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A Fast Video Illumination Enhancement Techniques

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Abstract:

Video enhancement is one of the most important and difficult components in video research. The aim of video enhancement is to improve the visual appearance of the video, or to provide a "better"transform representation for future automated video processing, such as analysis, detection, segmentation, recognition, surveillance, traffic, criminal justice systems. In this paper, we present an overview of video enhancement processing and analysis algorithms used in these applications. The existing techniques of video enhancement can be classified into two categories: Self-enhancement and Contextbased fusion enhancement. More specifically, we categorize processing methods based representative techniques of video enhancement. Thus, the contribution of the paper has fourfold: (1) to classify and review video enhancement processing algorithms, (2) to discuss the advantages and disadvantages of these algorithms, (3) according to this integrated consideration, attempt an evaluation of shortcomings and general needs in this field of active research, and (4) we will point out promising directions on research for video enhancement for future research.

Keywords: Video enhancement; self-enhancement; frame-based fusion enhancement; spatial-based domain enhancement; transform-based domain enhancement

Introduction

Video enhancement problem can be formulated as follows: given an input low quality video and the output high quality video for specific applications. How can we make video more clearer or subjectively better? Digital video has become an integral part of everyday life. It is well-known that video enhancement as an active topic in computer vision has received much attention in recent years. The aim is to improve the visual appearance of the video, or to provide a "better" transform representation for future automated video processing, such as analysis, detection, segmentation, and recognition [1-5]. Moreover, it helps analyses background information that is essential to understand object behavior without requiring expensive human visual inspection [6]. There are numerous applications where digital video is acquired, processed and used, such as surveillance, general identity verification, traffic, criminal justice systems, civilian or military video processing et al. Carrying out video enhancement understanding under low quality video is a challenging problem because of the following reasons [2-3, 6-9]. (i)Due to low contrast, we cannot clearly extract moving objects from the dark background. Most color-based methods will fail on this matter if the color of the moving objects and that of the background are similar. (ii) The signal to noise ratio is usually very low due to high ISO (ISO is the number indicating camera sensors sensitivity to light). Using a high ISO

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number can produce visible noise in digital photos. Low ISO number means less sensitivity to light. (iii)The information carrying video signal is a degraded version of a source or originalvideo signal which represents the three dimensional continuous world. These degradations can be a result of the acquisition process, or the rate and format conversion processes. (iv)Environmental information affects the way people perceive and understand what has happened. Hence, dealing with moving tree, fog, rain, behavior of people in nighttime video are the difficult because they lack background context due to poor illumination. (v)Inter-frame coherence must also be maintained i.e. the moving objects region as weights in successive images should change smoothly. (vi)One pixel from a low quality image may be important even if the local variance is small, such as the area between the headlights and the taillights of a moving car. (vii)The poor quality of the used video device and lack of expertise of the operator. There are two main methods to process an image as defined by the domain in which the image is processed, namely spatial-based domain and frequency-based domain. Spatial based domain refers to the image plane itself, and approaches in this category are based on direct manipulation of pixels in an image. Frequency-based domain processing techniques are based on modifying the spatial frequency spectrum of the image as obtained by transform. Enhanced techniques based on various combinations of methods from these two categories are not unusual and the same enhancement technique can also be implemented in both domains, yielding identical results. With the same image processing, a lot of video enhancement methods have been proposed. However, in all of these methods, there still are no general standards, which could be used as a design criterion of video enhancement algorithms. There is also no general unifying theory of video enhancement. The survey of available techniques is based on the existing techniques of video enhancement, which can be classified into two broad categories: spatial-based domain video enhancement and transform-based domain video enhancement [1,9-14]. Spatial-based domain video enhancement operates directly on pixels. The main advantage of spatial-based domain technique is that they are conceptually simple to understand, and the time complexity of these techniques is low which favors real time implementations. But these techniques generally lacks in providing adequate robustness and imperceptibility requirements. A survey of spatial-based domain enhancement techniques can be found in [4,15-18]. Transform based domain video enhancement is a term used to describe the analysis of mathematical functions or signals with respect to frequency, and operate directly on the transform coefficients of the image, such as Fourier transform, discrete wavelet transform(DWT), and discrete cosine transform(DCT) [1,13-14,18-20]. The basic idea in using this technique is to enhance the video by manipulating the transform coefficients. The advantage of transform-based video enhancement include (i) Low complexity of computations, (ii) Ease of viewing and manipulating the frequency composition of the image, and (iii) the easy applicability of special transformed domain properties. The basic limitations including (i) it cannot simultaneously enhance all parts of the image very well, and (ii) it is difficult to automate the image enhancement procedure. In this paper, according to if enhanced video embed high quality background information, the existing techniques of video enhancement can be classified into two broad categories: Self-enhancement and frame-based fusion enhancement. Traditional

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methods of video enhancement are to enhance the low quality video itself. It doesn't embed any high quality background information. Such as contrast enhancement method, HDR-based video enhancement, compressed-based video enhancement, and wavelet-based transform video enhancement. These approaches are uniformly called self-enhancement of low quality video. It don't enough luminous of low quality video. The reason is that in the dark video, some areas are so dark that all the information is already lost in those regions. No matter how much illumination enhancement you apply, it will not be able to bring back lost information. Frame-based fusion enhancement refers to low quality video, which fuse illumination information in different time video. The approach is that it is by extracting high quality background information to embed low quality video. How would one combine information from two (or more) background images in a meaningful way? How would one pick high-quality background parts while keeping all the low-quality important information? To these problems, the previous researchers have abundant research. Fig.1 shows the more detail categories of video enhancement.

PROPOSED WORK:

In this paper, we focus on video enhancement considering both areas of self-enhancement and frame-based fusion enhancement. Research in the field started as early as in the 70s with the advent of computers and the development of efficient video processing techniques. We also discuss related image enhancement techniques, since most video enhancement techniques are based on frame enhancement. We don't aim at covering the whole field of video enhancement and its applications. It is a broad subject that is still evolving. E.g. we don't discuss contributions, which are made by ITU and ISO standard in this area. The remainder of the paper is organized as follows.

The approaches can be classified into four categories: contrast enhancement, HDR-based video enhancement, compressed-based video enhancement, and wavelet-based video enhancement. An overview of some of the well-known methods in these categories is given below.

2.1. Contrast enhancement. Video enhancement techniques involve processing an image/frame to make it look better to human viewers. It is usually used for post processing by modifying contrast or dynamic range or both in an image. The aim of contrast enhancement process is to adjust the local contrast in different regions of the image so that the details in dark or bright regions are brought out and revealed to the human viewers. Contract enhancement is usually applied to input images to obtain a superior visual representation of the image by transforming original pixel values using a transform function of the form. $g(x, y) = T[r(x, y)]$ (1) where $g(x, y)$ and $r(x, y)$ are the output and input pixel values at image position. Usually for correct enhancement it is desirable to impose certain restrictions on the transformation function T [20]. The existing techniques of contrast enhancement techniques can be broadly categorized into two groups: direct methods [22,23] and indirect methods [10, 24-28]. Direct methods define a contrast measure and try to improve it. Indirect methods, on the other hand, improve the contrast through exploiting the under-utilized regions of the dynamic range without defining a specific contrast term. In fact, there are other type of algorithm for contrast enhancement, such as gamma enhancement, power-low rule, logarithmic approach, automatic gain/offset, and transform enhancement. In this paper, contrast enhancement techniques can be broadly categorized into two groups: histogram equalization (HE), tone mapping.

A) Histogram equalization Histogram equalization is one of the most commonly used methods for contrast enhancement. It attempts to alter the spatial histogram of an image to closely match a uniform distribution. The main objective of this method is to achieve a uniform distributed histogram by using the cumulative density function of the input image[24-28]. The advantages of the HE include (i) it suffers from the problem of being poorly suited for retaining local detail due to its global treatment of the image. (ii) small-scale details that are often associated with the small bins of the histogram are eliminated. The disadvantage is that it is not a suitable property in some applications such as consumer electronic products, where brightness preservation is necessary to avoid annoying artifacts. The equalization result is usually an undesired loss of visual data, of quality, and of intensity scale. Fig.2 shows the experimental result of histogram equalization [21].

HE methods are divided into two major categories: global and local methods. Global histogram equalization (GHE) attempts to alter the spatial histogram of an image to closely match a uniform distribution [21]. In this approach, the contrast stretching is limited in gray levels with high frequencies. This causes significant contrast loss for gray levels having lower frequencies. To overcome this problem, different local histogram equalization (LHE) methods have been proposed. Typical histogram specification, histogram equalization, and gamma correction to improve global contrast appearance only stretch the global distribution of the intensity. More adaptive criterions are needed to overcome such drawback. [26] uses two adaptive histogram equalization techniques to modify intensity's distribution inside small regions. To unsharp masking for contrast enhancement of images/videos,[27]employes an adaptive filter that control the contribution of the sharpening path in such a way that contrast enhancement occurs in high detail areas and littleor no image sharpening occurs in smooth areas. Some methods to transform domain by way of a transform coefficient histogram have been fully explored. In another local method which is called shape preserving histogram modification, instead of a rectangular block, connected components and level-sets are used for contrast enhancement. Partially overlapped sub block HE is another local method in [28]. Some local methods that don't use histogram have been proposed in literature also. Statistic-based properties of the image method determine a transformation function for each pixel by considering the local minimum/maximum and local average in a window centered at that pixel [29]. Another local method is based on using 2D teager-kaiser energy operator to compute the value of local contrast of each pixel [30]. The computed value is transformed by a predefined function to emphasize the pixel's contrast. Then, a reverse process is performed to obtain the new value of the pixel according to the new value of the contrast. The local histogram equalization and adaptive histogram equalization can provide better results but are computationally intensive. Recently, a novel and effective video enhancement algorithm for low lighting video is proposed. The algorithm works by first inverting the input low-lighting video and then applying an image de-haze algorithm on the inverted input. To facilitate faster computation and improve temporal consistency, correlations between temporally neighboring frames are utilized [23]. For preserving the input brightness of the image, which is required to avoid the generation of non-existing artifacts in the output image, different methods based on histogram equalization have been proposed. Mean preserving bi-histogram equalization (BBHE), equal area dualistic sub-image histogram equalization (DSIHE), minimum mean brightness error bi-histogram equalization (MMBEBHE), recursive mean-spread histogram equalization (RMSHE), and multi-HE are HE based methods which tend to preserve the image brightness with a significant contrast enhancement [31]. In BBHE, histogram of the input image is separated into two parts according to the mean of gray levels and each part is equalized independently. DSIHE is similar to BBHE except that it separates the histogram at the median of gray levels instead of the mean. MMBEBHE is an extension of BBHE and provides maximal brightness preservation. In RMSHE, scalable brightness preservation is achieved by partitioning the histogram recursively more than once. MultiHE consists of decomposing the input image into several sub-images, and then applying the classical HE process to each one. This methodology performs a less intensive image contrast enhancement [32]. This technique is a generation of BBHE. Although these methods preserve the input image brightness on output, they may fail to produce images with natural looks [31]. In order to overcome this drawback, two multi histogram equalization methods, i.e. Minimum within-class level squared error MHE (MMLSEMHE), have been proposed. In these methods, number of sub-images is determined by a cost function. They usually perform a less intensive image contrast enhancement [31]. This is the cost that is paid for achieving contrast enhancement, brightness preservation and natural looking images at the same time. [33] uses the histogram of each frame, along with upper and lower bounds computed per shot in order to enhance the current frame. This ensures that the artifact introduced during the enhancement is reduced to a minimum. Traditional methods don't compute per-shot estimates tend to over-enhance parts of the video such as fades and transitions. Histogram specification technique is another approach for contrast enhancement [21]. In this method, the shape of the histogram is specified manually, and then a transformation function is constructed based on this histogram to transform input image at gray levels. Dynamic histogram equalization (DHS) method tends to preserve the details of the input image[25]. Image histogram is partitioned based on local minima and specific gray level ranges that are assigned to each partition. After partitioning, HE is appliedon each partition. Another modified HE approach is presented in [34]. The histogram is divided into three regions as dark, mid and bright. In order to keep original histogram features, the differential information is extracted from the input histogram, and then desired histogram is specified based on this information and some extra parameters such as direct current and gain value of the input image. [35]propose a modified version of histogram specification, in which a block around each pixel is defined and the desired histogram for that block is specified automatically. Histogram specification is done based on an optimization problem, whose main constraint is preserving the mean brightness of the block [32]. In histogram specification techniques, to reduce noise in enhancement produce, an efficient technique for real-time enhancement of video containing inconsistent and complex conditions like non-uniform and insufficient lighting is proposed. The method enhances video in low lighting conditions without any loss of color information and makes real-time enhancement for homeland security application successfully realized [17]. Different genetic approaches have been applied for images/videos contrast enhancement[36]. [37] uses a local enhancement technique. Genetic algorithms are meta-heuristic optimization techniques based on natural theory and survival of the fittest. [32]uses a simple chromosome structure and genetic operators

CONCLUSION Nighttime image context enhancement is one of the crucial areas in image processing. In this paper, three techniques have been discussed and their enhanced image results have been shown as well. The enhanced images of all the above techniques can be judged on qualitative grounds. Based on quality metrics best results are obtained in the Gradient domain method. It possesses the problem of color shift which is due to improper maintenance of a valid vector field and also due to the difficulty in maintaining the high contrast in a single image due to different exposure of light of day and night time images. Another issue is of capturing a high quality background. The Frame subtraction technique is also a good technique as it is reliable, fast, cost effective and also consumes less memory. The issues have also been discussed so that important measures can be taken for further enhancement in the algorithms.

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