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Intensification of Dark Mode Images Based on Bilog Transform and Fast Fourier Transform

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ABSTRACT:

The relationship between the image histogram and contrast of images are established with the intensification of dark mode images to overcome the below problems such color distortion, data losses and dark mode image enhancement. Dark mode image enhancement model for image has been proposed based on our analysis on the relationships between image histogram and contrast enhancement/ white balancing. A model possessing highly enhanced image integrating contrast enhancement and white balancing into a unified framework of convex programming of image histogram. The relationships between image histogram and tone/contrast of image, and establish a dark mode image enhancement model. A series of definitions for context-free contrast, tone distortion and its nonlinearity, and clarify their relationships in terms of different parameters in the unified model have been analyzed. The Dark mode image enhancement model consolidates histogram-based tone mapping algorithms in a statistical framework of convex programming and therefore is a joint strategy. Extensive experimental results show that the proposed method can be widely used in a series of enhancement applications with promising results.

KEYWORD: contrast enhancement, tone mapping, white mapping, color constancy, dehazing, histogram equalization.

1.INTRODUCTION:

In computer graphics, the process of improving the quality of a digitally stored image is by manipulating the image with software. It is quite easy, for e.g., to make an image lighter or darker or to increase or decrease advance image enhancement software also supports many filter for altering images in various ways. Programs specialized for image enhancements are sometimes called image editors.

Image enhancement is the process of adjusting digital images so that the results are more suitable for display or further image analysis. For instance, you can remove noise, sharpen or brighten an image, making it easier to identify the key features. From the comparison results of the proposed algorithm and some existing methods, we can find that the proposed method achieves the best over visual effect. It not only enhances the contrast, but also prevents serious non linear tonal distortion. The picture randomly chosen from the internet suffers not only from low contrast but also serious tonal distortion. Using algorithm based on statically regularization model, we can achieve contrast enhancement and white balancing the proposed method on under exposed images are also tested. With the help of proposed method the details in the dark region become clearer. The behavior of the proposed model is close to white balancing. To do this, we test the proposed method on three color constancy data sets. Compared with grey edge method, under suitable configuration method provides comparable color constancy results. We can see the proposed method not only corrects the tone bias in original image but also enhance the contrast.

In spite of the huge knowledge on image enhancement, it has two drawbacks which is yet not resolved first, how to accomplish contrast enhancement while protecting a good tone. The contrast and tone of an image have same relationship. Due to the difficult interaction, those algorithm focuses on contrast enhancement or white balancing cannot offer favorable visual effect. The main objective of this paper is to unify more local image enhancement methods into the model through local image feature analysis.

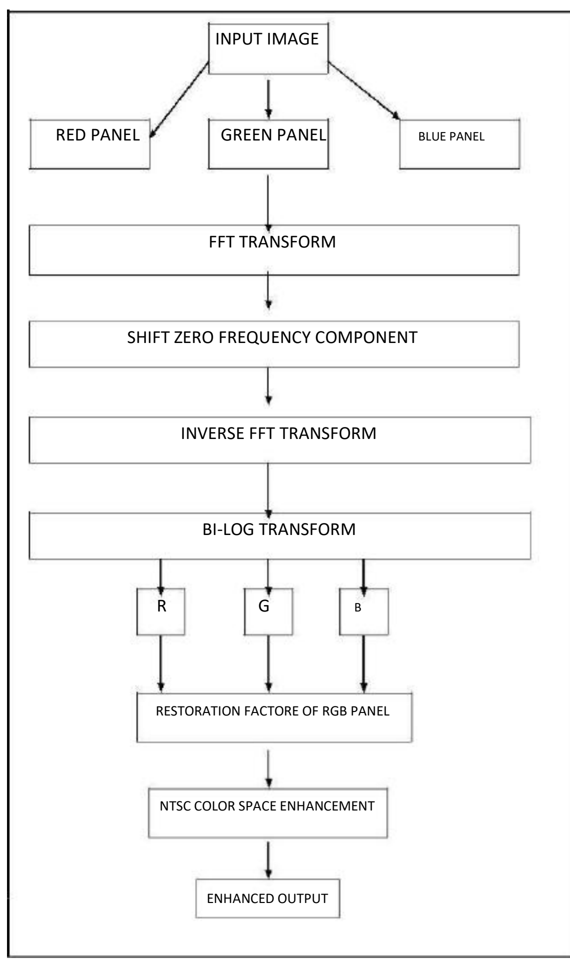
Both white balancing and contrast enhancement subdivided from image enhancement system into two separate independent phases. This plan of action has a clear disadvantage even though tone has changed in the white balancing phase. Contrast enhancement may deliberately influence it again. This difficulty has been grasped in many applications e.g. Contrast enhancement is accomplished by enhancing resultant effect of the image, but tonal distortion is caused is some situation.

Second how to combine various sorts of enhancement algorithms totally. The spatial filtering based enhancement method is combined by this work including bi-lateral filter, non-local means filter, steering regression, etc. In spite of all the mentioned advantages, there exits some computational complexity of filtering based method is almost superior than traditional histogram based methods. In real time video surveillance, the histogram based methods are extensively used. Considering the improvement in many circumstance, unified frame work of histogram based methods.

The relationship between image histogram and tone/contrast of an image has been analyzed and model called dark mode image enhancement model. A series of definitions are proposed for context free contrast tone distortion and its tonal aberration and its non-linearity. The dark mode image enhancement model combines histogram based tone mapping algorithm in a more common supporting beam of programming and considered as a joint policy. The relationship between histogram and contrast tone of image are established. The popular image enhancement method is been white balancing.

The dark mode image enhancement model has been applied to dark images. This technique is to enhance the image in various applications such as medical images, satellite images, undersea images and all other applications. This technique is proven highly efficient. The convex optimization problem can be solved with mature optimization algorithms and packages. The generalized equalization model achieves the desired purposes as mentioned in the beginning of this section. Both white balancing and contrast enhancement problems can be described as transforms of the image histogram. If the transform tends to be linear, the result is closer to the white balancing. Meanwhile, if the transform tends to be nonlinear, the result is closer to contrast enhancement. The generalized equalization model, with suitable parameters, keeps a balance between contrast enhancement (measured by contrast gain) and tonal distortion (measured by nonlinearity of transform). Moreover, it gives a unified framework accommodating many histogram based image processing algorithms. Under different configurations of parameters, the solution of generalized equalization model is equivalent to many existing algorithms that gives a list of the equivalent algorithms corresponding to different configurations of the model parameters. Another advantage of the generalized equalization model is its efficiency and is a convex optimization problem that can be solved with mature optimization algorithms.

In this model the values of spatial domain will be converted into frequency domain. The output obtained as a result is in the form of real and imaginary combination. Then a method called shift zero frequency component is determined. This involves keeping only the corner values. The output obtained as result in inversed. If the output obtained from this is over brighter, then in order to reduce this over brightness and to get a normal image a method called bilog transform is followed i.e.) taking logarithm. The output obtained from this is an image without pixel loss and data loss with an enhanced contrast. Next the resultant image is subjected to NTSC in order to get an image with no color distortion.



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2. PRE- PROCESSING:

RGB panel is used to view the red, green and blue components of the image separately. It has already been mentioned that an RGB image is overlap of three two dimensional matrix. . Convert RGB color map to HSV color map.

3.WHITE BALANCING:

The white balancing operation uses the color white as the standard for adding the correct overall color ―bias‖ to a captured image. The aim of this is to basically want all white objects in the scene to be white in the image. Automatic white balance is important function of digital still cameras. The goal of white balance is to adjust the image such that it looks as if it is under canonical light.

The white balance command automatically adjusts the colors of the active layer by stretching the red, green, and blue channels separately. To do this, it discards pixel colors at each end of the red, green and blue histograms which are used by only 0.05% of the pixels in the image and stretches the remaining range as much as possible. The result is that pixel colors which occur very infrequently at the outer edges of the histograms do not negatively influence the minimum and maximum values used for stretching the histograms in comparison with stretch contrast. Like ―stretch contrast‖ however there may be hue shifts in the resulting image.

It all boils down to the concept of color temperature. Color temperature is a way of measuring the quality of a light source. It is based on the ratio of the amount of blue light to the amount of red light, and the green light is ignored. The unit for measuring this ratio is in degree Kelvin (K). A light with higher color temperature (*i.e.*, larger Kelvin value) has "more" blue lights than a light with lower color temperature (*i.e.*, smaller Kelvin value). Thus, a cooler (*resp.*, warmer) light has a higher (*resp.*, lower) color temperature.

Human brain can quickly adjust to different color temperatures. More precisely, our eyes, with the help from the experience we learned, see a white paper as a white paper no matter it is viewed under strong sunlight or in a room illuminated with incandescent lights. Unfortunately, color films can only correctly record the colors in certain range of color temperatures. Therefore, we have daylight and tungsten films. On the other hand, digital cameras are very different! Digital cameras usually have built-in sensors to measure the current color temperature and use an algorithm to process the image so that the final result may be close to what we see. But, the algorithm(s) being used may not be accurate enough to make every situation correct. Under some difficult situations when the in-camera algorithm is not able to set the color temperature correctly or when some creative and special effects are needed, we can instruct the camera to use a particular color temperature to fulfill our need. This adjustment that makes sure the white color we view directly will also appear white in the image is referred to as white balance.

3.1 STEPS:

1. Convert to YUV color space.

2. Estimate illuminant by finding pixels that are similar to gray within a threshold: $(|U|+|V|)/Y < T$

3. Apply adaptation. The original method was to adjust the gain on the R and B channels because these are the ones primarily affected by a illuminant color cast. For example, in a sunset scene, the red channel is very bright so its gain should be lowered. However, this makes more sense in a hardware application. I had the idea of applying a chromatic adaptation transform (CAT) instead. R/B gain: Either the red or blue channel is adjusted according to the illuminant estimation. We quit if we're close enough to neutral gray.

4. Loop until the average of the off-gray points converges to a neutral gray or until we are no longer improving.

4. FFT TRANSFORM:

A **fast Fourier transform** (**FFT**) is an algorithm to compute the discrete Fourier transform (DFT) and its inverse. Fourier analysis converts time (or space) to frequency (or wave number) and vice versa; an FFT rapidly computes such transformations by factorizing the DFT matrix into a product of sparse (mostly zero) factors.[1] As a result, fast Fourier transforms are widely used for many applications in engineering, science, and mathematics. The basic ideas were popularized in 1965, but some FFTs had been previously known as early as 1805. In 1994 Gilbert Strang described the fast Fourier transform as "the most important numerical algorithm of our lifetime".

4.1 ALGORITHM:

By far the most commonly used FFT is the Cooley–Tukey algorithm. This is a divide and conquer algorithm that recursively breaks down a DFT of any composite size $N = N_1N_2$ into many smaller DFTs of sizes N_1 and N_2, along with $O(N)$ multiplications by complex roots of unity traditionally called twiddle factors .

This method was popularized by a publication of J. W. Cooley and J. W. Tukey in 1965, but it was later discovered that those two authors had independently re-invented an algorithm known to Carl Friedrich Gauss.

The best known use of the Cooley–Tukey algorithm is to divide the transform into two pieces of size $N/2$ at each step, and is therefore limited to power-of-two sizes, but any factorization can be used in general. These are called the **radix-2** and **mixed-radix** cases, respectively. Although the basic idea is recursive, most traditional implementations rearrange the algorithm to avoid explicit recursion. Also, because the Cooley–Tukey algorithm breaks the DFT into smaller DFTs, it can be combined arbitrarily with any other algorithm for the DFT.

5. GAMMA CORRECTION:

$$V_{out} = AV_{in}^{\gamma}$$

Gamma correction, gamma nonlinearity, gamma encoding, or often simply gamma, is the name of a nonlinear operation used to code and decode luminance or tri stimulus values in video or still image systems. Gamma correction is, in the simplest cases, defined by the following power-law expression: 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. A gamma value $\gamma < 1$ is sometimes called an encoding gamma, and the process of encoding with this compressive power-law nonlinearity is called gamma compression; conversely a gamma value $\gamma > 1$ is called a decoding gamma and the application of the expansive power-law nonlinearity is called gamma expansion.

6. BILOG TRANSFORM:

The bilog transform smoothly modifies the gradient of the transformation so that in the region near zero it remains finite. A single constant C is provided to tune this behavior, so as to adjust the meaning of ―region near zero‖. The default value of this constant is 1/ ln(10); this gives a unity transfer function at zero but other values can be applied as wished, to focus into the region near zero or not. The modified logarithmic transformation called Bilog transform can be both one-sided and symmetric, and thus can transform negative data to scaled negative data. It can be applied to both the X and Y data, when it becomes a bi-symmetric log transform. Applying log transformation to an image will expand its low valued pixels to a higher level and has little effect on higher valued pixels so in other words it enhances image in such a way that it highlights minor details of an image.

7. NTSC COLOR SPACE:

The NTSC color space is used in televisions in the United States. One of the main advantages of this format is that grayscale information is separated from color data, so the same signal can be used for both color and black and white sets. In the NTSC format, image data consists of three components: luminance (Y), hue (I), and saturation (Q). The first component, *luminance*, represents grayscale information, while the last two components make up *chrominance*.The function `rgb2ntsc` converts color maps or RGB images to the NTSC color space. `ntsc2rgb` performs the reverse operation. For example, these commands convert the flowers image to NTSC format.

```
RGB = imread('flowers.tif');
YIQ = rgb2ntsc(RGB);
```

Because luminance is one of the components of the NTSC format, the RGB to NTSC conversion is also useful for isolating the gray level information in an image. In fact, the toolbox functions rgb2gray and ind2gray use the rgb2ntsc function to extract the grayscale information from a color image.

For example, these commands are equivalent to calling `rgb2gray`.

```
YIQ = rgb2ntsc(RGB);
```

NTSC, named after the **National Television System Committee**,[1] is the analog television system that was used in most of the Americas; Burma; South Korea; Taiwan; Japan; the Philippines; and some Pacific island nations and territories .

The first NTSC standard was developed in 1941 and had no provision for color. In 1953 a second NTSC standard was adopted, which allowed for color television broadcasting which was compatible with the existing stock of black-and-white receivers. NTSC was the first widely adopted broadcast color system and remained dominant until the 2010s, when it is gradually being replaced with different digital standards such as ATSC and others.

Most countries using the NTSC standard, as well as those using other analog television standards, have switched to or are in process of switching to newer digital television standards, there being at least four different standards in use around the world. North America, parts of Central America, and South Korea are adopting the ATSC standards, while other countries are adopting or have adopted other standards. After nearly 70 years, the majority of over-the-air NTSC transmissions in the United States ceased on June 12, 2009,[3] and by August 31, 2011,[4] in Canada and most other NTSC markets.[5] The majority of NTSC transmissions ended in Japan on July 24, 2011, while Mexico completed their transition in 2012, the same year as the cessation of NTSC broadcasts in the Japanese prefectures of Iwate, Miyagi, and Fukushima.[4] Digital broadcasting allows higher-resolution television, but digital standard definition television continues to use the frame rate and number of lines of resolution established by the analog NTSC standard.

8. EXPERIMENTAL RESULTS:

8.1 Intensification of Dark mode image enhancement model.

A] Histogram based analysis on white balancing.

The popular image enhancement method is white balancing with a critical step of color constancy. Based on this method, it is focused on a low level approach to color constancy and a ationship between color constancy and histogram is established. The color constancy involves the estimation of the projection of light source on the RGB space. Many assumptions are undergone to accomplish this target. The light source from the maximum responses of the three channels are determined by the proposed max – RGB the average reflectance in the scene in achromatic assumed by gray-world hypothesis.

The process is found to be linear. The histogram based white balancing algorithm has to feature of linearity of the transform. The difference between white balancing and contrast enhancement is this linearity.

B] Histogram – Based analysis on contrast enhancement.

The expected context-free contrast is defined for an image. The binary black and white image achieves the maximum contrast. If the image is constant, then the minimum contrast is zero. The output image still has a suitable dynamic range is imposed by the first condition the minimum distance between adjacent gray level is imposed by the second condition. These two limitations are included to hold the artifacts which consider the model to be a complex and accurate for some factors which are predefined. Histogram based algorithm has been extensively in practice for enhancing contrast before this work established. Histogram equalization makes the probability density function of enhanced image similar to uniform distribution which has been commonly used.

The results of histogram equalization are not suitable for many situations. The signification reason for this constraint is found that the histogram of a prefect image follows uniform distribution. In order to get a better equalization performance, a better distribution has to be found which big challenge is. Some adaptive histogram equalization methods are proposed but the methods gave neither a clear definition of contrast nor an explicit objective function of contrast enhancement. The enhancement methods mentioned above are the transform of histogram which is non-linear and which is entirely different from white balancing.

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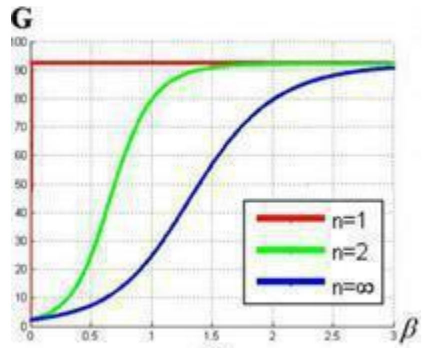
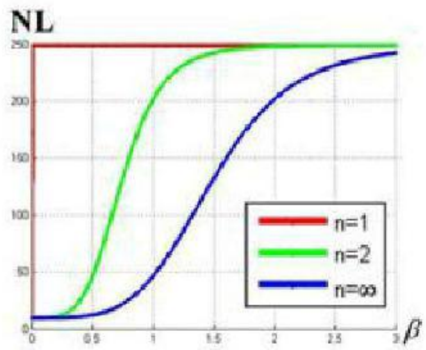
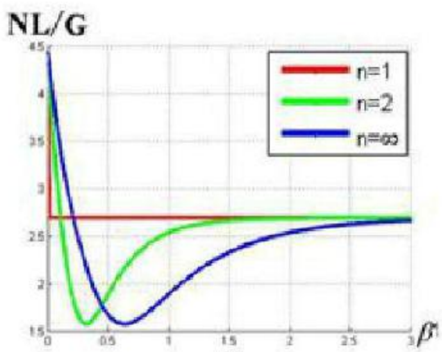


(a)



(b)



(c)

CONCLUSION:

The relationship between image histogram and contrast / tone has been analyzed. A dark mode image enhancement model for global image tone mapping is established. The proposed method has unified more local image enhancement methods into the model through local image features analysis besides global image enhancement image contrast enhancement, tone correction white balancing and post-processing of de-hazed image. Extensive experimental results suggest that the proposed method has good performances in many typical applications including image contrast enhancement, tone correction, white balancing and post-processing of de-hazed images. In the future, besides global image enhancement, we expect to unify more local image enhancement methods into the model through local image feature analysis. Thus a model has been proposed to enhance the image with no data losses and color distortions have been established.

REFERENCES

[1] T. Arici, S. Dikbas, and Y. Altunbasak, ―A histogram modification framework and its application for image contrast enhancement,‖ *IEEE Trans. Image Process.*, vol. 18, no. 9, pp. 1921–1935, 2009.

[2] M. Ashikhmin, ―A tone mapping algorithm for high contrast images,‖ in *Proc. 13th Eurographics Workshop Rendering*, 2002.

[3] K. Barnard, L. Martin, B. Funt, and A. Coath, ―A data set for colour research,‖ *Color Res. Applicat.*, vol. 27, no. 3, pp. 147–151, 2002. XU *et al.*: GENERALIZED EQUALIZATION MODEL FOR IMAGE ENHANCEMENT 81

[4] G. Buchsbaum, ―A spatial processor model for object colour perception,‖*J. Frank. Inst.*, vol. 310, 1980.

[5] Z. Chen, B. Abidi, D. Page, and M. Abidi, ―Gray-level grouping (glg): An automaticmethod for optimized image contrast enhancement—Part i: The basic method,‖ *IEEE Trans. Image Process.*, vol. 15, no. 8, pp. 2303–2314, 2006.

[6] F. Ciurea and B. Funt, The SunBurst Resort, Scottsdale, AZ, USA, ―A large image database for color constancy research,‖ in *Proc. IS&T/SIDs Color Imaging Conf.*, 2004, pp. 160–164.

[7] D. Coltuc, P. Bolon, and J.-M. Chassery, ―Exact histogram specification,‖ *IEEE Trans. Image Process.*, vol. 15, no. 5, pp. 1143–1152, 2006.

[8] F. Drago, K. Myszkowski, T. Annen, and N. Chiba, ―Adaptive logarithmic mapping for displaying high contrast scenes,‖ in *Proc. Computer Graphics Forum*, 2003, vol. 22, no. 3.

[9] E. D. P. *et al.*, ―Contrast limited adaptive histogram image processing to improve the detection of simulated speculations in dense mammograms,‖*J. Digital Imag.*, vol. 11, no. 4, pp. 193–200, 1998.

[10] J. K. *et al.*, ―Deep photo: Model-based photograph enhancement and viewing,‖ *ACM Trans. Graph.—Proc. ACM SIGGRAPH*, vol. 27, no.5, 2008.

[11] Z. Farbman, R. Fattal, D. Lischinski, and R. Szeliski, ―Edge-preserving decompositions for multi-scale tone and detail manipulation,‖ *ACM Trans. Graph.*, vol. 27, no. 3, 2008.

[12] H. Farid, ―Blind inverse gamma correction,‖ *IEEE Trans. Image Process.*, vol. 10, no. 10, pp. 1428–1433, 2001.

[13] R. Fattal, ―Single image dehazing,‖ *ACM Trans. Graph.—Proc. ACM SIGGRAPH*, vol. 27, no. 3, 2008.

[14] R. Fattal, M. Agrawala, and S. Rusinkiewicz, ―Multiscale shape and detail enhancement from multi-light image collections,‖ *ACM Trans .Graph.*, vol. 26, no. 3, pp. 51–59, 2007.

[15] G. Finlayson and S. Hordley, ―A theory of selection for gamut mapping colour constancy,‖ in *Proc. IEEE Int. Conf. Computer Vision and Pattern Recognition*, 1998, pp. 60–65.

[16] G. Finlayson, S. Hordley, and P. Hubel, ―Colour by correlation: A simple, unifying approach to colour constancy,‖ in *Proc. IEEE Int. Conf. Computer Vision*, 1999, vol. 2, pp. 835–842.

[17] G. Finlayson and E. Trezzi, ―Shades of gray and colour constancy,‖ in *Proc. IS&T/SID 12th Color Imaging Conf.*, 2004, pp. 37–41.

[18] D. Forsyth, ―A novel algorithm for color constancy,‖ *Int. J. Comput.Vision*, vol. 5, no. 1, pp. 5–36, 1990.

[19] B. Funt and L. Shi, ―The effect of exposure on maxrgb color constancy,‖ in *Proc. SPIE Volume 7527, Human Vision and Electronic Imaging*.

[20] B. Funt and L. Shi, ―The rehabilitation of maxrgb,‖ in *Proc. IS&T 18th Color Imaging Conf.*.

[21] P.Gehler, C. Rother, A. Blake, T.Minka, and T. Sharp, ―Bayesian color constancy revisited,‖ in *Proc. IEEE Int. Conf. Computer Vision and Pattern Recognition*, 2008, pp. 1–8.

[22] R. C. Gonzalez and R. E.Woods, *Digital Image Processing*. Beijing, China: Publishing House of Electronics Industry, 2002.

[23] M. Grant and S. Boyd, CVX users guide, Technical report, Information Systems Laboratory, Department of Electrical Engineering, Stanford University, 2009.

[24] J.-H. Han, S. Yang, and B.-U. Lee, ―A novel 3-d color histogram equalization method with uniform 1-d gray scale histogram,‖ *IEEE Trans.Image Process.*, vol. 20, no. 2, pp. 506–512, 2011.

[25] N. Hautière, J.-P. Tarel, D. Aubert, and E. Dumont, ―Blind contrast restoration assessment by gradient rationing at visible edges,‖ in *Proc.Int. Congr. Stereology (ICS'07)*, Saint Etienne, France, 2007 [Online]. Available: http://perso.lcpc.fr/tarel.jean-philippe/publis/ics07.html

[26] K. He, J. Sun, and X. Tang, ―Single image haze removal using darkchannel prior,‖ in *Proc. IEEE Int. Conf. Computer Vision and PatternRecognition*, 2009, pp. 1956–1963.

[27] K. He, J. Sun, and X. Tang, ―Guided image filtering,‖ in *Proc. ECCV*,2010.

[28] E. Land and J. McCann, ―Lightness and retinex theory,‖ *J. Opt. Soc.Amer. A*, vol. 61, no. 1, pp. 1–11, 1971.

[29] P. Ledda, A. Chalmers, T. Troscianko, and H. Seetzen, ―Evaluationof tone mapping operators using a high dynamic range display,‖ *ACM Trans. Graph.—Proc. ACM SIGGRAPH*, vol. 24, no. 3, 2005.

[30] P. Milanfar, ―A tour of modern image filtering: New insights andmethods, both practical and theoretical,‖ *IEEE Signal Process. Mag.*, vol. 30, no. 1, pp. 106–128, 2013.

[31] S.-C. Pei, Y.-C. Zeng, and C.-H. Chang, ―Virtual restoration of ancient Chinese paintings using color contrast enhancement and lacuna texture synthesis,‖ *IEEE Trans. Image Process.*, vol. 13, no. 3, pp. 416–429,2004.

[32] Y.-F. Pu, J.-L. Zhou, and X. Yuan, ―Fractional differential mask: A fractional differential-based approach for multiscale texture enhancement,‖ *IEEE Trans. Image Process.*, vol. 19, no. 2, pp. 491–511, 2010.

[33] E. Reinhard, M. Stark, P. Shirley, and J. Ferwerda, ―Photographic tonereproduction for digital images,‖ *ACM Trans. Graph.—Proc. ACM SIGGRAPH*, vol. 21, no. 3, 2002.

[34] Y. Shi, J. Yang, and R.Wu, ―Reducing illumination based on nonlinear gamma correction,‖ in *Proc. IEEE Int. Conf. Image Processing*, 2007,vol. 1, pp. 529–532.

[35] J.-L. Starck, F. Murtagh, E. Candes, and D. Donoho, ―Gray and color image contrast enhancement by the curvelet transform,‖ *IEEE Trans.Image Process.*, vol. 12, no. 6, pp. 706–717, 2003.

[36] J. A. Stark, ―Adaptive image contrast enhancement using generalizations of histogram equalization,‖ *IEEE Trans. Image Process.*, vol. 9, no. 5, pp. 889–896, 2000.

[37] R. Tan, ―Visibility in bad weather from a single image,‖ in *Proc. IEEE Int. Conf. Computer Vision and Pattern Recognition*, 2008, pp. 1–8.

[38] J.-P. Tarel and N. Hautiere, ―Fast visibility restoration from a single color or gray level image,‖ in *Proc. IEEE Int. Conf. Computer Vision*, 2009, pp. 2201–2208.

[39] C. Tomasi and R. Manduchi, ―Bilateral filtering for gray and color images,‖in *Proc. ICCV*, 1998.

[40] J. van de Weijer, T. Gevers, and A. Gijsenij, ―Edge-based color constancy,‖*IEEE Trans. Image Process.*, vol. 16, no. 9, pp. 2207–2214,2007.

[41] J. van de Weijer, C. Schmid, and J. Verbeek, ―Using high-level visual information for color constancy,‖ in *Proc. IEEE Int. Conf. ComputerVision*, 2007, pp. 1–8.

[42] Y.Wang, Q. Chen, and B. Zhang, ―Image enhancement based on equal area dualistic sub-image histogram equalization method,‖ *IEEE Trans. Consum. Electron.*, vol. 45, no. 1, pp. 68–75, 1999.

[43] X. Wu, ―A linear programming approach for optimal contrast-tone mapping,‖ *IEEE Trans. Image Process.*, vol. 20, no. 5, pp. 1262–1272, 2010.

[44] X. Zhu and P. Milanfar, ―Restoration for weakly blurred and strongly noisy images,‖ in *Proc. 2011 IEEE Workshop Applications of Computer Vision (WACV)*, 2011, pp. 103–109.

[45] Hongteng Xu, Guangtao Zhai, Member,IEEE, Xiaolin Wu, Fellow: IEEE, and Xiaokang Yang, Senoir Member; IEEE ,‖Generalized Equalization Model for Image Enhancement‖.