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A Survey for Various Techniques of Image Enhancement

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Abstract— Image Enhancement is one of the important and tough techniques in digital image processing. The main objective of image enhancement is to find out the hidden details in an image. Image Enhancement improves the quality of image for human presentation. Contrast increment, elimination of noise and blurring and enlightenment of details are examples of enhancement operation. Image enhancement is basically divided into two main categories such as spatial domain and Frequency domain. In this paper we discuss and compare these two techniques with their related techniques. Thus, the contribution of this paper is to various image enhancement techniques

Keywords— Image Enhancement

I. INTRODUCTION

Image enhancement is the process of digitally manipulating a stored image using software. The tools used for image enhancement include many different kinds of software such as filters, image editors and other tools for changing various properties of an entire image or parts of an image.

Image enhancement is basically improving the interpretability or perception of information in images for human viewers and providing `better' input for other automated image processing techniques. The principal objective of image enhancement is to modify attributes of an image to make it more suitable for a given task and a specific observer. During this process, one or more attributes of the image are modified. The choice of attributes and the way they are modified are specific to a given task. Moreover, observer-specific factors, such as the human visual system and the observer's experience, will introduce a great deal of subjectivity into the choice of image enhancement methods. There exist many techniques that can enhance a digital image without spoiling it. The enhancement methods can broadly be divided in to the following two categories:

Spatial Domain Methods
Frequency Domain Methods
Spatial domain techniques directly deal with the image pixels. The pixel values are manipulated to achieve desired enhancement. In frequency domain methods, the image is first transferred in to frequency domain. It means that, the Fourier Transform of the image is computed first. All the enhancement operations are performed on the Fourier transform of the image and then the Inverse Fourier transform is performed to get the resultant image. These enhancement operations are performed in order to modify the image brightness, contrast or the distribution of the grey levels. As a consequence, the pixel value (intensities) of the output image will be modified according to the transformation function applied on the input values. Image enhancement is applied in every field where images are ought to be understood and analyzed. For example, medical image analysis, analysis of images from satellites etc.

II. NEURAL NETWORK IN IMAGE ENHANCEMENT

Deep Learning, as a branch of Machine Learning, utilizes calculations to process information and impersonate the reasoning procedure, or to create deliberations. Deep learning (DL) utilizes layers of calculations to process information, comprehend human discourse, and outwardly perceive objects. Data is gone through each layer, with the yield of the previous layer giving contribution to the following layer. The main layer in a system is known as the info layer, while the latter is called a yield layer.

Neural Network
Execute image processing undertakings, for example, removing noise from images and constructing high-resolution images from low-resolutions images, utilizing convolutional neural networks. Deep learning utilizes neural networks to learn valuable portrayals of highlights straightforwardly from information. For instance, you can utilize a pertained neural network to recognize the images and remove various type of noise from images.

III.TECHNIQUES

The image enhancement process consists of various techniques that improve the visual appearance of the given image or convert the input image into better form

for better analysis by machines as well as humans. Various enhancement techniques are as follows:
1. Spatial domain methods.
2. Frequency domain methods.
3. Fuzzy domain methods.

Spatial Domain Method:
Image processing techniques based on spatial methods operate directly on pixels. These methods modify the pixel values according to rules depending on original pixel value i.e. local or point process. Numerous methods exist to compare or combine the pixel values with their immediate or neighbouring pixels.

Histogram Equalization:
It is one of the most popular techniques for contrast enhancement of image. HE is a technique based in spatial domain using histogram of the image [1]. A histogram plots the frequency of gray level, at each pixel of the image, varying from 0(black) to 255(white). Histogram is a discrete function given by:

$$h(rk)=(nk)/N$$

Where, rk and nk are intensity levels of the pixels, N is the number of pixels in the image with intensity resp.

Global Histogram Equalization (GHE):
In this technique, each pixel of the image is assigned a new intensity value based on previous cumulative density function. To perform GHE, the original histogram of the grayscale image needs to be equalized. GHE accounts the global information. The resultant image of GHE is enhanced in contrast. But, it may have unnatural looks due to over enhancement of brightness. Also, GHE technique is not adaptable to local light conditions

Local Histogram Equalization (LHE):
This technique uses sub-blocks of the input image and use these blocks to retrieve their histograms. Histogram equalization is applied to the central pixel of that block by applying Cumulative Density function. The process is repeated for every pixel until the end-pixel is equalized. This technique results in over-enhanced portions. This technique is not adaptable with partial light information. Also, computational costs are high for this technique.

Histogram Specification (HS):
Under this approach, histogram of input image is transformed into the histogram of another image. This approach is used at the times when output is required to form a specific histogram by achieving highlighted gray-level ranges. This approach allows to obtain the desired output. Using this approach is bit complicated, since it's difficult to specify the output histogram as it varies for all the images.

Dynamic Histogram Specification (DHS):
In these techniques, some Critical Points (CPs) of the input image are selected. On the basis of CPs and some other variants, a specified histogram is created dynamically. This approach enhances the image, by preserving some of the characteristics of the input image's histogram. But, it does not enhance the overall contrast of the image. Histogram equalization techniques suffer from mean-shift problem [4]. The mean intensity value of the image is shifted to the middle gray-level of the intensity range. Thus, HE based techniques are not useful in the cases where brightness preservation is required.

Frequency domain methods:
Frequency domain methods are based on Fourier transform. High-frequency contents in the Fourier transform are responsible for Edges and sharp transitions in an image. Smooth areas of image appear due to low frequency contents of Fourier transform. Enhancement of image f(x,y) is performed by applying frequency domain based on DFT.

Fuzzy domain
Various uncertainties and functions in image processing can be easily applied using fuzzy logic. Fuzzy based image processing is collection of various fuzzy approaches that understand, represent and process the image. Fuzzy approach has three main steps: fuzzification, modification of membership function values, and defuzzification. Some steps of fuzzy reasoning can be such as:

Fuzzification: Input values are compared with the membership function to obtain membership values for each part of image in case of image processing.
Modification of membership function values: The membership values are then combined with the defined fuzzy set operations to get weight of each fuzzy rule.
Defuzzification: The qualified output results are combined to obtain crisp output based on the defined methods.

IV. RELATED STUDY

Guo, Y.; et al. [1] proposed pipeline neural network, consisting of denoising net and low-light image enhancement net, which learns a function from a pair of dark and bright images and show that multiscale retinex (MSR) can be considered as a convolutional neural network with Gaussian convolution kernel, and blending the result of DWT can improve the image produced by MSR. Low-light image enhancement is an important challenge in computer vision. Most of the low-light images taken in low-light conditions usually look noisy and dark, which makes it more difficult for subsequent computer vision tasks. In this paper, inspired by multi-scale retinex, we present a low-light image enhancement pipeline network based on an end-to-end fully convolutional networks and discrete wavelet transformation (DWT).

Zhou, J. et al. [2] proposed a retinex-based laplacian pyramid method for image defogging. The method is implemented via MSRCR and laplacian pyramid, and it doesn't require additional hardware devices. The overall defogging process is composed of three vital parts: illumination color enhancement, detail of reflection component enhancement, and linear weighted fusion and add the gamma correction illumination back to reflection to achieve color enhancement. And then, the detail enhancement is achieved by the laplacian pyramid to process the reflection component. Finally, the detail enhanced image and color corrected image are used to reconstruct the clear image.

Mei, Y.; and Ning, Y.; [3] proposed a natural hazy image enhancement method which combines with multilayer fusion and chunk-based aiming at the uneven distribution of haze concentration and color imbalance in haze weather. Based on the atmospheric physical model, the detail and base layers of scene images can be extracted using multilayer decomposition and nonlinear mapping function. Iterative Box Filter can improve the accuracy of ambient light selection and avoid the imbalance of ambient light estimation. The image is segmented into blocks, and the block images are processed by the same operations which are multilayer decomposition and nonlinear mapping function to obtain the detail maps of block images.

Ma, F.; et al. [4] proposed a novel methodology for low-light image enhancement. The proposed algorithm contains three stages: image reconstruction, image enhancement and color restoration. Two-dimensional compact variational mode decomposition (2D-TV-VMD) is employed to covert the RGB image into gray map through decomposing it on multiple gray Eigen functions. A binary artifact indicator function is used to identify and eliminate potential artifact pixels in an image, and then low-light image enhancement via illumination map estimation (LIME) is used to enhance the reconstructed gray-scale map. Finally, color restoration is performed in RGB-color space to recover the color information. Subjective evaluation and objective evaluation of the proposed method, including no-reference image quality metric of contrast-distorted images based on information maximization (NIQMC), is conducted on different low-light images

Li, D. et al. [5] utilized the pre-processing method to the captured retinal images. Then, the DTCWT is applied to decompose the gray retinal image to obtain high-pass sub bands and low-pass sub bands. Then, a Contour let-based enhancement method is applied to the high-pass sub bands. For the low-pass sub bands, we improve the morphology top-hat transform by adding dynamic multi-scale parameters to achieve an equivalent percentage enhancement and at the same time achieve multi-scale transforms in multiple directions. Finally, we develop the inverse DTCWT method to obtain the enhanced retinal image after processing the low-frequency sub images and high-frequency sub images.

Aladem, M. et al. [6] presented and investigate four methods to enhance images under challenging night conditions. The findings are relevant to a wide range of feature-based vision systems, such as tracking for augmented reality, image registration, localization, and mapping, as well as deep learning-based object detectors. As autonomous mobile robots are expected to operate under low-illumination conditions at night, evaluation is based on state-of-the-art systems for motion estimation, localization, and object detection. Cameras are attractive sensors because they are passive and relatively cheap and can provide rich information. However, being passive sensors, they rely on external illumination from the environment which means that their performance degrades in low-light conditions.

Sharma, A. et al. [7] proposed a novel underwater image enhancement technique by review the existing underwater enhancement methods. The proposed algorithm tested on standard underwater image enhancement methods with their standard parameters. The result shows the proposed method is better than standard algorithms and techniques. The contrast and sharpness of the images captured in underwater in general significantly deteriorates and diminish caused by the less perceptibility of the image due to the water medium’s physical properties.

Rani, G.R.R. and Samson, C. [8] presented techniques that are developed to enhance the visual appearance of images. This survey includes Image Enhancement using traditional methods along with fuzzy logic, genetic-based, and machine learning algorithms. The role of machine learning in the field of digital image enhancement is a new frontier. Machine learning is an application of artificial Intelligence that provides systems the ability to automatically learn and improve from experience without being explicitly programmed.

V. EXISTING STUDY

Existing study presented a novel pipeline network for low-light image enhancement. We illustrate that multi-scale Retinex is equivalent to a CNN with different Gaussian convolution kernels. Furthermore, we find blending the low-low component of the image DWT with MSR can improve the results produced only by MSR. Inspired with this experiment, we propose LLIE-net, which is an end-to-end neural network without any artificial parameters in prediction phase. We compare our LLIE-net with existing state-of-the-art approaches from the qualitative and quantitative perspective respectively. Experiments reveal that our method achieves the better performance. Considering the fact that dealing with real-world low light images sometimes causes noise and add a denoising-net and construct a pipeline network. This method not only performs well in synthetic images but also in the real-world image sets. It is because that the measure methods are subjective evaluation indexes, which would bring experimental error, and test method in a bigger image set consisting of the public real-world low light images.

This method can be improved by using some large data set and to improve performance of this method on hidden layer. So, in the proposed technique hidden layer image dataset can be used based on deep learning techniques.

VI. CHALLENGES IN GRID COMPUTING

In this paper, a survey on various image enhancement techniques on different domains has been done. From the survey, it has found that

Spatial domain image enhancement techniques namely Mean filter, Median filter and Laplacian of Gaussian filters are widely used for contrast enhancement in medical X-ray images. Edges plays significant role in vision processing but image enhancement technique may change the edges too. Therefore, it leads to degraded edges. Histogram based enhancement techniques namely AHE, CLAHE provide better enhancement than conventional spatial domain techniques.

The existing transform domain-based techniques introduce the color artefacts and Gaussian noise in the enhanced image. The traditional methods pay no attention to the regions or objects present in the image and enhancement is performed by predefined rules thus resulting in color imbalance of the output image. Haar transform based image enhancement technique provides better results than the spatial domain techniques.

The existing fuzzy based image enhancement techniques have used an adjustment factor k statically and it is found to be satisfactory at k=128 which is only feasible for very low contrast images' enhancement and hence over contrast images when enhanced result in loss of information

VII. CONCLUSION

Image enhancement algorithm provides a wide variety of approaches for enhancing or modifying images to provide a better view. It is not possible to say which technique is good because the image enhanced by using such technique if it is looks good to user then it is good. The choice of such technique is depend on the requirements. In this paper, we provides an overview of image enhancement techniques, which can be divide into two main categories such as spatial domain enhancement technique and Frequency domain enhancement technique. Spatial domain technique is operate on pixels of an image, thus it enhances the overall contrast of an image. Whereas Frequency domain technique is operates on Fourier transform of an image, thus it helps in enhancing edges and other information of an image. This survey provides detailed information about the different image enhancement techniques and their related method. And also discuss their advantages and disadvantages.

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