Dark Image Enhancement through Channel Division Using Super Resolution Technique

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Abstract–**Image enhancement is the one of the challenging issues in image processing. Since Image clarity is very easily affected by lighting, weather, or equipment that has been used to capture image .These conditions lead to image may suffer from loss of information. Principle objective of image enhancement is to process an image so that result is more suitable than original image for specific application. The Content aware algorithm enhances the image by producing ad hoc transformation for each image by selecting particular content of an image which has to be processed. In order to produce better result of an image content aware method with super resolution technique is introduced in this paper. To implement the proposed algorithm, first transform the image into hue–saturation–value color space. Then proposed algorithm applied to image intensity. After the enhancement, use hue (H) and saturation (S) components from the original image and merge with the enhanced intensities to create the final image. These procedures maintain the color (HS) of the image while improving its intensity level (V).Then super resolution technique is applied to the image. It creates an improved resolution image from all low feature values.**

Keywords- **Image enhancement, Channel division, Content Aware,Contrast pair, super resolution**

I. INTRODUCTION

Image enhancement means to process an image so that the outcome is more suitable than original image. The technique not only improves the visual quality but also increases the acuity of information contained within the image. That means
to bring out detail that is hidden in an image or to increase contrast in a low contrast image. Contrast enhancement is essential to improve substandard images that are captured in extreme lighting conditions, such as excessive bright or dark environments that produce low contrast images or are backlit, which produce normal global contrast images with a low dynamic range in shadowed areas. Several algorithms have been proposed to overcome this problem.One of the most common approach is Histogram Equalization [HE][1].one of the simplest and most widely used method is Histogram Equalization. In HE the cumulative density function (cdf) of histogram is used as the intensity transfer function. This method enhances the contrast by distributing the cdf across the entire dynamic range. However, this even distribution creates artifacts in the smooth regions of the image. Moreover it does not consider the boundaries, which degrades the sharpness of the resulting image. This assignment expanded the dark regions and compressed the bright ones, which created artifacts. Another disadvantage of HE is the wash-out effect that occurs when the original histogram dose not occupy the entire dynamic range of the image[2].Consequently the equal redistribution of HE can leave gaps in the final histogram. Thus, several methods based on HE have been proposed in order to eliminate the shortcomings of the original technique.

In Bi-histogram equalization (BHE) [3] method, it splits the histogram into two parts based on where the mean lies. Each part is then enhanced independently using HE.BHE maintains the intensity mean of the original image, which supresses the over enhancement problem. But this may lead to unnatural images.

Another popular method is Adaptive histogram equalization (AHE), whereby the histogram is equalized based on localized data [6]. Even though AHE provides significant contrast enhancement and may preserve small details, over enhancement and unnatural images are still occasionally

produced. Contrast stretching algorithm and their adaptive versions can produce good results in dark images however they produce no noticeable improvement over the image. Another method is the multi scale retinex algorithm which is fast version of retinex algorithm which mainly focuses on dark-tone correction [4]. This method has high computational complexity. The first step in content-based enhancement is the intensity pair distribution algorithm .This algorithm combines the global property of HE and local properties of AHE. Expansion and anti-expansion forces are used while processing the image. Partially overlapped sub-block histogram equalization which is a derivation of local histogram and spend more expense for calculation complexity. Three new methods of transform histograms are logarithmic transform histogram mapping, logarithmic transform histogram shifting, and logarithmic transform histogram shaping. These methods needs less computational complicated techniques and are used only in spatial domain[9]. The above
mentioned methods significantly improve the contrast of an image but not much appropriate results in dark images.

The content aware method for image processing that analyses the contrast in the boundaries and in the texture region to produce ad hoc transformation of the image [5]. Due to independent treatment needed for the groups, build specific function for each group that will enhance its characteristics. In this channel division enhancement (CDE) is used. In CDE the contrast pairs are accumulated into Local Contrast Indicator (LCI) functions, and merge such functions into channels to reduce artifacts creation. Sometimes accumulation of contrast pairs inaccurately spread the dynamic range of some intensity because of the contribution of intensities with different characteristics, such as bright intensities contributing to the separation of dark intensities. It overcomes the above problem.Then, channels are grouped into region channels, which may simulate human visual characteristics, and create a set of transformation functions from their accumulated LCIs. Intensity channel used to control the interference and overlap of the contrast pairs. These intensity channels became the building blocks for the region channels. Finally, region channel functions are used to enhance the specific characteristics of each image and merge the results of that process to reduce the artifacts and to ensure maximum enhancement.To implement the proposed algorithm, first transform the RGB image into hue–saturation–value color space. Then, proposed system is applied to the image intensity (V component). The hue (H) and saturation (S) components are preserved and merge with the enhanced intensities to create the final image. Then super resolution technique is applied to the image. It creates an improved resolution image from all low feature values.

The remainder of this paper is organized as follows. Section 2 explains about the methodology. Section 3 discusses the experimental results. Finally, conclusion and given in Section 4.

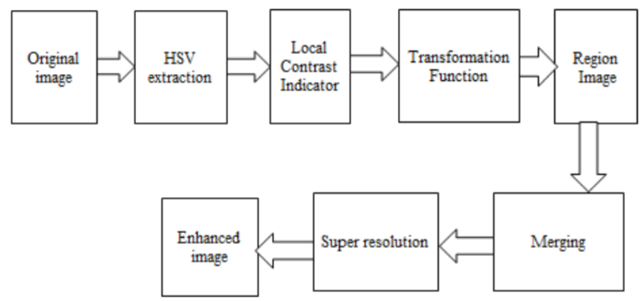

Fig. 1 Block diagram of the proposed algorithm

II. METHODOLOGY

A. CHANNEL DIVISION METHOD

In this method first the original image is split into regions of hue (H), saturation (S), and value (V) using adhoc transformation which is based on information from contrast of textured and boundary regions [7].Proposed algorithm is only applied to the value (V) region and at the same time H &S is maintained constant until merging. Contrast is encoding using contrast pairs. Contrast pairs are formed so that it spread over the dynamic range of intensities. In enhancement process, eachcontrast pairs acts like a force that spreads the intensities that define it. Intensity channels are building blocks of region channel that can be used to control the interference and overlap of contrast pairs. We use region channel functions to enhance the specific characteristics of each image and merge the results of that process to reduce the artifacts and to ensure enhancement.Fig. 1 summarizes the entire algorithm.

B. CONTRAST PAIR

Contrast i.e., the intensity difference between two pixels—in the image through contrast pairs is modeled. A contrast pair acts like a force that spreads apart the intensities that define it.

LCI function is used to model the contrast pairs interaction. A set of contrast pair is defined by,

$$p(a,b) = \{ p^{r(a',b')}_{r(a,b)} \,\big|\, (a',b')\ \mathcal{E}\ N(a,b) \qquad (1)$$

Where $p_{r(a,b)}^{r(a',b')}$ is a contrast pair, N (a, b) contains 8 neighbors of (a, b), and I (a, b) are the intensities of the pixels (a, b) and (a', b'). The contrast pairs can be computed efficiently by scanning the top-left neighbours of each pixel (i.e., the three neighbours above the pixel and the one directly to its left), and the other four pairs are processed when the bottom-right neighbours are scanned. Edge and smooth are two types ofcontrast pairs of each image. Edges are found in the boundary and smooth in flat region. LCI function x is stated by

$$x(i) = \sum_{(a,b)} \sum_{p \in pe\,(a,b)} p(i) \qquad (2)$$

Where ∈ is a constant, and (a, b) and (a', b') are pixel positions in the image. Contrast pair after computing the LCI is given by,

$$X(k) = \sum_{i=0}^{k} \frac{x(i)}{\sum_{i=0}^{N} x(i)} \qquad (3)$$

Where X (k) is the position of force of integration X, k is the intensity index range $0 \leq k \leq N$, and N is the maximum number of intensity. Transformation function is stated by,

$$s(k) = \frac{X(k) + I(k)}{\max(I + X)}, 0 \leq k \leq N \qquad (4)$$

A. REGION IMAGES

Grouping the contrast pairs into intensity channels is not sufficient to produce the best enhancement, as there may be (intensity) channels with similar properties. So mix the channels with similar characteristics into region channels. Consequently, a region channel is a mix of intensity channels that share some characteristics. Hence, an image may have R different region channels that are defined by,

$$T_r = \frac{\sum_{i=I_{min}}^{I_{max}^r} T^i}{I_{max}^r - I_{min}^r + 1}, 1 \leq r \leq R \qquad (5)$$

Here T_r is the r^{th} region channel transformation, T^i is the transformation function for each intensity channel i, and I_{min}^r and I_{max}^r are the lower and upper bound (intensities) for the r^{th} region channel. Experimentally, mix the intensity channels into three regions (R equal 3), which may simulate the human visual system, further improves the resultant image and approximate each region channel to accommodate dark, middle, and bright intensities. These functions produce different results, which are then merged using weighting functions to create the final image. The enhanced image is a mixture of region channels; each channel has a different weighting function that emphasizes its characteristics.The final transformation function T can be computed by,

$$s(i) = \sum_{r=1}^{R} w_r(i)\, T_r(i) \qquad (6)$$

Where w_r is the weighting function for the r^{th} region channel and T_r (i) indicates the i^{th} position in the r^{th} region channel transformation function.

B. SUPER RESOLUTION

Finally, super resolution technique is applied. It is a technique that enhances the resolution of the imaging system. Single frameSuper-resolution is the process of recovering a high-resolution image from low-resolution image. High resolution image offers a high pixel density and there by more details about the original scene.Here single image super resolution technique used which based on both spatial and wavelet domain and take the advantage of both. Algorithm is iterative and use back projection to minimize reconstruction error.

Wavelet based denoising method is also introduced to remove noise [8] .
Following are the steps used for super resolution.

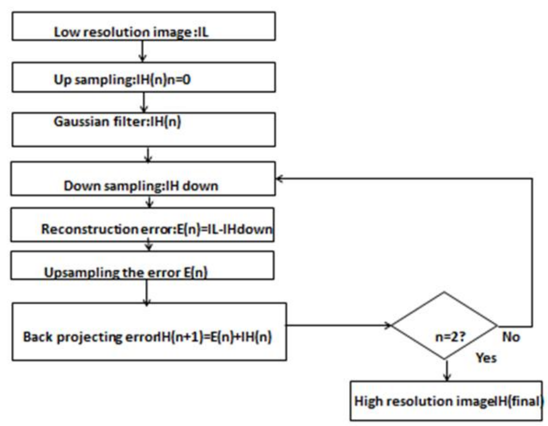

Fig 2 Flow diagram

1. Down sampling to get low-resolution image

To acquire the low-resolution image, take high-resolution image and convert it into low resolution image using below method (Figure 3). Here block of 2 x 2 is chosen and 1 pixel of low-resolution image for every 4 pixel of high-resolution image is derived.

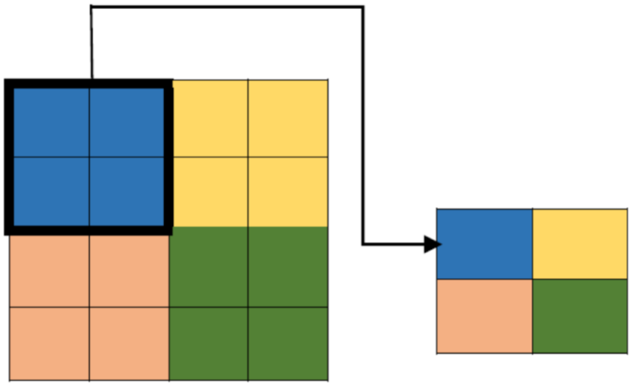

Fig.3 Method of down sampling

2.Up sampling of the image

For signal decomposition, one can use analysis filter bank which consist of low pass and high pass filters at each decomposition stage and split signal into two bands. The low pass filter fetch the coarse information (corresponds to an averaging operation) while high pass filter fetch detail information (corresponds to a differencing operation) of the signal. Finally divide the output of filtering operations' by two .For two-dimensional transform, the image is filtered along the x-dimension using low pass andhigh pass analysis filters and decimated by two. Then it is followed by filtering the sub-imagealong the y-dimension and decimated by two. Finally, the image has been split into four bands denoted by LL, HL, LH, and HH, after one level of decomposition. The LL band is againsubject to the same procedure. This process of filtering the image is called pyramidal decomposition of image. This is depicted in Fig. Reversing the above procedure can carry out theirconstruction of the image and it is repeated until the image is fully reconstructed.

3. Gaussian Filter and Down sampling

After up sampling due to point spread function (PSF) image can be look blurred little bit. SoGaussian filter merely work like smoothing kernel. As the blurred effect is very low or ignorableGaussian filter applies only once.

4.Reconstruction and up sampling the error

In this stage of algorithm error is calculated between original low-resolution image of step 1 anddown sampled image of step 4. This is the most important part of algorithm because the error that we find in this stage is used as the correction parameter in getting super resolution image.

Up sampling the error is most important step of the proposed algorithm. For reconstructing superresolution image, error must be back projected and for that error matrix must be up-sampled to meet super resolution image.

5. Back projecting error

Finally error matrix generated in step 6 is added with high-resolution image generated in step 3.Repeat the above procedure as shown in the figure till we acquire satisfactory results. Withinthree iterations appropriate result comes.

III. EXPERIMENTAL RESULT

In this section the performance of the proposed method is optimized. The proposed method was able to reveal the details in picture. And also the proposed method was able to recover details in mixed images as well. In general the proposed method produces the better result by producing images withmeans closer to ideal images. From the graph it is clear that proposed method give better enhancement.

Fig. 4(a)Input image

Fig. 4(b)Enhanced image

Fig. 5(a) Input image

Fig. 5(b) Enhanced image

Fig. 5(b)Enhanced image

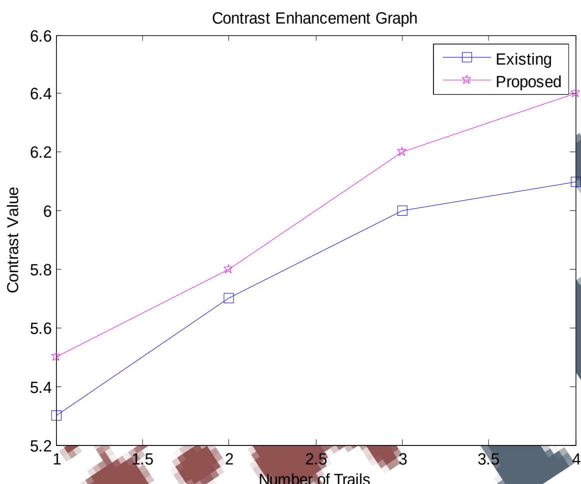

Fig.6 Contrast Enhancement Graph

IV. CONCLUSION

Content aware enhancement algorithm with super resolution method can improve images from a variety of different environments. The proposed algorithm isimplemented in MATLAB.This method improves the content of image thereby improving its enhancement capabilities and reduces the artifacts. The proposed method is robust because it adapts its transformation function to the contents of image.

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