Digital Images Enhancement using Tiny Character Adjustment and Referenced Image Approach

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ABSTRACT: *Digital image enhancement has been a hot topic during the past decades. In this paper, we have established a new approach for local gray contrast adjustment of tiny characters and global referenced base contrast enhancement approach to improve the contrast of degraded images. The proposed approach initially adjusts the contrast of tiny characters and then enhances the contrast of whole image by finding out some vital information from the histogram of the referenced image. The experimental results show that the proposed algorithm can adjust the tiny characters and increase the image contrast efficiently.*

Keywords: Gray value enhancement, tiny characters, referenced image, histogram equalization.

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1. Introduction

Digital image enhancement is an obligatory process to upgrade the image quality. The goal of the image enhancement is not only to collect meaningful information based on given requirements, but also to fade unnecessary information. However, to make isolate tiny characters and get them enhanced without alteration is a difficult task. The major dilemma is how to discriminate the tiny characters and noise. Therefore, an efficient image enhancement approach is required to increase the tiny or meaningful characters for preserving the edges and to readjust the intensity values. Median filter is best choice for impulse noise removal from digital images. However, all its remedies use to process each pixel regardless of the current pixel being contaminated or not. Therefore, this operation can produce serious image blurring and may also suffer noise free pixels. Moreover, median filter and all its remedies cannot enhance the tiny characters. Early developed switching median filters provide satisfactory results but only at smaller noise levels [2]. Similarly a soft-switching impulse detector at the expense of computational complexity works on highly corrupted noisy images [3]. The Progressive Switching Median Filter (PSMF) involves in numerous iterations bringing down the computational efficiency [4]. [5] Proposed an efficient Switching Median Filter. Similarly (Krishnan filter) based on [5] [6], removes impulse noise from the images degraded by it, in an efficient way. However, it cannot discriminate corrupted and noise free pixels. The Noise Adaptive Soft-Switching Median (NASM) filter was proposed to solve the problem of impulse noise reduction [7]. All these techniques works well for impulse noise removal but cannot enhance the tiny characters. Therefore, the problem remains unresolved as how to enhance the image quality while smearing off noise.

Similarly, Contrast enhancement is an important step in preprocessing. It can deliver improved visual quality. Due to its world renowned importance; image contrast enhancement has been widely studied over the years. Among the several proposed techniques, histogram equalization (HE) is possibly the most widely used solution [8] but HE has the limitation that it modifies the brightness of each pixel based on image statistic. Many digital image enhancement techniques have been introduced [9] [10] [11], designed to improve the quality of image by increasing the visibility of low contrast image characters while reducing noise. Brightness preserving Bi-Histogram Equalization (BBHE) increase the contrast of images and divide the histogram in sub histogram but it has the drawback of hallo effects [13]. Recursive Mean Separate Histogram Equalization (RMSHE) enhances the idea of BBHE with iterative realizations but having bright effects in some bright area [14]. These techniques can improve image display quality, but some of tiny or weak characters are normally considered as noise. Therefore, it is very hard to distinguished tiny characters and noise.

In this paper, we have established a new approach for local gray contrast adjustment of tiny characters and global referenced base contrast enhancement approach to improve the contrast of degraded images.

2. Proposed Algorithm

The proposed algorithm consists of two phases. In first phase, we will adjust the local gray contrast of tiny characters and in the next phase, we will enhance the global contrast of the whole image using referenced image approach.

2.1 Tiny Characters Adjustments

To isolate tiny or weekend characters from noisy pixels, it is essential isolate the noisy pixels by using suitable noise corrupted pixels detection approach. It is very much clear from the research studies presented in [2] [3] [4] [5] [6] and [7] of the 'Introduction Part' that it detects corrupted pixels in an efficient way. However, the idea presented in "unpublished" [12] outclasses all the previous approaches and can detect noisy pixels with least computational steps, reliability and with less complexity. Once we isolate the corrupted pixels, we can adjust the tiny characters easily. The steps for noisy pixels isolation and tiny character adjustment are detailed below:

Detection of noisy pixels:

1. Read Noisy X-ray Image & Impose 7*7 Window around i^{th} & j^{th} pixel and Create a Binary Map (BM) of same sub Image.

2. Store all the values under the window in a vector (V) and Sort it in ascending order.

3. Find Lowest & Highest values in Vector V.

4. From Lowest to (Lowest + Highest) / 2, Compute the difference of Non-Zero adjacent pixels in V and store it in Vector D.

5. Find the maximum difference in D (From Lowest to (Lowest + Highest) / 2) & Mark its corresponding pixel in V as b1.

6. Similarly, from (Lowest + Highest) / 2 to Highest, Compute the difference of Non-Zero adjacent pixels in V and store it in Vector D.

7. Find the maximum difference in D (From Lowest + Highest) / 2 to Highest) & Mark its corresponding pixel in V as b2.

8. If selected pixel belongs to middle cluster then Uncorrupted. Set corresponding location in BM as "0" and go to step 11.
ELSE

9. Check for repetition

10. Invoke 2^{nd} iteration and impose 3*3 window on same pixel and Go to step 2.

11. End.

Gray Contrast Adjustment:

1. Read X-ray image Z and BM

2. Check for the first i^{th} & j^{th} location in BM IF i^{th} & j^{th} location = 'Null' **Then**

Select the corresponding pixel in X-ray image Z and Averaging the gray contrast of neighboring pixels and Replace i^{th} & j^{th} value with new average value and Go to 8
Else
Go to 8

3. End (move to next pixel in BM)

After isolating of noisy pixels and gray contrast adjustment of tiny characters, the next step is to restored all those detected pixels using idea presented in [12] to make the image suitable for next global contrast enhancement phase.

2.2 Global Contrast Enhancement

Image histogram approach can be used for tonal scattering of an image. It shows the number of pixels at each individual intensity value. The most noticeable area of the image represents gray level pixels. If we divided the histogram into sub histograms i.e. dark and bright on the bases of average minimum and maximum pixel value in the image, then we can easily find the peak points in the two sub histograms, denoted as "dark", "bright" in "Fig. 1". Therefore, the distance between these two peaks can be denoted by "Dst" and it can accurately reflect the intensity difference between bright and dark regions.

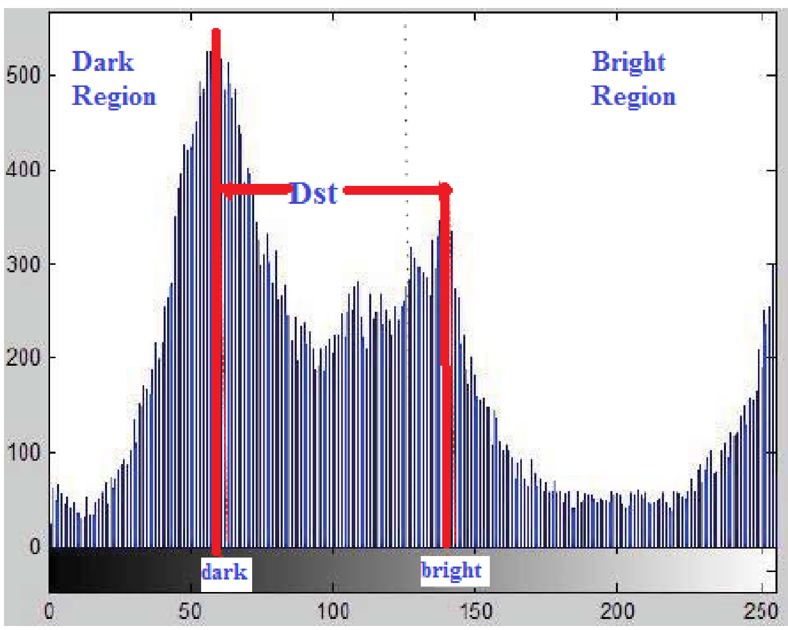

Figure 1. Dark and bright area division of Histogram

Contrast of the final image can be enhanced using histogram division approach. We stretch the histogram "Dst" area only to enhance the final image. "Fig. 2" and "Fig. 3" shows the proposed approach. If we stretched the parameter "Dst" properly then image contrast is enhanced efficiently.

This "Dst" stretching approach does not work for all kind of images. Therefore, we consult some good quality reference image to assess the "Dst" of that image which can later on used to enhance the contrast of the observing image. We will compute the "Dst" values of observing image and consultant image because if we stretch the "Dst" value of observing image as equal to that of the referenced image then it can bring the same contrast as referenced image. Experimental results show the whole process.

Figure 2. Old film original image

Figure 3. Old film “Dst” stretching image

3. Experimental Results

In this section first of all we will see the results of tiny character adjustment approach that how it enhance the quality of digital images and then in second part we will observe the global contrast enhancement using referenced image approach.

Table 1 and table 2 shows MSE and PSNR values of all these approaches. We have tested out X-ray baggage image contaminated with a range of impulse noise densities.

The tables clearly depicts that our proposed approach performs well and outclass all the existing approaches. The proposed approach has better results even than idea presented in [12] due to tiny character enhancement theory.

Now we will check the results for global contrast enhancement using referenced image approach. In “Fig. 4”, we tested an

Noise Density	Median Filter	SMF with BDND	LDNzAdEE Algorithm	Proposed
1%	-	1.0234	0.0098	0.0002
5%	-	2.2541	1.2054	0.0018
10%	-	3.6521	1.6521	0.1104
20%	-	5.8741	2.0014	0.2384
30%	-	6.7453	2.6584	0.3222
40%	-	8.9651	3.6521	1.0247
50%	-	9.3212	3.9987	2.9841
60%	-	11.9851	4.2541	3.0001
70%	-	14.9851	4.9684	3.9854
80%	-	18.2142	7.9654	4.2547
90%	-	21.6254	9.6521	5.6584
95%	-	22.8541	11.3251	6.0098

Table 1. MSE Values of Median Filter, BDND with SMF, LDNzAdEE and Proposed algorithms

Noise Density	Median Filter	SMF with BDND	LDNzAdEE Algorithm	Proposed
1%	-	56.3214	64.6521	66.2651
5%	-	53.9542	63.6254	65.6545
10%	-	48.8541	61.9851	64.9899
20%	-	40.9854	58.3214	64.1241
30%	-	39.8748	55.6351	63.0904
40%	-	38.0021	53.6521	61.4125
50%	-	36.2512	51.6541	59.6541
60%	-	33.9854	49.9857	57.6521
70%	-	31.1245	47.9541	55.6521
80%	-	29.2351	46.3651	52.2145
90%	-	28.3214	39.9854	51.9854
95%	-	27.0128	37.9541	48.9541

Table 2. PSNR Values of Median Filter, BDND with SMF, LDNzAdEE and Proposed algorithms

image “Grake” having best quality to be the referenced image of the observing image “Nida”. It can be observed that RMSHE and HE techniques have increased the contrast excessively while BBHE cannot enhance the contrast sufficiently and the image is likely close to original one. However, our proposed technique enhances the contrast of observing image in an efficient way and looks like more natural and visually acceptable.

From the results, the other three techniques increase noise and degraded the image quality. Moreover, the proposed approach also improve the video contrast through using the referenced image approach and the inter frame consistency can sustained efficiently. The proposed approach is very simple; comparison complexity is very low and meets the requirement of real time computation.

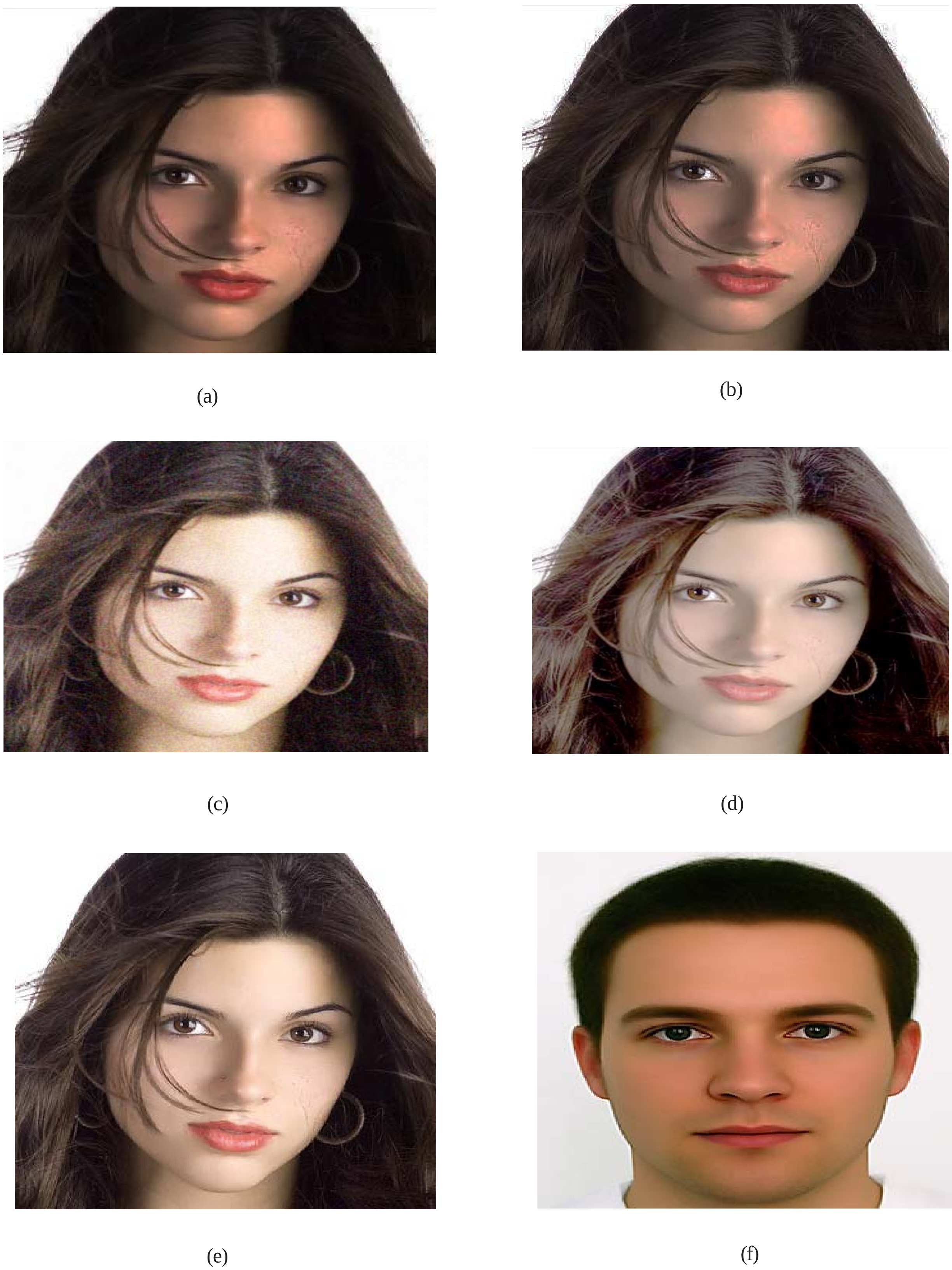

Figure 4. Results of “face” image. (a) Original image. (b) BBHE result. (c) HE result. (d) RMSHE result. (e) Proposed result. (f) Referenced image

4. Conclusion

In this paper, we propose a fast and reliable approach for local tiny character contrast adjustment and global contrast enhancement using reference image approach. From empirically calculated results, it is evident that the proposed approach increases the contrast in short time calculation and complexity. The tremendous advantage of the proposed approach is that it is simple and can be realized even faster than all existing approaches. The proposed approach can be applied as a real application for image production.

References

[1] Huang, T.S., Yang, G.J., Tang, G.Y. (1979). Fast two-dimensional median filtering algorithm, *IEEE Trans. Acoustics, Speech, Signal Process,* 1 (1) 13-18.

[2] Sun, T., Neuvo, Y. (1994). Detail-preserving median based filters in image processing, *Pattern Recognition. Lett*, 15, p. 341C347, April.

[3] Abreu, E., Lightstone, M., Mitra, S.K., Arakawa, K. (1996). A new efficient approach for the removal of impulse noise from highly corrupted images, *IEEE Trans. Image Processing*, 5, p. 1012-1025

[4] Wang, Z., Zhang, D. (1999). Progressive switching median filter for the removal of impulse noise from highly corrupted images, *IEEE Trans Circuits and Systems-II: Analog and Digital Signal Processing*, 46 (1) Jan.

[5] Nallaperumal, K., Varghese, J., Krishnaveni, K., Saudia, S. (2007). An efficient switching median filter for salt & pepper impulse noise reduction, *In*: Proc. Of IEEE ICDIM 2006, Bangalore, India, April.

[6] Nallaperumal, K., Varghese, J., Saudia, S., Selvakumar, R.K., Vinsley, S.S. (2006). Selective switching median filter for the removal of slat & pepper noise, *In*: Proc. Of IEEE WOCN 2006, Bangalore, India, April 2006.

[7] Eng, H.L., Ma, K.K. (2001). Noise adaptive soft-switching median filter, *IEEE Trans. Image Processing*, 10, p. 242- 251, Feb.

[8] Gonzalez, R.C., Woods, R.E. (1992). Digital image processing. 2nd ed. Reading, MA. Addison-Wesley, 1992, p. 85-103.

[9] Davis, T.J., Gao, D. (1995). Phase-contrast imaging of weakly absorbing materials using hard x-rays, *Nature*, 373, p. 595-597.

[10] Manjunath, Li.H., Mitra, B.S. (1995). Multisensor image fusion using the wavelet transform, *Graphical Models and Image Processing*, . 57 (3) 235-245 .

[11] Hongxia, Y. (2005). Diffraction enhanced X-ray imaging for observing guinea pig cochlea, *In*: Proceedings of the 2005 IEEE Engineering in Medicine and Biology 27th Annual Conference, p. 5699-5701, 2005.

[12] Khan, S.U., Wang, Y.C., Chai, S.S. Layer Discrimination using non-zero adjacent element and pixel restoration wiener filter approach for impulse and poisson noise removal from X-ray images, *International Arab Journal of Information Technology*, Unpublished: (submitted: 14th April, 2014).

[13] Wang, Y., Chen, Q., Zhang, B. (1999). Image enhancement based on equal area dualistic sub-image histogram equalization method, *IEEE Tran.Consumer Electron*., 45 (1) 68–75, Feb.1999.

[14] Chen, S.D., Ramli, A.R. (2003). Contrast enhancement using recursive mean-separate histogram equalization for scalable brightness preservation, *IEEE Transactions on Consumer Electronics*, 49 (4) 1301-1309.