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GA based Blind Deconvolution Technique of Image Restoration using Cepstrum Domain of Motion Blur

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Abstract

Objectives: In this paper, the image restoration technique is designed based on the Genetic algorithm (GA) and cepstrum filtering. **Methods/Statistical Analysis:** We used the cepstrum method to find out motion blur parameters angle and length of spectrum according to the observed image for the cepstrum filtering. **Findings**: The GA as an optimization strategy can adjust the parameters and provide an appropriate value of theta and length. Optimized values of theta and length help to compute the PSF which is close to the real value of PSF as it increases the PSNR. The experimental results demonstrate that use of optimization technique in cepstrum filtering improve the PSNR of the restored image, but encounters some ringing effect.

Keywords: Cepstrum, Genetic Algorithm, Image Restoration, Parameter Estimation

1. Introduction

During the capturing of image some error occurs in the imaging system, due to which the image gets deteriorated. The reversing method of retrieving the actual image by eliminating the noise and blur is the challenging problem in image processing. It is difficult to analyse the information in the image due to blur. The Logarithm of the Inverse Fourier transform (IFT) of the estimated spectrum of a signal is called a cepstrum of that image. The cepstrum of g(x, y) is given by equation (1)

$$c[g(x,y)] = F^{-1}(\log | F(g(x,y)|) \quad (1)$$

An additive property of the cepstrum is represented as equation (2)

$$C(g(x,y)) = C(f(x,y)+C(h(x,y)) \quad (2)$$

The power cepstrum used in an application is required for the analysis of human speech. But in our proposed method we performed Fourier transform of logarithm spectrum to discover the periodic blur pattern in cepstrum domain instead of spectral nulls. If we apply optimization technique along with cepstrum technique, then estimated PSF[1] will help for better restoration. In image, edges and other vital components for the most part add to high frequencies. So as to concentrate better features, high frequency component cells of the 2D DFT matrix are multiplied with higher weights compared with low recurrence part cells in the framework. As a result, high frequency components are further

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emphasized. Basically Genetic Algorithm is widely used in optimization and it is a useful search technique also. It is a type of evolutionary algorithm which uses genetic techniques inspired by evolutionary biology which consists of process of mutation selection, and crossover. Firstly, with the randomly generated individuals, the evolution is usually started. In each generation, the fitness of every individual in the population is computed. The fitness function differs as indicated by the problem. At first numerous individual solutions are arbitrarily produced to estimate the initial population. The population size relies on nature of the problem, yet regularly contains a few hundred or a great many conceivable solutions. In every successive generation, a part of the existing population is selected to produce offspring of new generation. Fitness-based processes are used for Individual selection. Best solution depends on how we choose the fitness function. Many functions are stochastic so as to select less fit solutions in small proportion. In poor solutions, the premature convergence is not possible for this. In genetic programming, the algorithm has to look into many no. of equations so the search space is huge. Therefore, normally before running a GA to search for an equation, the user keeps the provision of choice of numerical range of searching. Here in our method, we have considered 100 iterations, and sharpness of an image as a fitness function.

In blind deconvolution PSF is unknown; hence the main aim in blind deconvolution is that the PSF has to be estimated. If PSF is close to correct value, better will be the restoration. Here, we have explored the review of PSF estimation mostly related to motion blur. An estimation technique[2]is an unbiased estimation with the filtered mean squared error (mse) i.e. Blur-Stein's unbiased risk estimation (SURE). In that paper, authors proposed for blind PSF parameter estimation using Blur-SURE. In this paper Blur MSE is minimized by exact wiener filtering and then Blur-SURE estimation has been applied over Blur MSE. The scaling factor of the non Gaussian PSF Estimation is done. The main limitation of this research is that the MSE estimation is not defined over frequency responses when phase variations values did not match with amplitude variations. A patch based image degradation model is used for PSF estimation in blurred image using the gradient spatial correlation[3]. Bayesian model technique[4] was used to generate a covariance matrix of the gradient domain natural images. Autocorrelation function of PSF is estimated by image degradation model that is patch based image restoration and also by the Phase Retrieval (PR) technique[5]**.** In the paper[6] describes comparison of seven different cepstrum based method from the generalized to complex method. It helps to select the cepstrum method as per the application[7]. A method has been proposed for blur computation of an image during the motion between the object and video camera[8]. In this research PSF estimation is completed more precisely in the inverse filtering, in addition wiener filter is used for restoration of the motion blur of an image. From the comparative analysis it is found that motion blur image can be reestablished much better with cepstrum method as compared to inverse filter. Here, blur angle and blur length are calculated by detailed cepstrum analysis of the motion-blurred image. Inverse filter is useful for feature extraction and object recognition. But Effect of noise in inverse filter is very large. In literature[9] there are many methods projected for the blur parameters detection. Here different approaches for estimation of motion blur parameters are compared such as direction and length from the actual image with and without the effect of Gaussian noise. Standard non-blind deconvolution algorithm can be applied for deconvolution using estimated motion blur parameters. The restoration based on 2D-DWT and cepstrum point spread function parameter identification algorithm[10], applied morphological processing and canny edge detection to calculate length and theta. In the technique of Isophote Constraint Optimization[11], cost function has been minimized with the help of Genetic Algorithm. Here isophotes have been obtained by separating an image of constant intensity using connected components. The smoothness for connecting the disconnected isophotes, has been estimated using the best chromosomes of the GA. The authors created a technique for image restoration by Richardson–

Lucy algorithm. Here, Genetic Algorithm (GA) is used to obtain Optimized PSF and and can be greatly advantageous in the real time applications[12]. An integration of genetic algorithm[13] founded on the theory of the adaptive chaos algorithm helps to improve the conventional genetic algorithm, and makes the algorithm in a moderately fast to get acceptable results. Algorithm first optimizes the generation of initial population, and effectively to protect the species variety. The process of crossover and mutation o f genetic algorithm, is made by vigorously changing the value of crossover probability and mutation probability to complete chromosomal crossover and mutation operation; and then of the new population of chaos optimization as the next generation of population, it will continue the loop till satisfy the condition, otherwise loop will terminate.

2. Degradation Model of Motion Blur

The degradation of an image can cause due to movement of an object position in the scene during capturing an image or simultaneous motion of camera and object. Both the moving object and camera shake contribute to this blurring. Various methods are there to remove the motion blur, sometimes the hardware in the camera helps to calculate motion blur and many software methods mostly in frequency domain which helps to compute motion blur. Suppose an image of size M×N as input image as ‗f' to be convolved with ‗h' as the Point Spread Function. Also some noise is added during the capturing process, which is ‗n'. Hence, mathematical expression of the blurred image expressed by equation (3).

$$g = h*f+n \quad (3)$$

Let x0(t) and y0(t) be the components of motion of the object in the x and y directions. The image is given as equation (4)

$$g(x,y) = \int_0^T f(x - x0(t), y - y0(t))dt \quad (4)$$

Where T is the time required to capture the image and x0(t), y0(t) are the motion in x and y direction. Taking the Fourier transform of (3) we acquire the following equation (5).

$$G(u,v) = H(u,v)F(u,v) + N(u,v) \quad (5)$$

The Fourier transform of the function h(x,y) i.e. PSF is oriented in the direction of the blur. By multiplying this PSF by F(u, v) in the frequency domain, ripples of the PSF are conserved. Later on by applying mathematical computations on the ripples in G (U, V), blur length and angle can be blur image.

3. Proposed Algorithm

In the proposed method of initial cepstrum based motion blur, we estimated the angle of a motion blur image using mathematical model which helps to compute PSF of blur image. These theta and length will be input parameters to GA and GA will produce the optimized theta and length parameters. The PSF is computed using derived theta and length. Deconvolution is done using Lucy Rechardson non- blind deconvolution technique with computed PSF and blur image.

4. Result Analysis

We have implemented above proposed algorithm by step by step approach. First found out FFT amplitude spectrum. Figure 1 and 2 shows the FFT spectrum of Cameraman image. Then computed theta and length of spectrum by applying mathematical computational model. Table 1, 2 and 3 shows theta and length computation by Cepstrum Method and GA based method of three images (Cameraman, Rice and Lena image). Table 4 shows the comparison of PSNR for these three images. The computed parameters which we have calculated using cepstrum method are the input parameters to GA which increases precision of theta and length of the motion blur.

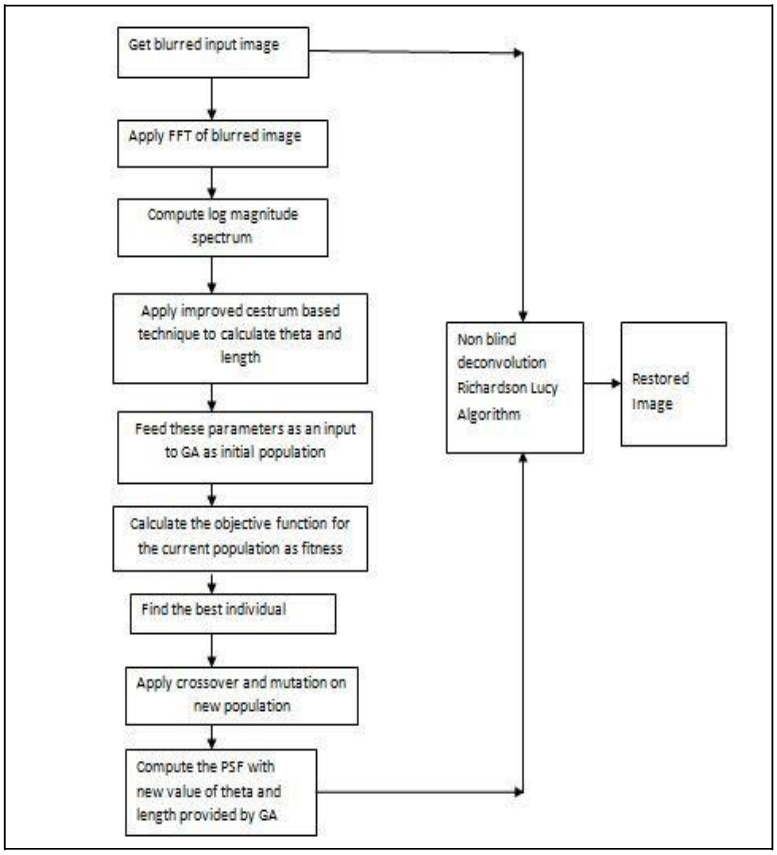

Figure 1. Flow chart of the proposed scheme of GA based optimization of image restoration.

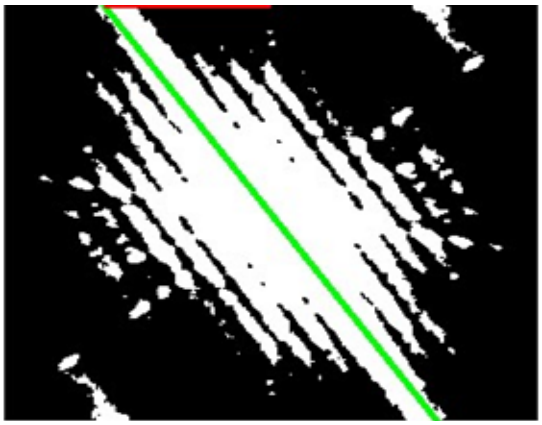

Figure 2. FFT amplitude spectrum of Cameraman image.

Table 1. Comparison of the theta and length for cameraman image

Parameters of blur	Cepstrum method	GA based proposed method
THETA	32	32.085
Length	20	20

Table 2. Comparison of the theta and length for rice image

Parameters of blur	Cepstrum method	GA based proposed method
THETA	32	32.085
Length	20	20

Table 3. Comparison of the theta and length for lena image

Parameters of blur	Cepstrum method	GA based proposed method
THETA	32	32.085
Length	20	20

Table 4. Comparison of cepstrum and proposed method in terms of psnr

Parameters of blur	Cepstrum method	GA based proposed method
THETA	32	32.085
Length	20	20

Figure 3. (a) motion blurred camera image (b) restored using Cepstrum method (c) restored using proposed method.

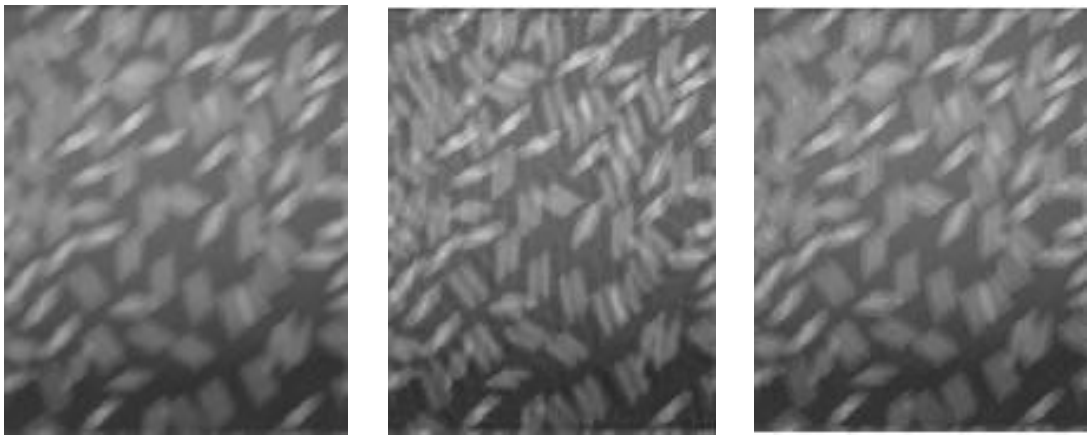

Figure 4. (a) motion blurred rice image (b) restored using cepstrum method (c) restored using proposed method.

Figure 3–5 show the three images blurred with Motion blur and restored images with Cepstrum and GA based method. The proposed method gives better result in terms of PSNR, but it encountered the ringing effects in image. All three images degraded with the same parameters θ=30 and length of blur=20. It may be observed that proposed optimized GA based cepstrum shows better performance in all three images. The change of cepstrum based genetic algorithm helps to optimize theta and length of the blur, which effectively increased the PSNR, but the calculation of the theta and length increases the running time to certain extent. The algorithm not only

Figure 5. (a) motion blurred Lena image (b) restored using Cepstrum method (c) restored using proposed method.

improves PSNR value but also improves the visual quality of an image restoration. The integration of the cepstrum along with genetic algorithm has good effect.

In Figure 4 Rice blurred image is restored using calculated PSF obtained from Theta and Length of Table 2 using cepstrum method and GA based proposed method respectively. From table 4, it is found that the PSNR obtained is very high but visual appearance is poor. Similarly in Figure 5 Lena blurred image has been restored.

5. Conclusion

In this paper, a new motion blur PSF detection method has been developed. The two blur parameters, which consist of angle and length of motion blur, were estimated more accurately. The mathematical computing steps are used in finding theta and length in normal cepstrum method. To optimize in a better way we have adopted GA technique to increase precision of theta and length of spectrum. The experimental results show that estimation angles of blur, length are found to be close to true values. We obtained higher precision in estimation of blur length which in return improves the value of PSNR. As the encountered restoration suffered from ringing effect. So we can remove the ringing effect in future work.

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7. References

1. Kundur D, Hatzinakos D. Blind image deconvolution revisited. IEEE signal processing magazine. 1996 Nov; 13(6):61–3. CrossRef.
2. Xue F, Blu T. A novel SURE-based criterion for parametric PSF estimation. IEEE Transactions on Image Processing. 2015 Feb; 24(2):595–607. CrossRef, PMid:25531950

3. Tian D, Tao D. Coupled learning for facial deblur. IEEE Transactions on Image Processing. 2016 Feb; 25(2):961–72. CrossRef. PMid:26685244
4. Hu W, Xue J, Zheng N. PSF estimation via gradient domain correlation. IEEE Transactions on Image Processing. 2012 Jan; 21(1):386–92. CrossRef, PMid:21693420
5. Joshi N, Szeliski R, Kriegman DJ. PSF estimation using sharp edge prediction. IEEE Conference on Computer Vision and Pattern Recognition, 2008 Jun. p. 1–8. CrossRef.
6. Taxt T. Comparison of cepstrum-based methods for radial blind deconvolution of ultrasound images. IEEE transactions on ultrasonics ferroelectrics and frequency control. 1997 May; 44(3):666–74. CrossRef.
7. Fu Z, Xian H, Xu J, Ge X. Evaluation of motion blur parameter based on cepstrum domain of the intentional restored image. International Conference on Computational Problem-Solving (ICCP). 2010 Dec. p. 271–4.
8. Lokhande R, Arya KV, Gupta P. Identification of parameters and restoration of motion blurred images. Proceedings of the 2006 ACM symposium on Applied computing, 2006 Apr. p. 301–5. CrossRef.
9. Tiwari S, Shukla VP, Singh AK, Biradar SR. Review of motion blur estimation techniques. Journal of Image and Graphics. 2013 Dec; 1(4):176–84.
10. Li Q, Rao J, Yang X. Research Motion Blurred Image Restoration Algorithms. International Journal of Signal Processing, Image Processing and Pattern Recognition. 2015; 8(9):31–44. CrossRef.
11. Kim JB, Kim HJ. GA-based image restoration by isophote constraint optimization. EURASIP Journal on Advances in Signal Processing. 2003; (3):349873. CrossRef.
12. Shah M, Dalal UD. 3D-image restoration technique using Genetic Algorithm to solve blurring problems of images. The Imaging Science Journal. 2014 Sep; 62(7):365–74. CrossRef.
13. Zheng G, Yiran WA. Adaptive Genetic Algorithm Based on Chaotic Intelligent Algorithm to Image Restoration Research. International Journal of Signal Processing, Image Processing and Pattern Recognition. 2016 Jul; 9(7):305–14. CrossRef.