Low Light Video Enhancement: A Survey

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ABSTRACT
From last few years, there has been substantial work on video processing and wide improvements being carried out in video processing including resolutions and sensitivity. Despite these improvements, still there is a problem to capture a high dynamic range images and videos in low-light conditions especially when light is very low. If the intensity of noise is higher than the signal then the conventional denoising techniques cannot work properly. For the said problem there are many approaches being developed for low-light video enhancement but still Low contrast and noise remains a barrier to visually pleasing videos in low light conditions. To capturing videos in concerts, parties, social gatherings, and in security monitoring situations are still an unanswered problem. In such conditions the video enhancement of low quality video is a really tedious job. This paper is elaborating a survey of different type of methods and technologies that have been used and implemented in the area of video enhancement. The study is further going on to find a technique so that more accuracy can obtained in video enhancement.

Keywords
Video Enhancement, quality assessment, enhancement algorithm, low light images, noise, filter, image enhancement.

1. INTRODUCTION
Over the previous couple of years, there has been a in depth capability improvement were take place in digital cameras within the space of resolutions and sensitivity But still there is limitation in modern digital cameras in capturing high dynamic range images in low-light situation [1]. Noise in video frames creates the serious poverty of image quality [3]. The noise remains as large residual errors after motion compensation [3]. The typical digital cameras can only capture images with a dynamic range of thousands in magnitude just because of that limited dynamic range of digital cameras, poor visibility causes due to overexposure in bright regions and underexposure in dark regions of a captured image [4]. During processing of very dark videos mostly specific algorithms being adopted for enhancement process which causes of low dynamic range videos remains largely untouched [5]. 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 [6]. The prime intention of video enhancement is to bring out detail information that is hidden in video [7]. Video up gradation or enhancement may be defined as to give an input of low light or low quality video and collect the high quality video a output for specific applications. Videos are the integral part of our life and that's why it's an active subject which brings much attention in recent years [10]. Color of the objects with similar background, low intensity of light (low light condition) and the unknown level of darkness while capturing a video, make it more complicated [10]. This investigation is going to present a survey of different types of methods and technologies that have been used for video enhancement and will help to design and develop a technology which will deliver more accuracy in video enhancement.

2. LITRATURE REVIEW

2.1 Low Light Video Enhancement by Temporal Noise Reduction and Non-local means denoising:

Local Mean filter take the mean value of group of pixels surrounding to target pixel to smooth the image where as "Non Local Means" filtering take a mean of all pixels in the image, weighted by how similar those pixels are to the target pixels. If the image sequences are temporally correlated, noise can be reduced effectively by temporal filtering [1] because of temporal (inter-frame) filter can exploit the correlation to achieve high noise attenuation [10]. In the working areas of the video frames it cannot be applied as it is because it creates a motion blur. In respect to identified the true noise the temporal filter may use. Most of the noise is removed by the temporal filtering and the remaining noise can be exaggerated by the Non-local means denoising. The level of noise is much higher in low-light environment, edges and textures are often over smoothed during the denoising process.

2.2 Tone Mapping:
Tone Mapping is a technique used in image processing and computer graphics to map one set of colors to another to approximate the appearance of high dynamic range image in a medium that has a more limited dynamic ranges. Tone mapping is the process of amplify intensity of low-light video by judicious histogram adjustment [1]. Mostly three types of histograms of RGB color are computed separately after grouping pixels of each color channel from a CFA (color filter array) image, and then they are transformed with adaptively selected low and high feature thresholds [1]. System use transform value which should be less than 1 to map dark pixels to a bright level. Because most of pixels have very small intensity values ranging about 5% of maximum intensity in extremely low light condition, stretching all pixels causes an associate degree incorrect conversion with a high offset intensity. By clipping pixels below the highest value of histogram and pixels with intensity beyond top 99th percentile, system can obtain satisfactory tone-mapped result while color balance is retaining always better than the result generated [1]. The principle behind the tone mapping process is to extend the

dynamic range of dark image areas and meanwhile it slightly affected in other areas. If system wish to deliver an output in high dynamic range (HDR) image on paper or on a display, there must somehow convert the wide intensity range in the image to the lower range supported by the display [6]. The tone mapping technique is operated on brightness level (luminance) [7].

2.3 Histogram equalization:

Histogram Equalization is image processing technique. Greater is the histogram stretch greater is the contrast of the input image [2]. Histogram Equalization is one of the foremost familiar, computationally quick and straightforward to implement techniques for image enhancement but it mostly prefer for contrast enhancement of digital images [3]. A histogram is a graphical representation of the distribution of data while an image histogram is a graphical representation of the number of pixels in an image as operate of their intensity. The HE Histogram equalization technique is used to stretch the histogram of the input image. If the distinction of the image is to be exaggerated then it means that the histogram equalization distribution of the corresponding image has to be widened. Histogram equalization is that the most generally used enhancement technique in digital image process because it deliver better result and cleanness in output that other [3]. The histogram of an input image is generally refers to a histogram of the pixel intensity values. The bar graph may be a graph showing the amount of pixels in a picture at every totally different intensity worth found therein image. For an 8 bit grayscale image there are 256 different possible intensities are available and so that the histogram will graphically display 256 numbers showing the distribution of pixels amongst those grayscale values. Histograms take input as color picture and may provide individual demonstration of red, green and blue color channels of histograms [3]. It tries to change the special bar graph of a picture to closely match the same distribution. The main aspire of this process is to obtained a uniform distributed histogram by using the cumulative density function of the given image. HE consist of following advantages such as,

2.3.1 It suffers from the problem of being poorly suited for retaining local detail due to its global treatment of the image.

2.3.2 Small-scale details that are often associated with the small bins of the histogram are eliminated [6].

2.4 Adaptive Intensity Transfer Function:

The intensity-transfer function realized in the proposed algorithm is a tunable nonlinear transfer function for providing dynamic-range alternate arrangement adaptively. To attain this level a hyperbolic tangent function satisfies the condition of continuous differentiability. Another improvement of the hyperbolic tangent function is that the output value always comes in the range from zero to one for any positive input. It guarantees that output always follow the desired range of value. The adaptive hyperbolic tangent function characterized by the local statistical characteristics of the image where as proposed intensity-transfer function is local tone mapping operator. The purpose of this task is to improve the low intensity pixels while preserving the stronger pixels [4].

2.5 Spatial Domain Techniques:

Spatial domain techniques directly operate on image pixels where noise reduction is applied to each frame individually. Exploitation of given pixel values are done to attain the desired improvements. Spatial domain techniques such as the Logarithmic Transforms, Histogram Equalization and Power Law Transforms, are all based on the direct manipulation of the pixels values available in image. This technique is applicable in the area of directly altering the gray level values of individual pixels and the overall contrast of the entire image [5].

2.5.1 *Point Operation*

Point operations are applied to individual pixels only.

2.5.2. Mask Operation

In mask operation, each pixel is modified according to neighborhood pixel values.

2.5.3. Global Operation

All pixel values are taking into consideration for performing operation [5].

2.6 Frequency Domain Techniques:

Frequency domain techniques are based on the manipulation of the orthogonal transform of the image rather than the picture itself. A frequency domain technique is based on the frequency content of the image [1]. The concept used by frequency domain technique for image enhancement is to compute a 2 dimensional structure of an image. For instance the 2-D DFT, manipulating the transform coefficients by an operator and then performing the inverse transform. The Magnitude and Phase are the two components of an orthogonal transform of the image. The frequency content is available in magnitude where as the phase is used to reset up the image back to the spatial domain [4]. The standard orthogonal transforms are discrete cosine transform, discrete Fourier transform and Hartley Transform. The frequency content of the image enables to transform domain operations, therefore high frequency content such as edges and other suitable information can easily modified [5].

2.7 Contrast enhancement:

Video enhancement techniques involve processing an image or video frame to make it superior in terms of visibility. The superior quality is achieved by modifying contrast or dynamic range or both in an image or video frames [6]. The main objective of contrast enhancement process is to adjust the local contrast in different regions of the image or video frames, so that the details in dark or bright regions are brought out and disclosed to the human viewers. Contract enhancement is mostly applied to given video frames or images to archive a superior visual representation of the image by transforming original pixel values using a transform function [6]. The contrast enhancement is performed using a technique almost like to auto-leveling the contrast of low-light images [11].

2.8 Context Based fusion Enhancement:

The intention behind the use of context-based video enhancement is to extract and fuse the meaningful information of video sequence captured from a fixed camera under different light conditions [6]. Context-based fusion means to insert high quality information from the same scene such as to overcome bright regions and blurred details to improve the low quality video. The information which is being gathered and analyzed from multiple images (scenes) is used for video up gradation purpose [6]. Using context based fusion the information is automatically combined in images at different time intervals by image fusion. All the data and information from original low quality sources (scenes) is combining with high quality background scenes in same viewpoint [6]. There are so many methodologies were invented for video up gradation but low contrast and noise are major barrier to visually pleasing videos in low light conditions. Such conditions make it more complex and challenging. Hence it has been realized that there is a wide scope to make an investigation in low light video enhancement specially to determine the intensity of individual pixel channel values and enhanced them as per the requirement.

3. CONCLUSION

This paper presents a survey of different types of methods and technologies that have been used for video enhancement. But the low contrast and noise remains a barrier to visually pleasing videos in low light conditions. In that condition, to find out a more accuracy in video enhancement process there is need to detect and measure the intensity level of individual pixel channel as well as have to present an appropriate enhancement factor for enhancement purpose, so that effective and efficient video enhancement process will be created. In future, the video enhancement process will measure the intensity level of individual pixels channels and decide the best enhancement factor which might be random or constant depends on the requirement of video enhancement algorithm.

4. REFERENCES

[1] Minjae Kim, Dubok Park, David K. Han and Hanseok Ko, "A Novel Framework for Extremely Low-light Video Enhancement," IEEE International Conference on Consumer Electronics (ICCE), 2014.

[2] Zhengying Chen, Tingting Jiang and Yonghong Tian, “Quality Assessment for Comparing Image Enhancement Algorithms,” IEEE, Computer Vision Foundation, CVPR, 2014.

[3] Er. Mandeep Kaur, Er. Kiran Jain and Er Virender Lather, ”Study of Image Enhancement Techniques: A Review,” International Journal of Advanced Research in Computer Science and Software Engineering, Volume 3, Issue 4, April 2013, ISSN: 2277 128X.

[4] Chi-Yi Tsai, Member, “A Fast Dynamic Range Compression with Local Contrast Preservation Algorithm and Its Application to Real-Time Video Enhancement,” IEEE Transactions On Multimedia, Vol. 14, No. 4, August 2012.

[5] Snehal O. Mundhada and Prof. V. K. Shandilya, “Image Enhancement and Its Various Techniques,” International Journal of Advanced Research in Computer Science and Software Engineering, Volume 2, Issue 4, April 2012, ISSN: 2277 128X.

[6] Yunbo Rao, Leiting Chen, “A Survey of Video Enhancement Techniques,” Journal of Information Hiding and Multimedia Signal Processing Ubiquitous International, Volume 3, Number 1, January 2012, ISSN 2073-4212.

[7] Qing Xu1, Hailin Jiang, Riccardo Scopigno and Mateu Sbert, “A New Approach For Very Dark Video Denoising And Enhancement,” IEEE 17th International Conference on Image Processing, Hong Kong, September 26-29, 2010.

[8] Xuan Dong,Yi (Amy) Pang, Jiangtao (Gene) Wen, Guan Wang, Weixin Li, Yuan Gao, Shiqiang Yang, “A Fast Efficient Algorithm for Enhancement of Low Lighting Video,” Journal of Information & Computational Science, 2021–2030, 2010.

[9] M. Rizwan†, M. K. Islam††and H. A. Habib, “Local Enhancement for Robust Face Detection in Poor SNR Images,” IJCSNS International Journal of Computer Science and Network Security, Vol. 9 No.6, June 2009.

[10] Seong-Won Lee, Vivek Maik, Jihoon Jang, Jeongho Shin and Joonki Paik, “Noise-Adaptive Spatio-Temporal Filter for Real-Time Noise Removal in Low Light Level Images,” IEEE Transactions on Consumer Electronics, Vol. 51, No. 2, MAY 2005.

[11] Patrick Martinchek Nobie Redmon and Imran Thobani, “Low Light Mobile Video Processing,” Stanford University Publication.

[12] Sandeep Mishra and Abanikanta Pattanayak, “Integrated Low Light Image Enhancement In Transportation System”

[13] A. Buades, B. Coll, and J.M. Morel, “A Review Of Image Denoising Algorithms, With A New One,” Siam Journal On Multiscale Modeling and Simulation, 490-530, 4, 2 (2005).

[14] Adrian Stern, Doron Aloni and Bahram Javidi, “Experiments With Three-Dimensional Integral Imaging Under Low Light Levels,” IEEE Photonics Journal, Volume 4, Number 4, August 2012.

[15] Gary J. Sullivan, Fellow, Jill M. Boyce, Senior Member, YingChen, “Standardized Extensions of High Efficiency Video Coding (HEVC),” IEEE Journal of Selected Topics In Signal Processing, Vol. 7, No. 6, December 2013.

[16] Nikos Deligiannis, Joeri Barbarien, Marc Jacobs, Adrian Munteanu, Athanassios Skodras and Peter Schelkens, “Side-Information-Dependent Correlation Channel Estimation in Hash-Based Distributed Video Coding,” IEEE Transactions on Image Processing, Vol. 21, No. 4, April 2012.

[17] Rickard Sjöberg, Ying Chen, Akira Fujibayashi, Miska M. Hannuksela, Jonatan Samuelsson, Thiow Keng Tan, Ye-Kui Wang, and Stephan Wenger, “Overview of HEVC High-Level Syntax and Reference Picture Management,” IEEE Transactions On Circuits And Systems For Video Technology, Vol. 22, No. 12, December 2012.