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Low Light Image Enhancement

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A B S T R A C T

Each day, countless photographs are shot using the cameras on a wide variety of mobile devices. Even though advancements in image sensor technology have greatly enhanced the clarity of such obtained images, the visual quality is by no means guaranteed under varied illumination conditions. An original and straightforward strategy for improving images in dim conditions is provided in this work. The suggested method's central idea is to use several diffusion spaces to estimate the illumination component, which is likely to appear as the bright pixel even under the low-light scenario. By choosing the maximum value at each pixel position of those diffusion spaces, the illumination component can be correctly isolated from the scene reflectance and fine-tuned separately for improved visual quality. So, since the iterative diffusion process has a tendency to disclose previously hidden lighting components with brilliant intensities, we propose adopting the maximal value among diffused intensities at a specific pixel point, so-called maximal diffusion value, as the illumination component. The suggested method enhances image quality without major distortion while effectively suppressing the problem of noise amplification, in contrast to prior approaches that still face difficulties to balance between over-saturated and conservative restorations. Results from experiments conducted on reference datasets demonstrate the effectiveness and robustness of the suggested strategy in comparison to previously introduced methods in the literature.

KEYWORDS: Low-light image enhancement; deep learning; retinex; YCbCr.

1. INTRODUCTION

The low-light condition in everyday photographs is typically the result of a combination of circumstances, such as the time of day, the quality of the available light, and the presence of deliberate shadows. As a result, important details are lost and the scene's underlying structures take on a different appearance on the surface, thus diminishing the image quality and user experience. Many computer vision algorithms, including those for object detection [1], recognition [2], stereo matching [3], etc., suffer significantly when presented with such distorted inputs. Despite the fact that modern mobile devices, especially smartphones, contain camera modules that have the applicable solution, its usefulness is still constrained. Several techniques have been developed to effectively enhance the visual quality of low-light photographs. Historically, the most common method for this task has been to use the statistical information of the original input image to directly boost the hidden structure so that it becomes visible. However, the restoration outputs of those algorithms have a tendency to oversaturate relatively bright sections, making the textural qualities of the associated region likely unnoticeable. In order to alleviate this issue, histogram equalisation and its derivatives [4, 5] can slightly flatten the distribution of pixel intensities across the whole range. Additionally, they may be easily integrated with a number of optimization approaches, which greatly aid in adaptively adjusting the dynamic range by normalising the histogram of the original image. However, most histogram-based algorithms primarily focus on enhancing the contrast, rather than estimating the illumination component in an image, and therefore they typically fail to moderately restore the underlying structure that is buried in the shadows (e.g., under- orover-enhanced in uneven illuminations). Low-light image enhancement has instead made extensive use of the Retinex theory's [6] underlying assumption that the image may be divided into scene reflectance and its illumination. A large body of research in this domain, known as the decomposition-based method, has focused on isolating the lighting component from the reflectance component in an effort to get an improved early result. Over-highlights of edge-like regions generate aesthetically odd effects in the enhanced result, despite the fact that textural features are properly disclosed in the reflectance component. Furthermore, such an overemphasis frequently results in defects of halo artefacts around edge structures. In this work, we suggest a new, straightforward strategy for improving images shot in dim conditions. The proposed method is based on our realisation that the diffusion process provides a clear indication of the bright-light attribute present in the illumination component even in the shadowed area. Accordingly, we suggest using the highest value at each pixel position across various diffusion spaces as the lighting factor. Comparing the results of illumination estimate using this scheme with those using the maximal value among RGB channels or the association with neighbour pixels, as shown in Fig. 1(c) and (d), demonstrates a striking difference. It's worth noting that our pixel-wise pooling procedure has a good capacity to decrease the blur artefact caused by aggregation in the local window, which is commonly recognised for the local consistency of lighting in prior methods [7], [8]. Color inconsistency is avoided by choosing the highest diffusion value in the intensity channel alone throughout the enhancement process. It should be kept in mind that the predicted illumination component is modified in accordance with both global and local stretching techniques, as done in earlier methods [9], [10]. Here is a brief overview of the paper's most important findings: • The proposed method makes an effort to implement the idea that lights will typically show up brightest in the dark [6, 11]. To this purpose, we suggest using the highest value across all pixels in a set of diffusion spaces for the illumination. To avoid magnifying extraneous noise, which still makes it difficult to clearly show the illumination space in prior methods, we retain the maximal value during the diffusion process, resulting in an efficient representation of the estimated illumination space as the piecewise constant form. This is ideally achieved by considering the relationship between diffusion spaces on a pixel-by-pixel basis, as opposed to the colour channel or neighbour pixel-based methodologies previously used, which led to colour and blur distortions. Surface features at the pixel level are restored with remarkable precision, adding further enhancement. The proposed solution also avoids the need for the intricate optimization processes used in modern systems, which often tackle issues by focusing on their local context.

PRESENT WORK :

Image enhancement is one of the modern topics that are discussed now a days and Deep Learning play a major part in it. We see various types of smartPhones with their night mode in camera which help us to take beautiful images at night or low light situation.

The Camera is not able to take the perfect image at low light because of the noise created at the camera sensors. During night mode the noise is cancelled out by the camera to get the perfect image.

RELATED WORK :

HE-based methods perform light enhancement through expanding the dynamic range of an image. Histogram distribution of images is adjusted at both global and local levels. There are also various methods adopting the Retinex theory that typically decomposes an image into reflectance and illumination. The reflectance component is commonly assumed to be consistent under any lighting conditions; thus, light enhancement is formulated as an illumination estimation problem. Building on the Retinex theory, several methods have been proposed. Wang et al.designed a naturalness- and information-preserving method when handling images of nonuniform illumination; Fu etal. proposed a weighted variation model to simultaneously estimate the reflectance and illumination of an input image; Guo et al. first estimated a coarse illumination map by searching the maximum intensity of each pixel in RGB channels, then refining the coarse illumination map by a structure prior; Li et al.proposed a new Retinex model that takes noise into consideration. The illumination map was estimated through solving an optimization problem. Contrary to the conventional methods that fortuitously change the distribution of image histogram or that rely on potentially inaccurate physical models, the proposed ZeroDCE method produces an enhanced result through imagespecific curve mapping. Such a strategy enables light enhancement on images without creating unrealistic artifacts.

Yuan and Sun proposed an automatic exposure correction method, where the S-shaped curve for a given image is estimated by a global optimization algorithm and each segmented region is pushed to its optimal zone by curve mapping. Different from,our Zero-DCE is a purely datadriven method and takes multiple light enhancement factors into consideration in the design of the non-reference loss functions, and thus enjoys better robustness, wider image dynamic range adjustment, and lower computational burden. Data-Driven Methods. Data-driven methods are largel

CONCLUSION :

In this work, we suggest a new, straightforward strategy for improving images shot in dim conditions. The suggested method's central idea is to use the maximum value derived from the diffusion process as the illumination component, which closely matches the illumination property in low-light conditions. Using the Retinex theory, the estimated illumination component is then extracted from the scene reflectance, and the resulting stretch is optimised through the use of global and local correction techniques. The suggested method has the advantage of successfully disclosing the underlying structure of an image while also suppressing fuzzy artefacts thanks to the pixel-wise process for illumination estimation. Based on the results of several experiments, it is believed that the proposed technology can be used to effectively enhance the visual quality of photographs captured in a variety of low-light settings.

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