Low Light Image Enhancement using Convolutional Neural Network

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Abstract - *Good quality images and videos are important for many tasks. However, not all images are in good qualities because they are captured in various light conditions. When an image is capture in a poor light environment the pixel values are in a low-value range, which will cause image quality to reduce apparently. Since the whole image appears very dark, it's hard to identify objects or textures clearly. So, it is very important to improve the quality of low-light images. Low light image enhancement is needed in many computer vision tasks for object detection and scene understanding. Sometimes there is a condition when image captured through satellite or in low light always suffer from very low contrast and brightness which increases the difficulty of subsequent high level task in great extent. Low light image enhancement using convolutional neural network system takes dark images as input and produces bright images as an output without disturbing the content of the image. So understanding the scene captured through image becomes easier task.*

Key Words:* *Low Light Image Enhancement, CNN, Kernel, Convolutional Layer

1. INTRODUCTION

In reality, when we capture an image in a low light environment, the image quality would be strongly influenced by noise and low contrast, which makes it more difficult to deal with the following tasks such as image segmentation, object detection etc. Various low-light image enhancement methods were proposed most of them focused on contrast enhancement. However, these methods usually imposed a uniform enhancement on the whole image which tended to cause over enhancement for very bright regions or under enhancement for very dark regions. Image enhancement is a process to improve visual appearance of image or to provide a better transform representation for future automated image processing. As we all know that today high quality image and video play critical role in computer vision task such as for object detection and tracking. Unfortunately, many images suffer from poor contrast. So it becomes necessary to enhance contrast and increase image quality.

2. NEED OF PROJECT

In daily life, people receive information from images, music, videos, etc., and the human brain is capable of effectively processing such visual information. In the modern age of smart phones in which social media is so popular, many people have become interested in capturing and sharing photos. The photos captured on professional or mobile phone cameras are impacted by various weather conditions, which influence the image quality. Thus, the important contents of an image are not always clearly visible. The conditions that most often lead to the degradation of such image quality include bad weather, low illumination, and moving objects, among many others. The influence of such conditions on the image quality can make it difficult for the human eye to clearly identify the contents of the image. Images with clear visibility tend to depict more details, and the useful contents of the image can be more easily identified. Enhancement techniques are often used to make the hidden content of images visible, and they aim to facilitate the usability of valuable information for human and computers alike. Thus, image enhancement is one of the fundamental research topics in image processing. To remove darkness and extract meaningful contents are very important tasks in applications such as medical imaging, object tracking, face detection, facial attractiveness, and object detection. Therefore, such enhancement techniques play an important role in many fields.

3. AIM AND OBJECTIVES

The main aim is to propose a system based on Convolutional Neural Network method and retinex theory to enhanced low light images and improve brightness of images for many applications like scene understanding, object detection etc.

Objective of the project is to produce an automated, interactive and fast system which provide bright images as an output by taking dark images as an input. Also the content of an output images must be undisturbed.

There are many specific objectives we can extract from the main objective such as:

1. Make object detection task easier.

2. Make scene understanding easier through satellite images.

4. PROPOSED SYSTEM

In the proposed system backpropagation algorithm is used which consists of three hidden layers namely 1) Gamma correction, 2) Different convolutional layers, 3) Color Restoration. Following is the brief description of proposed system and algorithm. The Backpropagation algorithm looks for the minimum value of the error function in weight space using a technique called the delta rule or gradient descent. The weights that minimize the error function is then considered to be a solution to the learning problem. While constructing a Neural Network, at the initial stage, we initialize weights with some random values or any variable for that fact. It's not necessary that whatever values of the weights we have selected need to be correct or it fits the model best. We have selected some weight values in the beginning, but our model output is somewhat different than the actual output i.e. the error value is huge. To reduce the errors, we need to explain the model to change the weights, such that error becomes minimum. One way to train our model is using a technique called as Backpropagation.

Gamma correction is a method which is also known as the Power Law Transform. First, our image pixel intensities must be scaled in the range [0, 255] to [0, 1.0]. From there, we obtain our output is now a gamma corrected image by applying the following equation: O = I ^ (1 / G) Where I is our input image and G is our gamma value. The output image O is then scaled back to the range [0, 255]. Gamma values < 1 will shift the image towards the darker end of the spectrum while gamma values > 1 will make the image appear lighter. A gamma value of G=1 will have no changes on the input image.

DIFFERENT CONVOLUTIONAL LAYERS:

An image is just a multidimensional matrix. Our image has a width (# of columns) and a height (# of rows), just like a matrix. But not like the traditional matrices you may have worked with back in school, the images also have a depth to them, the number of channels in the image. For a normal RGB image, we have a depth of 3 — one channel for each of the Red, Green, and Blue channels, respectively. Given this information, we can think of an image as a big matrix and kernel or convolutional matrix as a small matrix that is used for blurring, sharpening, edge detection, and other image processing functions. Essentially, this tiny kernel sits on top of the big image and slides from left-to-right and top-to-bottom, applying a mathematical operation (i.e., a convolution) at each (x, y)-coordinate of the original image. It is normal to manually define kernels to obtain various image processing functions. In fact, you might already be familiar with blurring, edge detection (Laplacian, Sobel, Scharr, Prewitt, etc.), and sharpening — all of these operations are forms of hand-defined kernels that are specifically designed to perform a particular function. Convolution itself is actually very easy. All we need to do is Select an (x, y)-coordinate from the original image. Place the center of the kernel at this (x, y)-coordinate. Perform the element-wise multiplication of the input image region and the kernel, then sum up the values of these multiplication operations into a single value. The sum of these multiplications is called the kernel output.

5. RESULTS AND DISCUSSION

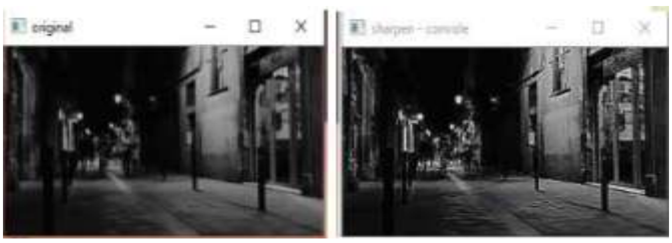

Fig – 1: Output of Convolutional Layer

The first step in the proposed system namely different convolutional layers. In this step coloured image gets transformed into greyscale image and gets converted into big matrix. After transformation of image into big matrix we multiplied this big matrix with predefined small matrix of sharpen convolutional layer. From this we get image with clearly visible edges as an output.

The third step in the proposed system namely colour restoration. In this step greyscale images restored their colours using RGB space values.

Fig -2: Output of Gamma Correction

5. CONCLUSION

In this project, we propose convolutional neural network and retinex theory approach for low-light image enhancement. It shows that multiscale Retinex is equivalent to a feedforward convolutional neural network with different Gaussian convolution kernels. After this, we build a Convolutional Neural Network (MSR net) that directly learns an end-to-end mapping between dark and bright images with extra pre/post-processing beyond the optimization.

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