Journal of Engineering and Applied Sciences 12 (Special Issue 4): 6690-6693, 2017
ISSN: 1816-949X

Contrast Enhancement of an Image Using ABC Based Discrete Shearlet Transform

[1]S. Premkumar and [2]K.A. Parthasarathy
[1]St. Peter's University,
[2]Aksheyaa College of Engineering, Chennai, Tamil Nadu, India

Abstract: Image enhancement plays a vital role in image processing technique. This study presents a novel method for image enhancement by using Artificial Bee Colony (ABC) based discrete shearlet transform. In this proposed algorithm, the RGB image converted into HSI (Hue, Saturation and Intensity) Model where as intensity and Hue colour considered for image enhancement after conversion. The Hue component decomposed into directional co-efficient by discrete shearlet transform. The higher directional coefficients are eliminated as it causes artifact and unnatural efforts in a image and the intensity components of image is contrast enhanced by using ABC algorithm. The performance of the proposed image enhancement method is compared with existing histogram equalization and discrete shearlet transform based image enhancement. The result of the proposed method achieves satisfactory performance in visualization.

Key words: Discrete, shearlet, transform, artificial, bee colony, contrast, enhancement, image, result

INTRODUCTION

Image enhancement techniques make an image easier to analyze and interpret. The range of brightness values present on an image is referred to as contrast. Contrast enhancement is a process that makes the image features stand out more clearly by making optimal use of the colors available on the display or output device. Contrast enhancement, a process applied on image to increase their dynamic range.

Contrast enhancement is an important area in image processing for both human and computer vision (Haack, 1995). It is widely used for medical image processing and as a preprocessing step in speech recognition, texture synthesis and many other image/video processing applications. Contrast enhancement automatically brightness the images that appear very dark or hazy and apply appropriate tone correction to deliver improved quality and clearly. It will be used to perform adjustment on darkness or lightness of the image and mainly used to bring out the feature hidden in an image or increase the contrast of low contrast image. This can be done using several contrast enhancement techniques. These techniques applied for various applications such as remote sensing and general images. Histogram Equalization (HE) is most popular technique in contrast enhancement (Pei *et al*., 2004). There are variants of HE techniques are available. Dualistic sub-image histogram equalization produces good image contrast enhancement and the enhanced image mean brightness is similar to input image but equalization effect is reduced (Stark, 2000). Automatic weighting mean separated histogram equalization is more suitable for gray scale images. Recursive sub-image histogram equalization has a good contrast enhancement effect. Recursively, separated weighting histogram equalization (Pizer *et al*., 1987) the enhanced image has no severe effect also maintain mean brightness of the input image. Automatic weighting mean-separated histogram equalization is suitable for gray scale images.

A new method for un-sharp masking for contrast enhancement of images is explained by Cheng *et al*. (2011). The approach employs an adaptive filter that control 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. The enhancement is reduced in uniform areas of an image which prevents over enhancement of noise and reduces edge shadowing effect of unlimited adaptive histogram equalization. The size of pixel's contextual region and clip level of histogram are basic parameters of contrast limited adaptive histogram equalization (Polesel *et al*., 2000). Another efficient method is enhancement using discrete shearlet transform (Premkumar and Parthasarathi, 2014) and is only enhanced the contrast colour of an image.

ABC algorithm: The revolution of Bee's algorithm is started during 2005 for optimizing parameters. This technique is based on intelligent foraging behavior of

Corresponding Author: S. Premkumar, St. Peter's University, Chennai, Tamil Nadu, India

honey bee swarms. The purpose of bees is to find the places of food sources where high amount of nectar is present. It consists of three phases: employee bees, onlooker bees and scout bees.

The employed bees: It flies around the multidimensional search space and find food sources depending on their experiences and their neighbor bees. The colony size consists of sum of same number of employee bees and onlooker bees. Initially the food source positions are randomly generated by using Eq. 1. Then by using the fitness function the fitness value is calculated. If the current fitness value is higher than that of the previous fitness value then the current value is replaced by the previous one. Otherwise, the value is not replaced and remains the same. By using greedy mechanism the process of comparing and replacing the value is done:

$$V_{ij} = X_{ij} + \varphi_{ij}(X_{ij} - X_{kj}) \quad (1)$$

Where:

V_{ij} = The new feed position

k and j = The randomly chosen parameters of different values

where, k∈[1, 2, ..., SN] and j∈[1, 2, ..., D]. $(X_{ij}-X_{kj})$ is the difference between two old food source positions. D is the number of optimization parameters and SN is the number of employed bees. The φ_{ij} is a random number between {-1, 1].

The onlooker bees: It gets the information of food sources from the employed bees and selects one of the best food position which is having high nectar amount. Then by using Eq. 2 the probability value is calculated. Now, based on the probability information the current and previous value are compared by using greedy approach. If the present value is higher than the previous then the current value is replaced by the best value. During this process a limit value is assigned. Each time when the values are compared and if best result is obtained then the counter is set to zero otherwise, the limit value will be incremented. Similarly, the process is repeated for other bees:

$$P_i = \frac{fit_i}{\sum_{j=1}^{SN} fit_j} \quad (2)$$

Where:

P_i = The probability value associated with ith food source

fit_i = The ith food source's nectar amounts

SN = The number of food source which is equal to the number of employed bees

Best food source: The best value that is obtained from the above process is stored in the memory. The scout bees finds the new food positions randomly without any experience for the exhausted food sources and the iteration are repeated. The scout bee finds a new random food source position using Eq. 3:

$$x_i^j = x_{min}^j + rand(0, 1)(x_{max}^j - x_{min}^j) \quad (3)$$

where, x^j_{min} and x^j_{max} are lower and upper bounds of parameter j, respectively.

Stopping criteria: If the previous value is equal to the current value while comparing the value by using greedy mechanism then the algorithm is stopped. A particular limit value is assigned while comparing the value by using greedy if until the limit, the value obtained is not best then the algorithm is stopped. If the maximum numbers of iterations are executed then the Algorithm 1 is terminated:

ABC Algorithm:

Step 1: Create an initial population of artificial bees within the search space $x_{i,j}$

Step 2: Evaluate the fitness of the population using sphere function given in Eq. 4:

$$f(x) = \sum_{i=1}^{SN} x_i^2 \quad (4)$$

Step 3: While (stopping criterion not met) where stopping condition is Maximum Number of Iterations (MNI). Produce new solutions (food source positions) $v_{i,j}$ in the neighborhood of $x_{i,j}$ for the employed bees. Memorize the best food source position (solution) achieved so far

Step 4: End while

The application of this algorithm for assigning fusion weight in multi feature similarity score fusion method is helped to gain a better image contrast enhancement.

Discrete shearlet transform: The proposed contrast image enhancement is based on new multi-scale directional representations called the shearlet transform introduced by Munteanu and Rosa (2000) and Qinqing *et al*. (2011). An N×N image consists of a finite sequence of values $\{x[n_1, n_2]^{N-1, N-1}{}_{n1, n2 = 0}$ where, N∈N identifying the domain with the finite group Z^2N, the inner product of image x, y: $Z^2N \rightarrow C$ is defined as:

$$(x, y) = \sum_{u=0}^{N-1} \sum_{v=0}^{N-1} x(u, v)\overline{y(u, y)} \quad (5)$$

Thus, the discrete analog of $(L^2\mathbb{R}^2)$ is $l^2Z^2_N$. Given an image $f \in l^2(Z^2N)$ let, $\hat{f}[k_1, k_2]$ denote its 2D Discrete Fourier Transform (DFT):

$$\hat{f}[k_1, k_2] = \frac{1}{N}\sum_{n_1, n_2 = 0}^{N-1} f[n_1, n_2]e^{-2\Pi i(\frac{n_1}{N}k_1+\frac{n_1}{N}k_2)} \quad (6)$$

The brackets in the equations [., .] denote arrays of indices and parentheses (., .) denote function evaluations. Then the interpretation of the numbers $\hat{f}[k_1, k_2]$ as samples $\hat{f}[k_1, k_2] = \hat{f}(k_1, k_2)$ is given by the following equation from the trigonometric polynomial:

$$\hat{f}(\xi_1, \xi_2) = \sum_{n_1, n_2 = 0}^{N-1} f[n_1, n_2]e^{-2\Pi i(\frac{n_1}{N}\xi_1+\frac{n_1}{N}\xi_2)} \quad (7)$$

First, to compute:

$$\hat{f}(\xi_1, \xi_2)\overline{V(2^{-2j}\xi_1, 2^{-2j}\xi_2)} \quad (8)$$

In the discrete domain, at the resolution level j, the Laplacian pyramid algorithm is implemented in the time domain. This will accomplish the multi scale partition by decomposing $f^{j-1}_a[n_1, n_2]$, $0 \leq n_1, n_2 < N_j-1$, into a low pass filtered image $f^j_a[n_1, n_2]$, a quarter of the size of $f^{j-1}_a[n_1, n_2]$ and a high pass filtered image $f^{j-1}_d[n_1, n_2]$. Observe, that the matrix $f^{j-1}_a[n_1, n_2]$ has size $N_j \times N_j$ where, $N_j = 2^{-2j}N$ and $f^0_a[n_1, n_2] = f[n_1, n_2]$ has size $N \times N$. In particular:

$$\hat{f}^j_d(\xi_1, \xi_2) = \hat{f}(\xi_1, \xi_2)\overline{V(2^{-2j}\xi_1, 2^{-2j}\xi_2)} \quad (9)$$

Thus, $f^j_d[n_1, n_2]$ are the discrete samples of a function $f^j_d[x_1, x_2]$ whose Fourier transform is $\hat{f}^j_d[\xi_1, \xi_2]$. In order to obtain the directional localization the DFT on the pseudo-polar grid is computed and then one-dimensional band-pass filter is applied to the components of the signal with respect to this grid. More precisely, the definition of the pseudo-polar co ordinates $(u, v) \in \mathbb{R}^2$ as follows:

$$(u, v) = (\xi_1, \frac{\xi_2}{\xi_1}), \text{ if } (\xi_1, \xi_2) \in D_0 \quad (10)$$

$$(u, v) = (\xi_1, \frac{\xi_1}{\xi_2}), \text{ if } (\xi_1, \xi_2) \in D_1 \quad (11)$$

After performing this change of co ordinates $g_j(u, v) = \hat{f}^j_d(\xi_1, \xi_2)$ is obtained and for $l = 1-2^j, .., 2^j-1$:

$$\hat{f}(\xi_1, \xi_2) = \overline{V(2^{-2j}\xi_1, 2^{-2j}\xi_2)W^{(d)}_{jl}(\xi_1, \xi_2)} = g_j(u, v)\overline{W(2^j v\text{-}l)} \quad (12)$$

This expression shows that the different directional components are obtained by simply translating the window function w. The discrete samples $g_j[n_1, n_2] = g_j(n_1, n_2)$ are the values of the DFT of $f^j_d[n_1, n_2]$ on a pseudo-polar grid. That is, the samples in the frequency domain are taken not on a Cartesian grid but along lines across the origin at various slopes. This has been recently referred to as the pseudo-polar grid. One may obtain the discrete frequency values of f^j_d on the pseudo-polar grid by direct extraction using the Fast Fourier Transform (FFT) with complexity ON^2 log N by using the Pseudo-polar DFT (PDFT).

MATERIALS AND METHODS

The proposed contrast image enhancement approach using ABC based DST is shown in Fig. 1. The input RGB image is initially, converted into HSI Model. Further, Hue and intensity components are used as the inputs for the proposed resolution enhancement process. Hue is decomposed by DST at 2 levels with 2 directions which produces five shearlet bands includes four higher sub-bands and one lower sub-band. The decomposed lower frequency is alone taken into the account for inverse shearlet transforms. Then intensity values are transformed by using ABC algorithm. Finally, the HSI Model (modified Hue by DST and modified intensity values by ABC and preserved saturation) which are converted into RGB Model to obtain enhanced image.

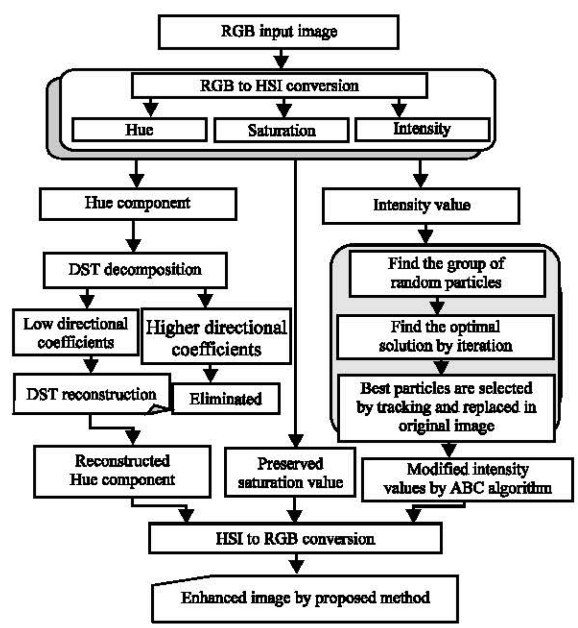

Fig. 1: Block diagram of the proposed image enhancement system using DST and PSO

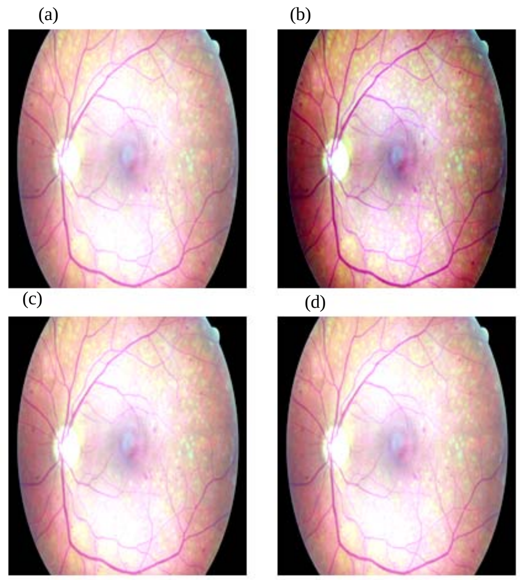

Fig. 2: Comparison of proposed technique with histogram equalization method and DST: a) Input image; b) Histogram equalization image; c) Discrete shearlet transform and d) Proposed technique

RESULTS AND DISCUSSION

In this study, to demonstrate the performance of the proposed algorithm, the proposed method is compared with other image enhancement techniques in terms of ability in contrast and detail enhancement, the proposed method to produce fundal images. Histogram equalization, DST contrast enhancement methods which are used for comparison. In this study, the proposed method was simulated on 512×512 images (Fig. 2).

CONCLUSION

A novel approach for image enhancement has been proposed in this study based on ABC based discrete shearlet transform. Initially, the color image converted into HSI Model. In order to improve the contrast of the image, the Hue colour and intensity channels only considered. The shearlet decomposition produces low and high directional sub bands on the Hue channel. The lower directional sub band is used for inverse shearlet transform to reconstruct the Hue channel. Intensity value is transformed by ABC algorithm and saturation is preserved. Then, the enhanced image is obtained by converting HSI to RGB Model. The satisfactory result is achieved from the proposed ABC based DST image enhancement approach.

REFERENCES

Cheng, F.C., S.J. Ruan and C.H. Lin, 2011. Color contrastenhancement using automatic weighting mean-separated histogram equalization with spherical color model. Intl. J. Innovative Comput. Inf. Control, 7: 5377-5387.

Haack, S., 1995. Evidence and Inquiry: Towards Reconstruction in Epistemology. Wiley-Blackwell, Hoboken, New Jersey, ISBN:9780631196792, Pages: 272.

Munteanu, C. and A. Rosa, 2000. Towards automatic image enhancement using genetic algorithms. Proceedings of the 2000 Congress on Evolutionary Computation, July 16-19, IEEE Press, La Jolla, CA., USA., pp: 1535-1542.

Pei, S.C., Y.C. Zeng and C.H. Chang, 2004. Virtual restoration of ancient Chinese paintings using color contrast enhancement and lacuna texture synthesis. IEEE Trans. Image Process., 13: 416-429.

Pizer, S.M., E.P. Amburn, J.D. Austin, R. Cromartie and A. Geselowitz *et al*., 1987. Adaptive histogram equalization and its variations. Comput. Vision Graphics Image Process., 39: 355-368.

Polesel, A., G. Ramponi and V.J. Mathews, 2000. Image enhancement via adaptive unsharp masking. IEEE Trans. Image Process., 9: 505-510.

Premkumar, S. and K.A. Parthasarathi, 2014. An efficient approach for colour image enhancement using Discrete Shearlet Transform. Proceedings of the 2nd International Conference on Current Trends in Engineering and Technology (ICCTET'14), July 8, 2014, IEEE, Coimbatore, India, ISBN:978-1-4799-7988-2, pp: 363-366.

Qinqing, G., C. Dexin, Z. Guangping and H. Ketai, 2011. Image enhancement technique based on improved PSO algorithm. Proceedings of the 6th IEEE Conference on Industrial Electronics and Applications (ICIEA'11), June 21-23, 2011, IEEE, Beijing, China, ISBN:978-1-4244-8754-7, pp: 234-238.

Stark, J.A., 2000. Adaptive image contrast enhancement using generalizations of histogram equalization. IEEE Trans. Image Process., 9: 889-896.