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ADAPTIVE HISTOGRAM STRETCHING AND GAMMA CORRECTION BASED IMAGE CONTRAST AND COLOR ENHANCEMENT

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ABSTRACT

This paper proposes an efficient algorithm for contrast and color enhancement of digital images. The contrast of an image is very important characteristic by which the quality of image can be judged as good or poor. Also enhancement of image plays a significant role in digital image processing, computer vision, etc. In this paper an automatic transformation technique has used, that improves the brightness of low contrast images via the gamma correction and probability distribution of luminance pixels. Due to time complexity, low efficiency and only contrast enhancement leads to the proposed method. Temporal information is used to reduce the computational time for several image frames of a video sequence. Proposed technique is very simple and efficient approach for contrast and color enhancement of image and the proposed method produces enhanced images of comparable or higher quality than conventional method.

KEYWORDS*:* Contrast enhancement, gamma correction, histogram equalization and histogram stretching

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INTRODUCTION

Image enhancement is to improve the interpretability or perception of information in images for human viewers, or to provide `better' input for other automated image processing techniques. In other words the principle objective of enhancement is to process an image so that the result is more suitable than the original image for a specific application. Image enhancement is one of the most interesting and visually appealing areas of image processing. Image enhancement techniques can be divided into two broad categories: spatial domain methods, which operate directly on pixels and frequency domain methods, which operate on the Fourier transform of an image. Image enhancement refers to accentuation, or sharpening, of image features such as boundaries, or contrast to make a graphic display more useful for display & analysis. This process does not increase the inherent information content in data. It includes gray level & contrast manipulation, noise reduction, edge crispening and sharpening, filtering, interpolation and magnification and so on. Contrast enhancement plays an important role in the improvement of visual quality for computer vision, pattern recognition, and the processing of digital images. Contrast is the difference between maximum and minimum pixel intensity.

There are two methods of enhancing contrast. The first one is called Histogram stretching that increase contrast. The second one is called Histogram equalization that enhances contrast. Contrast enhancements improve the perceptibility of objects in the scene by enhancing the brightness difference between objects and their backgrounds. Contrast enhancements are typically performed as a contrast stretch followed by a tonal enhancement, although these could both be performed in one step. A contrast stretch improves the brightness differences uniformly across the dynamic range of the image, whereas tonal enhancements improve the brightness differences in the shadow (dark), midtone (grays), or highlight (bright) regions at the expense of the brightness differences in the other regions. Poor contrast in digital video or images can result from many circumstances, including lack of operator expertise and inadequacy of the image capture device. Unfavorable environmental conditions in the captured scene, such as the presence of clouds, lack of sunlight or indoor lighting, and other conditions, might also lead to reduced contrast

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Journal home page: www.ijreb.org

quality [1].Essentially, if the overall luminance is insufficient, then the details of the image or video features will be obscured.

In general, the enhancement techniques for low contrast images can be broadly divided into two categories: direct enhancement methods and indirect enhancement methods. In direct enhancement methods, the image contrast can be directly defined by a specific contrast term. However, most of these metrics cannot simultaneously gauge the contrast of simple and complex patterns in images which contain both. Conversely, indirect enhancement methods attempt to enhance image contrast by redistributing the probability density. In other words, the image intensities can be redistributed within the dynamic range without defining a specific contrast term. Histogram Modifications (HM) techniques are the most popular indirect enhancement techniques due to their easy and fast implementation [2]–[3].

Gamma correction, gamma nonlinearity, gamma encoding, or often simply gamma, is the name of a nonlinear operation used to code and decode luminance in video or still image systems. Gamma correction controls the overall brightness of an image. Images which are not properly corrected can look either bleached out, or too dark. Trying to reproduce color accurately also requires some knowledge of gamma. Varying the amount of gamma correction changes not only the brightness, but also the ratios of red to green to blue. Gamma correction is, in the simplest cases, defined by the following power-law expression:

$$V_{out} = A V_{in}^{\gamma} \quad (1)$$

where A is a constant and the input and output values are non-negative real values; in the common case of $A = 1$, inputs and outputs are typically in the range 0–1.

The shape of the gamma curve is determined by a number ranging from 0.0 to 10.0 known as the “gamma value”. The pixel values range from 0.0 representing pure black, to 1.0, which represents pure white. Gamma values of less than 1.0 darken an image. Gamma values greater than 1.0 lighten an image and a gamma equal to 1.0 produces no effect on an image. Gamma correction techniques make up a family of general HM techniques obtained simply by using a varying parameter γ. The simple form of the transform-based gamma correction (TGC) is derived by

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IJREB
Journal home page: www.ijreb.org

$T(l) = l\max(l/l\max)^{\gamma}$ (2)

where $l$max is the maximum intensity of the input. The intensity$l$ of each pixel in the input image is transformed as $T(l)$ after performing Eq. (1). As expected, the gamma curves illustratedwith $\gamma >1$ have exactly the opposite effect as those generatedwith $\gamma <1$, as shown in Fig.1.It is important to note that gamma correction reduces toward the identity curve when $\gamma = 1$.However,different images will exhibit the same changes in intensity as a result of the parameter gamma thereby contrast is directly modified by this gamma correction. To overcome this, probability density of each intensity level in a digital image can be calculated.

$pd\,f(l) = nl/(MN)$ (3)

where nl is the number of pixels that have intensity l and MN is the total number of pixels in the image.

The rest of this paper is organized as follows: Section IIprovides a brief discussion of previous works. Section III presents the existing method in detail. In Section IV, the efficiency of the proposed method is supported by comparingthe experimental results obtained through use of our methodto those obtained via existing methods. Finally, concluding remarks are presented in Section V.

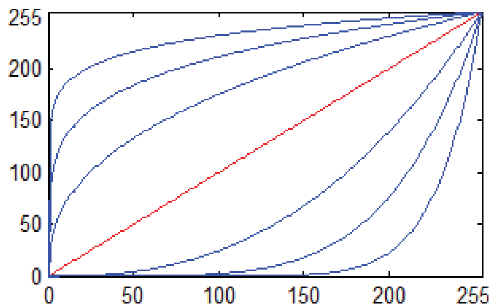

Fig. 1 Transformation curves illustrated by gamma correction

PREVIOUS WORKS

Contrast enhancement is posed as an optimization problem that minimizes a cost function. By introducing specifically designed penalty terms, the level of contrast enhancement can be adjusted; noise robustness, white/black stretching and mean-brightness preservation may easily be incorporated into the optimization. In this low complexity histogram modification algorithm is used. It deals with histogram spikes and adjusts the level of enhancement adaptively so that the dynamic range is better utilized while handling the noise visibility and the natural look requirements. Also using histogram smoothing or weighted histogram approximation is computationally complex. In histogram computing, to deal with histogram spikes in a

IJREB

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simple way, instead of smoothing or weighting the input histogram, one can change the way a histogram is computed. Histogram spikes are created because of a large number of pixels that have the same gray-level and these pixels almost always come from smooth areas in the input image when they create artifacts/noise in the enhanced image. Hence, histogram computation can be modified so as to take pixels that have some level of contrast with their neighbors into account, which will solve the histogram spike problem at the very beginning. For a successful contrast enhancement, the histogram should be modified in such a way that the modified histogram represents the conditional probability of a pixel, given that it has a contrast with its neighbors. In adjusting the level of enhancement, is possible to adjust the level of histogram equalization to achieve natural looking enhanced images. The modified histogram is a weighted average of the input histogram $\mathbf{h_i}$ and the uniform histogram $\mathbf{u}$. The level of histogram equalization should be adjusted depending on the input image's contrast. Low contrast images have narrow histograms and with histogram equalization, contouring and noise can be created. The stretching parameter should also be adapted with image content. For dark images white stretching can be favored, while for bright images black stretching can be favored. The disadvantages with this method are less effective and becoming problem when histogram has spikes [1].

To enhance the contrast in fuzzy domain the first step is to map an image from space domain to fuzzy domain Then propose a more powerful and adaptive fuzzy contrast enhancement method than adaptive contrast enhancement (ACE) method with adaptive power variation and interpolation techniques. The algorithm used in this mapping an image to fuzzy domain. Adaptive fuzzy contrast enhancement with adaptive power variation: ACE combines local contrast measurement with con-tour detection operator; therefore, it is very efficient for contrast enhancement. The goal of proposed method is to take care of the fuzzy nature of an image and the fuzziness in the definition of the contrast to make the contrast enhancement more adaptive and more effective, and to avoid over-enhancement/under-enhancement. The main problem associated with this is that, not reduce the over-enhancement/under-enhancement [2].

IJREB

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A new method for unsharp masking for contrast enhancement of images. In this approach, employs an adaptive filter that controls the contribution of the sharpening path in such a way that contrast enhancement occurs in high detail areas and little or no image sharpening occurs in smooth areas.Adaptive contrast enhancement method has used in this.The disadvantages with this method are high computational complexity and low performance [3].

A Gaussian membership function is proposed to fuzzify the image information in spatial domain. We introduce a global contrast intensification operator (GINT), which contains three parameters, viz., intensification parameter **t**, fuzzifier $\mathbf{f_h}$, and the crossover point $\boldsymbol{\mu_c}$, for enhancement of color images. While defining fuzzy contrast-based quality factor $\mathbf{Q_f}$ and entropy-based quality factor $\mathbf{Q_e}$and the corresponding visual factors for the desired appearance of images. By minimizing the fuzzy entropy of the image information with respect to these quality factors, the parameters **t,** $\mathbf{f_h}$ and $\boldsymbol{\mu_c}$are calculated globally. Algorithm used in this is fuzzy optimization. The disadvantage is low performance [4].

Feature-similarity (FSIM) index for full reference IQA is proposed based on the fact that human visual system (HVS) understands an image mainly according to its low-level features. Specifically, the phase congruency (PC), which is a dimensionless measure of the significance of a local structure, is used as the primary feature in FSIM. Considering that PC is contrast invariant while the contrast information does affect HVS' perception of image quality, the image gradient magnitude (GM) is employed as the secondary feature in FSIM. The FSIM index is designed for grayscale images or the luminance components of color images. Since the chrominance information will also affect HVS in understanding the images, better performance can be expected if the chrominance information is incorporated in FSIM for color IQA. Such a goal can be achieved by applying a straightforward extension to the FSIM framework. At first, the original RGB color images are converted into another color space, where the luminance can be separated from the chrominance. To this end, we adopt the widely used YIQ color space, in which Y represents the luminance information and I and Q convey the chrominance information. The disadvantages are less accuracy and efficient.

IJREB

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Journal home page: www.ijreb.org

EXISTING METHOD

In the existing work, low contrast image has considering and after analyzing its histogram. Then taking the weighting distribution, which was considering the probability distribution function and cumulative distribution function after then applying the gamma correction. Gamma correction controls the overall brightness of an image. After then obtaining the enhanced image and there is color enhancement results artifacts such as noise. The following figure shows the block diagram of the existing system.

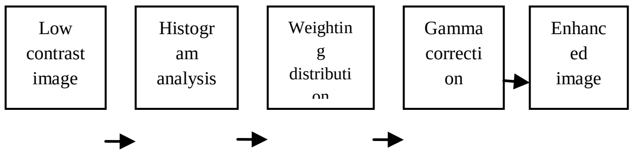

Fig 2 Block diagram of the existing system.

Fig 3 Image on various in contrast.

Using low contrast image as an input, most of the pixels are densely distributed in the low level region. Based on the weighting distribution function, using pdf (probability distribution function) and cdf (cumulative distribution function) contrast is directly modified by the gamma correction. The probability density of each intensity level in a digital image can be calculated to solve this problem. The probability density function(*pd f*) can be given by eqn(3)

$$pd\,f\,(l) = nl/\,(MN)$$

where nl is the number of pixels that have intensity l and MN is the total number of pixels in the image. The cumulative distribution function (cdf) is based on pdf, and is formulatedas:

$$cdf(l)=\sum_{k=0}^{l} pdf\ (l) \qquad (4)$$

The disadvantages with this paper are complexity is high, low efficiency and it cannot be automatically generated.

PROPOSED METHOD

In this proposed work using Adaptive Histogram Stretching method. By using this method thereby, can increase the contrast and color also.

IJREB

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Journal home page: www.ijreb.org

The Adaptive Histogram Stretching (AHS) will be increases the contrast. It is a method is used to redistribute the brightness of images, enhancing and normalizing the contrast characteristics. For color images, histogram stretching is applied to the Y component that is the luminance component of YUV color images. The images are also converted from YUV to other formats. In the infrared images, histogram stretching is applied to the gray scale component. The adaptive nature of this method spreads the majority of values to 80% of the luminance range while compressing the lowest and highest luminance values through the use of pivotal points in the histogram stretching mapping function. The lowest and the highest luminance values primarily represent dark shadows.The following figure shows the block diagram of the existing system.

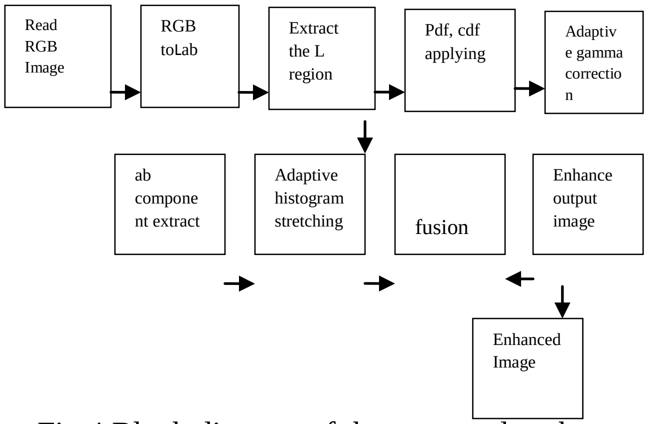

Fig 4 Block diagram of the proposedwork.

Contrast is the difference between maximum and minimum pixel intensity. In the existing work, low contrast image has considering and after analyzing its histogram. Then taking the weighting distribution, which was considering the probability distribution function and cumulative distribution function. Then applying the gamma correction. Gamma correction controls the overall brightness of an image. After then obtaining the enhanced image and there is color enhancement results artifacts such as noise.

The proposed method is composed of three major steps. First, the histogram analysis provides the spatial information of a single image based on probability and statistical inference. In the second step, the weighting distribution is used to smooth the fluctuant phenomenon and compute histogram stretching threshold. In the third and final step, Adaptive gamma correction with respect to color constraint can automatically enhance the image contrast and color through use of a smoothing curve. Proposed technique performs efficiently in different dark and bright images by adjusting their contrast very frequently. Proposed technique is very simple and efficient approach for contrast and color enhancement of image.

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Journal home page: www.ijreb.org

The proposed method produces enhanced images of comparable or higher quality than conventional method.

In this proposed work contrast and color has enhanced by applying the adaptive histogram stretching. This method will increase the contrast, and in the color images, consider an RGB image, have to convert it into lab component. A Lab color space is a color-opponent space with dimension L for lightness and a and b for the color-opponent dimensions, Unlikethe RGB and CMYK color models, Lab color is designed to approximate human vision. Its L component closely matches human perception of lightness. It can thus be used to make accurate color balance corrections by modifying output curves in the a and b components, or to adjust the lightness contrast using the L component. When performing this process contrast and color will be results an enhanced image.

The proposed adaptive gamma correction (AGC) is formulated as follows:

$$T(l) = l\max (l/l\max)^{\gamma} = l\max (l/l\max)^{1-cdf(l)} \quad (5)$$

The WD function is formulated as:

$$pdf_w(l) = pdf\max \, (pdf(l) - pdfmin|pdfmax - pdfmin) \quad (6)$$

where α is the adjusted parameter, *pdf*max is the maximum *pd f* of the statistical histogram, and *pdf*min is the minimum *pdf*. Based on Equation (6) the modified *cdf* is approximated by

$$cdf_w(l) = \sum pdf_w(l) / \sum pdf_w \quad (7)$$

Finally, the gamma parameter based on *cdf* of Equation (5) is modified as follows:

$$\gamma = 1 - cdf_w(l).$$

The advantages are low complexity, can be implemented in a real-time video system with limited resources, reduce the processing time and image contrast and color enhancement. The applications are digital video, DVDs, scientific imaging, medical imaging etc.

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IJREB
Journal home page: www.ijreb.org

EXPERIMENTAL RESULTS

In this section summarizes that, the results produced by the previously existing methods that is, using the fuzzy logic, histogram modification and based on these HM methods.The following figures shows the illustration of low contrast grayscale image with its pdf,cdf,performing the gamma correction and producing the enhanced image.

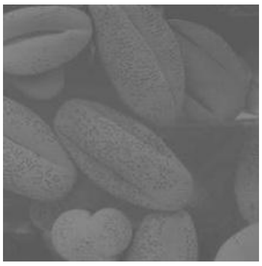

Fig 4a. Input image

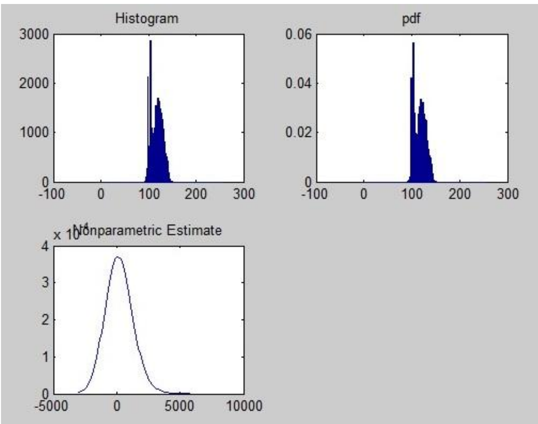

Fig 4bHistogram, pdf & cdf of fig 4a.

Fig 4c Enhanced image

The following figures shows the illustration of low contrast color image with its pdf, cdf, performing the gamma correction and producing the enhanced image.

Fig 5a . Input image

Fig 5b Lab image

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Volume 2 (Issue 4) Pages (148-159)
IJREB
Journal home page: www.ijreb.org

Fig 5c Extract L region

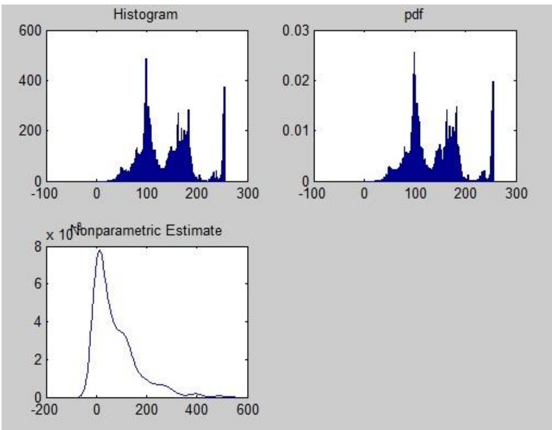

Fig 5d Histogram, pdf & cdf of fig 5a.

Fig 5e Enhanced image

In the Fig 4a to 4c shows the low contrast grayscale image has got enhanced by means of performing the pdf, cdf and gamma correction. And in the case of low contrast color image, taking the Lab component of the input image and extracting its L region and performing the weighting distribution such as pdf,cdf ,gamma correction resulting in the enhanced image as explained in Fig 5a to 5e.

CONCLUSION

This paper proposes and enhances the contrast and color of the images. In the proposed method, the color and contrast has got enhanced when compared to the existing method. While in the existing work, only contrast has got enhanced and results color artifacts. The advantages of proposed method are: reduce the computational complexity, can be implemented in a real-time video system with limited resources, reduce the processing time.

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