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ANALYTICAL SURVEY ON VARIOUS IMAGE ENHANCEMENT TECHNIQUES FOR VARIOUS PARAMETERS

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ABSTRACT

Image enhancement is a technique to improve the quality of an image. The aim of image enhancement technique 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 this paper, we will analyze how the incremental growth takes place in various image enhancement techniques on different parameters.

KEYWORDS: Human Viewers, Biomedical Image Analysis, Global Contrast

INTRODUCTION

Good contrast images with preserving details are required for many important areas namely machine vision, remote sensing, dynamic and traffic scene analysis, biomedical image analysis and autonomous navigation. However most of the recorded images suffer from poor contrast which is due to the inadequate lighting during image acquiring, wrong setting of aperture size and shutter speed as well as nonlinear image intensities mapping.

Difficulties in controlling the lighting conditions during image acquisition process have resulted in variability in image illumination. The captured images turn out to be low contrast and contained underexposed and overexposed regions. Thus, image enhancement has been employed to increase the quality of the image. Image enhancement is a fundamental task applied in image processing to improve interpretability and appearance of the image. It provides better input image for further image processing task [1].

Image enhancement can be clustered into two groups namely frequency domain and spatial domain methods. In the frequency domain method, the enhancement is conducted by modifying the frequency transform of the image. Meanwhile in the latter method, image pixels are directly modified to enhance the image. However, computing the enhancement in frequency domain is time consuming process even with fast transformation technique thus made it unsuitable for real time application [2].

VARIOUS WORK PROPOSED ON IMAGE ENHANCEMENT

An Optimal Fuzzy System for Color Image Enhancement

Madasu Hanmandlu and Devendra Jha [3] proposed that Gaussian membership function is proposed to fuzzify the image information in spatial domain. They introduce a global contrast intensification operator (GINT), which contains three parameters, *viz.*, intensification parameter (t), fuzzifier (f_h), and the crossover point (μ_c), for enhancement of color images. They define fuzzy contrast-based quality factor (Q_f) and entropy-based quality factor (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, f_h and μ_c are calculated globally. By using the proposed technique, a visible improvement in the image quality is observed for under exposed images, as the entropy of the output image is decreased. The terminating criterion is decided by both the visual and quality factors. For over exposed and under plus over exposed images, the proposed fuzzification function needs to be modified by taking maximum intensity as the fourth parameter. The type of the images is indicated by the visual factor which is less than 1 for under exposed images and more than 1 for over exposed images.

They concluded that Fuzzy logic-based image enhancement method is presented by fuzzifying the color intensity property of the image using Gaussian membership function, which is suitable for under exposed images. Enhancement of the fuzzified image is carried out using a general intensification operator GINT of sigmoid type, which depends on the crossover point and the intensification parameter. The optimum values of these parameters are obtained by the constrained fuzzy optimization. A modified univariate method involving gradient descent learning is used for the optimization. A visually pleasing image is obtained with the appropriate choice of quality factors. It may be noted that GINT is guided by these factors since ultimate enhancement leads to the binarization of the image. The visual factor provides a clue for knowing the type of the image. However, this information is available after enhancement.

Limitation: For over exposed and under plus over exposed images, the proposed fuzzification function needs to be modified by taking maximum intensity as the fourth parameter.

Gray-Level Grouping (GLG): An Automatic Method for Optimized Image Contrast Enhancement

ZhiYu Chen. *et.al* [4] proposed a new automatic method for contrast enhancement. The basic procedure is to first group the histogram components of a low-contrast image into a proper number of bins according to a selected criterion, then redistribute these bins uniformly over the grayscale, and finally ungroup the previously grouped gray-levels. Accordingly, this new technique is named gray-level grouping (GLG). They succeded in developing a new automatic contrast enhancement technique GLG is a general and powerful technique, which can be conveniently applied to a broad variety of low-contrast images and generates satisfactory results. The GLG technique can be conducted with full automation at fast speeds and outperforms conventional contrast enhancement techniques. The benchmark image quality measure, Tenengrad criterion, indicates that the GLG results are superior to conventional HE techniques. The optimized GLG algorithm generally can process an image within a few seconds on a personal computer (PC). The basic GLG method also provides a platform for various extensions of this technique, such as selective gray-level grouping (SGLG), (S)GLG with preprocessing steps for eliminating image background noises, (S)GLG on color images, and so on.

Limitation: The proposed technique is only suitable for low contrast image enhancement.

The Role of Entropy in Intuitionistic Fuzzy Contrast Enhancement

Ioannis K. Vlachos and George D. Sergiadis [5] studied the impact of selecting different entropy measures in the framework of intuitionistic fuzzy image processing and especially in the process of intuitionistic fuzzification of images. Different notions of entropy characterized by different properties are reviewed and their behavior is thoroughly studied under the scope of performing contrast enhancement. Finally, experimental results using grayscale images reveal the characteristics of the aforementioned measures.

They explored the role of entropy in the context of intuitionistic fuzzy image processing. Different entropy measures for A–IFSs with different characteristics were evaluated and their behavior to contrast enhancement of low-contrasted images was examined. Finally, experimental results to real-world images demonstrated that the different notions of intuitionistic fuzzy entropy treat images in different ways, thus making the selection of the appropriate entropy measure to be application-dependent.

Limitations: Selecting appropriate entropy measures in the framework of intuitionistic fuzzy image processing can be complex for different characteristics of images.

Intuitionistic Fuzzy Information –Applications to Pattern Recognition

Ioannis K. Vlachos and George D. Sergiadis [6] addressed the issue of information-theoretic discrimination measures for intuitionistic fuzzy sets (IFSs). Although many measures of distance, similarity, dissimilarity, and correlation between IFSs have been proposed, there is no reference regarding information-driven measures used for comparison between sets. Finally, they demonstrated the efficiency of the proposed discrimination information measure for pattern recognition, medical diagnosis, and image segmentation.

In this paper they presented an information-theoretic approach to discrimination measures for IFSs. A symmetric discrimination information measure was proposed and the notion of intuitionistic fuzzy cross-entropy was introduced. Furthermore, a generalized version of the De Luca–Termini nonprobabilistic entropy was derived for IFSs. Based on this generalization, a connection between the concepts of fuzziness and entropy in the fuzzy and the intuitionistic fuzzy setting was established. Finally, we demonstrated the efficiency of the proposed symmetric discrimination information measure in the context of pattern recognition, medical diagnosis, and image segmentation.

A Novel Optimal Fuzzy System for Color Image Enhancement Using Bacterial Foraging

Madasu Hanmandlu. et.al [7] presented a new approach for the enhancement of color images using the fuzzy logic technique. An objective measure called exposure has been defined to provide an estimate of the underexposed and overexposed regions in the image. This measure serves as the dividing line between the underexposed and overexposed regions of the image. The hue, saturation, and intensity (HSV) color space is employed for the process of enhancement, where the hue component is preserved to keep the original color composition intact. A parametric sigmoid function is used for the enhancement of the luminance component of the underexposed image. A power-law operator is used to improve the overexposed region of the image, and the saturation component of HSV is changed through another power-law operator to recover the lost information in the overexposed region. Objective measures like fuzzy contrast and contrast and visual factors are defined to make the operators adaptive to the image characteristics. Entropy and the visual factors are involved in the objective function, which is optimized using the bacterial foraging algorithm to learn the parameters. Gaussian and triangular membership functions (MFs) are chosen for the underexposed and overexposed regions of the image, respectively. Separate MFs and operators for the two regions make the approach universal to all types of contrast degradations. This approach is applicable to a degraded image of mixed type. On comparison, this approach is found to be better than the genetic algorithm (GA)-based and entropy-based approaches.

The conclusion was Fuzzy logic-based image enhancement has been undertaken by fuzzifying the color intensity property of an image. An image may be categorized into underexposed and overexposed regions with the amount of exposure indicated by a parameter. A Gaussian MF suitable for underexposed region of the image has been used for the fuzzification. Enhancement of the fuzzified image has been carried out using a generalized intensification operator, i.e., GINT, of sigmoid type, which depends on the crossover point and the intensification parameter. A triangular MF has been used for the fuzzification of overexposed region of the image, and a power-law transformation operator has been used for the enhancement that depends on the gamma parameter. The optimum values of these parameters have been obtained by the constrained fuzzy optimization. BF involving an iterative learning has been adapted for the optimization. They also introduced entropy and visual factors as objective measures for evaluating the appearance of images. A visually pleasing image has been obtained with the appropriate choice of contrast factors. It may be noted that GINT and power-law operators are controlled by these factors since ultimate enhancement leads to the binarization of the image.

Table 1: Comparison of Visual Factors with the Entropy-Based Approach

Images	V_f of Entropy Based Approach	V_f of Proposed Approach
Man	1.0894	1.5224
Scene	1.22.64	1.4410
Rose	1.0277	1.6009
Hills	1.0780	1.4180

Adaptive Fuzzy Enhancement Algorithm of Surface Image Based on Local Discrimination via Grey Entropy

Gang Li et.al[8] used the value of grey entropy in the neighborhood window as parameters to measure the level of current pixel being edge point, which can be used to be the basis of image enhancement operation. Simulation results show that the algorithm can effectively improve the quality of surface image, and it supplied a good approach to surface image processing compared with other methods.

This paper described a fuzzy mapping based on translation transformation, which can increase the stability of the algorithm; making use the grey entropy of pixels in neighborhood to judge the level of edge for pixels, the dynamic adaptive selection of central point of neighborhood in fuzzy contrast enhancement was achieved, and can increase the local gray contrast of the image, rich the texture layer of the image, improve the quality of the image, make it more adaptive for further treatment and analysis.

This method is very good for local contrast enhancement along with it also preserves global contrast of the image with clear fine edges.

Limitations: In this technique noise and artifacts contained in the image might also get enhanced.

Enhancement of the Low Contrast Image Using Fuzzy Set Theory

Khairunnisa Hasikin and Nor Ashidi Mat Isa [9] presented a fuzzy grayscale enhancement technique for low contrast image. The degradation of the low contrast image is mainly caused by the inadequate lighting during image capturing and thus eventually resulted in nonuniform illumination in the image. Most of the developed contrast enhancement techniques improved image quality without considering the nonuniform lighting in the image. The fuzzy grayscale image enhancement technique is proposed by maximizing fuzzy measures contained in the image. The membership function is then modified to enhance the image by using power-law transformation and saturation operator. The qualitative and quantitative performances of the proposed method are compared with the other methods. The proposed method produced better quality enhanced image and required minimum processing time than the other methods.

Table 2: Quantitative Enhancement Analyses for 100 Standard Images (Average Values)

Method Analysis	Processing Time (s)	IOF	PSNR (dB)	C
Propsed Method	0.062	**0.349**	**22.039**	**71.969**
NINT	**0.050**	0.443	13.947	88.391
Fuzzy rule based	11.921	0.367	19.096	78.793
Fuzzy Quantitati-ve Measure	0.063	0.410	15.417	82.654
Fuzzy Local Enhance-ment	11.163	0.584	19.063	81.929

Finally, the new enhancement technique using fuzzy set theory has been developed for grayscale non-uniform illumination image. Findings signified that the proposed method produced better image quality and defeated other methods in terms of image contrast and measure of fuzziness without enhancing existing noise in the image. The proposed algorithm only required minimum processing time (*i.e* approximately 62ms) and thus made it as suitable approach to be used in the real time application.

A Single Image Enhancement Using Inter-Channel Correlation

Jin Kim et.al [10] proposed that a single image enhancement algorithm using inter-color channel relationship. It is based on the fact that the property of an infrared range image is similar to that of red channel in a visible range color image. Specifically, the proposed method analyzes the image details, which are mostly resided in dark area and not visible well in the visible range image, directly from the red channel of the given image. And they are used as a guidance to generate a weighting map for image enhancement.

Analyzing the red channel and luminance channel guided to improve the given image details seamlessly in dark and bright. Additionally, we employed a simple contrast correction for the better pleasing images. Experimental results showed that the proposed algorithm produced good outcomes in terms of improving image details and visual observation. Therefore, the proposed scheme can be used as a simple and effective tool for image enhancement in related fields.

Limitation: Since the proposed technique is based on the fact that the property of an infrared range image is similar to that of red channel in a visible range color image showing some problems while enhancing many reddish input images.

Significance Level of Image Enhancement Techniques for Underwater Images

Norsila Shamsuddin. et.al [11] underwater imaging is quite a challenging in the area of photography especially for low resolution and ordinary digital camera. There are a few problems occur in underwater images such as limited range visibility, low contrast, non uniform lighting, blurring, bright artefacts, color diminished and noise. This paper concentrates on color diminished. Significant application of standard computer vision techniques to underwater imaging is required in dealing with the said problems. Both manual and auto level techniques are used to record the mean values of the stretched histogram. The objective of the paper is to identify which technique is more significant in terms of color correction. It is hoped that the finding will benefit to non divers to visualize the underwater as the real underwater world.

They concluded that there is a significant effect of using either manual or auto correction techniques at 5% level. They identified that there is a significant difference between auto enhanced techniques and depth at 5% level of significance and also significant difference between manual enhance technique and depth at 1 % level of significant. Hence, we can conclude that the manual enhanced technique is more precise as compared to auto enhanced technique due to the level of significance. Both techniques used are different between 1m and 5m depth at 5% level of significance.

Demosaicking of Noisy Bayer-Sampled Color Images with Least-Squares Luma-Chroma Demultiplexing and Noise Level Estimation

Gwanggil Jeon and Eric Dubois [12] adapted the least-squares luma-chroma demultiplexing (LSLCD) demosaicking method to noisy Bayer color filter array (CFA) images. A model is presented for the noise in white-balanced gamma-corrected CFA images. A method to estimate the noise level in each of the red, green, and blue color channels is then developed. Based on the estimated noise parameters, one of a finite set of configurations adapted to a particular level of noise is selected to demosaic the noisy data.

The noise-adaptive demosaicking scheme is called LSLCD with noise estimation (LSLCD-NE). Experimental results demonstrate state of- the-art performance over a wide range of noise levels, with low computational complexity.

This paper has extended the adaptive luma-chroma demultiplexing algorithm of to noisy CFA images, taking into account the different noise levels in the different color channels, and providing a noise-level estimation scheme. The resulting method shows that LSLCD is an algorithm of choice for noisy CFA demosaicking, and performs very well at all noise levels with a very competitive level of complexity. This is the only method we have seen that explicitly accounts for different noise levels in the different channels in designing the demosaicking algorithm.

The methods proposed are general and can be applied to other CFA designs than the Bayer, including those with more than 3 types of color filters, and other noise models. For example, some CFA designs use a panchromatic channel to improve noise performance, and the proposed algorithm can be adapted to exploit this feature as much as possible. It would also be interesting to combine the LSLCD method with modern, locally adaptive denoising schemes to get better overall performance.

Table 3: CPSNR Results of Selected Demosaicking Algorithms and the Proposed LSLCD-NE Algorithm When ANL$\in$ {1, 2, 3…11}

ANL	AHD	LMMSE	RAD	LSLCD	LSLCD-NE
1	37.58	40.10	39.76	40.22	40.26
2	36.27	37.99	37.75	37.96	37.51
3	33.93	34.84	34.63	34.68	34.91
4	31.74	32.22	32.02	32.00	32.90
5	29.87	30.11	29.91	29.85	31.41
6	28.27	28.38	28.18	28.10	30.27
7	26.91	26.93	26.72	26.64	29.37
8	25.71	25.68	25.47	25.38	28.64
9	24.67	24.58	24.38	24.28	28.03
10	23.73	23.62	23.41	23.31	27.51
11	22.89	22.75	22.54	22.44	27.06
Avg	**29.23**	**29.75**	**29.52**	**29.53**	**31.62**

CONCLUSIONS

In this paper, we analyze the various techniques based on various parameters. There is always some space of improvement in mostly proposed techniques. If these techniques are emphasized on different entropy measures, power law transformation and saturation operators then image enhancement techniques might be improved upto a greater extent. So, in future some new techniques can exhibit which can improve image enhancement.

REFERENCES

1. Khairunnisa Hasikin and Nor Ashidi Mat Isa, “Enhancement of the low contrast image using fuzzy set theory,” 14th International Conference on Modelling and Simulation, IEEE 2012.
2. M. Hanmandlu and D. Jha, "An Optimal Fuzzy System for Color Image Enhancement," *Image Processing, IEEE Transactions on,* vol. 15, pp. 2956-2966, 2006.
3. Madasu Hanmandlu, *Member*, *IEEE*, and Devendra Jha, “An Optimal Fuzzy System for Color Image Enhancement” IEEE transactions on image processing, vol. 15, no. 10, october 2006.
4. ZhiYu Chen *and* Besma R. Abidi “Gray-Level Grouping (GLG): An Automatic Method for Optimized Image Contrast Enhancement” IEEE transactions on image processing, vol. 15, no. 8, august 2006.
5. Ioannis K. Vlachos and George D. Sergiadis “The Role of Entropy in Intuitionistic Fuzzy Contrast Enhancement” IFSA 2007, LNAI 4529, pp. 104–113, 2007.
6. Ioannis K. Vlachos and George D. Sergiadis. “Intuitionistic fuzzy information – Applications to pattern recognition, Elsevier, Pattern Recognition Letters 28 (2007) 197–206, 2007”.
7. Madasu Hanmandlu, *Senior Member, IEEE*, Om Prakash Verma, Nukala Krishna Kumar, and Muralidhar Kulkarni, “A Novel Optimal Fuzzy System for Color Image Enhancement Using Bacterial Foraging”, IEEE transactions on instrumentation and measurement, vol. 58, no. 8, August 2009.
8. Gang Li, Yala Tong, Xinping Xiao, “Adaptive Fuzzy Enhancement Algorithm of Surface Image based on Local Discrimination via Grey Entropy”, Elsevier Procedia Engineering 15 (2011) 1590 – 1594, 2011.
9. Khairunnisa Hasikin and Nor Ashidi Mat Isa, “Enhancement of the low contrast image using fuzzy set theory” 14th International Conference on Modelling and Simulation, IEEE, 2012.
10. Jin Kim, Soowoong Jeong, Yong-Ho Kim, and Sangkeun Lee, *Member, IEEE* “A Single Image Enhancement using Inter-channel Correlation*” 2012* IEEE International Conference on Consumer Electronics (ICCE).
11. Norsila Shamsuddinl,, Wan Fatimah Wan Ahmadi, Baharum Baharudinl, Mohd Kushairi Mohd Rajuddin, Farahwahida Mohd. “Significance Level of Image Enhancement Techniques for Underwater Images, IEEE”, 2012 International Conference on Computer & Information Science (ICCIS).
12. Gwanggil Jeon, *Member, IEEE*, and Eric Dubois, “Demosaicking of Noisy Bayer-Sampled Color Images with Least-Squares Luma-Chroma Demultiplexing and Noise Level Estimation”, IEEE transactions on image processing, vol. 22, no. 1, January 2013.