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Remove Noise from Medical Images

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ABSTRACT

Noise can be defined as unwanted information that is distributed random in the image and works to disturb or distort the image. Noise removal is necessary until the image is closer to the original image. In this research, two gray level images (medical images) were used, and three basic filters ((Median filter, Wiener filter, Gaussian filter) and fuzzy logic were used to remove noise from medical images for example (Salt and pepper noise, Shot noise, Speckle noise and Gaussian noise). In order to compare filters and fuzzy logic, a program was created in Matlab language. The signal to noise ratio (PSNR) and mean square error (MSE) were measured. The median filter and fuzzy logic gave better results than the other methods for the images were treated.

Keywords: Noise, Mean Square Error, Signal to Noise Ratio.

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INTRODUCTION:

Preprocessing is one of the simplest and important methods of image processing and try to make the diagnostic details clearer. It is an important and diverse set of image preparation for the next process of image processing. Preprocessing techniques play an important role in the accuracy and performance of the post processing application [1].

Preprocessing include removing noise and eliminating unnecessary and invisible information. Other preprocessing steps might include gray level or spatial quantization (reducing the number of bits per pixel or the image size) [2].

Noise:

Noise is any distortion that occurs in the digital image and may damage the contents of the image. So removing the noise is necessary until the image becomes closer to the scene of the real goals of the photographer. The noise in the images is a serious problem, or it is happening by any introduced into the data via any electrical system used for storage, transmission, and processing [3].

Different types of noise exist in the image and there are a variety of noise reduction techniques to remove noise [4]. The selection of noise removal algorithm depends on the application. In this research (Salt and pepper noise, Gaussian noise, Shot noise and Speckle noise) are types of noises that are present in an image. The principle approach of remove noise in image is filtering. Available filters to remove noise from the image are (Median filter, Gaussian filter, Wiener filter and Fuzzy logic) [5].

Noise removal is an important step in digital image processing. it is consider important step to be taken before analyzing image data. It is necessary to apply an effective technique to compensate for data damage [6].

The main properties of a good model are eliminates noise while maintaining edges. The goal of eliminating noise is to reduce noise through two phases namely: noise detection and noise removal. (Figure 1) represent the de-noising model. The noise detection is a process in which screening the image pixel is noise. After noise removal, the damaged pixels of the input image are replaced by the appropriate values calculated from the specified methods [7, 8].

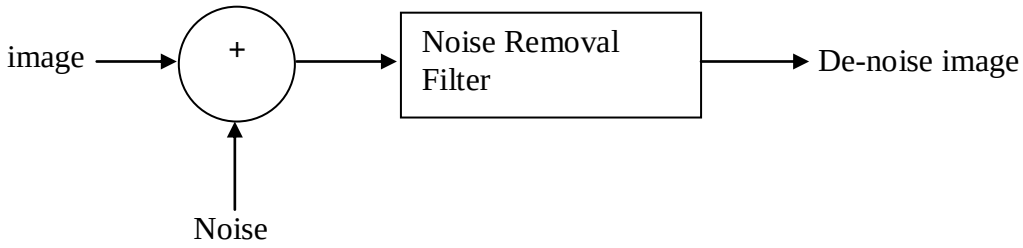


Figure (1) represent de-noising model

Types of noise existing in the images used in the research are following:

1.Salt-and-pepper noise
The image with salt and pepper noise will contain dark pixels in bright areas and bright pixels in dark areas [9]. This type of noise is an impulse, which is also called to as intensity spikes, This is due to data transmission errors [10, 11].

2. Shot noise (Poisson noise)
This type of noise occurs in the lighter parts of the image due to statistical fluctuations. Noise occurs in different pixels and is independent of each other. Shot noise is also called Poisson noise, and does not differ significantly from the Gaussian noise [4, 12].

3. Speckle noise
This type of noise is double noise because the random interference between obstacles is coherent. It's usually occurs in imaging systems. Its follows the gamma distribution [12].

4. Gaussian noise (Amplifier noise)
Gaussian noise is a kind of statistical noise. It is a essential part of reading image sensor noise. The probability density function for Gaussian noise is equal to the normal distribution function, also known as the Gaussian distribution. which has a bell shaped probability distribution function [6, 13].

METHODS:

There are many methods to remove noise from medical image, In this research three best types of filter (median filter, wiener filter, Gaussian filter) and fuzzy logic are used.

1.Median filter
This technique is one of the most important techniques used to remove noise and is a necessary step for the pre-analysis of the subsequent processing [14]. The important property in this type is to remove the effect of large quantities of noise. It can also eliminate various types of noise and is a non-linear digital filtering technology [15].

2. Wiener Filter
This filter is one of the filters used to reduce the amount of signal in the image signal compared to the estimate of the signal without noise. It is not an adaptive candidate because the theory assumes that input is constant [16, 17].

3. Gaussian filter
The Gaussian filter set filters the input signal. This type of filters is designed to reduce the rise and fall time. It is modifies input signal by embedding with a Gaussian function [16].

4. Fuzzy logic
Fuzzy logic techniques is used extensively to eliminate noise in digital image processing [18]. The main objective is to find the average pixel processing based on adjacent pixel values. The characteristics of the image should not be affected. The center pixel is denoted as Pij. The neighboring pixels are present: (i-1,j-1), (i-1,j), (i-1,j+1), (i,j-1), (i,j+1), (i+1,j-1), (i+1,j) and (i+1,j+1) respectively [19].

Performance Evaluation Factors
Peak Signal to Noise Ratio (PSNR)

PSNR is the ratio between the potential strength of the signal and the force of the noise affecting its representation. It is often measured to see the quality between the original image and the image after noise removal [20]. The higher PSNR value, the better the image quality will be after the noise is removed. PSNR depends on MSE and is calculated by the following equation: [21]

$$PSNR = 10 \log_{10} \frac{255^2}{MSE}$$

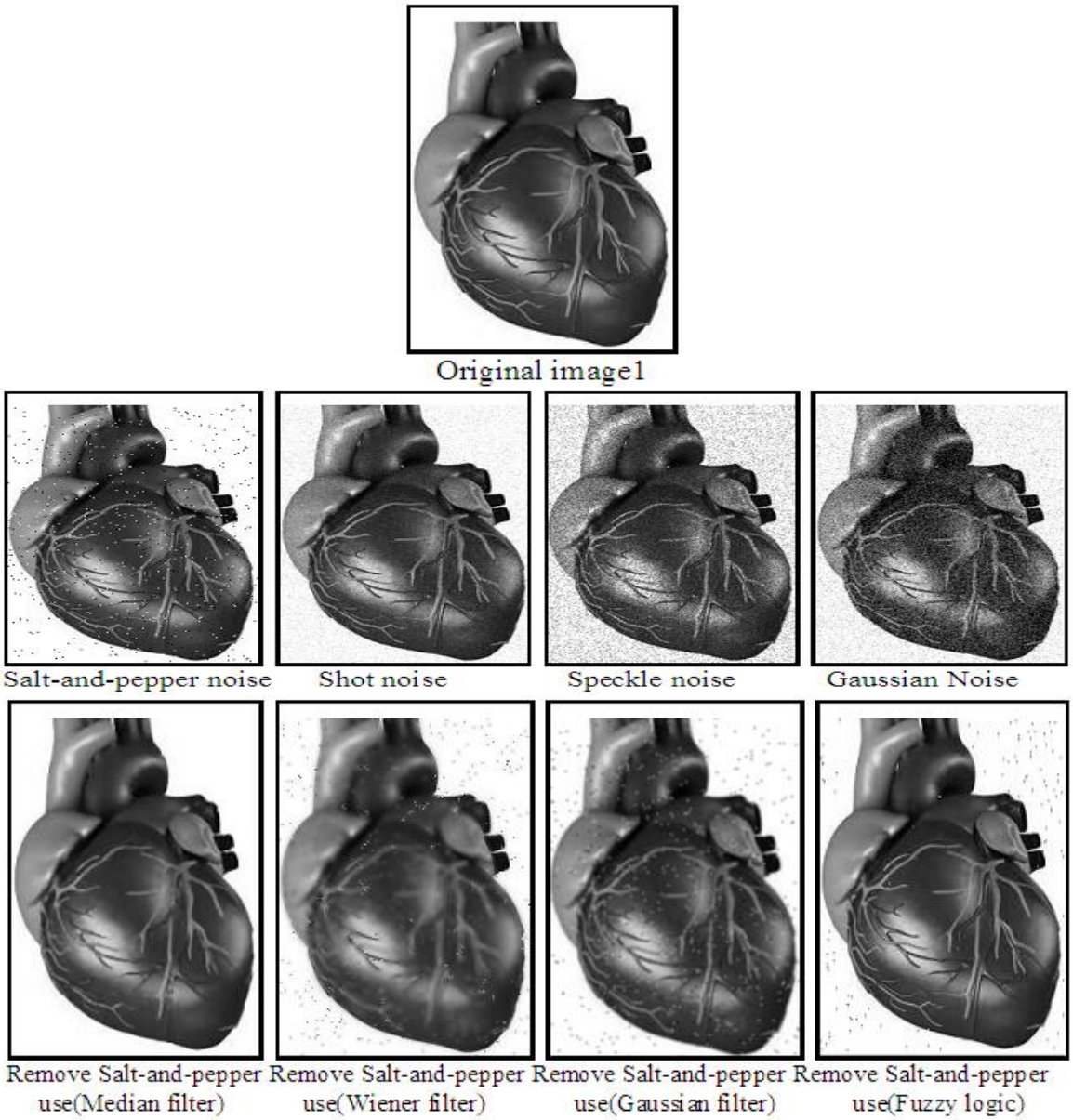
Where MSE is the mean square error between the original image (input image) and the resolution image after noise removal (output image). MSE is defined as followed: [20]

$$MSE = \frac{1}{N\,M} \sum_{x=1}^{M} \sum_{y=1}^{N} [g(x,y) - f(x,y)]^2$$

Where: M= Number of rows in the image, N: Number of columns in the image, g: Input image (Damaged image), f: Output image (Filtered image). The Less value than MSN is the best result in image [22].

RESULTS AND DISCUSSION:

In this research, noise in medical images was removed by used the best three types of filters (Median filter, Wiener filter, Gaussian filter) and fuzzy logic to remove (Salt and Pepper noise, Shot noise, Speckle noise and Gaussian noise).To determine the quality of the noise reduction in medical images is measured by the statistical quantity measures: Mean Square Error (MSE) and Peak Signal to Noise Ratio are used. If the lowest value of MSE and the largest value of PSNR represents the best filtered image.The results of program implementation for images 1 and 2 show in (Figure 2 and 3), The values of MSE and PSNR are show in (Table 1- 4), The graph of MSE and PSNR values are show in (Figure 4-7).



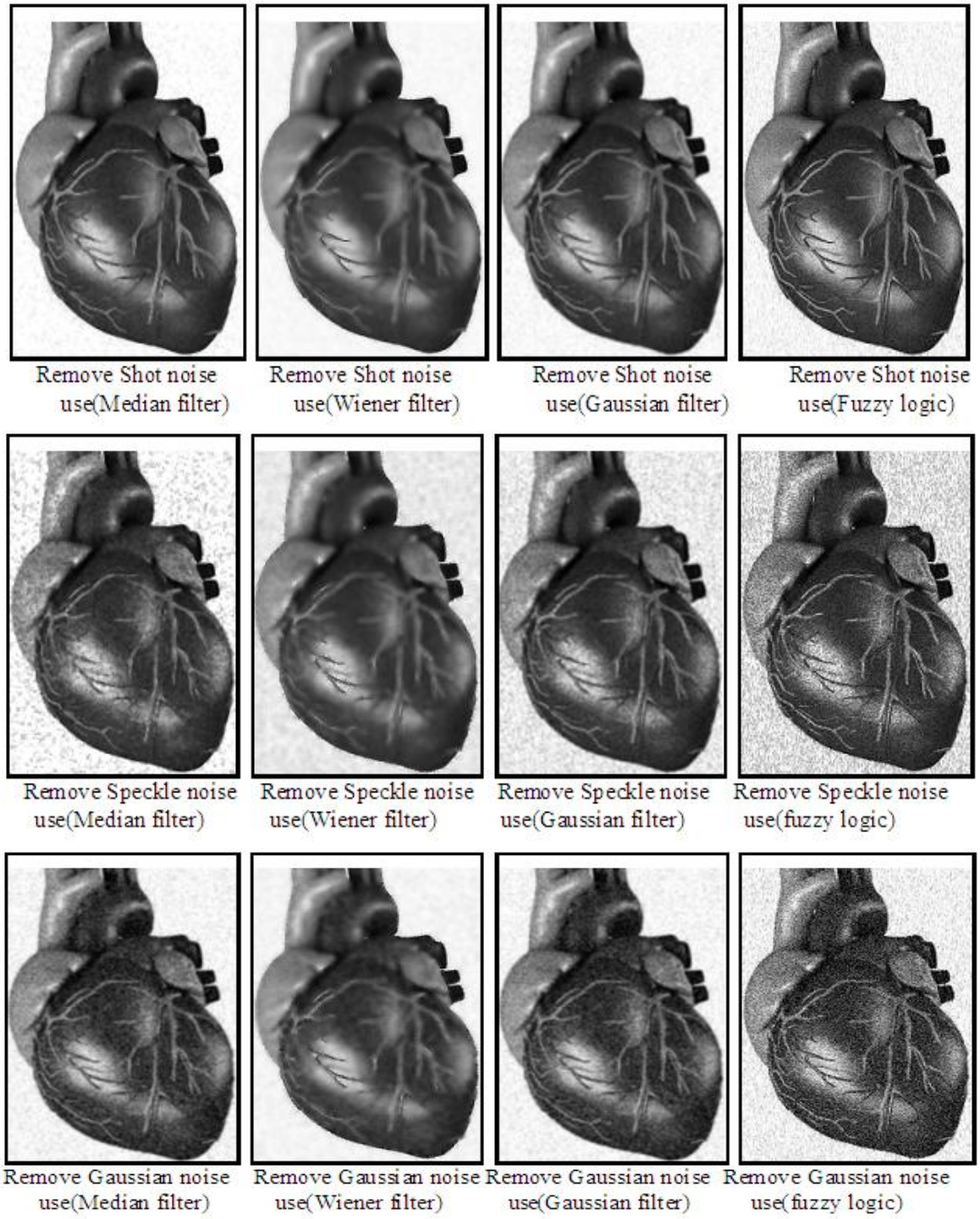
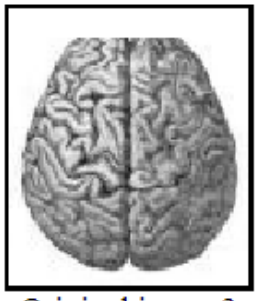


Figure (2) original image1 and image1 after add noises used (Salt-and-pepper noise, Shot noise, Speckle noise and Gaussian Noise) and remove its by using (Median filter, Wiener filter, Gaussian filter and Fuzzy logic)



Original image2

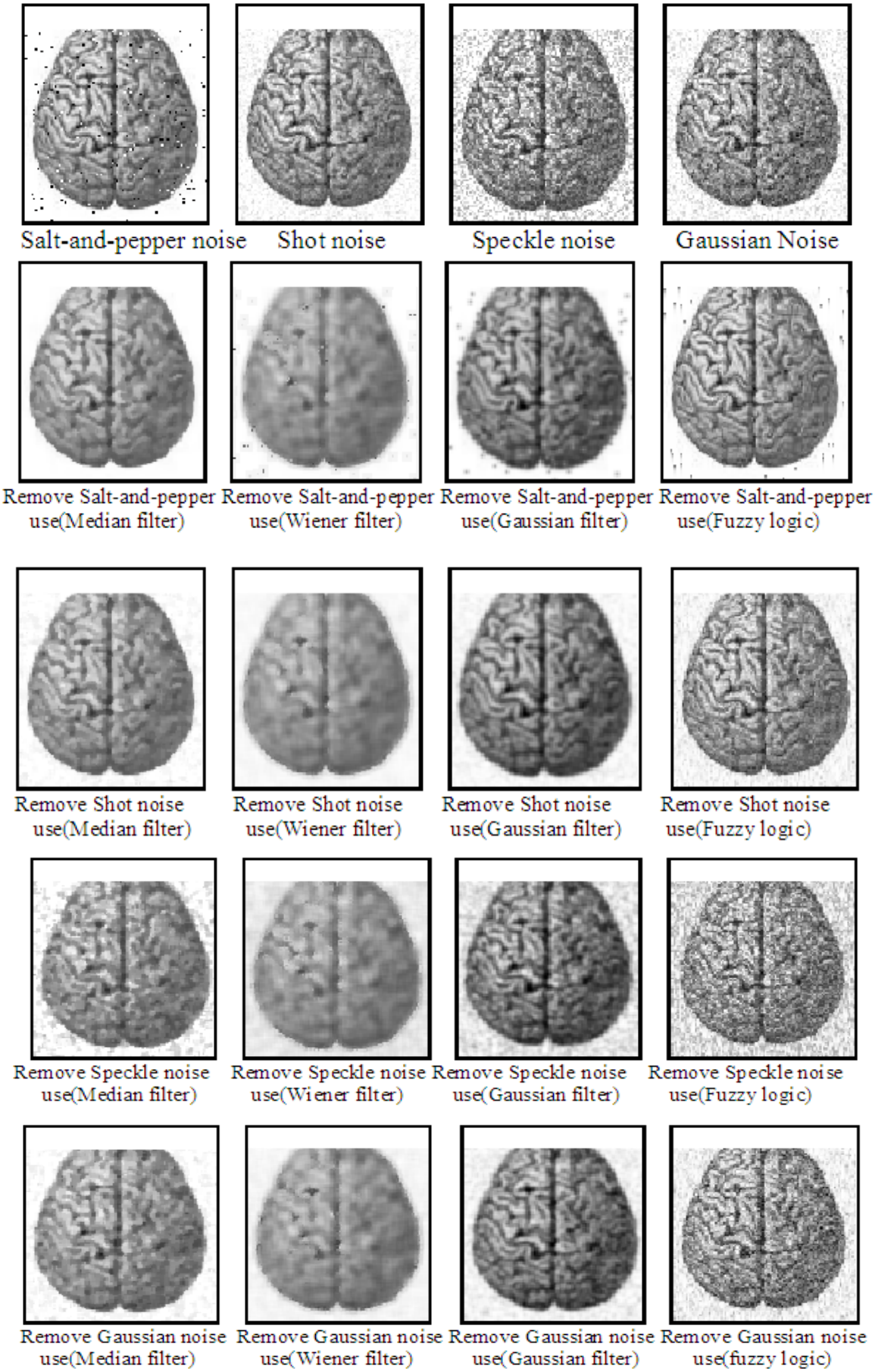


Figure (3) original image2 and image2 after add noises used (Salt-and-pepper noise, Shot noise, Speckle noise and Gaussian Noise) and remove its by using (Median filter, Wiener filter, Gaussian filter and Fuzzy logic)

Table 1 Represent compare the values of the MSE of different filtering methods and fuzzy logic for various noise in the image 1

	Median	Wiener	Gaussian	Fuzzy logic
Salt-and-pepper	69.3731	227.4001	226.8388	75.0323
Shot	92.3507	124.0542	196.3106	121.7857
Speckle	307.8136	355.5099	425.7330	348.6539
Gaussian	183.8045	193.0527	276.8451	186.8672

Table 2 Represent compare the values of the PSNR of different filtering methods and fuzzy logic for various noise in the image 1

	Median	Wiener	Gaussian	Fuzzy logic
Salt-and-pepper	29.7189	24.5629	24.5736	29.3783
Shot	28.4764	27.1947	25.2014	27.2748
Speckle	23.2479	22.6223	21.8394	22.7069
Gaussian	25.4872	25.2740	23.7084	25.4155

Table 3 Represent compare the values of the MSE of different filtering methods and fuzzy logic for various noise in the image 2

	Median	Wiener	Gaussian	Fuzzy logic
Salt-and-pepper	236.6997	576.0933	825.4983	117.1280
Shot	274.8325	503.9063	907.5423	162.4209
Speckle	622.9080	1.2352e+003	1.4985e+003	828.0544
Gaussian	373.0339	578.6371	1.0156e+003	570.6414

Table 4 Represent compare the values of the PSNR of different filtering methods and fuzzy logic for various noise in the image 2

	median	Wiener	Gaussian	Fuzzy logic
Salt-and-pepper	24.3888	20.5259	18.9636	27.4442
Shot	23.7401	21.1073	18.5521	26.0244
Speckle	20.1866	17.2134	16.3741	18.9502
Gaussian	22.4133	20.5067	18.0637	20.5672

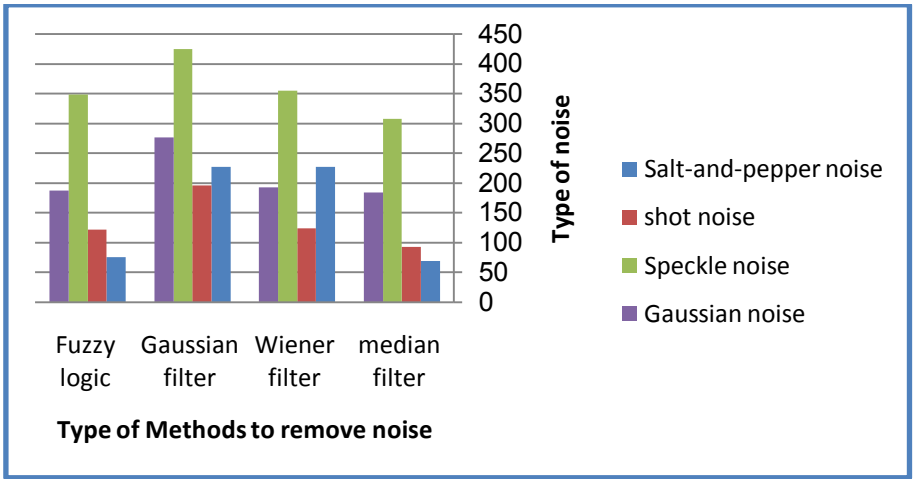


Figure (4) Graph of MSE values from image1

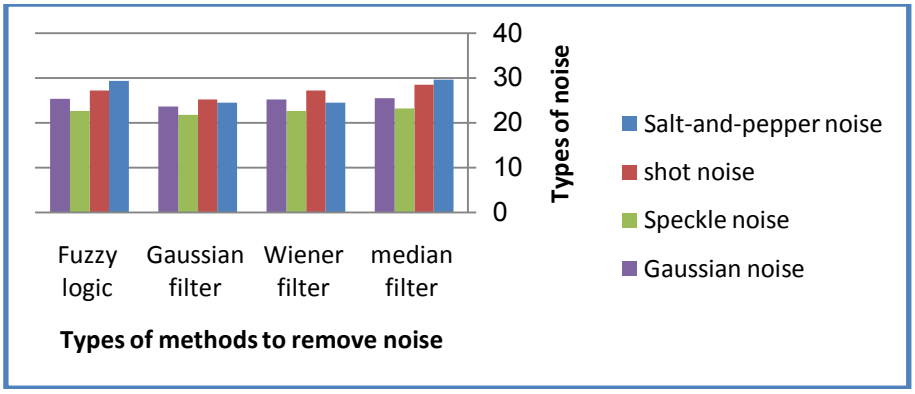


Figure (5) Graph of PSNR values from image1

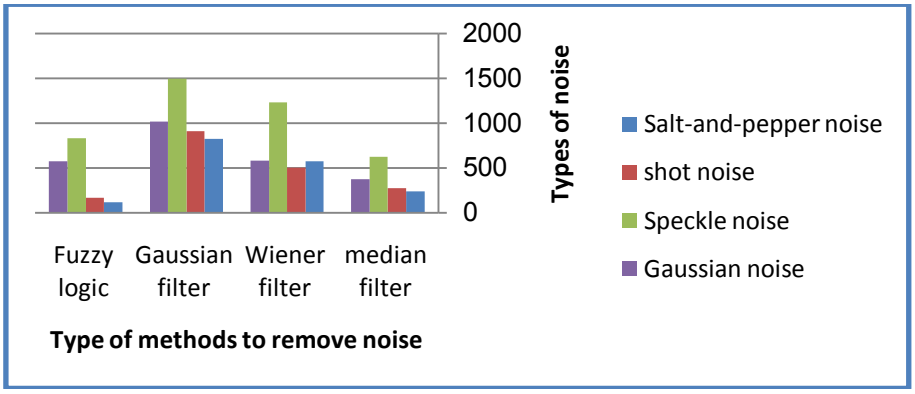


Figure (6) Graph of MES values from image2

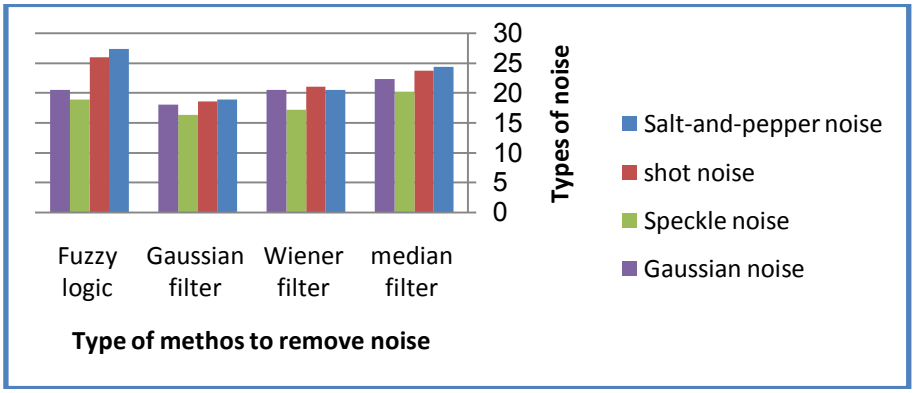


Figure (7) Graph of PSNR values from image2

CONCLUSION:

Noise removal is an important step in medical image processing. and there are many methods to eliminate noise, the best methods is to remove noise while retaining image detail.

In this research, used most effective basic filtering techniques : (Median filter, Wiener filter, Gaussian filter and Fuzzy logic) to remove noise.

From the values of MSE and PSNR of image 1 and image 2 obtained, I found that median filter and fuzzy logic are the best methods for noise remove compare to other methods. Both methods gave the lowest values of MSE and the highest values of PSNR.

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