Proposed Contrast Enhancement Technique on Low Illumination Color Images with Implemented CLAHE Module

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Abstract— Contrast is an important factor in any subjective evaluation of image quality. It is the difference in visual properties that makes an object distinguishable from other object and background. This paper aiming to do best for an image taken in low illumination or hazy condition by using contrast enhancement technique. For that HSV color space is used which is good for color enhancement over traditional RGB color space. Then using DWT on the S component and CLAHE on V component of HSV color space, develop a better contrast. The final result is compared with other techniques on bases of MSE, PSNR and AMBE parameter.

Key words: Contrast Enhancement, RGB Color Space, HSV Color Space, DWT

I. INTRODUCTION

In this digital era, digital image processing plays an important role. The objective of image enhancement is to improve visual quality of image depending on the application circumstances [1]. A digital color image, as its fundamental purpose requires, is to provide a perception of the scene to a human viewer or a computer for carrying out automation tasks such as object recognition. An image of high quality that could truly represent the captured object and the scene is hence in great demand. Contrast is an important factor in any subjective evaluation of image quality [2]. It can be used as controlling tool for documenting and presenting information collection during examination. The contrast enhancement of image refers to the amount of color or gray differentiation that exists between various features in digital images. It is the range of the brightness present in the image. The images having a higher contrast level usually display a larger degree of color or gray scale difference as compared to lower contrast level. The contrast enhancement is a process that allows image features to show up more visibly by making best use of the color presented on the display devices. The contrast enhancement techniques are commonly used in various applications where subjective quality of image is very important [3].

To human viewers, sharp contrast of edges and subtle tone of smooth surfaces in an image are often interpreted as high perceptual quality. But various condition, such as foggy weather, poor illumination, low grade imaging sensor, etc., can make an acquired image look faded and blurry. However, it is not uncommon that raw image with low perceptual contrast still contains information on the details of the captured scene. Therefore, since every early days of image processing many contrast enhancement techniques have been proposed and used, aiming to fully utilize the dynamic range of the raw sensor data and reproduce a visually more appealing and informative image.

Elementary enhancement techniques are mainly histogram based as they are simple, fast and produces acceptable results. Histogram modification basically modifies the histogram of an input image so as to improve the visual quality of the image. Histogram equalization is a process that attempts to spread out the gray levels in an image so that they are evenly distributed across their range. Normal histogram equalization usually leads to over enhanced output image with raised noise level [4].

Based on the camera and display design characteristics, most images are coded in terms of three primary color channels, i.e., signals are represented in the red-green-blue (RGB) color space. RGB is frequently used in most computer applications since no transform is required to display information on the screen. For this reason it is commonly the base colour space for most applications, but it is non-linear with our visual perception. Converting it in the other color space such as HSV (Hue, Saturation, Value) which is describes the model similarly to visual perception gives the benifts over RGB color model.

II. LITERATURE REVIEW

Many algorithms for achieving contrast enhancement have been developed; among them is histogram equalization technique that is attractive due to its simplicity. Histogram equalization generates a grey map that changes the histogram of an image and redistributes all pixel values to be as close as possible to a user-specified desired histogram. An adaptation of histogram equalization is the contrast limited adaptive histogram equalization (CLAHE). CLAHE divides input image into a number of equal size blocks and then performs contrast limited histogram equalization on each block. The contrast limiting is done by clipping the histogram before histogram equalization. Other colour enhancement methods have been proposed based on histogram equalization, these also include multiscale approaches and other hue preservation contrast enhancement schemes. Earlier works have also shown that the performance of HSV colour space is good in colour improvement. Hue preservation methods keep the Hue constant to avoid the problem of colour shifting, while either only the Luminance (V) component or both Luminance (V) and Saturation (S) components are modified to make the image soft and vivid. Compared with other models such as CIE LUV colour space and CIE Lab colour space, it is easier to control the Hue component and still avoid colour shifting in the HSV colour space [1].

This paper proposed an efficient algorithm for contrast enhancement of natural images. The contrast of images is very important characteristics by which the quality of images can be judged as good or poor. The proposed algorithm consists of two stages: In the first stage the poor quality of an image is processed by modified sigmoid function. In the second stage the output of the first stage is further processed by contrast limited adaptive histogram equalization to enhance contrast of images. In order to achieve better contrast enhancement of images, a novel mask based on input value together with the modified sigmoid formula that will be used as contrast enhancer in addition to contrast limited adaptive histogram equalization. This new contrast enhancement algorithm passes over the input image which operates on its pixels one by one in spatial domain. Simulation and experimental results on benchmark test images demonstrates that proposed algorithm provides better results as compared to other state-of-art contrast enhancement techniques. Proposed algorithm performs efficiently in different dark and bright images by adjusting their contrast very frequently. Proposed algorithm is very simple and efficient approach for contrast enhancement of image. This algorithm can be used in various applications where images are suffering from different contrast problems [2].

This paper proposes a contrast enhancement technique to enhance color images captured under poor illumination and varying environmental conditions. In this first RGB color space converted into HSV color space. DWT is applied to its saturation component. Use a derived mapping function to modify approximate coefficients. Reconstruct S using IDWT. Then enhance V component using CLAHE technique. Combine H, new S component, and V components to get the enhanced HSV image. Lastly image is converted back into the RGB color space and get the enhanced image in RGB space. Its performance is compared with HE and CLAHE techniques on the bases of AMBE, MSE and PSNR parameters. The proposed method produces image with the lowest MSE, AMBE, and highest PSNR [4].

III. PROPOSED WORK

When humans see a color, we interpret it by its hue, saturation and brightness. However the RGB color space does not correspond well to how we interpret colors in such way. Hence first convert the RGB color space into HSV (Hue, Saturation, Value) color space and then process further. Apply 2-D DWT (Discrete Wavelet Transform) on saturation component of HSV color space of image. The major advantage to using wavelets is that they provide a strong mathematical framework for analyzing functions at various scales. This property makes wavelet-based analysis a powerful tool in image processing. DWT sampled the wavelet function which is based on sub-band coding, is found to yield a fast computation of wavelet transform. Use CLAHE on the luminance (V) of the HSV color space. Get together the all components of HSV. Now the result is in HSV color space, convert it back to RGB color space.

To verify this technique's performance, compare it with HE and CLAHE technique on AMBE, MSE and PSNR parameters.

Absolute mean brightness error (AMBE) is the absolute difference between input and output mean.

Proposed works flow is goes as follows:

1) Take a color image.
2) Convert its RGB color space into HSV color space.
3) Apply 2D- DWT on HSV's S components.
4) Take out the LL band among created bands.
5) Interpolate this LL band by 2.
6) Wiener filter removes the noise from above output if present any.
7) Output of filter is added in original S component.
8) Enhance luminance (V) component of HSV using CLAHE.
9) Preserves the H component by passing it as it is.
10) Take all the component together to form HSV color space image.
11) Convert HSV color space into RGB color space.
12) Evaluate its result using MSE, PSNR and AMBE parameters.

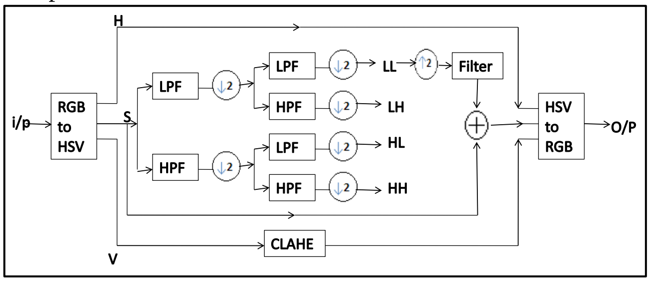

Fig. 1: Block diagram of proposed technique

IV. IMPLEMENTED MODULE

A. *Implemented Contrast Limited Adaptive Histogram Equalization Technique*

Adaptive histogram equalization technique used to improve contrast in images, it uses several histograms on each distinct section of image and uses them to redistribute the lightness values of the image. However, AHE has tendency to over amplify noise in relatively homogeneous regions of an image. Contrast Limited AHE (CLAHE) prevents this by limiting the amplification. The contrast amplification in the vicinity of a given pixel value is given by the slope of the transformation function. This is proportional to the slope of the neighbourhood cumulative distribution function (CDF) and therefore to the value of the histogram at that pixel value. CLAHE limits the amplification by clipping the histogram at a predefined value before computing the CDF. This limits the slope of the CDF and therefore of the transformation function. The value at which the histogram is clipped, the so-called clip limit, depends on the normalization of the histogram and thereby on the size of the neighbourhood region.

Flowchart for CLAHE is as follows

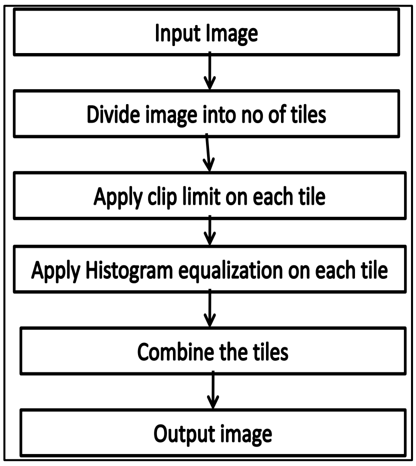

Fig. 2: Flowchart for CLAHE

V. RESULTS

We applied CLAHE technique on many different images. Apply CLAHE on V component of HSV. Following results we get after using 8x8 tiles and clipping limit 0.01.

A. *Image- Shed*

Fig. 3: Image- Shed
AMBE= 53.6864 MSE= 0.2685 PSNR= 53.8408

B. *Image- Girl*

Fig. 4: Image- Girl
AMBE= 64.7032 MSE= 0.2239 PSNR= 54.6298

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