International Journal of Engineering Research and Development
e-ISSN: 2278-067X, **p**-ISSN: 2278-800X, www.ijerd.com
Volume 7, Issue 7 (June 2013), PP. 49-53

Broadband Signal Noise Reduction by Various Techniques

Shelja Kumari[1], Himanshu Sharma[2], Taruna Sharma[3]
[1]M.tech student, M.M Engineering College, Mullana (Ambala), Haryana, INDIA
[2]Asstt. Prof., ECE Deptt. M.M Engineering College, Mullana (Ambala), Haryana, INDIA
[3] Asstt. Prof., Chitkara University, Rajpura , Punjab, INDIA

Abstract:- The Empirical Mode Decomposition (EMD) was proposed as the fundamental part of the Hilbert–Huang transform (HHT). The key feature of EMD is to decompose a signal into so-called intrinsic mode function (IMF). EMD is a method of breaking down a signal without leaving the time domain. The major advantage of the EMD is that the basis functions are derived from the signal itself. The process is useful for analyzing natural signals, which are most often non-linear and non-stationary. Huang and Wu proposed a new Noise-Assigned Data Analysis (NADA) method, known as Ensemble EMD. Ensemble Empirical Mode Decomposition (EEMD) has been used to recover a signal from observed noisy data. Ensemble EMD (EEMD), which defines the true IMF components as the mean of an ensemble of trials, each consisting of the signal plus a white noise of finite amplitude. In this thesis reduced the broadband signal noise by using various techniques (EMD and EEMD) and compare these techniques at different SNR values. Experimental results show that the EEMD is an efficient techniques for reduce the broadband signal noise at different SNR values.

Key Parameters:- Broadband Signal , Empericial Mode Decomposition, Ensemble Empericial Mode Decomposition Intrinsic Mode Function.

I. INTRODUCTION

Estimating a signal of interest degraded by additive random noise is a classical problem in signal processing. In many applications, signal denoising is used to produce estimates of the original signal from noisy observations. The recovered signal should be as close as possible to the original one while retaining most of its important properties. Many algorithms for noise reduction have been reported so far in the literature including traditional linear filter, such as Butterworth low pass filter, Wiener filter, and wavelet based thresholding filter [1]. Most of them have been proved to be effective in removing the unwanted components. For example, Hsu et al. succeeded in removing the aliasing on the original step-edge response curve (SRC) caused by the binning of Moire patterns [8]. However, the linear filtering methods are not very effective when the signals contain sharp edges and impulses of short duration [21]. As for wavelet based denoising methods, it's difficult to select the wavelet base, scale, threshold function, and optimal threshold value. To overcome these drawback huang invented Empericial mode decomposition (EMD) and Huang and Wu proposed a new Noise-Assigned Data Analysis (NADA) method, known as Ensemble EMD. The locally adaptive nature of both the EMD and EEMD algorithms means they are suitable for application to non-linear and or non-stationary time series.

II. PROPOSED WORK

The proposed work presents two techniques. The purpose of these techniques is to eliminate the noise from broadband signal at different SNR (Signal to noise ratio) .

1.EMPERICIAL MODE DECOMPOSITION

The Empirical Mode Decomposition (EMD) was proposed as the fundamental part of the Hilbert–Huang transform (HHT). The HHT allows to obtain the instantaneous frequency spectrum of nonlinear and nonstationary sequences. These sequences can consequently also be dealt with using the empirical mode decomposition.the main advantage of EMD is that it depends entirely on the data itself. The key feature of EMD is to decompose a signal into so-called intrinsic mode function (IMF). the EMD method is superior to the wavelet analysis approach, where the basic functions are fixed and, thus, do not necessarily match all real signals.[21]
An IMF is defined as a function that satisfies the following requirements:
1. In the whole data set, the number of extrema and the number of zero-crossings must either be equal or differ at most by one.
2. At any point, the mean value of the envelope defined by the local maxima and the envelope defined by the local minima is zero.
The procedure of extracting an IMF is called sifting.

The sifting process is as follows:
1. Identify all the local extrema in the test data.
2. Connect all the local maxima by a cubic spline line as the upper envelope.
3. Repeat the procedure for the local minima to produce the lower envelope.

The EMD algorithm can be described as follows . [1]
(1) Extract all the local maxima and minima of x(k).
(2) Form the upper and lower envelop by cubic spline interpolation of the extrema point developed in step (1).
(3) Calculate the mean function of the upper and lower envelop, m1(k).
(4)Let h1(k) = x(k) − m1(k). If h1(k) is a zero-mean process, then the iteration stop sandh1(k) is an IMF1, named c1(k), else go to step (1).
(5) Define r(k)=x(k)−c1(k).
(6) If r(k) still has least 2 extrema then go to step (1) else decomposition process is finished.
At the end of the procedure, we have a residue r(k) and a collection of n IMF, named from c1(k) to cn(k). The original signal can be represented as

$$X(k)= \sum_{i=1}^{n} ci(k) + r(k) \qquad (1)$$

2. Ensemble empirical mode decomposition (EEMD)

Ensemble empirical mode decomposition (EEMD) has been used to recover a signal from observed noisy data. EEMD is used to decompose a signal into several intrinsic mode functions (IMFs). Ensemble EMD (EEMD), which defines the true IMF components as the mean of an ensemble of trials, each consisting of the signal plus a white noise of finite amplitude. With this ensemble approach, separate the scale naturally without any a priori subjective criterion selection.

The EEMD algorithm can be described as follows . [19]
(1) Initialize the number of ensemble J, the amplitude of the added white noise, and j =1.
(2) Add a white noise series to the targeted signal, $xj(k)=x(k)+n_j(k)$.
(3) Apply EMD to the noise-added signal xj(k) to derive a set of IMFs $c_{i,j}(k)$ (i = 1,2,...,n) and residues $r_j(k)$, where $c_{i,j}(k)$ denotes the ith IMF of the jth trial, and n is the number of IMFs.
(4) Repeat steps (1) and (2) until j>J .
(5) Average over the ensemble to obtain the final IMF of decompositions as the desired output:

$$\bar{c}_i(k) = \frac{1}{J}\sum_{j=1}^{J} c_{i,j}(k) \quad (i = 1,2,\ldots,n),$$
$$\bar{r}(k) = \frac{1}{J}\sum_{j=1}^{J} r_j(k). \qquad (2)$$

Just as the EMD method, the given signal, x(k) can be reconstructed according to the following equation:

$$x(k) = \sum_{i=1}^{n} \bar{c}_i(k) + \bar{r}(k). \qquad (3)$$

III. RESULTS

For both the techniques Empericial Mode Decomposition and Ensemble Empericial Mode Decomposition, the original signal is same. But the final outputs are different.

In fig 1 IMF’s are calculated IMF’S has been calculated . firstly set the initial value equal to the original signal and find the exterma of the input signal . secondly connect the maxima with spline functions to form upper envelope and connect the minima with spline functions to form lower envelope . then calculated the mean of the envelope . after that the final step subtract this mean from the input signal . these step has calculated imf1 and these steps repeated until stopping crieteria has been fulfilled. At the IMF5 stopping crieteria has been fulfilled and this is the residual signal.

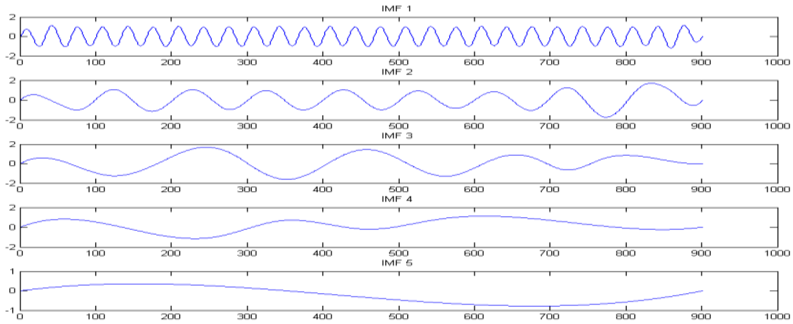

FIG1. DECOMPOSITION RESULT WITH EMD

In the FIG2. Residual signal has been calculated . residual signal is a signal left over at the end of a process.

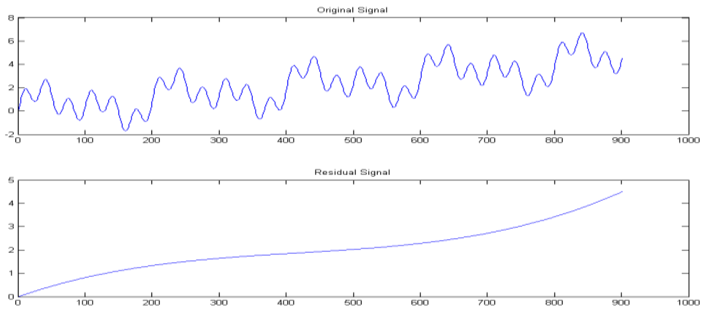

FIG2. RESIDUAL SIGNAL

This FIG3. Shown the original signal , residual signal and the reconstructed signal .

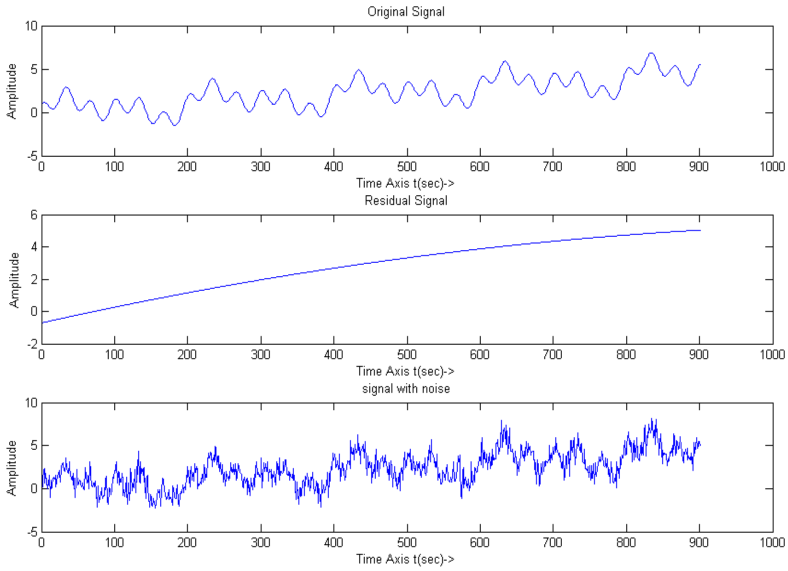

FIG3. EMD WITH SNR 10

In this when the noise presented in the signal aand signal to noise ratio 10 is applied then noise has not been completely removed by the Empericial Mode Decomposition.

In FIG4 original signal and reconstructed signal when EEMD algorithm is applied has been shown. In this original signal and reconstructed signal is same. This means that no noise presented .

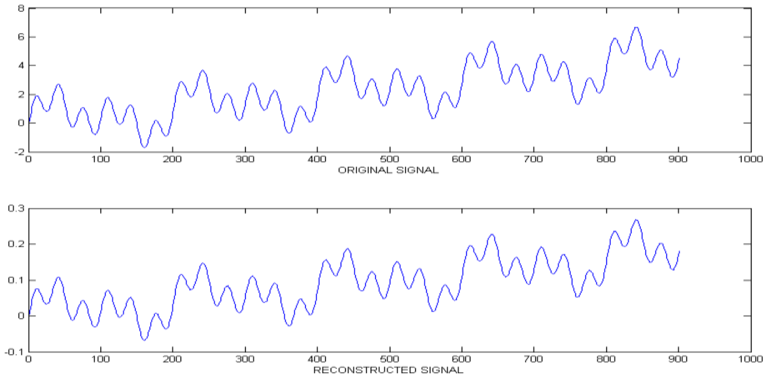

FIG 4. EEMD SIGNAL

In FIG 5 orignal signal and reconstructed signal has been shown . in this when signal to noise ratio 10 is applied then no noise presented in signal . In EEMD at different -2 snr value no noise has been presented in the signal . it removes most of the noise .

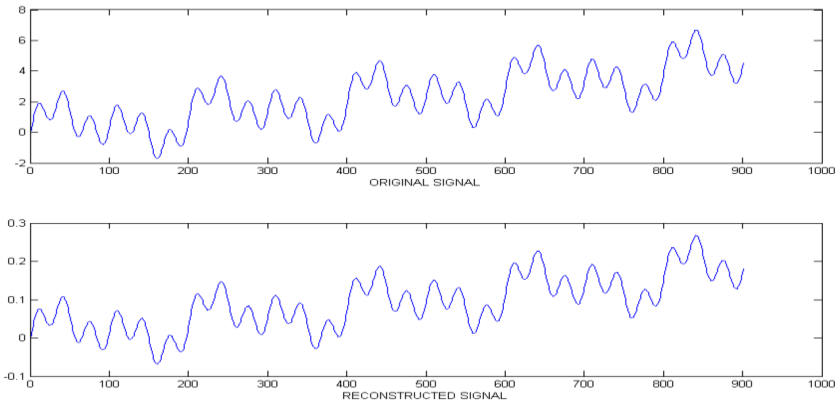

Fig5. EEMD at 10 SNR

IV. COCLUSION

In this paper the main focus is on the removal of broadband signal noise by using different techniques at different SNR values. When compare the EMD and EEMD at different SNR values in broadband signal EEMD is more effective. When different SNR values apply EMD will not properly reduce the noise in broadband signal .It is found that the EEMD algorithm reduced better noise in broadband signal at different SNR values.

REFERENCES

[1]. Hai-Lin Feng, Yi-Ming Fang, Xuan-Qi Xiang, Jian Li," A Data-Driven Noise Reduction Method and Its Application for the Enhancement of StressWave Signals" ScientificWorld Journal article id 353081 , 2012 .

[2]. Xiaochuan, He Goubran, R.A. ; Liu, X.P. "Ensemble Empirical Mode Decomposition and adaptive filtering for ECG signal enhancement" IEEE International Symposium on Medical Measurements and Applications Proceedings (MeMeA), p.p1 – 5 May 2012 .

[3]. XiangLei Autom. Xiong Weihua ; Li Junfeng ; Ji Ruisong " Application of EEMD and Hilbert marginal spectrum in speech emotion feature extraction" Control Conference (CCC), p.p. 3686-3689, July 2012.

[4]. Wallis, K. Akers, G. ; Collins, P. ; Davis, R. "Complex empirical mode decomposition, Hilbert-Huang transform, and fourier transform applied to moving objects " Geoscience and Remote Sensing Symposium (IGARSS), IEEE International Page 4395 – 4398 , July 2012.

[5]. Torres, M.EColominas, M.A. ; Schlotthauer, G. ; Flandrin, P. “A complete ensemble empirical mode decomposition with adaptive noise” . IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), Page 4144 - 4147 May 2011

[6]. Xiaohong Niu Jiping “Review of EMD-Based Image Fusion” International Conference on intelligence Science and Information Engineering (ISIE), page -282-285 Aug 2011 .

[7]. De Ridder, S. Neyt, X. ; Pattyn, N. ; Migeotte, P.-F.“comparison between EEMD, wavelet and FIR denoising: Influence on event detection in impedance cardiography” Annual International Conference of the IEEE Engineering in Medicine and Biology Society,EMBC, Page(s):806 – 809, Sept. 2011.

[8]. S. W. Hsu, C. Y. Chang, Z. Y. Chung, and K. N. Wu, “Improved measurement of dynamic modulation transfer functions on display using pursuit camera method based on wavelet- denoising method,” Optical Review,vol.18,no.1,pp.153–156, 2011.

[9]. Jinshan Lin , Qian Chen “Application of the EEMD method to multiple faults diagnosis of gearbox” 2nd International Conference on Advanced Computer Control (ICACC), volume 2 , page 395-399, March 2010.

[10]. El Hadji S Diop ; Alexandre, R. ; Boudraa, A.O. “Analysis of Intrinsic Mode Functions: A PDE Approach” IEEE Signal Processing Letters, Volume:17 , Issue: 4 , Page 398 - 401 April 2010 .

[11]. Wang Jinfeng Cheng Cheng ; Zhao Song “De-noising method for mechanical vibration signals based on EMD” Second International Conference on Geoscience and Remote Sensing (IITA-GRS), Volume:1 ,Page 411 – 413 , Aug. 2010.

[12]. Li Xiaofeng; Liu Mingjie “The de-noising method of EMD threshold based on correlation” IEEE 10th International Conference on Signal Processing (ICSP), Page: 2613 - 2616 , Oct. 2010.

[13]. Zhang Yong-deHou Meng ; Liu Zeng-liXie Ping “Empirical mode decomposition with wavelet de-noising” IEEE International Conference on Intelligent Computing and Intelligent Systems (ICIS), Volume:1 ,Page 183 - 186 , Oct. 2010 .

[14]. Hasan, THasan, M.K. “ Suppression of Residual Noise From Speech Signals Using Empirical Mode Decomposition” IEEE Signal Processing Letters, Volume:16 , Issue: 1 , Page 2 - 5 , Jan. 2009 .

[15]. Huang Chengti Wang Houjun ; Long Bing “Signal Denoising Based on EMD” . IEEE Circuits and Systems International Conference on Testing and Diagnosis, Page 1 – 4, April 2009

[16]. Nianqiang Li Univ. of Jinan, Jinan, China Ping Li “An Improved Algorithm Based on EMD-Wavelet for ECG Signal De-noising”. International Joint Conference volume 1 page 825-827 April 2009. Kopsinis,Y. McLaughlin, S. Development of “EMD-Based Denoising Methods Inspired by Wavelet Thresholding” IEEE Transactions on Signal Processing, volume 57 issue 4 April 2009

[17]. Baykut,S. Akgul, T. ; Ergintav, S. “EMD-based analysis and denoising of GPS data”IEEE Applications Conference Signal Processing and Communications,2009.

[18]. Z. Wu and N. E. Huang, “Ensemble empirical mode decom- position: a noise-assisted data analysis method,” Advances in Adaptive Data Analysis, vol. 1, no. 1, pp. 1–41, 2009.

[19]. Yunchao Gao Enfang Sang ; Zhengyan Shen “Comparison of EMD and Complex EMD in Signal Processing” image and Signal Processing, 2008.

[20]. Khaldi, K.Speech “Signal noise reduction by EMD” Communications, Control and Signal Processing, March2008.

[21]. Tsung-Ying Sun Chan-Cheng Liu ; Jyun-Hong Jheng ; “An efficient noise reduction algorithm using empirical mode decomposition and correlation measurement” Intelligent Signal Processing and Communications Systems, Feb2008.

[22]. Abdel-Ouahab Boudraa, and Jean-Christophe Cexus” EMD-Based Signal Filtering” IEEE transactions on instrumentation and measurement, vol. 56, no. 6,page 2196 December 2007

[23]. BinweiWeng “ECG Denoising Based on the Empirical Mode Decomposition” 28th Annual International Conference of theIEEE Engineering in Medicine and Biology Society,Aug 2006 page 1-4.

[24]. Flandrin, P. Ecole Normale Superieure de Lyon, UMR CNRS, Lyon, France Rilling, G. ; Goncalves, P. “Empirical mode decomposition as a filter bank” Signal Processing Letters, IEEE Feb.2004.