ISSN:2320-0790

An International Journal of Advanced Computer Technology

Performance Evaluation of Dominant Brightness Level Based Image Enhancement

Geetika Mahajan, Prof. Aman Arora
Dept. of Computer Science and engineering, SIET, Amritsar, (Punjab) India

Abstract: This paper has concentrated on the distinctive image enhancement methods. Image enhancement has discovered a standout amongst the most imperative vision applications as it has capability to improve the quality of the digital images. Quality of the poor pictures is improved by this. Various methodologies have been proposed so far for enhancing the nature of the digital pictures. To upgrade picture quality image enhancement can particularly enhance and limit some information introduced in the input image. It is a sort of vision framework which diminishes picture commotion, kill antiquities, and keep up the useful parts. Its aim is to open up certain picture attributes for examination, conclusion and further utilization. The main aim of this paper is to assess the effectiveness of the DBLA over different image enhancement strategies.

Keywords: Image enhancement, human visual perception, DBLA, CLAHE, HSV

1. Introduction

The methods for improving the quality of digital images are known as image enhancement techniques. It is relatively simple, for example, to make an image light or dark or to enlarge or reduce contrast. Sophisticated image enhancement software also supports several filters for changing images in a variety of ways. The main purpose of image enhancement is to process a given image so that the outcome is more appropriate than the original image for a definite use.

It sharpens image features such as edges, boundaries, or contrast to build a graphic display more useful for display and analysis. The enhancement doesn't raise the inbuilt information content of the data, but it increases the active range of the selected features so that they can be detected simply. Image enhancement methods can be based on either spatial or frequency domain techniques.

2. Adaptive histogram equalization (AHE):

Adaptive histogram equalization is a technique used to obtain better contrast in images. It differs from usual histogram equalization as adaptive technique computes several histograms, each connected to a special part of the image, and uses them to reorganize the lightness values of the image. Hence, it is suitable for improving the restricted contrast of an image and bringing out new detail. However, AHE has a tendency to over extend noise in relatively regular regions of an image. An alternate of adaptive histogram equalization called contrast limited adaptive histogram equalization (CLAHE) prevents this by limiting the amplification. Contrast Limited AHE (CLAHE) differs from usual adaptive histogram equalization in its contrast limiting. This advantage can also be helpful to global histogram equalization, give rise to contrast limited histogram equalization (CLHE), which is not frequently used in practice. In case of CLAHE, the contrast limiting technique has to be applied for all region from which a transformation function is derived. CLAHE was developed to avoid the excess amplification of noise that adaptive histogram equalization can provide. This is achieved by limiting the contrast enhancement of AHE.

3. Histogram Equalization (HE):

Histogram equalization is the straight forward method used to get enhanced quality images in black and white color level in different application areas such as medical image processing that includes X-ray ,MRIs and CT scans ,object tracking ,speech recognition etc. A high-quality histogram is which covers all the possible values in the gray scale used. This histogram suggests that the image has superior contrast and information in the image may be observed easily. Histogram is a way of improving the local contrast of an image exclusive of altering the global contrast to a large amount. This method is mostly useful in images having huge regions of associated tone such as an image with a very light environment and dark front. Histogram equalization can show unseen details in an image by stretching out the contrast of local regions and hence building the differences in the regions more visible. The chief advantage is that it is effortless and proficient. The main two disadvantages are: the damage property; not frequently utilized in customer electronics products such as TV because it may broadly alter the original brightness and cause adverse artifacts.

4. L*A*B* Stretching:

Contrast is a method used to measure how really the pixel intensity alters relative to the usual intensity. A technique known as histogram stretching can be used to transfer the pixel values to fill the entire intensity range, resulting in high contrast. In common, histogram stretching tends to work well on images that have a poor image contrast to start with and which should have full contrast. A color space that better signify the human visual system, like L*a*b* can give extra natural stretching in some cases. In both of these color spaces, the L channel symbolize the brightness, as the (a*, b*) channels symbolize the color. The stretching is performed on the L channel after altering the colors. As only the L channel was adjusted, the colors stay the identical, but the brightness is re-mapped. This adjusts the contrast in a way that sometimes can be extra visually satisfying without significantly disturbing the color balance.

5. Base Paper:

This paper presents an original contrast enhancement method for remote sensing images by dominant brightness analysis and adaptive intensity transformation. This method decomposes the input image into four wavelet sub-bands and decomposes the LL sub-band into low, middle, and high intensity layers by examine the log-average luminance of the associated layer. The adaptive intensity transfer functions are calculated by joining the knee transfer function and the gamma adjustment function. All the contrast enhanced layers are combined with the appropriate smoothing and the processed LL band undergoes the IDWT jointly with unprocessed LH, HL, and HH sub-bands. This method can capably enhance the overall quality and visibility of local details. This method can also enhance the low-contrast satellite images and is suitable for unusual imaging devices such as consumer camcorders, real-time 3-D reconstruction systems and computational cameras.

6. Performance Metrics

Performance is calculated using the parameters such as Peak Signal-to-Noise Ratio (PSNR), Mean Square Error (MSE), Bit Error Rate, Root Mean Square Error (RMSE).

Peak signal to noise ratio (PSNR): The PSNR block computes the peak signal-to-noise ratio, between two images. This ratio is often used as a quality measurement between the original and a fused image. Higher the PSNR, better the quality of the fused or reconstructed image. PSNR value is computed by following equation:

$$PSNR = 10\log_{10}\left(\frac{255^2}{MSE}\right)$$

Mean square error (MSE): Mean square error is a measure of image quality index. The large value of mean square means that image is a poor quality. Mean square error between the reference image and the fused image is

$$MSE = \frac{1}{mn}\sum_{i=1}^{m}\sum_{j=1}^{n}(A_{ij} - B_{ij})^2$$

Where Ai, j and Bi, j are the image pixel value of reference image

Root mean square error (RMSE): The root mean square (RMS), also known as the quadratic mean, is a statistical measure of the magnitude of a varying quantity. It is especially useful when variants are positive and negative, e.g., sinusoids. RMS is used in various fields, including electrical engineering. The RMS value of a set of values is the square root of the arithmetic mean of the squares of the original values. In the case of a set of *n* values {x1, x2, x3}, the RMS

$$x_{rms} = \sqrt{\frac{1}{n}(x_{1^2} + x_{2^2} + \cdots \ldots\ldots + x_{n^2})}.$$

Bit Error Rate (BER):

A bit error rate is defined as the rate at which errors occur in a transmission system. This can be directly translated into the number of errors that occur in a string of a stated number of bits. The definition of bit error rate can be translated into a simple formula:

$$\text{BER} = \frac{\textbf{Number of errors}}{\textbf{Total number of tarnsmitted bits}}$$

7. Experimental results

Design and implementation is done in MATLAB by means of Image Processing Toolbox. This image enhancement approach is experienced on different 11 images of different format and size. We have shown the results on image 3. Fig 7.1 is showing the input image for experimental analysis.

Fig7.1: Input image

Fig 7.2: Final color image using Adaptive Histogram Equalization

Fig 7.2 has shown the output image taken by adaptive histogram equalization. The output image has better contrast and has shown other details.

Fig 7.3: Histogram Equalization

Fig 7.3 has shown the output image taken by histogram equalization. The output image is better enhanced and information can be observed easily.

Fig 7.4: Histogram Stretching in L*A*B color space

Fig 7.4 has shown the output image taken by histogram stretching in L*A*B color space. The output image has high contrast and can be more visually pleasant without considerably disturbing the color balance.

Fig 7.5: Base paper

Fig 7.5 has shown the output image taken by base paper method. This method can efficiently enhance the overall quality and visibility of local details.

8. Performance analysis

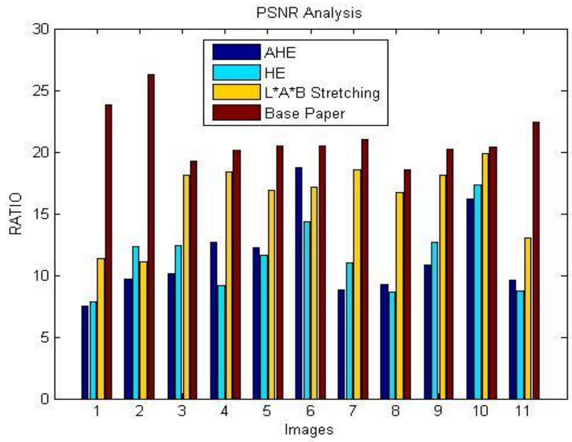
This section contains the cross confirmation between base paper and other techniques. Some well-known image performance metrics for digital images have been selected to prove that the performance of the base paper is quite better than the other methods.

8.1 Peak Signal to Noise Ratio Evaluation

Table 8.1 is showing the relative analysis of the Peak Signal to Noise Ratio (PSNR). As PSNR need to be maximized; so the main goal is to increase the PSNR as much as possible. Table 8.1 has clearly shown that the PSNR is maximum in the case of the base paper therefore base paper is providing better results than the available methods.

Table 8.1: Peak Signal to Noise Ratio Evaluation

Test Images	AHE	HE	L*A*B Stretching	Base Paper
1	11670	10725	4787	269
2	6990	3811	5064	152
3	6294	3767	1013	771
4	3511	7948	943	635
5	3855	4477	1329	583
6	868	2416	1257	582
7	8598	5132	899	516
8	7648	8839	1376	911
9	5413	3496	997	618
10	1580	1198	673	593
11	7070	8764	3266	374



Graph 8.1: PSNR of AHE, HE, L*A*B Stretching and base paper for different images

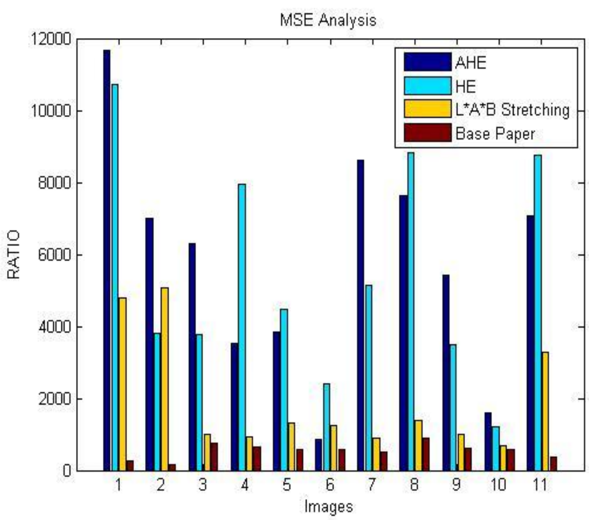
It is very clear from the plot that there is increase in PSNR value of images with the use of base paper method over other methods. This increase represents improvement in the objective quality of the image.

8.2 Mean Square Error Evaluation

Table 8.2 is showing the quantized analysis of the mean square error. As mean square error need to be reduced therefore the base paper method is showing the better results than the available methods as mean square error is less in every case.

Table 8.2: Mean Square Error Evaluation

Test Images	AHE	HE	L*A*B Stretching	Base Paper
1	7.4601	7.8268	11.3302	23.8333
2	9.6860	12.3204	11.0859	26.3124
3	10.1415	12.3708	18.0747	19.2603
4	12.6765	9.1282	18.3857	20.1031
5	12.2706	11.6209	16.8956	20.4741
6	18.7456	14.2998	17.1375	20.4816
7	8.7868	11.0279	18.5932	21.0043
8	9.2953	8.6668	16.7446	18.5356
9	10.7964	12.6951	18.1439	20.2209
10	16.1442	17.3462	19.8507	20.4003
11	9.6366	8.7038	12.9906	22.4021



Graph 8.2: MSE of AHE, HE, L*A*B Stretching and base paper for different images

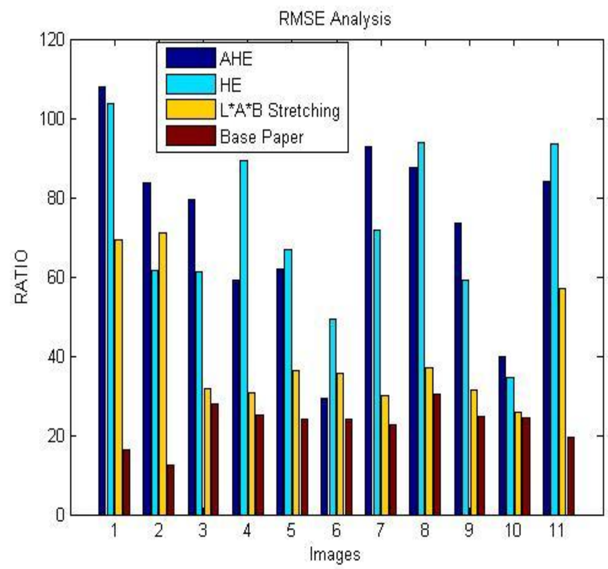
It is very clear from the plot that there is decrease in MSE value of images with the use of base paper method over other methods. This decrease represents improvement in the objective quality of the image.

a. Root Mean Square Error Evaluation

Table 8.3 is showing the quantized analysis of root mean square error. . As root mean square error needs to be reduced therefore the base paper method is showing the better results than the available methods as root mean square error is less in every case.

Table 8.3: Root Mean Square Error Evaluation

Test Images	AHE	HE	L*A*B Stretching	Base Paper
1	108.0278	103.5616	69.1881	16.4012
2	83.6062	61.7333	71.1618	12.3288
3	79.3347	61.3759	31.8277	27.7669
4	59.2537	89.1516	30.7083	25.1992
5	62.0886	66.9104	36.4555	24.1454
6	29.4618	49.1528	35.4542	24.1247
7	92.7254	71.6380	29.9833	22.7156
8	87.4528	94.0160	37.0945	30.1828
9	73.5731	59.1270	31.5753	24.8596
10	39.7492	34.6121	25.9422	24.3516
11	84.0833	93.6162	57.1489	19.3391



Graph 8.3: RMSE of AHE, HE, L*A*B Stretching and base paper for different images

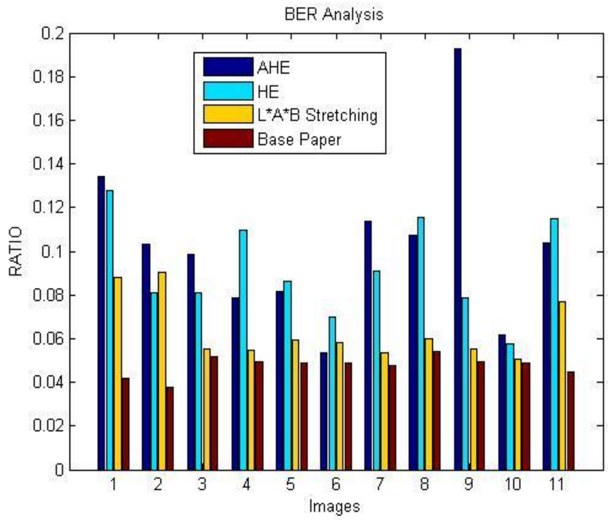
It is very clear from the plot that there is decrease in RMSE value of images with the use of base paper method over other methods. This decrease represents improvement in the objective quality of the image.

b. Bit Error Rate (BER)

Table 8.4 is showing the quantized analysis of bit error rate. As bit error rate needs to be reduced therefore the base paper method is showing the better results than the available methods as bit error rate is less in every case.

Table 8.4: Bit Error Rate Evaluation

Test Images	AHE	HE	L*A*B Stretching	Base Paper
1	0.1340	0.1278	0.0883	0.0420
2	0.1032	0.0812	0.0902	0.0380
3	0.0986	0.0808	0.0553	0.0519
4	0.0789	0.1096	0.0544	0.0497
5	0.0815	0.0861	0.0592	0.0488
6	0.0533	0.0699	0.0584	0.0488
7	0.1138	0.0907	0.0538	0.0476
8	0.1076	0.1154	0.0597	0.0540
9	0.1926	0.0788	0.0551	0.0495
10	0.0619	0.0576	0.0504	0.0490
11	0.1038	0.1149	0.0770	0.0446



Graph 8.4: BER of AHE, HE, L*A*B Stretching and base paper for different images

It is very clear from the plot that there is decrease in BER value of images with the use of base paper method over other methods. This decrease represents improvement in the objective quality of the image.

9. Conclusion and Future Scope

The image enhancements methods play a considerable role in digital vision processing. In this paper, it is shown that the image enhancement methods are successfully used to enhance the quality of images having poor intensity with the help of light source refinement. This paper evaluates the performance of the various techniques of the image enhancement. The design and implementation has been done with the help of MATLAB tool. The comparative analysis shows that the DBLA outperforms over the already present image enhancement techniques. It is found in this paper that the majority of the existing techniques rely on the transform domain methods, which introduces the color artifacts. In nearby future, a modified image enhancement model can be used to improve the limitations of previous work.

References

[1] Lee, Eunsung, et al. "Contrast enhancement using dominant brightness level analysis and adaptive intensity transformation for remote sensing images."*Geoscience and Remote Sensing Letters, IEEE* 10.1 (2013): 62-66.

[2] Imtiaz, Mohammad Shamim, TareqHasan Khan, and Khan Wahid. "New color image enhancement method for endoscopic images." Advances in Electrical Engineering (ICAEE), 2013 International Conference on. IEEE, 2013.

[3] Sun, Yaqiu, and Xin Yin. "Optical transfer function-based micro image enhancement algorithm." Communications Workshops (ICC), 2013 IEEE International Conference on. IEEE, 2013.

[4] Teng, Yanwen, Fuyan Liu, and Ruoyu Wu. "The Research of Image Detail Enhancement Algorithm with Laplacian Pyramid." Green Computing and Communications (GreenCom), 2013 IEEE and Internet of Things (iThings/CPSCom), IEEE International Conference on and IEEE Cyber, Physical and Social Computing. IEEE, 2013.

[5] Goel, Savita, Akhilesh Verma, and Neeraj Kumar. "Gray level enhancement to emphasize less dynamic region within image using genetic algorithm." Advance Computing Conference (IACC), 2013 IEEE 3rd International. IEEE, 2013.

[6] Tianhe, Yu, et al. "Enhancement of infrared image using multi-fractal based on human visual system." Measurement, Information and Control (MIC), 2012 International Conference on. Vol. 2. IEEE, 2012.

[7] Zhang, Chaofu, Li-ni Ma, and Lu-na Jing. "Mixed Frequency domain and spatial of enhancement algorithm for infrared image." Fuzzy Systems and Knowledge Discovery (FSKD), 2012 9th International Conference on. IEEE, 2012.

[8] Weizhen, Sun, Li Fei, and Zhang Qinzhen. "The Applications of Improved Retinex Algorithm for X-Ray Medical Image Enhancement." Computer Science & Service System (CSSS), 2012 International Conference on. IEEE, 2012.

[9] Yaping, Li, et al. "The recognition and enhancement of traffic sign for the computer-generated image." Digital Home (ICDH), 2012 Fourth International Conference on. IEEE, 2012.

[10] Juliastuti, E., and L. Epsilawati. "Image contrast enhancement for film-based dental panoramic

radiography." System Engineering and Technology (ICSET), 2012 International Conference on. IEEE, 2012.

[11] Fang, Xiaoying, et al. "A method to improve the image enhancement result based on image fusion." Multimedia Technology (ICMT), 2011 International Conference on. IEEE, 2011.

[12] Jin, Li, et al. "Industrial X-ray image enhancement algorithm based on adaptive histogram and wavelet." Strategic Technology (IFOST), 2011 6th International Forum on. Vol. 2. IEEE, 2011.

[13] Henan, Wu, et al. "Remote sensing image enhancement method based on multi-scale Retinex." Information Technology, Computer Engineering and Management Sciences (ICM), 2011 International Conference on. Vol. 3. IEEE, 2011.