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An Effective Video Noise Removal Algorithm

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Abstract- *This paper deals with the development and implementation of efficient video de-noising algorithm using moving average filter in MATLAB 2012a. In spite of simplicity, the moving average algorithm is optimal for reducing random noise while retaining edge sharpness. The performance analysis of proposed algorithm with its relative is performed by calculating mean square error (MSE) and peak signal to noise ratio (PSNR). The results show that the proposed algorithm gives higher value of PSNR as well better vision quality.*

Keywords- Moving average filter, Average filter, MSE, PSNR, Video denoising, Gaussian noise.

1. INTRODUCTION

Noise is a dominant factor that can severely degrade the quality of videos signals during acquisition, transmission and reception process. The corrupting noise might results variation in some pixels value of all the video frames. So the noise reduction is highly desirable for improving visual quality. Denoising is a pre-process step for improving the accuracy of subsequent image processing algorithms like segmentation, object detection, object tracking, feature extraction etc. This pre processing task is necessary to remove corrupted pixel value while preserving other important details[1]. Numerous algorithms have been developed for corrected the noise of video signals based on noise model. The observational model of a noisy signal is considered as:

$$\boldsymbol{f[k] = s[k] + \eta[k]}$$

Where $s[k]$ is a noise free signal, $f[k]$ is the noisy signal and $\eta[k]$ is the Gaussian noise. The developed algorithms depend on the noise model which is basically classified in to - substitutive noise (salt & pepper noise), additive noise like Gaussian noise and multiplicative noise (speckle noise). Most of the relatives of video denoising algorithms consider additive noise to be corrected. This paper proposed a new effective algorithm based on moving average filtering. The performance of proposed algorithm's simulation results on Gaussian noise are justified with PSNR and MSE metrics. Comparative analysis of moving average algorithm and simple average algorithm has been reported.

The rest of the paper is organized as follows; in section 2 the general theory of average filter and moving average filter is reviewed. Section 3 elaborates the proposed algorithm for video noise removal. In section 4 implementation results is given on a noisy video. Section 5 has table and bar graph for the performance evaluation analysis of proposed algorithm. The concluding remarks are in section 6.

2. FILTER

In image processing, the main approach for denoising is filtering and basically average filters, median filters, Wiener filters and Kalman filters are used to remove noise. The easiest filter to understand and use is average filter [2]. This paper proposed an algorithm based on moving average filter that has very simple hardware implementation with better performance as compare to average filter.

2.1 Average Filter

The average filter or mean filter is the simple and common filter in digital signal processing. This filter works as low pass filter. It replaces each pixel value in an image with the mean value in a square window surrounding these pixels. In video pre processing, average filters can be used to remove noise but they cannot preserve the edges which render the image blurry. An example of mean filter of a single window 3×3 is given below. The mean pixel value is 5.

9	3	2
1	2	9
8	7	4

Unfiltered pixel

*	*	*
*	5	*
*	*	*

filtered pixel

2.2 Moving Average Filter

The moving average filter operates by averaging a number of frames form noisy video to produce each frame in the output video. The number of frames is named as sample size or window size. For each frame in the output video, this filter averages same number of frames. As the length of filter increases, the smoothness of output increases. The equation for moving average is

$$\mathbf{y[i]= \sum_{j=0}^{N-1} x[i+j]}$$

Where x[i] is the video input signal, y[i] is video output signal and N is the window size or number of frames used in moving average. For example if you have the numbers 1, 2, 3, 4, 5, 6, 7, 8, 9 then a 5 window size moving average is

y(1)=(1+2+3+4+5)/5=3

y(2)=(2+3+4+5+6)/5=4and so on.

This type of averaging can retain edge sharpness while reducing random noise. Thus make it premier filter for time domain encode signals and Video signals are encoded in time domain, therefore proposed algorithm uses moving average filtering to retrieve the corrupted pixel value[3].

3. PROPOSED ALGORITHM

The proposed algorithm is –

Step1- read input video frames.

Step2- add Gaussian noise in input video frames.

Step3- apply moving average filter with window size 15.

Step4- calculate PSNR and MSE.

4. IMPLEMENTATION

A video having 300 video frames is taken as INPUT VIDEO. Gaussian noise is added to the video that has to be removing by proposed algorithm. The video frames are made denoised after applying average filter and moving average filter algorithm. The results of frame no. 50, 100, 150 and 200 are shown in figure 1. First four images of the figure has input frames, second row presents respectively frames with Gaussian noise, third row has denoise frames by average filter and the last row shows output of proposed algorithm.

INPUT VIDEO

Frame 50 **Frame 100**

Frame 150 **Frame 200**

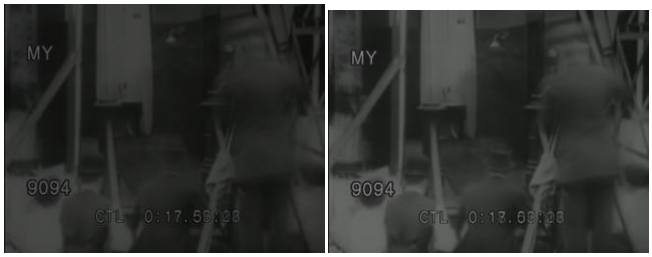
VIDEO FRAMES AFTER ADDING GAUSSIAN NOISE

(Frame 50) **(Frame 100)**

Frame 150 **Frame 200**

VIDEO FRAMES WITH MEAN FILTERING

Frame 50 **Frame 100**



Frame 150 **Frame 200**

VIDEO FRAMES WITH PROPOSED ALGORITHM

Frame 50 **Frame 100**

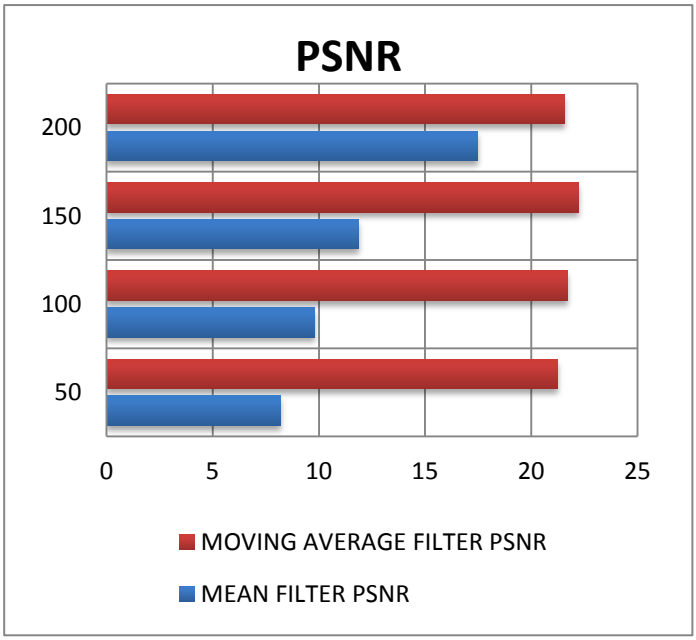
Frame 150 **Frame 200**

The PSNR is defined as 10*log10 of the ratio of peak signal energy to MSE observed of the processed video signal and original video signal. PSNR is calculating via Mean Square Error (MSE):

5. PERFORMANCE EVALUATION

The simulation results of proposed algorithm are justified by performance evaluation metrics PSNR and MSE [5]. PSNR is used to measure the quality of reconstruction.

Frame no.	Average Filter PSNR	Proposed Algorithm PSNR
50	8.2017	21.2310
100	9.8046	21.705
150	11.8551	21.5619
200	17.4662	22.2251

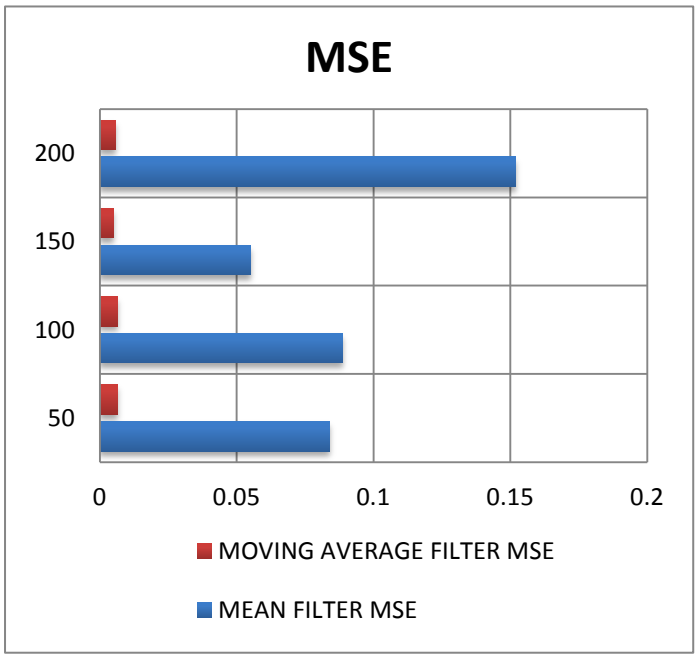


$$MSE = \frac{1}{m\,n}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2$$

$$PSNR = 10 \cdot \log_{10}\left(\frac{MAX_I^2}{MSE}\right)$$

Here max is the maximum possible pixel value of frame. The PSNR and MSE value of frame no. 50, 100, 150, 200 with average filter and proposed algorithm is shown in the table-

Frame no.	Average Filter MSE	Proposed Algorithm MSE
50	0.0839	0.0064
100	0.0886	0.0066
150	0.0552	0.0059
200	0.152	0.0051



6. CONCLUSION

In this paper, a video denoising algorithm is proposed where Gaussian noise filtering is done in time domain. The performance of moving average filtering is better than average filter. The experimental results with graph and table show larger value of PSNR and MSE with proposed algorithm.

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