

A Review Report on Denoising and Development of Very Low-light Video

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ABSTRACT: In this paper, investigation report is prepared on various approach for noise decrease and improvement of very low-light video. A general methodology for noise reduction and contrast improvement in very noisy image information with low dynamic vary is given. In color image information, the color property is restored and demosaicing of raw RGB input data is performed at the same time with the noise reduction. In [4] presents a completely unique three-stage algorithmic rule for very low-light video denoising and improvement. The projected technique invokes twice, within the 1st and therefore the third stages, the well-known Non-Local means that (NLM) technique for spatial and temporal denoising: it's well adapted to the appliance, leading to the definition of a completely unique NLM tool. In [1] for noise removal, a motion adaptive temporal filtering supported a Kalman structured change is presented.

KEYWORDS: Noise reduction, Video signal processing, Very low light video, Non-local means, Tone mapping, Noise reduction, Video filtering, video denoising, video deblocking, video enhancement.

I. INTRODUCTION

High-quality picture and video are key to critical automatic and human-level administrative for responsibilities ranging from protection purpose, armed forces missions, path plan-ning to medical diagnostics and commercial recommender systems. With the advancements made in computer vision and image understanding technologies, images/videos collected from a variety of sources have become an important part of real world data. Clean, high-definition pictures captured by camera systems provide better evidence for well-informed course of action. Insufficient lighting, in addition to low sensor quality, produce image noise that may inhibit Intelligence, Surveillance & Reconnaissance (ISR) missions and commercial industries. Noise removal and video improvement play a crucial role in several applications – like police investigation – involving videos taken under very poor light conditions: they set a really difficult drawback because of poor dynamic range and high noise level. In [4] a three-stage approach is proposed: its target is to broaden the very low dynamic range of very dark video and to remove the extremely high noise, while preserving movement and picture boundaries. Numerous factor such as noise blur, jamming, buzzing, and further accomplishment or compression relic, usually impair digital video sequences. However, cost constraints limit large scale applications of such systems, thus inexpensive sensors are usually employed. Clean, high-definition photos captured by camera systems give higher evidence for well-informed course of action. Video improvement problem are often developed as follows: given an input low quality video and also the output top quality video for specific applications. Digital video has turn out to be a significant module of everyday life. It's well-known that video enhancement as an active topic in computer vision has received a lot of attention in recent years. There are numerous applications wherever digital video is acquired, processed and used, like police investigation, general identification, traffic, criminal justice systems, civilian or military video processing. To design an effective and fast low lighting video enhancement is a challenging problem. Many approaches are developed for enhancing low-light video but most of them take into account video from moderately dark conditions. Strategies in temporal domain consider the correlations of neighbouring frames, but they're only applicable for still video.

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In [5] paper, a completely unique video denoising methodology supported a spatiotemporal Kalman-bilateral mixture model is planned. Firstly, we perform an appropriate average filtering on current noisy frame to reduce the influence of noise, which we call pre-filtering. Based on motion evaluation consequences, current noisy structure is process in the temporal domain by using Kalman filter [5] on the one hand. With the coming out of current multi decision tools, like the wavelet transform [7, 8], video denoising method performing in renovate area were expected regularly [9–12]. Moreover, approach that mix spatio activist area and change field were also estimated [13–16], that could produce exceptional denoising result. The anticipated video improvement technique is highly capable for user digital cameras, especially CCTV, black box camera for vehicles, and video signal-based inspection system.

II. RELATED WORK

Sometimes Minjae Kim. et. al. [1] “A Novel Approach for Denoising and Enhancement of Extremely Low-light Video” The projected system mechanism openly on the color filter array (CFA) unprocessed video for achieve low recollection use. In this paper, a new proceeds for noise cutback and enhancement of extremely low-light video is proposed. The separation of temporal and spatial filters in the proposed noise reduction scheme provides more visually pleasing results than the conventional spatio-temporal filters while preventing ghost effects around moving object regions. The proposed tone-mapping enhances visibility of a low-light video significantly while maintaining its color balance.

Hongqing HU et. al. [2] “Color Image Enhancement Based on the Improved Retinex” in this paper. The improved algorithm uses bilateral filtering on the each pixel and its neighbourhood instead of employing traditional Gaussian filter, which makes the estimated background luminance maintain a good discontinuity in light mutation. In addition, to model the local adaptation characteristics of human visual system, a local contrast enhance function is introduced to adjust the intensity of each pixel adaptively, and to enhance the local contrast of images effectively. The image background illumination gained by applying bilateral filter can avoid halo phenomenon; local contrast of images is also enhanced by introducing a contrast improvement function. Effective color image enhancement method is proposed on the basic idea of the improved Retinex algorithm.

Qing Xu et. al. [3] “A New Approach for Very Dark Video Denoising and Enhancement” The proposed technique invokes twice, in the first and the third stages, the well-known Non-Local Means (NLM) method for spatial and temporal denoising: it is well adapted to the application, leading to the definition of a novel NLM tool. The overall approach transforms very dark videos into more watchable ones, effectively reduces very high noise, and all in all, produces high quality restored image sequences outperforming the recent state-of-the-art results. The same framework can effectively handle normal light-level videos too. The proposed approach can be further speeded up and this constitutes.

Henrik Malm et. al. [4] “Adaptive enhancement and noise reduction in very low light-level video” The method is very general, contains few user-defined parameters and has been developed for efficient parallel computation using a GPU. A general methodology for noise reduction and contrast enhancement in very noisy image data with low dynamic range is presented. The approach is very general and adapts to the spatiotemporal intensity structure in order to prevent motion blur and smoothing across important structural edges. The best approach when applying the method to color images has been discussed, which includes demosaicing from the Bayer pattern in raw input color data simultaneously to the noise reduction.

Chenglin Zuo et. al. [5] “Video Denoising Based on a Spatiotemporal Kalman-Bilateral Mixture Model” In this paper, authors presented a ST-KBM model for large noisy video signals that have fixed background, and applied it to the restoration both of simulated noisy video sequences by additive white Gaussian noise and natural noisy video sequence in low light. Maintaining the Integrity of the Specifications. To take full advantage of the strong spatiotemporal correlations of neighboring frames, motion estimation is first performed on video frames consisting of previously denoised frames and the current noisy frame by using block-matching method. Video denoising method based on a spatiotemporal Kalman-bilateral mixture model to reduce the noise in video sequences that are captured with low light.

Matteo Maggioni et. al. [6] “Video Denoising, Deblocking and Enhancement through Separable 4-D Nonlocal Spatiotemporal Transforms” The algorithm implements the paradigm of nonlocal grouping and collaborative filtering, where a higher dimensional transform-domain representation of the observations is leveraged to enforce sparsity and

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thus regularize the data: 3-D spatiotemporal volumes are constructed by tracking blocks along trajectories defined by the motion vectors. The proposed filtering procedure addresses several video processing applications, such as denoising, deblocking, and enhancement of both grayscale and color data. In this analysis of the V-BM4D and VBM3D frameworks highlights that the temporal correlation is a key element in video denoising and that it represents an effective prior that has to be exploited when designing nonlocal video restoration algorithms...

III. METHOD

A. IMPROVED RETINEX ALGORITHM

From analysis of previous work algorithm gives a uniform expression for the improved Retinex algorithm. The expression is described as follows:

$$R(x, y) = \log(I(x, y)) - C(x, y) \cdot \log(I_b(x, y)) \quad (1)$$

where $I(x, y)$ represents normalized original images, $R(x, y)$ is the enhanced images, $C(x, y)$ is the local contrast improvement function which is introduced by the paper. Next we will elaborate the improvement of the proposed algorithm. The bilateral filtering method based on double weighted mechanism uses two Gaussian functions to simultaneously obtain weights of each neighborhood pixels via the similarity of the current points and neighborhood pixels in pixel value and spatial distance. The nature of the weighted approach is isotropous for the neighborhood pixels. So the deviation of estimation illumination is great which is obtained near the boundary of objects with obvious contrast, and the deviation can blur the boundary, thus results in halo phenomenon. The bilateral filtering method based on double weighted mechanism uses two Gaussian functions to simultaneously obtain weights of each neighborhood pixels via the similarity of the current points and neighborhood pixels in pixel value and spatial distance.

$$I_b(x, y) = \frac{\sum_{i,j=-W}^W K_d K_r I(x_i, y_j)}{\sum_{i,j=-W}^W K_d K_r} \quad (2)$$

where, K_d and K_r are spatial distance Gaussian function and numerical similarity Gaussian function respectively. Their definition is as follows:

$$K_d(x_i, y_j) = \exp \left\{ -\frac{(x - x_i)^2 + (y - y_j)^2}{2\sigma_d^2} \right\} \quad (3)$$

$$K_r(x_i, y_j; x, y) = \exp \left\{ -\frac{[I(x, y) - I(x_i, y_j)]^2}{2\sigma_r^2} \right\} \quad (4)$$

where $d \sigma$ and $r \sigma$ are corresponding scale parameters, which are used to control decay rate of each weight coefficient. The purpose of introducing contrast improvement function is to enhance local contrast of images. From human visual characteristics, human eyes are sensitive to local contrast of images (local detail information), so how to improve local contrast of images plays an important role in the final visual effect. Because the local contrast is determined by the size relation between the luminance of the current point and neighborhood average luminance (background luminance), the ratio between the luminance of the current points and neighborhood average luminance can be used to improve local contrast by adjusting the luminance of the current point. If the luminance of the current point is higher than neighborhood average luminance, we enhance the luminance of the current point. Otherwise, we reduce the luminance of the current point. The paper uses the ratio between the luminance of the current points and neighborhood average luminance to construct the introduced contrast improvement function with a nonlinear sigmoid function, the concrete formula is as follows:

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$$C(x, y) = 1 - \frac{1}{1 + \exp\{-\lambda(E(x, y) - 1)\}} \quad (5)$$

$$E(x, y) = \frac{I(x, y)}{I_b(x, y)} \quad (6)$$

where experimental parameters λ equals to 15, $E(x, y)$ is the ratio of between the luminance of the current points and neighborhood average luminance, which is determined in Formula (6).

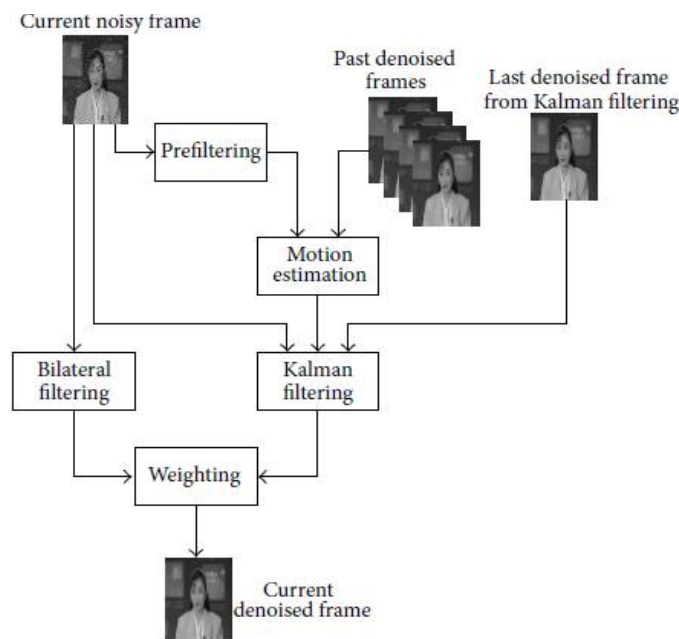


Figure 1: Diagram of ST-KBM video denoising algorithm. [5]

B. Spatiotemporal Kalman-Bilateral Mixture Model

Make use of Figure one demonstrates the diagram of our projected spatiotemporal Kalman-bilateral mixture (ST-KBM) model. The denoising of current noisy frame involves not only the frame itself, however additionally a series of past denoised frames. Motion estimation is performed between this noisy frame and past denoised frames, and also the estimation results are went to guide the Kalman filtering on current noisy frame. Firstly, prefiltering is performed on current noisy frame. The aim of this operation is to reduce the influence of noise as attainable and harden next motion estimation. Additionally, bilateral filtering is additionally performed on current noisy frame. So, when higher than process, there are 2 denoised frames, one comes from Kalman filtering and another comes from bilateral filtering. Finally, by weight the 2 denoised frames; we will acquire a satisfactory result.

C. Motion Estimation

Motion estimation itself may be a complicated drawback. Generally, motion estimation is performed directly. Once the video has relatively very little noise, estimation results are accurate. However, because the increase of noise, the preciseness of motion estimation becomes quite low. With the influence of enormous noise, precision motion estimation is becoming tough. So, we tend to perform average filtering on this noisy frame to restrain the influence of noise as possible before motion estimation that is termed prefiltering. Once the profiteering step, the big noise is restrained by a large margin whereas the motion within the video remains well. During this case, though the frame has become quite fuzzy, motion estimation isn't affected. Note that the pre filtering procedure is simply implemented for motion estimation, instead of contributing for the image-signal denoising. Then, take advantage of the robust

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correlations between adjacent frames, motion estimation based on block-matching is performed by comparing current pre-filtered frame with past denoised frames. Block-matching (BM) [21] may be a specific matching approach that has been extensively used for motion estimation in video compression. Here, we tend to use it to calculate whether or not motion exists within the block.

IV. CONCLUSION

We In this paper study of previous technique and algorithm for various approach for noise decrease and improvement of very low-light video. In [5] authors presented a ST-KBM model for large noisy video signals that have fixed background, and applied it to the restoration both of simulated noisy video sequences by additive white Gaussian noise and natural noisy video sequence in low light. In [2] image background illumination gained by applying bilateral filter can avoid halo phenomenon; local contrast of images is also enhanced by introducing a contrast improvement function. In [4] paper authors have presented a methodology for adaptive enhancement and noise reduction for very dark image sequences with very low dynamic range.

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