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A Novel Noise Reduction Method for Image and Video Denoising

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Abstract: An image and video are very good information carriers but they are corrupted and deviate from their original value received after transmission. The major factor that reduces the quality of the image and video is Noise. It hides the important details and changes value of pixels at key locations causing blurring and various other deformities. We have to remove noises from the images and videos without loss of any information. The main goal of denoising is to enhance or restore a denoised image or video and help the other system (or human) to understand it better. In order to improve the quality and visual perception of an image and video noise must be removed and the important features like edge details should be retained as much as possible. In this paper we have developed an efficient approach for image and video denoising. This work deals with denoising of Salt-pepper, Gaussian & Poison noise. Filtering and wavelet thresholding is applied separately on Image and video. In proposed method thresholding and filtering method applied simultaneously on noisy image and video. Performance is measured with respect of PSNR (Peak Signal to Noise Ratio), MSE (Mean Square Error) and visual perception. Proposed method gives excellent agreement of results.

Keywords: Image denoising, video denoising, PSNR, Median filter, Wiener filter, Wavelet Thresholding.

I. INTRODUCTION

When an Image is formed various factors such as lighting spectra, source, intensity and camera Characteristics (sensor response, lenses) affect the image. The main parameter that degrades the quality of the image is Noise. There are many types of noises which corrupt the images. These noises are appeared on images in different ways: at the time of acquisition due to noisy sensors, due to faulty scanner or due to faulty digital camera, due to transmission channel errors, due to corrupted storage media. The image needs image denoising before it can be used in applications to obtain accurate results. Many image denoising algorithms exist none of them are universal and their performance largely depends upon the type of image and the type of noise [1].

The video sequences are often corrupted by noise during acquisition and processing. The noise degrades the visual quality and also affects the efficiency of further processing like compression, segmentation etc. Hence, it becomes very important to remove the noise while preserving the original video contents [2]. Noise reduction is highly desirable in many applications, e.g. for improving visual quality in video surveillance, television, teleconferencing and medical imaging; for video coding and as a preprocessing step for improving the accuracy of subsequent processes like object detection, feature extraction etc [3].

The classification of noise relies mainly on the characterizing probabilistic specifications. There are the four types of noise categories in image processing:

1. Gaussian noise
2. Salt and Pepper Noise
3. Poisson noise [4]

In salt & pepper noise, pixels in the image are very different in intensity from the neighboring pixels. A noisy pixel doesn’t have any relation to the color of neighboring pixels. This noise effects only small number of pixels. It contains dark and white dots. Dust inside the camera and overheated or faulty CCD elements are the sources of this noise [5].

In Gaussian noise, each pixel of image changed by a small amount from its original value. It is most commonly utilized as additive white noise to give additive white Gaussian noise [6]. The Gaussian (normal) distribution is a very good model to represent this type of noise. This is due to central limit theorem which states that the sum of different noises tends to approach a Gaussian distribution.

Poison noise, which has the characteristic of multiplicative noise. This type of noise occurs in almost all coherent imaging systems such as laser, acoustics and SAR (Synthetic Aperture Radar) imagery. The source of this noise is attributed to random interference between the coherent returns [6]

The removing of noise from any affected image is referred as denoising. The goal of denoising is to remove the noise and to retain the important image features as much as possible [4].There are many filters that are used as an initial action before post-processing (i.e. image segmentation) by taking neighboring pixels into consideration which extremely ‘noisy’ pixels that could be filtered out. Recently many challenges have been made to reduce the noise from images using wavelet transform as a multi-resolution image processing tool. One widespread method exploited for reduction of noise form images is wavelet thresholding [7]. Other one is filtering method.

There are different wavelet thresholding approaches. The well-known technique of wavelet thresholding is hard and soft thresholding. In the hard thresholding techniques image is preserved if it is greater than the threshold; otherwise it is set to zero and in the soft thresholding technique image is shrunk to zero by an amount of threshold [8]. The reconstruction using hard thresholding is smoother and more visually appealing than the one obtained using soft thresholding.

There are different filtering techniques like averaging filter, median filter, wiener filter, adaptive filter etc. The median filter is one of the most popular nonlinear spatial filters for removing noise because of its good denoising effect and it is widely used to remove the salt and pepper noise only [9]. Adaptive filter takes a moving filter window and estimates the statistical information of all pixels' grey value, such as the local mean and the local variance. The central pixel's output value is dependent on the statistical information. Adaptive filters adapt themselves to the local texture information surrounding a central pixel in order to calculate a new pixel value [7].

The rest of the paper is organized as follow: Section 2 describes the wavelet and wavelet domain noise filtering, Section 3 describes thresholding and thresholding estimation technique, Section 4 describes the image denoising, Section 5 describes the video denoising, Section 6 describes the new proposed denoising method, employing PSNR and MSE, Section 7 presents the experimental results of the proposed method and Section 8 concludes the paper.

II. WAVELET DOMAIN NOISE FILTERING

Recently there has been a significant investigation in medical imaging area using the wavelet transform as a tool for improving images from noisy data. Wavelet denoising attempts to remove the noise present in the image and video while preserving the image characteristics, regardless of its frequency content [7]. The continuous wavelet transform (CWT) performs a multi resolution analysis by contraction and dilatation of the wavelet functions and discrete wavelet transform (DWT) uses filter banks for the construction of the multi-resolution time-frequency plane. The DWT uses Multi resolution filter banks and special wavelet filters for the analysis and reconstruction of signals. As the discrete wavelet transform (DWT) corresponds to basis decomposition, it provides a non redundant and unique representation of the signal [10]. All the wavelet filters use wavelet thresholding operation for denoising noise is a high-frequency component of the image and appears in wavelet coefficients [7].

The basic Procedure for all thresholding method is as follows:

- Calculate the DWT of the image and video.
- Compute the threshold value & threshold the wavelet coefficients.
- Compute the IDWT to get the denoised image and video.
- There are two thresholding functions frequently used, i.e. a hard threshold, a soft threshold [11].

III. THRESHOLDING AND THRESHOLD ESTIMATION TECHNIQUE

It has been observed that in many signals, energy is mostly concentrated in a small number of dimensions and the coefficients of these dimensions are relatively large compared to other dimensions or to any other signal (especially noise) that has its energy spread over a large number of coefficients [12]. The simpler way to remove noise or to reconstruct the original image using the wavelet coefficients used the result of decomposition in wavelet transform, is to eliminate the small coefficient associated to the noise [13]. The thresholding is classified into two categories:

A. Hard Thresholding: Hard thresholding can be defined as follow:

$$D(U, \lambda) = U \text{ for all } |D| > \lambda \quad \text{…. (1)}$$
$$= 0 \text{ otherwise}$$

Hard threshold is a "keep or kill" procedure and is more intuitively appealing. The Hard thresholding may seem to be natural. Sometimes pure noise coefficients may pass the hard threshold and appear as annoying "blips" in the output [14].

B. Soft Thresholding: Soft thresholding can be defined as follows:

$$D(U, \lambda) = \text{sgn}(U) \max(0, |U| - \lambda) \quad \text{…. (2)}$$

Soft threshold shrinks coefficients above the threshold in absolute value. The false structures in hard thresholding can overcome by soft thresholding. Now a days, wavelet based denoising methods have received a greater attention [14].

IV. IMAGE DENOISING

The aim of an image-denoising algorithm is then to reduce the noise level, while preserving the image features. All digital images contain some degree of noise due to the corruption in its acquisition and transmission by various effects [15]. Because the wavelet transform has an ability to capture the energy of a signal in few energy transform values, the wavelet denoising technique is very effective. When an image is decomposed using wavelet transform, the four sub images are produced and by using the obtained thresholding value denoise the image either by hard thresholding and soft thresholding [16]. PSNR parameter is often used as a benchmark level of similarity between reconstructed image and the original image [17]. The PSNR computes the peak signal-to-noise ratio, in decibels, between two images. This ratio is often used as a quality measurement between the original and a compressed image. The higher the PSNR, the better the quality of the compressed or reconstructed image or video [18].

The *Mean Square Error (MSE)* and the *Peak Signal to Noise Ratio (PSNR)* are the two error metrics used to compare image compression quality. The MSE represents the cumulative squared error between the compressed and the original image, whereas PSNR represents a measure of the peak error. The lower the value of MSE the lower will be error [19].

MSE is defined as:

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[X(i,j) - Xc\,(i,j)]^2 \quad \text{.... (3)}$$

Where,
X (i, j) =original image
X_c (i, j) =compressed image

PSNR represents a measure of the peak error & is expressed in decibels[20]. It is defined by:

$$PSNR = 10\log_{10}\left(\frac{255^2}{MSE}\right) \quad \text{... (4)}$$

V. VIDEO DENOISING

We apply DWT to video denoising in such a ways that to apply 2-D DWT on each frame separately rather than whole video [21]. The thresholding estimation technique is the hard and soft thresholding.

The importance of image sequence processing is regularly increasing with the ever use of digital television and video systems in consumer, commercial, medical, and communicational applications [22].Although there have been many papers addressed 3-Dwavelet-based video denoising. The main drawbacks of the 3-D wavelet transforms include long time latency and an inability to adapt to fast motions [23].

VI. PROPOSED METHOD

The proposed method algorithm can be better understood by the following flowchart. The flow starts from noisy image and video to final denoised results. Linear and non-linear filtering and wavelet thresholding is applied on noisy input and results have been observed. All the results are based on performance parameters PSNR and MSE. In this work hardthresholding and filtering applied simultaneously.

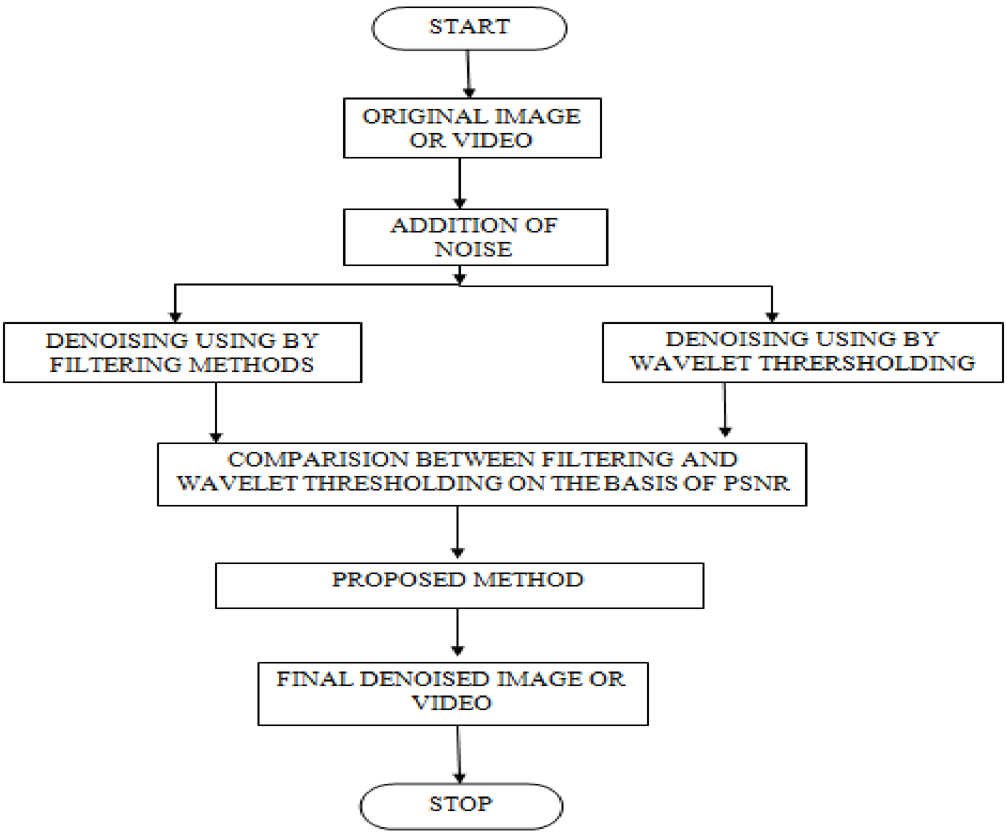

Fig 1: Flow Chart of Image or Video Denoising Procedure

VII. EXPERIMENTAL RESULTS

The performance of the wavelet based methods was tested on various Wavelets namely haar,db1, db3, db5, coif1,coif3, coif5, sym2,sym5, sym8, bior1.1, bior3.3, bior4.4 respectively on the basis of PSNR & MSE using the MATLAB [7.8.0.347(R2009a)]. Almost all the wavelet filters perform in a much similar fashion. Db5 wavelet is selected because of high PSNR. Daubechies wavelet with four vanishing moments (Db5) is used to decompose the input image into five wavelet levels. The performance of the thresholding method is evaluated by comparing it with the soft and hard thresholding methods.

7.1 EXPERIMENTAL RESULTS DURING IMAGE DENOISING PROCESSES:

Experiments are performed on the 512x512 noisy images. In this experiment, Chhaya image contaminated by Salt & pepper, Gaussian (white noise) & Poisson noise at different noise variance: σ = 0.02, 0.04, 0.06, 0.08 & 0.1. Figure 2(a) is noisy image is added with salt and pepper noise. Figure 3(a) is noisy image is added with Gaussian noise & figure 4(a) is noisy image is added with Poisson noise. Fig 2(b), 2(c), 2(d), 2(e) & 2(f) are the output of median filter, wiener filter, hard thresholding, soft thresholding & proposed method. Fig 3& 4 (b), (c), (d) & (e) are the output of median filter, wiener filter, hard thresholding, & proposed method implemented using MATLAB [7.8.0.347(R2009a)].

7.2 EXPERIMENTAL RESULTS DURING VIDEO DENOISING PROCESSES:

Experiments are performed on the 256x 256 noisy video. In these experiments, whole "Aadi " video is divided into 100 number of video frames then each frames is contaminated by Salt & pepper, Gaussian (white noise) and Poisson noise at different noise variances : σ = 0.02,0.04,0.06,0.08 & 0.1. Figure 5, 6 & 7 (a), (b), (c), (d) & (e) shows different noisy video frames, output of median filter, wiener filter, hard thresholding & proposed method respectively.

2(a) 2(b) 2(c) 2(d) 2(e) 2(f)

Fig 2: Denoising of 'Chhaya' image corrupted by Salt & pepper noise (a) noisy image (b) median filter (c) wiener filter (d) hard thresholding (e) soft thresholding (f) proposed method

3(a) 3(b) 3(c) 3(d) 3(e)

Fig 3: Denoising of 'Chhaya' image corrupted by Gaussian noise (a) noisy image (b) median filter (c)wiener filter (d) hard thresholding (e) Proposed method

4(a) 4(b) 4(c) 4(d) 4(e)

Fig 4: Denoising of 'Chhaya' image corrupted by Poisson noise (a) noisy image (b) median filter (c) wiener filter (d) hard thresholding (e) proposed method

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

(a) Fig 5: Denoising of ‘Aadi’ video corrupted by Salt & pepper noise (a) noisy video frame (b) median filter (c) wiener filter (d) hard thresholding (e) proposed method

(b) Fig 5: Denoising of ‘Aadi’ video corrupted by Salt & pepper noise (a) noisy video frame (b) median filter (c) wiener filter (d) hard thresholding (e) proposed method

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

Fig 6: Denoising of ‘Aadi’ video corrupted by Gaussian noise (a) noisy video frame (b) median filter (c) wiener filter (d) hard thresholding (e) proposed method

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

Fig 7: Denoising of ‘Aadi’ video corrupted by Poisson noise (a) noisy video frame (b) Median filter (c) Wiener filter (d) hard thresholding (e) proposed method

TABLE I: DENOISING RESULT OF THE CHAYYA IMAGE ON SALT & PEPPER NOISE:

S.NO	IMAGE NAME	NOISE VARIANCE	PSNR & MSE	DIFFERENT DENOISING METHODS					
				NOISY IMAGE	**MEDIAN FILTER**	**WIENER FILTER**	**HARD THRESHOLDING**	**SOFT THRESHOLDING**	**PROPOSED METHOD**
1.	CHHAYA	0.02	**PSNR**	24.31	32.50	27.34	34.13	32.90	**39.29**
			MSE	241.30	40.60	119.90	22.29	29.29	**7.66**
		0.04	**PSNR**	22.41	32.01	26.21	34.05	33.91	**39.22**
			MSE	373.00	40.90	155.50	22.87	27.87	**7.70**

		0.06	**PSNR**	21.28	31.90	25.75	34.69	33.02	**39.11**
			MSE	484.40	41.98	172.90	20.98	26.98	**7.80**
		0.08	**PSNR**	20.58	31.79	25.43	34.40	33.26	**39.11**
			MSE	568.50	43.07	167.43	20.70	26.70	**7.89**
		0.1	**PSNR**	20.02	31.63	25.17	34.65	33.54	**39.08**
			MSE	647.34	44.69	197.70	23.56	29.56	**7.94**

TABLE II: DENOISING RESULT OF THE CHAYYA IMAGE ON GAUSSIAN NOISE:

S.NO	**IMAGE**	**NOISE VARIANCE**	**PSNR & MSE**	**DIFFERENT DENOISING METHODS**					
				NOISY IMAGE	**MEDIAN FILTER**	**WIENER FILTER**	**HARD THRESHOLDING**	**SOFT THRESHOLDING**	**PROPOSED METHOD**
1.	CHHAYA	0.02	**PSNR**	20.63	27.54	29.83	34.56	33.78	**39.29**
			MSE	562.4	114.6	67.58	22.29	28.29	**7.66**
		0.04	**PSNR**	20.70	26.91	29.23	34.97	33.34	**39.28**
			MSE	552.8	132.4	77.72	22.87	28.87	**7.70**
		0.06	**PSNR**	20.74	26.89	29.12	34.73	33.87	**39.09**
			MSE	547.9	133.0	79.66	20.98	27.98	**7.80**
		0.08	**PSNR**	20.84	26.94	29.08	34.57	33.76	**39.01**
			MSE	536.2	131.7	80.44	20.70	27.70	**7.89**
		0.1	**PSNR**	20.91	26.94	29.12	35.08	33.06	**39.00**
			MSE	527.2	131.7	79.72	23.56	30.56	**7.94**

TABLE III: DENOISING RESULT OF THE CHAYYA IMAGE ON POISSON NOISE:

S.NO	**IMAGE**	**NOISE VARIANCE**	**PSNR & MSE**	**DIFFERENT DENOISING METHODS**					
				NOISY IMAGE	**MEDIAN FILTER**	**WIENER FILTER**	**HARD THRESHOLDING**	**SOFT THRESHOLDING**	**PROPOSED METHOD**
1.	CHHAYA	0.02	**PSNR**	25.01	30.51	31.53	35.76	34.67	**39.56**
			MSE	205.3	57.79	45.76	22.27	29.27	**7.50**

TABLE IV: DENOISING RESULT OF THE AADI VIDEO ON SALT & PEPPER NOISE:

S.NO	**VIDEO**	**FRAMES**	**PSNR & MSE**	**DIFFERENT DENOISING METHODS**					
				NOISY IMAGE	**MEDIAN FILTER**	**WIENER FILTER**	**HARD THRESHOLDING**	**SOFT THRESHOLDING**	**PROPOSED METHOD**
1.	AADI VIDEO	FRAME 1	PSNR	22.64	32.04	28.44	34.07	33.48	**39.49**
			MSE	352.7	41.78	92.78	23.69	29.99	**7.89**
		FRAME 10	PSNR	22.72	31.97	28.67	34.78	33.81	**39.34**
			MSE	347.5	41.29	88.32	21.62	26.89	**7.93**
		FRAME 20	PSNR	22.72	32.03	28.33	34.73	33.80	**39.35**
			MSE	347.5	40.71	95.53	22.83	27.94	**7.56**
		FRAME 30	PSNR	22.70	31.90	28.54	34.58	33.58	**39.62**
			MSE	349.3	41.96	91.01	22.54	29.28	**7.83**
		FRAME 40	PSNR	22.72	32.13	28.46	34.79	33.79	**39.39**
			MSE	347.8	44.31	86.89	21.53	27.56	**7.63**
		FRAME 50	PSNR	22.70	31.90	28.54	34.58	33.58	**39.62**
			MSE	349.7	45.89	92.68	21.78	27.8	**7.56**
		FRAME	PSNR	22.65	31.84	28.34	34.55	33.45	**39.55**

		60	MSE	349.3	43.73	91.70	25.78	30.75	**7.49**
		FRAME 70	PSNR	22.67	31.44	28.42	34.53	33.56	**39.60**
			MSE	351.5	44.64	93.50	23.89	27.71	**7.56**
		FRAME 80	PSNR	22.74	31.27	28.21	34.89	33.79	**39.23**
			MSE	346.1	48.52	98.18	24.29	28.78	**7.45**
		FRAME 90	PSNR	22.55	31.03	28.43	34.24	33.34	**39.19**
			MSE	361.7	48.56	93.42	25.89	29.34	**7.19**
		FRAME 100	PSNR	22.58	31.11	28.45	34.45	33.67	**39.54**
			MSE	359.2	50.39	93.01	21.67	28.78	**7.56**
		FRAME 110	PSNR	22.56	31.34	28.45	34.34	33.45	**39.40**
			MSE	355.5	47.81	92.78	23.78	29.77	**7.40**
		FRAME 120	PSNR	22.78	31.58	28.38	34.56	33.87	**39.56**
			MSE	349.9	46.39	94.56	24.56	28.87	**7.56**

TABLE V: DENOISING RESULT OF THE AADI VIDEO ON GAUSSIAN NOISE:

S.NO	**VIDEO**	**FRAMES**		**DIFFERENT DENOISING METHODS**					
				NOISY IMAGE	**MEDIAN FILTER**	**WIENER FILTER**	**HARD THRESHOLDING**	**SOFT THRESHOLDING**	**PROPOSED METHOD**
1.	AADI VIDEO	FRAME 1	**PSNR**	21.96	29.23	31.56	34.49	33.48	**39.49**
			MSE	155.3	45.73	38.72	23.69	29.99	**7.89**
		FRAME 10	**PSNR**	21.91	29.18	31.41	34.78	33.81	**39.34**
			MSE	159.3	44.9	38.92	24.69	30.67	**7.93**
		FRAME 20	**PSNR**	21.92	29.16	31.54	34.73	33.80	**39.35**
			MSE	153.6	46.57	40.96	24.83	27.94	**7.56**
		FRAME 30	**PSNR**	21.96	29.29	31.60	34.58	33.58	**39.62**
			MSE	158.9	50.01	45.81	24.87	29.28	**7.83**
		FRAME 40	**PSNR**	21.99	28.93	30.84	34.79	33.79	**39.39**
			MSE	160.0	49.57	46.36	25.89	27.56	**7.63**
		FRAME 50	**PSNR**	21.89	28.90	30.54	34.58	33.58	**39.22**
			MSE	156.2	47.02	41.71	22.51	29.78	**7.56**
		FRAME 60	**PSNR**	21.90	28.71	30.95	34.55	33.45	**39.55**
			MSE	161.8	51.73	51.70	27.78	30.75	**7.49**
		FRAME 70	**PSNR**	21.82	28.83	30.74	34.53	33.56	**39.60**
			MSE	156.1	47.64	43.50	23.89	27.71	**7.56**
		FRAME 80	**PSNR**	21.94	28.80	31.10	34.89	33.79	**39.23**
			MSE	158.2	48.92	47.20	24.29	28.78	**7.45**
		FRAME 90	**PSNR**	21.95	28.79	30.77	34.24	33.34	**39.19**
			MSE	157.8	47.06	45.89	25.89	29.34	**7.19**
		FRAME 100	**PSNR**	21.93	28.70	30.75	34.45	33.67	**39.54**
			MSE	154.2	45.82	40.85	20.82	28.78	**7.56**
		FRAME 110	**PSNR**	21.79	28.34	30.45	34.34	33.45	**39.40**
			MSE	156.8	47.81	41.56	25.78	29.77	**7.40**
		FRAME 120	**PSNR**	21.88	28.58	30.38	34.56	33.87	**39.56**
			MSE	155.7	46.39	40.87	24.56	28.87	**7.56**

TABLE VI: DENOISING RESULT OF THE AADI VIDEO ON POISSON NOISE:

S.NO	**VIDEO**	**FRAMES**	**PSNR & MSE**	**DIFFERENT DENOISING METHODS**					
				NOISY IMAGE	**MEDIAN FILTER**	**WIENER FILTER**	**HARD THRESHOLDING**	**SOFT THRESHOLDING**	**PROPOSED METHOD**
1.	AADI VIDEO	FRAME 1	**PSNR**	27.64	31.04	32.44	34.47	33.48	**39.89**
			MSE	110.7	39.36	29.26	22.78	26.78	**7.89**
		FRAME 10	**PSNR**	27.70	31.11	32.47	34.78	33.61	**39.64**
			MSE	116.7	40.89	29.89	22.94	25.56	**7.64**
		FRAME	**PSNR**	27.93	31.03	32.33	34.73	33.70	**39.35**

		20	**MSE**	108.4	35.62	26.81	23.89	24.70	**7.35**
		FRAME 30	**PSNR**	27.78	31.90	32.54	34.68	33.58	**39.62**
			MSE	114.2	41.37	27.54	24.68	28.58	**7.62**
		FRAME 40	**PSNR**	27.82	31.13	32.46	34.79	33.79	**39.49**
			MSE	107.5	38.27	26.78	20.98	24.67	**7.49**
		FRAME 50	**PSNR**	27.81	31.90	32.54	34.78	33.88	**39.82**
			MSE	107.7	38.40	26.98	20.78	24.88	**7.82**
		FRAME 60	**PSNR**	27.30	31.84	32.34	34.55	33.65	**39.45**
			MSE	121.1	44.22	30.45	23.55	28.65	**7.45**
		FRAME 70	**PSNR**	27.67	31.44	32.42	34.53	33.56	**39.80**
			MSE	121.9	41.44	32.42	24.53	28.56	**7.80**
		FRAME 80	**PSNR**	27.28	31.27	32.21	34.69	33.69	**39.23**
			MSE	119.6	40.27	29.21	20.69	26.69	**7.23**
		FRAME 90	**PSNR**	27.94	31.03	32.43	34.74	33.64	**39.49**
			MSE	131.9	41.03	32.43	21.74	28.64	**7.49**
		FRAME 100	**PSNR**	27.58	31.11	32.45	34.45	33.67	**39.74**
			MSE	124.8	40.11	29.45	21.45	28.67	**7.74**
		FRAME 110	**PSNR**	27.56	31.34	32.45	34.84	33.75	**39.70**
			MSE	121.7	39.34	30.45	24.84	26.75	**7.70**
		FRAME 120	**PSNR**	27.78	31.58	32.38	34.56	33.87	**39.56**
			MSE	104.8	38.58	29.38	24.56	27.87	**7.56**

VIII. CONCLUSION & FUTURE SCOPE

In this work, we performed filtering (median & wiener filtering) on noisy image and video than soft & hard thresholding performed for the same and obtain the best threshold, then finally we combine the result of filtering method and hard thresholding. Denoising is performed on the basis of performance measure like PSNR, MSE along with the better visual quality of image and video. Examining several techniques we have find that filtering and wavelet thresholding technique jointly gives good agreement of PSNR & MSE than other.

Further this denoising may be performing on other noises. From now on, it is further suggested that the proposed algorithm may be extended to the colored images and videos, which may further improve the video denoising. In future this work may be extending for medical images as well as texture images to get denoised image or video with improved performance parameter.

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