Image Restoration by Enhanced Empirical Mode Decomposition Algorithm

Er. Priyanka[1] Er. Divya[2]
[2]Guide
[1,2]Department of Electronic & Communication Engineering
[1,2]DVIET, Karnal, Haryana, India

Abstract— Historically Image processing domain has been seeing lots of extensions and apprises since its conceptualization. It's said nothing can match which is seen by natural eye retina but in order to capture the memories, scientific data images have been clicked and video have been created. But when it comes to data collection the quality of image being captured becomes of crucial importance and this has led to establishment of image processing field. It's not only about image capturing but it involves lot of background like capturing the exact characteristics of image to convert it into a digital signal so that it can be transmitted and restored back retaining the same characteristic as that of original image. Its common phenomenon that whenever any data is being transmitted via any media, data is vulnerable to get noisy and loose its original characteristics. Our main attempt in this thesis is to bring the innovative concept into discussion for image processing and de-noising. For better understanding; correlation among two phenomenon has been explored like Enhanced Empirical Mode Decomposition and wavelet transform keeping different parameters like Mean square error & Peak signal to noise ratio under observation.. In this thesis a concept of smart Empirical mode decomposition is used which is blend of Enhance Empirical Mode Decomposition and wavelet thresholding along with relative differentiation between different kinds of threholding analysis. In lieu of coming up with more possible combinations for best of the de-noising technique a new act threshold limitation has been put low pass components or the other way is to keep it intact before adding inverse DWT. Increasing one more step towards image reconstruction, algorithm has been tested with image blurring error and it has been noticed that the proposed scheme works more efficiently for image de-blurring then de-noising. In previous study it is always found that, there is a research gap to decide which IMFs must be used for reconstruction once all are extracted. Hurst exponent has been sued to choose potential IMF. The whole algorithm is implemented in MATLAB R2013a's image processing toolbox along with graph visualization toolbox is used. Results are compared on the basis of peak signal to noise ratio (PSNR) and mean square error (MSE).

Key words: Empirical Mode Decomposition Algorithm, Image Restoration, IMF

I. Introduction

Image processing is a domain that is already established and still growing at a rapid pace with new applications/functionalities getting created at an expedited pace. It is a desirable and exciting area to be concerned in these days with application areas starting from the industry to the programme. One of the foremost interesting facets of this data revolution is that the ability to send and receive complicated information that transcends normal written communication. Best part of this field is that it can applied from huge space images researches to defence image searches to medical industry's human body image researches and processing. Visual information, transmitted via digital images, is the most pre-dominant method for pictorial communication in today's era. Image process is any type of signal processing that the input is a picture, such as picture frames or series of picture frames making videos and also the output of image process will be either a picture or a collection of characteristics or parameters associated with the image. Most of the imaging techniques involve considering the image as a 2-dimensional signal and make them undergo through digital/visual signal-processing techniques. Some of the applications in image process need the analysis to be localized within the abstraction domain. The classical way of doing this is through what's referred to as Window Fourier transform. Central idea of windowing is mirrored in STFT - Short Time Fourier transform. STFT exhibits the presence of the local frequency component in signal within small window time frame and same philosophy can be applied to a two-dimensional abstraction image wherever the localized frequency parts could also be determined from the windowed transform. This is one in all the premise of the conceptual learning of wavelet transforms. Hence entire concept of thesis is revolving around wavelet transforms. It is learnt that even in normal scenarios abnormalities get into image taking the input image leaving the noisy image for future process. There is corrupted image naturally by presence of noise and making them de-noised is an old issue within the field of signal or image process. Additive random noise can simply be removed by easy threshold ways. De-noising of natural images corrupted by noise victimisation wavelet techniques is very effective due to its ability to capture the energy of a signal. The wavelet de-noising theme thresholds the wavelet coefficients arising from the wavelet transform. The wavelet transform results a massive range of tiny coefficients and a little range of big coefficients. Retrieve the wavelet transform of the noisy signal.

- Modify the noisy wavelet coefficients according to some rule
- Compute the inverse transform victimisation the changed coefficients.

The problem of Image de-noising can be summarized as follows, Let A (i, j) be the noise-free image and B (i, j) the image corrupted with noise Z (i, j),

B (i, j) = A (i, j) +sZ (i, j) ... (1.1)

The problem is to estimate the desired signal as accurately as possible according to some criteria. In the wavelet domain, the problem can be formulated as

Y (i, j) =W (i, j) + N (i, j) ... (1.2)

where Y (i, j) is noisy wavelet coefficient; W(i, j) is true coefficient and N(i, j) noise. In this thesis work, the algorithm has been carried out by using variety of inputs.

Objective of our work is to reconstruct the deformed image. Here two kind of deformation: noisy and blurring in the image are considered. For this purpose enhanced empirical mode decomposition is used followed by wavelet thresholding. EEMD is the enhanced version of empirical mode decomposition (EMD) as EMD suffers from mode mixing problem. After breaking deformed image into different IMFs by EEMD algorithm, each IMF is filtered by wavelet thresholding technique. A basic flow chart depicting the above said process is shown below in figures section.

A. Figures and Tables

1) Flowchart

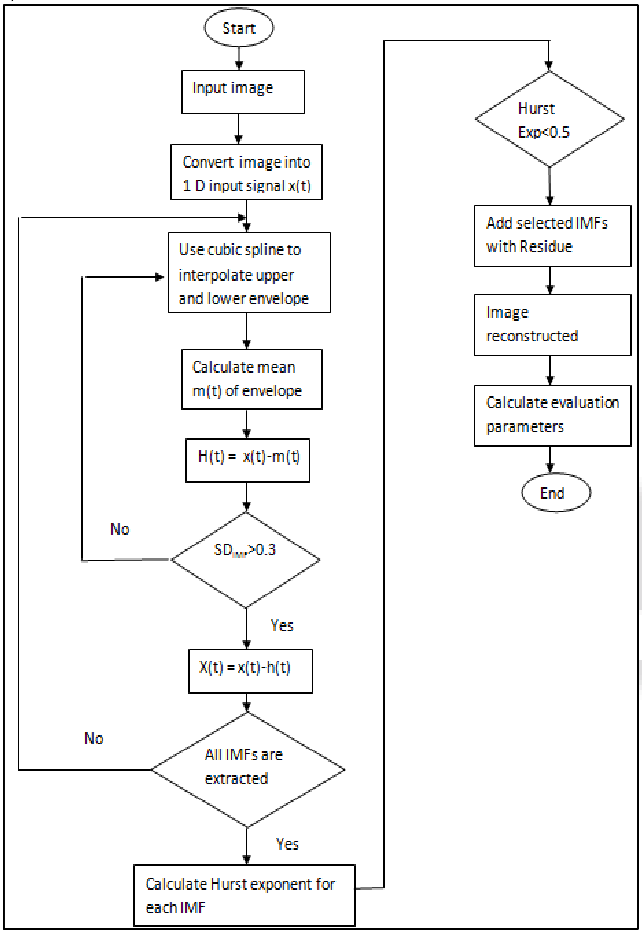

Fig. 1: A flow chart for EEMD algorithm

This below given Figure 2 shows Figure 4.1 shows the input image picked up for test and resized along with added noise to deform the image. Tests have been carried out by both methods i.e. EEMD + wavelet and EMD + wavelet for 10 number of IMFs.

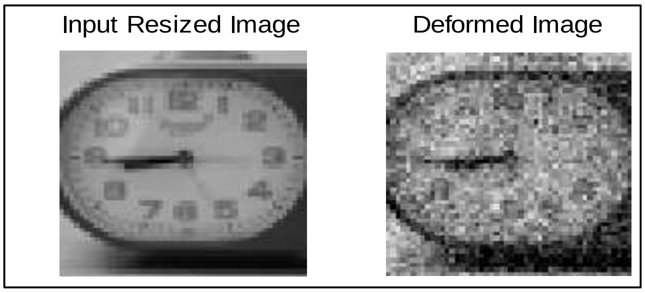

Fig. 2: Input resized image with added noise

This below figure illustrates 10 IMFs for deformed image

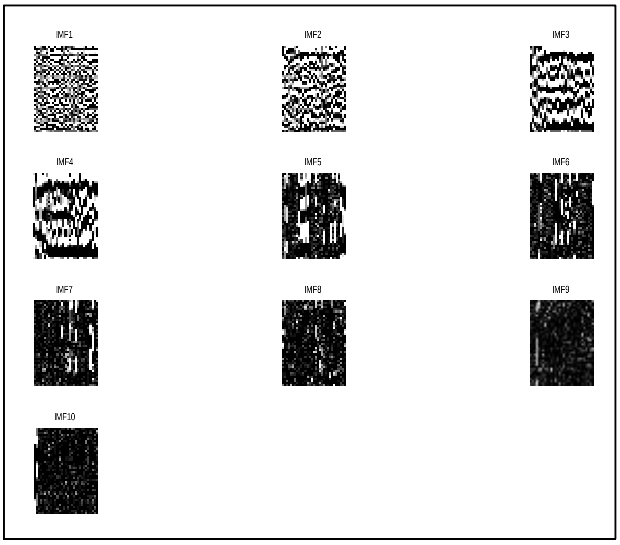

Fig. 3: 10 IMFs extracted by EEMD algorithm for deformed image in figure 2

Below given figure is surface peak plot of 10 IMFs

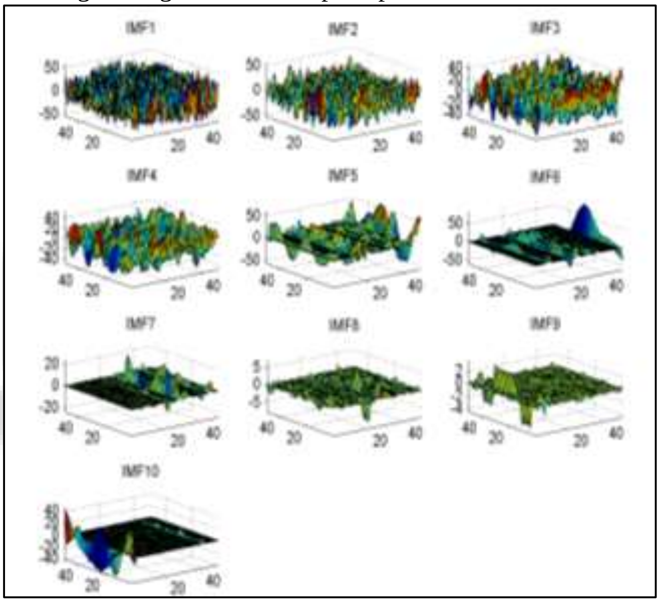

Fig. 4: Surface Peak plot of 10 IMFs form EEMD after filtered through wavelet transform

Here is the comparative analysis of surface peaks of input image vis-à-vis surface peaks after EEMD process

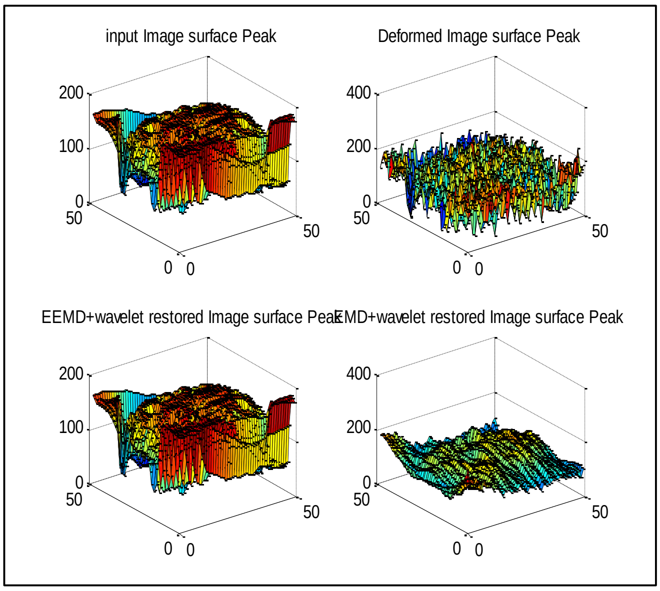

Fig. 5: Surface peak plot of reconstructed images

This below given figure shows the comparison of MSE & PSNR in case of EMD & EEMD

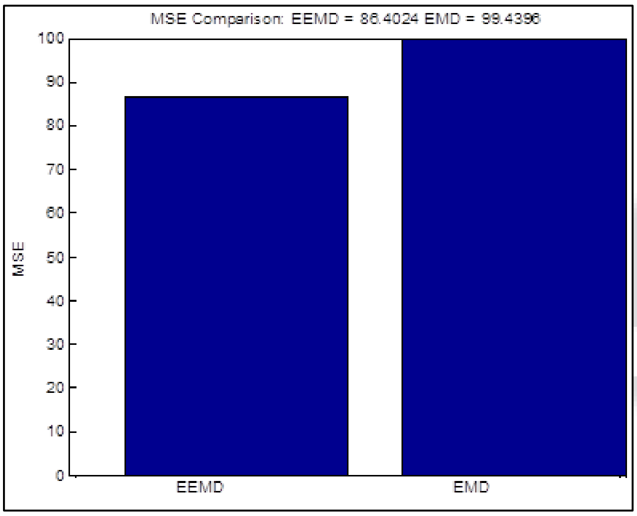

Fig. 6:

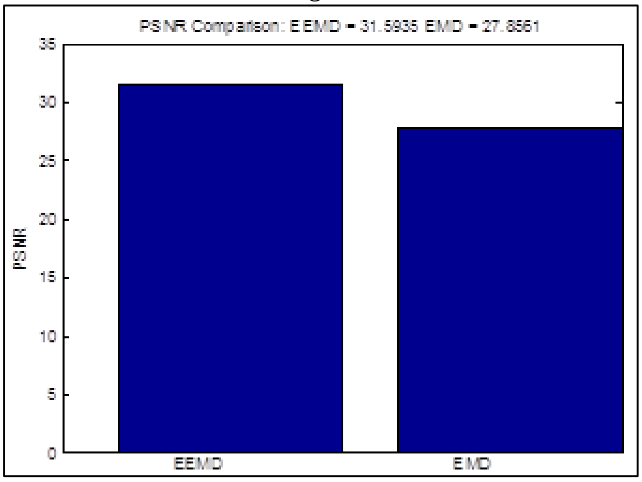

Fig. 7:

B. *Abbreviations and Acronyms*

Sr.No	Short Form	Full Form
1.	STFT:-	Short Time Fourier Transform
2.	CWT:-	Continuous Wavelet Transformation
3.	DWT:-	Discrete Wavelet Transformation
4.	IDWT:-	Inverse Discrete Wavelet Transformation
5.	MAP:-	Maximum-a-Posteriori
6.	IDR:-	Iterative distribution reweighting
7.	DLR:-	De-convolution using Lucy Richardson
8.	DRF:-	De-convolution using Regularized Filter
9.	BID:-	Blind Image De-convolution
10.	PSNR:-	Peak Signal to Noise Ratio
11.	RMSE:-	Root Mean Square Error
12.	MSE:-	Mean Square Error
13.	PDE:-	Partial Differential Equation
14.	HAF:-	Histogram Adaptive Fuzzy
15.	WFM:-	Weighted Fuzzy Mean
16.	MDB:-	Minimum-maximum Detector Based
17.	AFMF:-	Adaptive Fuzzy Mean Filter
18.	CWM:-	Centre Weighted Mean
19.	MRF:-	Markov Random Field
20.	EM:-	Expectation–maximization
21.	FFT:-	Fast Fourier transform
22.	ISTA:-	Iterative shrinkage-thresholding algorithm
23.	FISTA:-	Fast iterative shrinkage-thresholding algorithm
24.	IDR:-	Iterative distribution reweighting
25.	HDR:-	High dynamic-rang
26.	PSF:-	Point Spread Function
27.	ANFIS:-	Adaptive Neuro-fuzzy inference system
28.	IN:-	Impulse noise
29.	NFDMF:-	Neuro-fuzzy detector based median filter
30.	EC:-	Evolutionary computation
31.	PSO:-	Particle swarm optimization
32.	DOF:-	Depth of field
33.	EEMD:-	Ensemble empirical mode decomposition
34.	USGS:-	United States Geological Survey

C. *Equations*

The proposed combination of algorithms is analyzed on the basis of peak signal to noise ratio (PSNR) and mean square error (MSE).

MSE: The mean square error as its name indicates is mathematically defined as

$$MSE = \frac{1}{mn}\sum_{i=0}^{M-1}\sum_{j=0}^{N-1}(refI(i,j) - ReconsI(i,j))^2$$

Where m= number of rows in image matrix

n= number of columns in image matrix

refI=reference Image

ReconsI= reconstructed Image

PSNR: PSNR is mostly used to measure the quality of reconstruction of image. It is calculated form MSE. It is mathematically expressed as:

$$PSNR = 20log10\frac{maxI}{MSE}$$

where maxI is maximum possible pixel value of image I. A higher PSNR generally indicates that the reconstruction is of higher quality

D. *Results & Conclusions*

Our motive to write this paper is to present an analytic review of work done so far in image restoration field. During the process of reviewing, major stack of papers considered are of 2009-2013 time period. A lot of work in this field was published in 2011 and 2013 in which influence of wavelet transform algorithms in combination with other nonlinear filters and optimization algorithms used direct or to tune other parameters, is visible. Wavelet transform algorithm is always a hot cake for image restoration. Authors have been using it since 2009 (oldest one in our collection) and consistently giving satisfactory results.

REFERENCES

[1] Shiru Zhang, Xiaotong Chen, Qingfu Sun and Caiying Zhang, "De-noising Algorithms Based on EMD and Wavelets", IJ3C, 2015

[2] Hsuan Ren , Yung-Ling Wang, Min-Yu Huang , Yang-Lang Chang and Hung-Ming Kao," Ensemble Empirical Mode Decomposition Parameters Optimization for Spectral Distance Measurement in Hyperspectral Remote Sensing Data", emote Sens. 2014, 6, 2069-2083.

[3] Rinku Kalotra, Sh. Anil Sagar," A Review: A Novel Algorithm for Blurred Image Restoration in the field of Medical Imaging", International Journal of Advanced Research in Computer and Communication Engineering Vol. 3, Issue 6, June 2014

[4] X Xie," Illumination pre-processing for face images based on empirical mode decomposition", Signal Processing, 2014

[5] Nelly Pustelnik, Pierre Borgnat, and Patrick Flandrin, 2D Prony-Huang Transform: A New Tool for 2D Spectral Analysis, IEEE, 2014

[6] Rama Singh, Neelesh Gupta," Image Restoration Model with Wavelet Based Fusion" Journal of Information Engineering and Applications Vol.3, No.6, 2013 pp 21-26

[7] Sheena Kumar, Yogendra Kumar Jain," Performance Evaluation and Analysis of Image Restoration Technique using DWT" International Journal of Computer Applications (0975 – 8887) Volume 72– No.18, June 2013 pp 11-20.

[8] Lei Xuanhua1, Hu Qingping, Kong Xiaojian, Xiong Tianlin," A Regularization Blind Image Restoration Technique by Using Particle Swarm Optimization" 3rd International Conference on Multimedia Technology（ICMT 2013) pp984-992

[9] Mohsin Bilal, Muhammad Shams-ur-Rehman, and Muhammad Arfan Jaffar," Evolutionary Reconstruction: Image Restoration for Space Variant Degradation" Smart Computing Review, vol. 3, no. 4, August 2013 pp-220-232

[10] S. K. Satpathy, S. Panda, K. K. Nagwanshi and C. Ardil," Image Restoration in Non-Linear Filtering Domain using MDB approach" International Journal of Computer, Information Science and Engineering Vol:4 No:1, 2012 pp-8-12

[11] Aloysius George, B. R. Rajakumar, B. S. Suresh," Markov Random Field based Image Restoration with aid of Local and Global Features" International Journal of Computer Applications (0975 – 888) Volume 48– No.8, June 2012

[12] O. Niang, A. Thioune, M. C. E. Gueirea, E. Delechelle and J. Lemoine, "Partial Differential Equation-Based Approach for Empirical Mode Decomposition: Application on Image Analysis," in IEEE Transactions on Image Processing, vol. 21, no. 9, pp. 3991-4001, Sept. 2012.

[13] Y. T. Chen, M. Ou-Yang, S. D. Wu, S. G. Lin, Y. T. Kuo and C. C. Lee, "Using ensemble empirical mode decomposition to improve the static fringe analysis in optical testing," Instrumentation and Measurement Technology Conference (I2MTC), 2012 IEEE International, Graz, 2012, pp. 249-253

[14] Yao Pei, Yangang Wu ; Dacheng Jia, 2011, Image denoising based on Bidimensional Empirical Mode Decomposition, IEEE, 2011

[15] Vaddimukkala Naga, Dr. G. Samuel Vara Prasad," Image Restoration and Topological Optimization" International Journal of Computer Applications (0975 – 8887) Volume 22– No.1, May 2011 pp-17-21

[16] Atsushi Ito, Aswin C. Sankaranarayanan," BlurBurst: Removing Blur Due to Camera Shake using Multiple Images" ACM Transactions on Graphics, Vol. VV pp1-15

[17] M. E. Torres, M. A. Colominas, G. Schlotthauer and P. Flandrin, "A complete ensemble empirical mode decomposition with adaptive noise," 2011 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), Prague, 2011, pp. 4144-4147.

[18] Faten BEN ARFIA, Mohamed BEN MESSAOUD, Mohamed ABID," A New Image de-noising Technique Combining the Empirical Mode Decomposition with a Wavelet Transform Technique", IWSSIP 2010 - 17th International Conference on Systems, Signals and Image Processing.

[19] Jagadish H. Pujar, Kiran S. Kunnur," A Novel Approach For Image Restoration Via Nearest Neighbour Method" Journal of Theoretical and Applied Information Technology, pp-76-79.

