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390 – 394

Pixel Threshold Adjustment for Enhancing Degraded Frames of Uncompressed AVI

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Abstract**—**High noise level from darkness and low dynamic range severely degrade the visual quality of image or video. From previous few years there has been vital work on video process and improvements in Digital cameras. Still there is a problem in modern digital cameras to capture high dynamic range images and videos in low-light conditions. To resolve such issues associated with the deficient quality of low light there exist video enhancement technique which is used to make object standout from their background and become more detectable. Effective framework approach for Low vision frames enhancement using pixel threshold adjustment for enhancing degraded frames of uncompressed AVI has been proposed; aim to get clear video from low light or dark environments.

Keywords-*Video Enhancement, Pixel Threshold Adjustment, Degraded Frames, Uncompressed AVI.*

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I. Introduction

Digital video has become an integral part of day to day life. It is well-known that video enhancement as an active topic in computer vision has received abundant attention in recent years. From last the few years, there has been a substantial capability improvement in digital cameras together with resolutions and sensitivity. Despite these improvements, however, modern digital cameras are still limited in capturing high dynamic range videos in low-light conditions.

Low light videos are featured by poor contrast, poor resolution and limited dynamic range. Therefore, videos captured in the environment with low light aren't clear for human visual system. To solve such problems, it is necessary to create a video enhancement method. Video enhancement problem can be formulated as follows: given an input low quality video and the output high quality video for specific applications. The prime intention of video enhancement is to bring out detail information that is hidden in video [1]. The object of enhancement is to improve the signal and to decrease the noise. Many approaches are developed for enhancing low-light video; however most of them consider video from moderately dark conditions [2]-[3].

There are numerous applications where digital video is acquired, processed and used, such as surveillance, general identity verification, criminal justice systems, civilian or military video processing, biology, archaeology, medicine, spaceflight, and display industry.

Here the aim is to develop a novel framework to enhance video from extremely low-light environments. In this research, techniques presented are Adjust Pixel values, Histogram Equalization, Pixel Balancing.

II. Previous Work

In 1990, Perona and Malik [4] presented Scale-space and edge detection using anisotropic diffusion technique for noise reduction.

Lee, Kang [6] presented a technique i.e. 3D and spatiotemporal noise reduction in video in 1998.In [7] and [8], the so-called structure tensoror second moment matrix in order to analyze the local spatio-temporal intensity structureand stear the smoothing accordingly.

Malm and Warrant [9] presented a methodology for adaptive enhancement and noise reduction for very dark image sequences with very low dynamic range in 2007.

In 2008, Chao Wang, Li-Feng Sun, Bo Yang, Yi-Ming liu, and Shi-Qiang Yang [10] introduce a novel video enhancement system based on an adaptive spatio-temporal connective (ASTC) noise filter and an adaptive piecewise mapping function (APMF) introduced.

Qing Xu1 [11] presented a novel three-stage algorithm for very low-light video denoising and enhancement in 2010. A new framework for very dark videos denoising and enhancement has been introduced and shown to largely improve current state-of-the-art results.

In 2010, Xuan Dong, Jiangtao (Gene) Wen, Weixin Li, Yi (Amy) [12] presented a novel, simple and effective enhancement algorithm for low lighting video.

Ce Liu, William T. Freeman [13] in 2010 introduced an adaptive video denosing framework that incorporate robust optical flow into a non-local means (NLM) framework along with the noise level estimation.

In 2012, Dr.Ch. Ravikumar, Dr. S.K. Srivatsa [14] presents by using low-cost Field programmable gate array (FPGA)-based hardware to improve the computational speed of video enhancement.

Jinhui Hu [15] presented a technique of kinect depth based method for low light surveillance image enhancement in 2013. Pre-processing for Kinect depth map, depth constrained non-local means denoising and depth aware contrast stretching are performed successively in this algorithm to promote the visual quality for low light surveillance image.

Dr. A. Sri Krishna, G. Srinivasa Rao and M. Sravya [16] presents widely used image contrast enhancement technique Histogram equalization (HE) in 2013.

In 2013, Niraj Kumar Sahu, Sampada Satav [17] introduced basic idea of utilize intra frame techniques available for still image enhancement to develop video enhancement techniques. Intra frame Image enhancement processes consist of a collection of techniques that gives motion to improve thevisual appearance of an image or to convert the image which is suited for analysis by a human or machine.

In 2014, Minjae Kim, Student Member, IEEE [18] proposed a novel framework for enhancement of very low-light video. For noise reduction, motion adaptive temporal filtering based on the Kalman structured updating is introduced.

III. PROPOSED WORK

Enhancing the uncompressed video in low light includes object separation, Frames enhancement, Video creation, Audio insertion. Here video is used as input data. In Object separation it separates the objects of video that is frames and audio to work on frames of video. In the second stage i.e. Frames enhancement all the degraded video frames of low light input video get enhanced by pixel threshold adjustment. In this part frames of low light video get enhanced.

After enhancing all the frames there is video creation step in which video get created with all the enhanced frames. The last part i.e. audio insertion in which audio gets inserted in the video .i.e. User get enhanced video with sound.

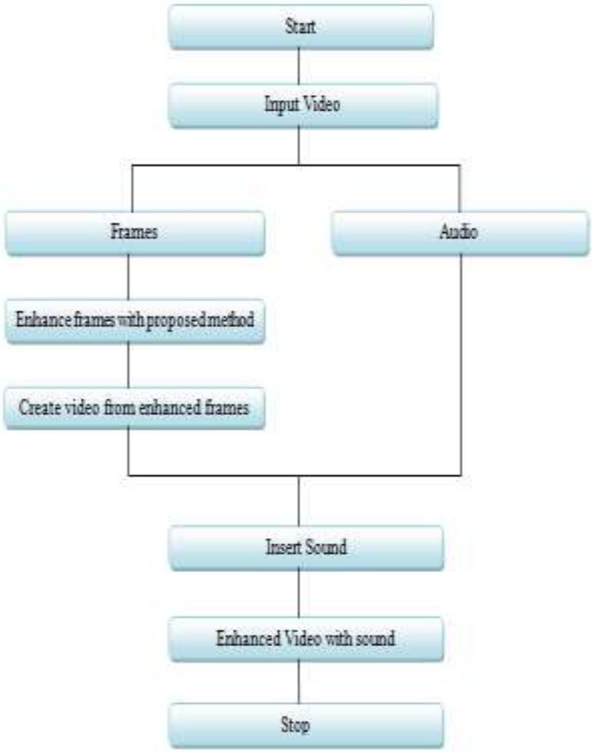


Figure1. Flowchart of Video Enhancement

Before Enhancement frames get classified by quality & degraded frames in which degraded frames get enhanced. For classification following equation is used:

$$f(x) = \begin{cases} \leq 0.4 & \text{Low Quality} \\ > 0.4 & \text{High Quality} \end{cases} \qquad (1)$$

Where X = Intensity value of frame.
Techniques used for Enhancement:

A. Adjust Pixel Values:

A pixel as the smallest element of an image.Here adjusting image intensity values for brightness of an image. For enhancement need to make darken pixel values to brighten. As zero is darker and one is brighter. As stated earlier image intensity values ranges from 0 to 0.45 are darker frames. So system works on the frames whose intensity value ranges from 0 to 0.45. For enhancement of dark frames some conditions are applied where enhancement factor (e.f.) is set by user.

If $0 \leq MI \leq 0.2$
Then e.f. = 0.8; (2)

If $0.2 \leq MI \leq 0.4$
Then e.f. = 0.85;(3)

If $0.4 \leq MI <= 0.5$
Then e.f. = 0.8;(4)

For example intensity value of image is 0.1 then 2nd equation is applied. Means enhancement factor will set to 0.8 for further calculations.After getting the enhancement factor (e.f.) system works on each pixel of that particular image. As the image on which system is working is color image. Each pixel has 3 color components which consist of red plane, blue plane & green plane and when the intensity values of each other is super imposed on each other the original color of image is produced. By multiplying the enhancement factor with value of r-g-b component of each pixel user can enhance the image.

Each parameter (red, green, and blue) defines the intensity of the color as an integer between 0 and 255. If for example, the value of r component is 90 i.e. nearer to 0 or darker region then by applying given equations with enhancement factor, intensity value of r, g & b components increases & brightness also increases. By using the enhancement factor which obtained in previous conditions user can enhance the image with following equations.

$$r' = r + r \times e.f. \quad (5)$$

$$g' = g + g \times e.f. \quad (6)$$

$$b' = b + b \times e.f. \quad (7)$$

Where,
r is red component of pixel& **r'** is resultant value of red componentafter applying pixel adjustment method.
g is green component of pixel & **g'** is resultant value of red component after applying pixel adjustment method .
b is blue component of pixel & **b'** is resultant value of red component after applying pixel adjustment method.
e. f. is Enhancement Factor.

After adjustment of pixel Median filter is applied. Median filter is most predominantly used to eradicate the unwanted disturbance which is present in an image.The results that are obtained for later processing will enhance the pre-processing function and is considered for reduction of noise in an image. Median filtering preserves edges while removing noise [19]. It is particularly effective at removing 'salt and pepper' type noise. Images will be corrupted by―salt(with value 255) and ―pepper (with value 0) noise with equal probability. Median filtering is done by, first sorting all the pixel values from the surrounds neighborhood into numerical order and then replacing the pixel being considered with the middle pixel value.

B. Histogram Equalization:

After adjustment of pixel & median filter, there is histogram Equalization is applied. Histogram Equalization enhances the contrast of images by transforming the values in an intensity image, or the values in the colormap of an indexed image, so that the histogram of the output image approximately matches a specified histogram [20].

For a simple RGB color image, histogram equalization cannot be applied directly on the channels. It needs to be applied in such a way that the intensity values are equalized without disturbing the color balance of the image. The first step is to convert the color space of the image from RGB into one of the color spaces that separates intensity values from color components. Here converting an RGB color map to an HSV (Hue-saturation-value) color map and enhancing the Intensity while preserving hue and saturation components. The updated HSV image matrix is converted back to RGB image matrix.

The following steps are performed to obtain histogram equalization:

1. Find the frequency of each pixel value.

Consider a matrix A= $\begin{bmatrix} 1 & 4 & 2 \\ 5 & 1 & 3 \\ 1 & 2 & 4 \end{bmatrix}$ With no of bins= 5

The pixel value 1 occurs 3 times.
Similarly the pixel value 2 occurs 2 times and so on.

2. Find the probability of each frequency.
   The probability of pixel value 1's occurrence = frequency(1)/ no of pixels.i.e. 3/9.

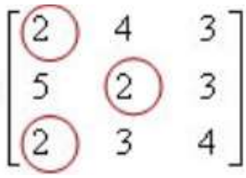
3. Find the cumulative histogram of each pixel:
   The cumulative histogram of 1 = 3.
   Cumulative histogram of 2 = cumulative histogram of 1+ frequency of 2=5.
   Cumulative histogram of 3 =
   Cumulative histogram of 2+ frequency of 3=5+1=6.

4. Find the cumulative distribution probability of each pixel cdf with(no of bins);
   Cdf of 1=
   Cumulative histogram of 1/no of pixels = 3/9.

5. Calculate the final value of each pixel by multiplying cdf with (no of bins);
   Cdf of 1= (3/9)*(5)= 1.6667. Round off the value.

 ISSN: 2321-8169
390 – 394

6. Now replace the final values :



The final value for bin 1 is 2. It is placed in the place of 1 in the matrix.

C. Pixel Balancing:

When the SNR is lower than a certain level, one can't remove all the noises and the image details are inevitably influenced by the noise reduction. At that time, one needs to choose a balance between the levels of noise versus the noise reduction effect to achieve an acceptable quality of image. If value of any pixel goes to extreme dark or extreme white condition then this method balances the value with neighboring values.

R-G-B component ranges from 0 to 255. If the value of any component is nearer to 255 i.e. more whiten or nearer to 0 i.e. more darker then this method balances the pixel values by performing addition & subtraction of the some numbers to original pixel values.

IV. Result Analysis

Image basically made up of number of pixels. Any work that is related with the image can be done on the basis of number of pixels in an image, size of the image, color intensity of the image and the shape of the image. The purpose of this section is to focusing on the various parameters i.e. entropy, mean intensity, time required for enhancement, peak signal to noise ratio, mean square error. The main parameter to analyze the result of this system is the HVS (Human Visual System).

For result analysis, low light video is taken and all proposed techniques are tested with the video.These methods took different processing time depends on the frame size (width & height) of input video.

Table 1.Showsthe informationabout low light input video which includes video name, size of video, Video Duration, Video Height, Video Width, Total no of frames of video, quality & degraded frames of video.

Table 1. Details of Input low light Video

Input Video Name	Lowlight.avi
Size of Video	308kb
Video Duration	4.7273sec
Video Height	288
Video Width	360
Total no of frames	134
Quality Frames	0
Degraded Frames	134

Table 2 shows the comparative study of input image andenhanced image of video:

Table 2. Comparative study of original & enhanced frames

	Original Frames		Enhanced Frames	
	Entropy	Mean Intensity	Entropy	Mean Intensity
Frame 1	4.9347	0.07843	6.063	0.43922
Frame 2	4.9347	0.08235	6.0418	0.43922
Frame 3	4.9329	0.08235	6.082	0.43529

Table 3.Gives the result of enhancement. After getting the information about video and frames of input videos, various operations are performed on images for enhancement. PSNRis the ratio of maximum power of the signal to the power of the noise which is corrupted, which affects the fidelity of representation. MSE is used to find out the occurrence of unwanted noise in the image

Table 3. Result of input video by Proposed System

Video Name	MSE	PSNR	Average Entropy	Mean Intensity
low light.avi	10846.86	7.8305	6.2119	0.43389

Figure 2.Shows the difference between input image & enhanced image. Input low light captured image get enhanced by proposed system.

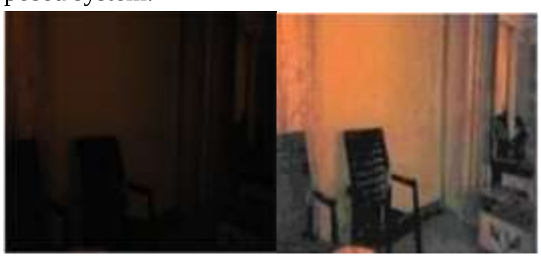


Figure 2. Input low light captured image (left) and enhanced image by proposed system (right)

V. Conclusion

It is always expected that the digital camera should work effectively in all types of lighting and whether condition but the majority of these cameras are failed to capture images and videos in low light state, hence the low quality of images and videos being captured. This research work is focused on proposing the methodologies for video enhancement which is automatic, computationally lightweight and real time. In this workmethods which are used are highly promising for real time applications to consumer digital cameras, especially

CCTV and the surveillance video system.The proposed system provides methods to perform an enhancement only on degraded frames by using Pixel Adjustment, Histogram Equalization, and Pixel Balancing. The system delivered the quality output when it compared with input video. Finally system is able to enhance unwatchable videos into acceptable footage.

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