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Low Light Image Enhancement using Machine Learning

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ABSTRACT

Deep Learning is a recent and very powerful machine learning approach which uses neural networks to mimic activities in layers of neurons. Deep learning algorithms have achieved remarkable performances in various image processing and computer vision tasks. low-light image enhancement is very challenging due to the difficulty in handling various factors simultaneously including brightness, contrast, artifacts and noise. So, we are going to propose a deep learning-based method for low-light image enhancement. The model here uses a Convolutional Neural Network (CNN) which makes the use of a dataset of raw short-exposure night-time images, with corresponding long-exposure reference images. This makes results from extreme scenarios like night photography very easy and efficient as compared to traditional denoising and deblurring techniques. The low-light image enhancement is of high importance for several computer vision and computational photography tasks. Low-light and image enhancement is important for video surveillance. In addition, low-light image enhancement leads to increasing the scope of many computer vision algorithms designed to deal with normal light images. However, a high quality low-light image enhancement is a challenging task and developing fast and reliable methods for low-light image enhancement still a topic for intensive research.

Keywords: Deep learning, CNN model, image enhancement, computer vision

I. INTRODUCTION

Images contains rich and detailed information of the scenes, and processing the image data, intelligent systems can be developed for various task such as image classification, segmentation, image recognition, object detection [1], scene understanding and 3D reconstruction, and afterward can be utilized in numerous applications like automated driving, video surveillance and virtual reality. So many different analysts have been submitted their work for low light image enhancement. They focus on restoring the image brightness, contrast [1] and suppressing the unexpected visual effects like difference in the color and brightness. Existing methods can be generally partitioned into two categories, the histogram equalization-based methods [2] and the second one retinex theory-based methods. Algorithms in the former category optimizing the pixels brightness based on the ideas of histogram equalization. Deep learning is a machine learning approach, it can be used in an image processing and computer vision. Here in this paper I am going to be use deep learning approach for image filtering, mainly filters focus on image quality and its enhancement. All we know, Deep learning is a sub branch of AI, uses supervised learning and unsupervised learning methods to train a neural network. neural net is mainly of two types artificial neural network and convolution neural network and in this paper a convolution neural network (CNN) is used to be work with the image. The CNN network is trained with a pair of image data, first given low exposure image as an input with reference high exposure image data, it is a type of supervised learning approach to train a neural network. later the trained network can be used for new input to get a desire output. The accuracy of the result depends on volume of the training data and the number of hidden layers used by the neural network. A literature survey work has been done on an existing methods and approaches which would be using deep learning approach and other image enhancement method to enhance quality of image. The analysis of an existing work helps in producing a proper model which full fill our requirements and produce a desire output. This paper proposed a deep learning method which uses supervise learning approach to teach a CNN model, which takes an input and next processed it though the network and save the produced output in a file. The training data paly very crucial role in an any Depp learning approach to get a desire output.

II. RELATED WORK

2.1 Low-light image enhancement using CNN and bright channel prior [3]

In this paper, the proposed method works in two steps, in first step its uses CNN (convolutional neural network) model to filter noise from the image and then based on atmosphere scattering model, they produced a low-light model to enhance an imagesetter proposed method is joint frame work of CNN noise filtering and image enhancement model. They propose image prior, bright channel prior, to estimate the transmission parameter, and an effective filter is designed to adapt idly estimate environment light in different image area.

2.2 Deep Residual Learning for Image Recognition [4]

Deep neural networks are more difficult to train. They proposed a residual learning framework to make easy the training of networks and that are substantially deeper than those used previous network. They explicitly reformulate the layers as learning residual functions with reference to the layer inputs, instead of learning unreferenced functions. they provide comprehensive empirical evidence showing that these residual networks are easier to optimize and can gain accuracy from considerably increased depth. On the ImageNet dataset we evaluate residual nets with a depth of up to 152 layers—8× deeper than VGG nets but still having lower complexity.

2.3 Contrast Enhancement Techniques [5]

Image contrast is an important parameter to conclude the quality of an image. A good quality image has a good and well-balanced contrast. A lot of image contrast enhancement techniques are proposed like histogram equalization [5] (enhancing image contrast), Histogram stretching techniques and its variants like brightness preserving bi-histogram equalization (BBHE) and quantized bi-histogram equalization (QBHE) gained prominence to enhance on the artifacts of histogram equalization [6,7]. Along these, we can work with both gray and colored image separately for image enhancement.

2.4 Image denoising [8]

Noise in an image is random variation of brightness or color information in images and is usually an aspect of electronic noise. It is always present in a digital image. It can be produced by the sensor and circuitry of a scanner or digital camera. Image noise can also originate in film grain and in the unavoidable shot noise of an ideal photon detector. Noise Models in Digital Image Processing [8] paper explained about noise in a digital image in detail. noise is generating in an image during image acquisition, coding, transmission, and processing steps. they present a complete and quantitative analysis of noise models available in digital images.

III. PROPOSED SYSTEM

After getting the raw data, the traditional image processing pipeline applies a sequence of modules such as white-balancing, de-mosaicing, de-noising, sharpening of image, color space conversion and gamma correction. But using this traditional pipelining method we are not able to deal with fast low-light images successfully and also extreme low SNR are not handled correctly. We propose to use an end-to-end learning for processing of low-light images. A fully convolutional network is used for training to perform image processing pipeline. We operate on raw-data images rather than images produced by traditional camera processing pipelines. Fig 1(a) is the traditional image processing pipeline. Fig1(b) is the presented pipeline structure. We reduce the resolution in each dimension to half for Bayer arrays. The input is packed into four channels in each dimension. We subtract the black level and scale the data by the desired amplification. This amplified data is fed to the fully convolutional neural network This half-sized output is processed through a sub-pixel layer used to recover the image to its actual resolution.

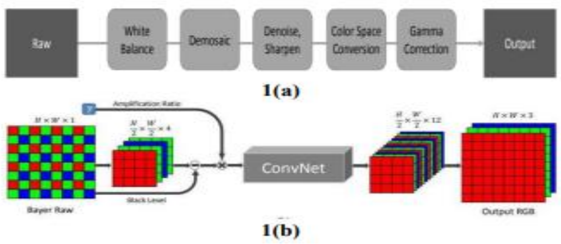

Fig. 1(a) Traditional pipeline 1(b) Our pipeline

In the first method, the pipeline is applied on the image as a whole directly and the results are observed. Whereas in the second method, for further improvement the pipeline present in the Figure1(b) is applied thrice for three channels and the results are merged. For each channel the image intensity values of other two color channels are made zero before applying the pipeline.

IV. RESULTS

4.1 Dataset

Most of the surviving methods proposed for processing of dark images are accessed using Artificial data and the real dark images but not on the ground truth images. We have captured some images in dark with a fast snap. We have created the dataset with this data. For every im age we have captured dark, we have also captured the corresponding image with long snap which is high quality reference for the dark image. Multiple short exposure images can correspond to their long snap references. The dataset which we have given consists of the images which are taken outside as well as inside. The outside images are usually captured at night times under some moonlight or roa d lights. The illuminance of the outside pictures was usually at a the range of about 0.2 lux and 5 lu x. The images captured inside are darker than the images captured outside. The inside images are captured under some different conditions of light and with some indirect lighting setup in a closed room. The dataset used is SID(See in Dark) dataset.

4.2 Training

We have made the networks to learn from the very basics using Adam optimizer and L1 loss. We train the networks with the raw data of the fast snap (short exposure) in their corresponding ground truth images (long exposure) in the sRGB. For training we apply some random rotations and flipping on a 512x512 image which is cropped ran domly for the data intensification. The learning spee d is about 10-4 at the former stage and after 2000 epochs it is reduced to 10-5. We train our netw ork for about 4000 epochs.

Initially input is an image that is rather dark. This input while being trained is compared to other images of same model captured at different light exposures.

4.3 ACCURACY MEASURE – PSNR

Peak Signal to Noise Ratio: The PSNR slab calculates the PSNR between two images in decibels. This ratio is often used as a quality assurance between the compressed and original image. High PSNR value in turn refers to high quality of corresponding image. Here we have two error metrics to assess the quality of the compressed image. They are PSNR and Mean Square Error(MSE). The PSNR value gives the peak error where as the increasing squared error concerning the compressed image and actual image. The lesser MSE value, the lesser error. To calculate the PSNR, the block first calculates the MSE using the succeeding equation.

V. CONCLUSION

In the paper, we have proposed the best methodology for enhancing the images in extreme low light conditions using the deep convolution networks(U-Net). From the above results we concluded that second model gives the better results than the first model but with slightly high color distortion. We can minimize this color distortion by adding the appropriate weights to each of the color channels. So, that the second model yields the promising results. We are intending to extend our work further by studying the generalized properties of low light imaging networks.

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