering stands out with a QI of (0.7885), which also shows that it is performing well in terms of overall quality.

On the other hand, in case of blurring artifact winner filter is the best, standing with the highest SNR (10.8201) and PSNR (18.1403), followed by Lucy Richardson deconvolution, which has drawback of losing fine details in dark boundaries.

IX. CONCLUSION

A review study was carried out and eight algorithms of restoration techniques were modified and applied for ten images from different body parts. The results was denoted for each technique and it seems that best performing was founded when using total variation filtering and bilateral filtering in de-blocking, stand out for their overall high PSNR, low MSE, high SSIM, and strong QI. These methods are highly effective at preserving image quality, with minimal noise and structural differences from the original image. In de-blurring methods winner filter, appear to perform the most effective technique, as demonstrated by its elevated SNR and minimal MSE. In the other hand using a contrast restoration based on adaptive histogram equalization and Contrast Stretching, seems to have high MSE, giving low quality images and that is obviously seen in the restored image.

RECOMMENDATIONS

From the results, it is clear that, in case of contrast restoration, Deep Learning-Based restoration technique is recommended instead of Contrast restoration based on adaptive histogram equalization and Contrast Stretching technique, and that for reducing high MSE with preserving high speed. In case of blocking artifacts, where preserving details and reducing MSE are very important points, bilateral filtering, and total variation filtering are the two competitors techniques for de-blocking DICOM compressed medical ultrasound image; so a hybrid technique that combine both of them as a blocking restoration technique is recommended. When speaking about de-blurring restoration, and since the winner filter has s high MSE value, Deep Learning-Based restoration technique again is recommended as an adaptive technique for de-blurring images, with preserving time and reducing complex procedures problems.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug206

REFERENCES

- [1]. Priyanka P, Rishabh S, Laxmi S. Image restoration of image with gaussian filter. International Research Journal of Engineering and Technology (IRJET). 2020; 7(12):555-8.
- [2]. Avola D, Cinque L, Fagioli A, Foresti G, Mecca A. Ultrasound medical imaging techniques: a survey. ACM Computing Surveys (CSUR). 2021 Apr 22; 54(3):1-38.
- [3]. Muthana R, Alshareefi AN. Techniques in de-blurring image. InJournal of physics: conference series 2020 May 1 (Vol. 1530, No. 1, p. 012115). IOP Publishing.
- [4]. Wang H, Wu H, Wang Z, Yue P, Ni D, Heng PA, Wang Y. A Narrative Review of Image Processing Techniques Related to Prostate Ultrasound. Ultrasound in Medicine & Biology. 2024 Nov 16.
- [5]. Bull D, Zhang F. Intelligent image and video compression: communicating pictures. Academic Press; 2021 Apr 7.
- [6]. El Abbadi NK, Abdulkhaleq AH, Al Hassani SA. A Survey on Blind De-Blurring of Digital Image. Iraqi Journal of Science. 2022 Jan 1; 63(1).
- [7]. Bull D, Zhang F. Intelligent image and video compression: communicating pictures. Academic Press; 2021 Apr 7.
- [8]. Lin L, Wang M, Yang J, Zhang K, Zhao T. Toward Efficient Video Compression Artifact Detection and Removal: A Benchmark Dataset. IEEE Transactions on Multimedia. 2024 Jul 3.
- [9]. Gunturk B, Li X. Image restoration. CRC Press; 2018.
- [10]. Abramova V, Lukin V, Abramov S, Kryvenko S, Lech P, Okarma K. A fast and accurate prediction of distortions in DCT-based lossy image compression. Electronics. 2023 May 23; 12(11):2347.
- [11]. Gonzalez RC. Digital image processing. Pearson education india; 2009.
- [12]. Jaiganesh M. Compendium on Image Restoration Techniques for Noise and Blur Reduction. In2024 International Conference on Computational Intelligence for Security, Communication and Sustainable Development (CISCSD) 2024 Apr 25 (pp. 35-39). IEEE.
- [13]. Ramesh C, Rao DV. A Comprehensive Analysis of Traditional and Advanced Approaches of Image Restoration Techniques. Micro and Nanosystems. 2024 Oct 11.
- [14]. Wali A, Naseer A, Tamoor M, Gilani SA. Recent progress in digital image restoration techniques: A review. Digital Signal Processing. 2023 Sep 1; 141:104187.
- [15]. Das S, Gulati T, Mittal V. Histogram equalization techniques for contrast enhancement: a review. International Journal of Computer Applications. 2015 Mar; 114(10):32-6.
- [16]. Gelogo YE, Kim TH. Compressed images transmission issues and solutions. Int J Comput Graph. 2013; 5(1):1-8.
- [17]. Hourani M, Basarab A, Varray F, Kouamé D, Tourneret JY. Block-wise ultrasound image deconvolution from fundamental and harmonic images. In2020 IEEE International Ultrasonics Symposium (IUS) 2020 Sep 7 (pp. 1-4). IEEE.
- [18]. Chacko S, Josh FT, Jayakumar J. Artifacts Removal of Compressed Digital Images by Linear Enhancement and Filtering.
- [19]. Balendra, Halder RS, Sahani A. Improvising limitations of DNN based ultrasound image reconstruction. Physical and Engineering Sciences in Medicine. 2022 Dec; 45(4):1139-51.
- [20]. Kang Q, Lao Q, Gao J, Liu J, Yi H, Ma B, Zhang X, Li K. Deblurring masked image modeling for ultrasound image analysis. Medical Image Analysis. 2024 Oct 1; 97:103256.
- [21]. Rafael C. Gonzalez and Richard E. Woods, *Digital Image Processing*, 4th Edition, Pearson, 2018.