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Center Weighted Median Filter for MRI Brain Image Enhancement

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Abstract :- Magnetic Resonance Image is used for diagnosing of brain tumor at advanced stages. Image enhancement is used to reduce the noise and improve resolution contrast of the image. This paper compares the performance of four commonly used filters: Median Filter, Weighted Median Filter, Central Weighted Median Filter and Decision Based Median Filter. The paper is divided into two stages. The first stage is enhancement of medical MRI Brain images. All four filtering methods are tested on 20 medical MRI brain images. The second stage is enhancement of non – medical MRI Brain images. 10 non – medical MRI Brain images are tested using four filtering methods. The comparison is based on the Peak Signal to Noise Ration. For both the MRI images, Central Weighted Median Filter shows high PSNR amongst all four filtering methods studied. Decision Based Median Filter shows slightly better PSNR than Median Filter.

Keywords :- Magnetic Resonance Image (MRI), Brain Tumor, Image enhancement, Median filter, Weighted Median Filter, Center Weighted Median (CWM) filter, Decision based Median Filter.

I. INTRODUCTION

MRI systems are very important in medical image analysis. Clear distinction between the tissues, bones and fluid is observed in MRI images, it easily distinguish the tumor part from the image. Tumor part can be obtained correctly if MRI image is enhanced properly. Image enhancement focus on sharpening of image features such as edges, boundaries and contrast [1-2].

Histogram Equalization (HE) usually increases the global contrast of image, when the data in the image is represented by close contrast values. It provides better views of bone structure in x-ray images, and detail in photographs that are over or under-exposed. The CLAHE algorithm partitions the images into contextual regions and applies the histogram equalization to every region. It equally distributes grey values and thus makes hidden features of the image more visible. CLAHE overcome the limitations of standard histogram equalization. Tracking algorithm [3] removes artifacts in Brain MR Images. From the first row and first column, the intensity values of the pixels are analyzed and the threshold values of the film artifacts are decided. The threshold value which is higher than that of the threshold value is removed from MRI. The film artifacts having high intensity values are removed from MRI brain image. For gray scale image, it utilize highest threshold 255. It removes artifacts of gray value of 255 only. It leaves all other artifacts on the image. This algorithm also removes data from ROI.

The median filter is a nonlinear digital filtering technique, often used to remove noise. It preserves edges and removes noise. Median filter runs through the signal entry by entry, each entry is replaced by the median of neighboring entries. The pattern of neighbors is called the "window", which slides, entry by entry, over the entire signal. Odd numbered entries of window, defines simple median. It is just the middle value after all the entries in the window are sorted numerically. Weighted median (WM) filters are the extension of median filters. They exploit rank order information with spatial information of input signal. Center weighted median (CWM) filters are preferred because of its simplicity and perfectness. CWM filters are the simplest WM filters and the easiest to design and implement. CWM filters can easily understood theoretically.

In this paper, we focus on finding the median filter based preprocessing technique which provides higher value of PSNR for both medical and non medical MRI Brain Images. The preprocessing techniques used are Median Filter, Weighted Median Filter, Central Weighted Median Filter and Decision Based Median Filter.

II. MEDIAN FILTER

Median Filter is used to remove noise with high frequency components from MRI. It does not disturb the edges and used to reduce salt and pepper noise. It calculates the median of the surrounding pixels to determine the new (denoised) value of the pixel. In order to calculate the median all pixel values are sorted by their size, the pixel value is replaced by new median value .The amount of pixels is used to calculate the median [4].

III. WEIGHTED MEDIAN FILTER

A weighted median filter is used to remove noise from MRI brain images with contrast. It is used in rank order filtering and image processing. Intensity value of the pixels in the MRI image decides the weights of the filter. Here four weights such as 0, 0.1, 0.2 and 0.3 are used. If the intensity value of the pixel is 0 then the weight of the pixel is considered as 0. Else if the range of pixel intensity is between 1-100 then the weight considered is 0.1, else if the range of pixel intensity is between 101-200, then the weight is considered as 0.2 and for remaining it is 0.3. The above considered weights are multiplied with pixel intensity. Next, the median filter is applied to calculate weighted median filter.

IV. CENTER WEIGHTED MEDIAN (CWM) FILTER

The center weighted median (CWM) filter is a weighted median filter. More weight is assigned only to the central value of each window which is used .This filter can preserve image details while suppressing additive white and impulsive-type noise. It is found that the CWM filter can outperform the median filter [5-8]. It is shown that the CWM filter is an excellent detail preserving smoother that can suppress signal-dependent noise as well as signal-independent noise [9].

V. IDECISION BASED MEDIAN FILTER

A decision based algorithm (DBA) first detects the salt and pepper noise. It checks the pixel values against the maximum and minimum values in the window selected. Thus, it detects the noisy and noise free pixels. The minimum and maximum values that the impulse noise exists will be in the dynamic range (0, 255). If the pixel is being currently processed has a value within the minimum and maximum values in the currently processed window, then it shows a noise-free pixel and modification is not done in the pixel .If the value doesn't lie within the range, then it shows a noisy pixel and it is replaced by either the median pixel value or by the mean of the neighboring processed pixels if the median itself is noisy [10].

VI. EXPERIMENTS AND RESULTS

The MRI data is obtained from open data source http://www. cancerimagearchive.net/display/public/collections. 30 MRI brain images are used. 20 images are medical (.dcm) and 10 images are non medical format (.png). These images are with the default size of 256 x 256. The four filters are implemented by using mat lab 7.9. The experimental results are tested in Intel Core 2 Duo CPU 2GHz processor with 1GB RAM. Performance of the Median filter, Weighted Median filter, Center weighted median filters and decision Based Median filter are analyzed and evaluated by the parameter peak signal-to-noise ratio (PSNR) given in equation 6.1,

$$\text{PSNR in dB} = 10 \log_{10}(255^2/\text{MSE}) \qquad (6.1)$$

$$MSE = \frac{\sum_i \sum_j (Y(i,j) - \hat{Y}(i,j))^2}{M \times \mathrm{N}} \qquad (6.2)$$

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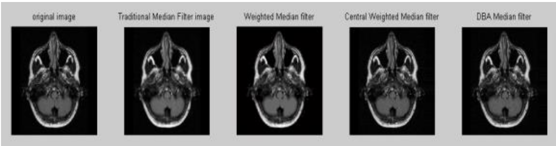


Fig. 6.1: 01.dcm

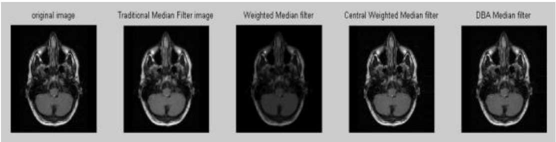
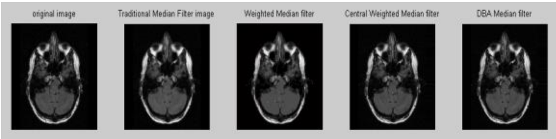


Fig. 6.2: 02.dcm



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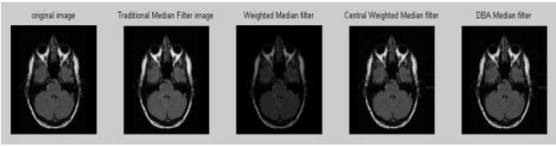

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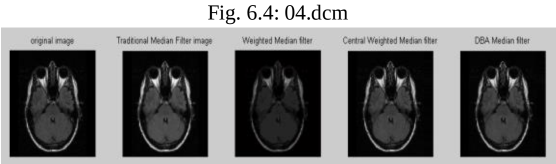

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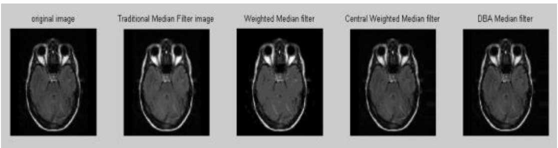

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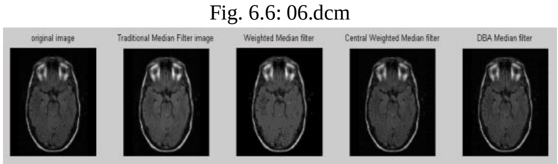

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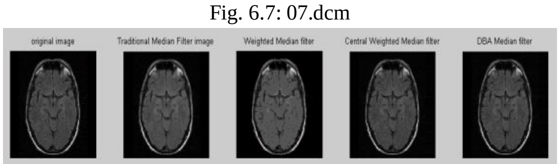


Fig. 6.8: 08.dcm

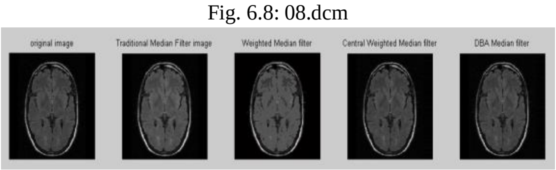


Fig. 6.9: 09.dcm

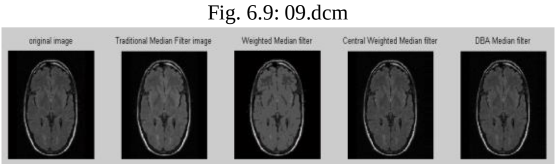
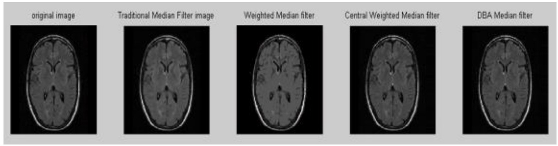


Fig. 6.10: 10.dcm



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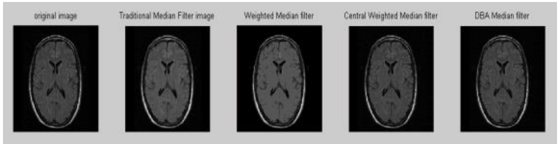

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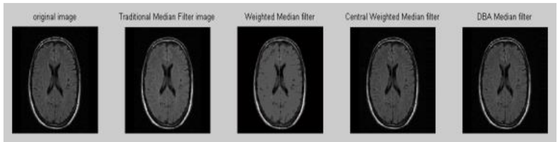

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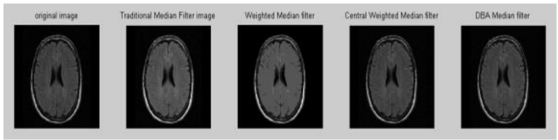
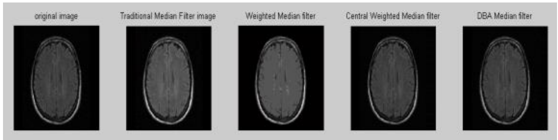


Fig. 6.14: 14.dcm



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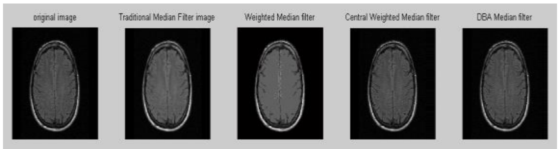

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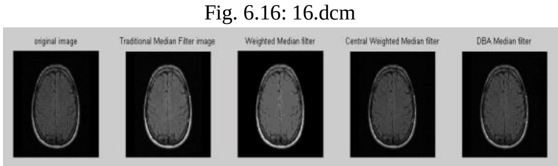

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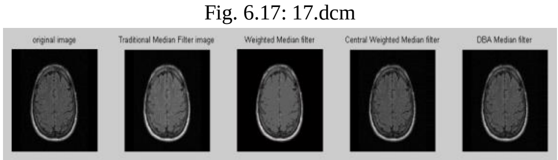

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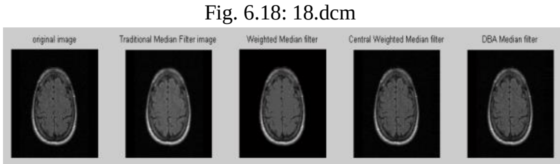


Fig. 6.19: 19.dcm

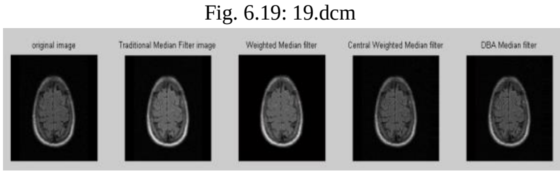
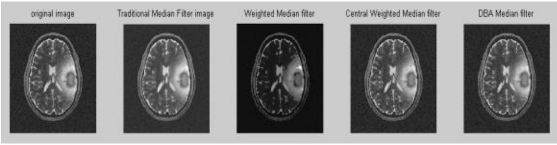


Fig. 6.20: 20.dcm



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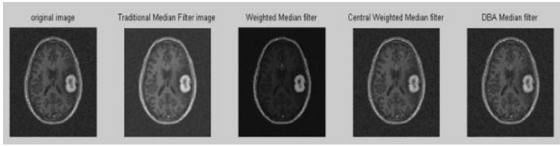

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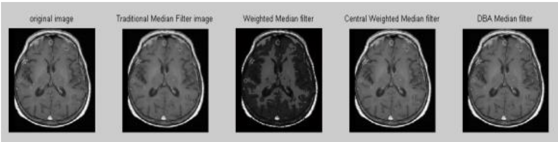

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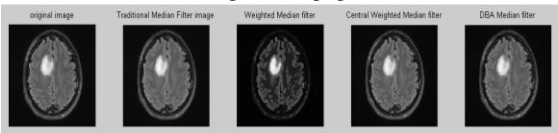

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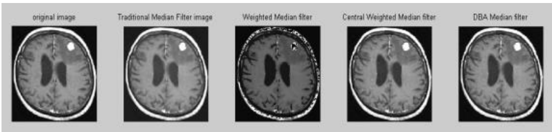


Fig. 6.25: 5.png

TABLE 6.1: PERFORMANCE OF FILTERS FOR MEDICAL IMAGES.

Sr. No	Images	PSNR CW (dB)	PSNR DBA (dB)	PSNR_ MEDIAN (dB)	PSNR_ WEIGHTED (dB)
1	01.dcm	69.05	30.01	24.47	0.58
2	02.dcm	69.80	30.41	24.55	0.77
3	03.dcm	69.80	30.41	25.86	1.73
4	04.dcm	68.23	29.59	26.38	1.51
5	05.dcm	70.80	30.50	26.10	1.61
6	06.dcm	70.85	28.13	26.04	0.83
7	07.dcm	68.56	30.68	26.37	0.75
8	08.dcm	70.49	30.75	26.81	1.07
9	09.dcm	70.99	31.55	26.91	1.28
10	10.dcm	69.47	30.99	26.65	1.27
11	11.dcm	69.84	30.62	26.43	1.37
12	12.dcm	71.00	30.85	26.45	1.50
13	13.dcm	70.52	30.76	26.97	1.57
14	14.dcm	68.95	30.94	27.65	1.60
15	15.dcm	70.71	30.73	27.95	1.38
16	16.dcm	70.23	30.83	28.22	1.68
17	17.dcm	69.74	31.06	28.32	1.92
18	18.dcm	68.45	30.98	28.31	2.43
19	19.dcm	71.18	30.94	28.49	3.00
20	20.dcm	71.04	30.83	28.84	3.88

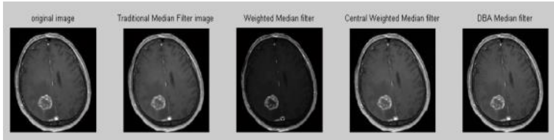
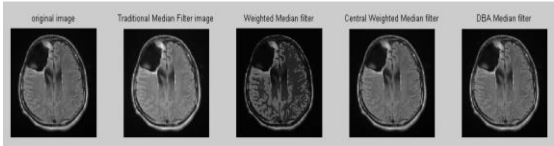


Fig. 6.26: 6.png



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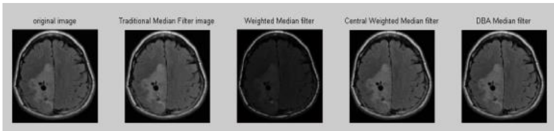

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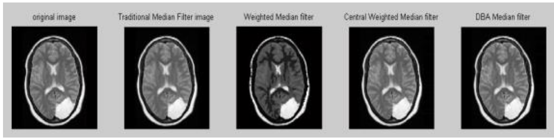

ig. 6.29: 9.png

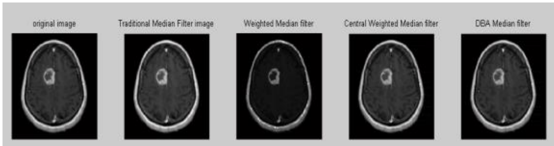

Fig. 6.30: 10.png

TABLE 6.2: PERFORMANCE OF FILTERS FOR NON - MEDICAL IMAGES.

Sr. No.	Images	PSNR_ CW (dB)	PSNR_ DBA (dB)	PSNR_ MEDIAN	PSNR_ WEIGHTED
1	1.png	31.57	43.67	13.41	-11.44
2	2.png	30.94	43.80	13.46	-10.62
3	3.png	47.08	45.49	22.94	-11.78
4	4.png	59.69	45.30	22.67	-9.59
5	5.png	26.43	26.46	24.01	-15.03
6	6.png	56.02	34.16	22.82	-10.00
7	7.png	51.55	60.25	22.59	-9.90
8	8.png	67.88	43.38	28.63	-9.04
9	9.png	41.04	27.56	22.83	-11.61
10	10.png	23.48	21.61	22.42	-6.82

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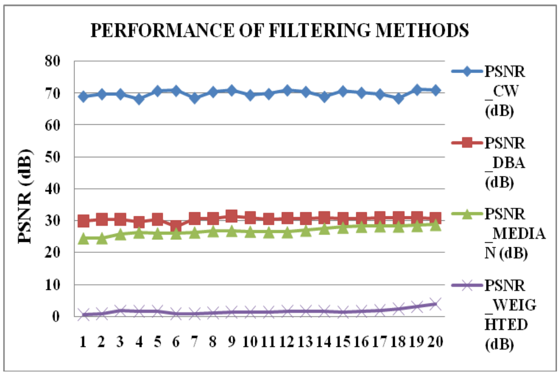

Fig.6.31: Performance of various filtering methods for medical images.

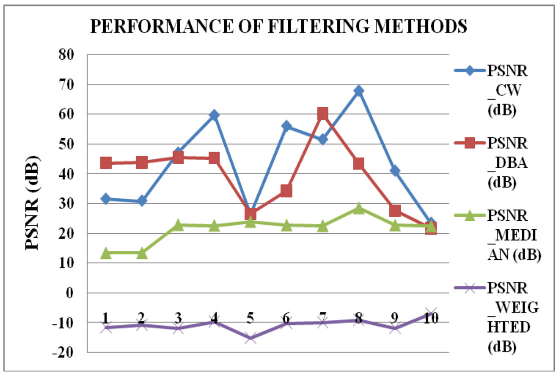

Fig 6.32: Performance of various filtering methods for Non - medical images

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VII. CONCLUSION

The results for medical images show comparatively better PSNR than non – medical images. Comparison of Median filter, Weighted Median filter, Center weighted median filters and decision Based Median filter shows that the Center Weighted Median filter is identified as the best filter for MRI brain image enhancement. It removes noise with high contrast from MRI brain images.

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