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DENOISING LOW LIGHT VIDEO USING WAVELET FILTER

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Abstract— ***Video quality enhancement is a long standing area of research. Noise is dominant factor that degrades image quality. Video denoising is a challenging topic in image processing; its main aim is to achieve an efficient, adaptive and high quality video denoising algorithm that can effectively remove real, structured noise introduce by digital camera. Noise reduction and enhancement of extremely low light video have poor dynamic range. Dynamic range of denoised video is increased by adjustment of RGB histogram. Usually the success of any algorithm depends on the method that helps to improve the quality of image. In the last decades video denoising has been studied, several types of filters have been used to remove noise from video. Noise is removed using a nonlocal means (NLM) denoising filter. This method work directly on color filter array (CFA) raw video for achieving low memory consumption.***

In video denoising quality of video is very important, for that purpose we use three methods to remove noise and enhance the quality of video. Whenever enhancement technique we have to use, we have to use it on degraded frames. Degraded frames mean low quality frames, dark frames. Instead of spatio temporal method, we use separate temporal and spatial method to get better result. Tone mapping is used to enhance low light video and try to remove color balance problem.

Index Terms— Video denoising, wavelet filter, Low light video, Non local mean.

I. INTRODUCTION

A: Video Denoising-

Video denoising is the process of removing noise from a video signal. The purpose of denoising is to get the original image from noisy data. Now a day, there have been substantial improvements in modern digital cameras including resolutions and sensitivity. Although these improvements, quality of videos in low light conditions is still limited. Low light videos have poor dynamic range. To capture images of high dynamic range, most consumer cameras often rely on automatic exposure control, but longer exposure time results motion blur. Secondly, image sequences captured in low-light conditions often have very low signal to noise ratio. Many approaches are developed for enhancing low light video [3]-[9]. Most of the approaches introduced only for videos under moderately dark conditions in which most objects and background are almost visually recognizable [3] - [15].

Two major characteristics of low light video is high level of noise and low dynamic range. Since these characteristics influence mutually on both denoising and tone mapping performances, they should be analyzed deliberately before developing low-light video enhancement technique. Another important characteristic of low-light video is its limited dynamic range. We focus on video denoising in this paper.

B: Video

Video can be defined as visual multimedia source that combines image sequences to form a moving picture. Audio components corresponding to the images being shown on the screen are the video content. Frame can be defined as one of the still image which composes the complete moving picture [5]. Video noise is random variation of brightness or color information in images, and is usually an aspect of electronic noise. It can be produced by the sensor and circuitry of a scanner or digital camera. Image noise can also originate in film grain and in the unavoidable shot noise of an ideal photon detector. The original meaning of noise is unwanted signal. In video, noise refers to the random dot pattern that is superimposed on the picture as a result of electronic noise.

C: Image Enhancement

Image enhancement means getting a clear image. Image enhancement can be treated as transforming one image to another so that look and feel of image can be improved. Image enhancement technique consists of collection of technique that seek to improve the visual appreance of image or to convert the image to form better suited for analysis by human or machine. The principal objective of image enhancement technique is to process an image so that result is more suitable than the original image for a specific application. It is often used to increase the contrast of images that are substainally dark or light. Image enhancement refer to those image processing operations that improve the quality of input image in order to overcome the weakness of human visual system.

Figure 1. a) 1) Original image 2)Enhance image

I. ANALYSIS OF RELATED WORK

Several works have been carried out by researchers on the concept of video denoising. In video denoising, noise is the dominant factor that degrades image quality; several methods are used to remove noise from video. Lot of work done by many researchers may have some advantages as well as disadvantages. We can see few of them in the following table.

Sr. no.	Paper title	Publication year	Main work	Advantage	Disadvantage
1	Adaptive histogram equalization and its variations.	Sept. 1987	Construct a 3D structure tensor method.	Get additional filter.	This method become unstable &Produces blurry result
2	Bilateral filtering for gray and color images.	Jan. 1998.	Use spatiotemporal method.	Good for high quality video.	Not give reliable result with low light video.
3	Noise-adaptive spatiotemporal filter for real-time noise removal in low light level images.	May. 2005.	Use both Poisson noise and false color noise of input videos	Maintain quality of frames.	Require longer time for calculation
4	A non-local algorithm for image denoising.	Jun. 2005.	Use modified version of NLM.	Maintain color of images.	Accuracy problem is there.
5	Video enhancement using per-pixel virtual exposures.	Jul. 2005.	Developed an enhancement framework for low dynamic range video.	Methods are applied to a large scale and detail features separately.	Dynamic range is omitted.
6	Adaptive enhancement and noise reduction in very low light level video.	Oct. 2007.	Use contrast limited histogram equalization (CLHE).	Improve the quality and color of images.	This method becomes unstable and produces blurry results.

Table1: Review work by different persons.

More recently, new approaches applying the concept of a single image de-hazing algorithm [14] on the intensity inverted low-light video were presented by Dong *et al*. [10] and Zhang *et al*. [13]. These methods are developed under an observation that statistics of an intensity inverted low-light video are similar to those of a hazy video. However, the estimation of a transmission term in the hazy image acquisition model by using a dark channel prior (DCP) becomes unreliable in very low-light conditions and requires large computation loads.

T. Liu and J. Zhao [11] suggested that under extremely low-light conditions, signal level becomes very low, therefore read-out noise is the dominant component but FPN can be removed with flat fielding or dark frame subtraction.

P. Chatterjee [12] and M. Kim [15] is aimed to developed a novel framework to enhance video from extremely low light environment, for this purpose they require additional artifact and this will take a lot of time.

III. PROPOSED WORK

Video denoising is a challenging topic in image processing; its main aim is to achieve an efficient, adaptive and high quality video denoising algorithm that can effectively remove real, structured noise introduce by digital camera. This paper presents a technique to overcome the drawback of previous work**.** Temporal noise reduction, tone mapping (Histogram equalization) and spatial noise reduction methods are used to remove noise from video. There are methods that transform data to other bases for the purpose of denoising such as wavelet or curvelet based methods. Non-local means is an algorithm in image processing for image denoising.

Algorithm:

1. Select input video.
2. Select video format (avi, mp4, mpg) which is required to enhance.
3. Divide video into frames and audio.
4. Then decide quality frames and degraded frames.
5. Next to enhance degraded frames using three methods.
6. After removing noise create video without sound.
7. Then add extracted sound in video.
8. Play enhance video.

Steps of proposed system-

1. Select input video- Give low quality video as input, video that contain dark frames or the frame that is not properly visible. This gives basic information about video such as video duration, video name, video path, video frame rate, video height, video bit per pixel and video format.

2. Select extract frame button-Video is combination of frames and audio. So extract all the frames from video and put it into extract frame folder. Here we take .bmp

uncompressed image format to secure all the information. Jpg is compressed image format means loss of information is there.

3. Select extract sound button-After extracting frames, next to extract sound from video and put it into extract sound folder with .wav extension. Wav stand for waveform audio file format, an audio file format for storing audio data on a computer system.

4. Select classify frames button-

After extraction, next to concentrate on each frame to remove noise. Whenever the enhancement technique is use, use it on degraded frames. Image is a combination of pixels and pixels is made up of RGB. When we have to calculate mean intensity convert it to gray scale means AV=R+G+B/3..So R= AV, G=AV, B= AV that image is single channel image i.e. R=G=B. This window contains quality frames and degraded frames. Mean intensity of frame is very important to decide quality and degraded frames. Work only on degraded frames, low quality frames and darken frames that is stored in degraded folder. Then calculate mean intensity with the help of following equation-

$$MI = \sum_{i=1}^{n} P_i + P_{i+1} + \ldots\ldots\ldots + P_{i+n}$$

equation (1)

$$MI = \begin{cases} > 0.3 & \text{Quality Frame} \\ \leq 0.3 & \text{Degraded Frames} \end{cases}$$

Where p is pixel and I is sum of all pixels in the image.

5. Select enhance frame button-

Then next is to concentrate on degraded frames to remove noise. Noise is the dominant factor that degrades image quality. Three methods are used to remove noise from frames. These methods are:

1) Temporal noise reduction- use adaptive spatio-temporal filter. This filter is a combination of temporal or spatial bilateral filter. Adaptive anisotropic filter uses 3D structure tensor to smooth a low light video. Intensity value of low light video before tone mapping step is very small and noisy. In temporal noise reduction enhancement factor is based on mean intensity, if mean intensity is 0 to1 then 0.6 is the enhancement factor. If mean intensity is 0.1 to 0.2 then 0.7 is the enhancement factor accordingly we have to calculate R'-is sum of R and enhancement factor. Accordingly calculate mean intensity for R, G, and B are as follow….

$$R' = R + R \times EF. \quad \text{equation (2)}$$
$$G' = G + G \times EF. \quad \text{equation (3)}$$
$$B' = B + B \times EF. \quad \text{equation (4)}$$

2) Tone mapping-is used to map one set of color with another. After the temporal noise is reduced, dynamic range of lowlight video is required to be stretched for enhancing visibility. Histogram equalization with gamma correction is used here to maintain color of image. Some pixel has very small intensity value, to enhance only those pixels, RGB histogram is stretched. In histogram equalization if absolute value of P_i and P_{i+1} is greater than 20, then one value is odd. To find out which pixel is odd we have to execute loop….

$$| P_i - P_{i+1} | > 20$$

If $P_i > P_{i+1}$

Odd P_i

Else

Odd P_{i+1}

$$\text{Avg} = \frac{\sum P_i + P_{i+1} + \ldots\ldots\ldots + P_{i+n}}{n}$$

Set

Odd = Avg

3) Spatial noise reduction-Large amount noise is removed in temporal and tone mapping. Temporal noise reduction method use spatio-temporal filter before tone mapping so additional filtering in spatial domain is required to remove remaining noise. Firstly, pixels of each color channel are smoothed separately with a modified Gaussian mask. Consider only those neighboring patch with same pattern as a reference patch to avoid any faulty inter color similarity computations.

i) If r value is > 250 or <=255 then decrement the value of r, g, b by 10. ii) If r value is > 240 or <=249 then decrement the value of r, g, b by 8. iii) If r value is > 230 or <=239 then decrement the value of r, g, b by 6. Iv) If r value is > 220 or <=229 then decrement the value of r, g, b by 4. V) If r value is > 200 or <=219 then decrement the value of r, g, b by 3. Vi) If r value is > 180 or <=199 then decrement the value of r, g, b by 2. Vii) If r value is > 0 or <=50 then increment the value of r, g, b by 10.

First check for "r" First check for "g" First check for "b"

RGB=
- 250 - 255r = r – 10 g = g - 10 b = b -10
- 240 - 249r = r – 8 g= g – 8 b = b - 8
- 230 - 239r = r – 6 g = g – 6 b = b - 6
- 220 - 229r = r – 4 g = g – 4 b = b –4
- 200 - 219r = r – 3 g = g – 3 b = b - 3
- 180 - 199r = r – 2 g = g – 2 b = b - 2
- 0-50 r = r +10 g = g +10b=b+10

6) Select create video without sound-

After removing all the noise from frame, next to collect all the frames in one folder. Then create video without sound.

7) Select insert sound button-

After creating video next to insert sound. Frame rate is very important, no of frames displayed per second. See how many frames are there, accordingly insert sound.

8) Select play enhance video button.

When we play enhance video, then we see the difference between low quality video and enhance video.

9) Select result analysis button.

In result analysis we get MI of original and resultant video, average entropy of original and resultant video. PSNR and MSE calculation are as follow.

S = S + (W_ double (j) - O_double (j)) ^2 ;

Where "S " is the sum of difference between two image pixels.

Mes = S/size _host;

Psnr = 10 x log 10((225) ^2/mes);

10) Select exit application button.

Data Flow Diagram of Proposed Work

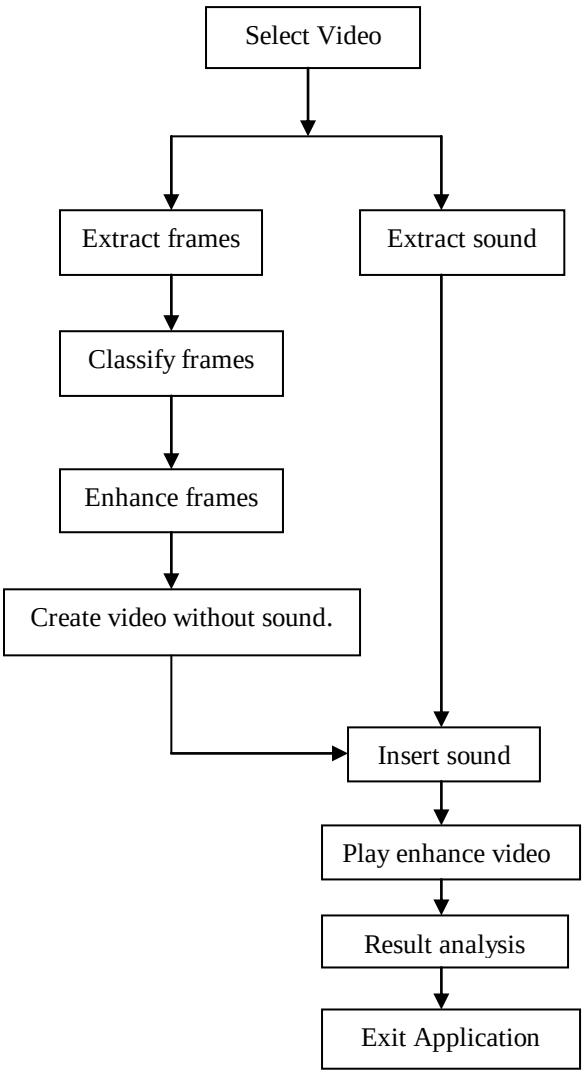

Fig 2. Flow diagram, for denoising low light video using wavelet filter.

IV Result Analysis:

We take different video samples with different size and check for quality and degraded frames using three methods.

Table 2. Different video samples with varying values and time for quality check and time required for image enhancement

Sr. No	Video Name	Video Size	No of Frames	Extracted Frames	Quality Frames	Degraded Frames	Time for Quality Check	Time Image Enhancement			Enhance Video Size
								Temporal Noise Reduction	Tone Mapping	Spatial Noise Reduction	
1	Video1.Avi	48.2 MB	91	50	00	50	3.54 sec	12.74	38.29sec	1.77sec	56MB
2	Video2.Avi	559KB	36	36	00	36	1.25 sec	4.99sec	8.93sec	0.34sec	7MB
3	Video3.Avi	1.05 MB	51	50	00	50	1.69 sec	7.42sec	12.20sec	0.34sec	10MB
4	Video4.MPG	6.73 MB	486	50	00	50	3.06 sec	10.35sec	31.46sec	1.32sec	43MB
5	Video5.MPG	3.85 MB	279	50	00	50	2.97 sec	9.99sec	29.98sec	1.36sec	43MB
6	Video6.MP4	1.03 MB	775	50	00	50	1.86 sec	7.52sec	12.98sec	0.41sec	12MB
7	Video7.MP4	321KB	402	50	00	50	1.79 sec	7.78sec	15.47sec	0.51sec	17MB
8	Video8.MP4	1.04 MB	784	50	15	35	1.44 sec	5.39sec	9.85sec	0.41sec	13MB

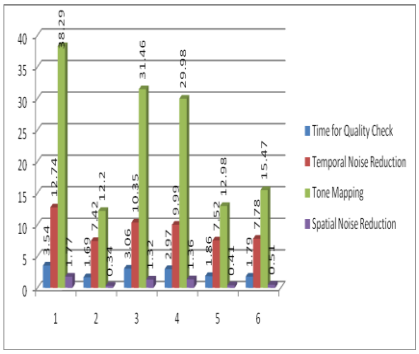

Fig 2. Time required for quality check ffor three methods.

From table 2 and figure 2 we observe that,

- The graph shows time, time required to divide quality frames and degraded frames.
- Three methods are used to remove noise from frames.
- Temporal method removes noise from frame and time required to remove is shown in graph.
- As compare to temporal and spatial, tone mapping required more time to remove noise.
- Spatial noise requires less time to remove noise as compared to tone mapping and temporal method.
- Spatial noise reduction method is our proposed work.
- So this work is satisfied.

Future Scope

1) Extreme low light video (Probably all frames having mean intensity closer to 0) need to have an improved enhancement approach in proposed methodology.
2) Proposed methodology not focuses on removal of noises like paper salt, Gaussian and speckle noise etc.

Conclusion-

In this paper of denoising low light video using wavelet filter, the characteristic of low light video that is captured in low light condition is analyzed. Enhancement of low light video is also proposed. Separation of temporal and spatial method in the proposed noise reduction scheme provides more visually pleasing result than conventional spatio temporal method. Histogram equalization with gamma correction is used to increase dynamic range of low light video. Tone mapping is used to enhance the visibility of low light video and maintaining the color balance problem. The proposed technique is capable of removing noise from video is very well shown by experimental results. The performance of approach is tested on several videos. Results are satisfactory and encouraging.

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V. REFERENCES

[1] S. Pizer, E. Amburn, J. Austin, R. Cromartie, A. Geselowitz, T. Geer, B. H. Romeny, J. Zimmerman, and K. Zuiderveld, "Adaptive histogram equalization and its variations," *Comput. Gr. Image Process*, vol. 39, no. 3, pp. 355-368, Sept. 1987

[2] C. Tomasi and R. Manduchi, "Bilateral filtering for gray and color images," in *Proc. International Conference on Computer. Vision*, Bombay, India, pp. 839-846, Jan. 1998.

[3] S. W. Lee, V. Mail, J. Jang, J. Shin, and J. Paik, "Noise-adaptive spatiotemporal filter for real-time noise removal in low light level images," *IEEE Trans. Consumer Electron.*, vol. 51, no. 2, pp. 648-653, May. 2005.

[4]A. Buades, B. Coll, and J. Morel, "A non-local algorithm for image denoising," *In Proc. IEEE Conference on Computer Vision and Pattern Recognition*, San Diego, USA, vol. 2, pp. 60-65, Jun. 2005.

[5] E. Bennett and L. McMillan, "Video enhancement using per-pixel virtual exposures," *ACM Trans. Graphics*, vol. 24, no. 3, pp. 845-852, Jul. 2005.

[6] H. Malm, M. Oskarsson, E. Warrant, P. Clarberg, J. Hasselgren, and C. Lejdfors, "Adaptive enhancement and noise reduction in very low light level video," *In Proc. IEEE International Conference on Computer Vision*, Rio de Janeiro, Brazil, pp. 1-8, Oct. 2007.

[7] C. Wang, L. Sun, B. Yang, Y. Liu, and S. Yang, "Video enhancement using adaptive spatio-temporal connective filter and piecewise mapping," *EURASIP J. on Advances in Signal Process.*, vol. 2008, pp. 1-13, 2008.

[8] Q. Xu, H. Jiang, R. Scopigno, and M. Sbert, "A new approach for very dark video denoising and enhancement," *In Proc. IEEE International Conference on Image Processing*, Hong Kong, China, pp. 1185-1188, Sept. 2010.

[9] A. Loza, D. Bull, and A. Achim, "Automatic contrast enhancement of low-light images based on local statistics of wavelet coefficients," *In Proc. IEEE International Conference on Image Processing*, Hong Kong, China, pp. 3553-3556, Sept. 2010.

[10] X. Dong, G. Wang, Y. Pang, W. Li, J. Wen, W. Meng, and Y. Lu, "Fast efficient algorithm for enhancement of low lighting video," *In Proc. IEEE International Conference on Multimedia and Expo*, Barcelona, Spain, pp. 1-6, Jul. 2011.

[11] T. Liu, J. Zhao, H. Feng, Z. Xu, and H. Chen, "Image noise removal using Kalman-filter on dark frame," *in Proc. SPIE International Symposium on Photoelectronic Detection and Imaging*, vol. 8194, Beijing, China, May. 2011.

[12] P. Chatterjee, N. Joshi, S. B. Kang, and Y. Matsushita, "Noise suppression in low-light images through joint denoising and demosicing," *In Proc. IEEE Conference on Computer Vision and Pattern Recognition*, Colorado Springs, USA, pp. 321-328, Jun. 2011.

[13] X. Zhang, P. Shen, L. Luo, L. Zhang, and J. Song, "Enhancement and noise reduction of very low light level images," *In Proc. International Conference on Pattern Recognition*, Tsukuba, Japan, pp. 2034-2037, Nov.2012.

[14] D. Park, D. K. Han, and H. Ko, "Single image haze removal with WLS-based edge preserving smoothing filter," *in Proc. IEEE International Conference on Acoustics, Speech, and Signal Processing*, Vancouver, Canada, pp. 2469-2473, May. 2013.

[15] M. Kim, D. Park, D. K. Han, and H. Ko, "A novel framework for extremely low-light video enhancement," *in Proc. IEEE International Conference on Consumer Electronics*, Las Vegas, USA, pp. 95-96, Jan. 2014.

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