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Self Adaptive Harmony Search Algorithm for Optimizing ECG Signal

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***Abstract*—In this study, a filter design approach which uses the harmony search (HS) algorithm for additive white Gaussian noise cancellation and the reduction of broad-band myopotentials (EMG) in ECG signals is described. In order to improve the design, additive white Gaussian noise was added to the signal at different values of signal to noise ratio which were selected. Testing was performed on artificially noised signals from the MIT BIH Arrhythmia database sampled at 250 Hz. The main goal is to improve performance denoisy signal optimally.**

Keywords— **ECG signal, MIT BIH database, LTWF, HSA, WF**

I. INTRODUCTION

Electrical activity of heart is registered by graph of cardiac signal that preserves clinical details and features is ECG. This signal is generated in response to electrical impulses by pacemaker cells. Main source of errors are power line interference, baseline wanders, electrical interferences, muscle contraction at rest measured by EMG. Myopotential spectrum is predominant at higher frequencies and significantly overlaps with the spectrum of the ECG signal, primarily with QRS complex [1]. De-noising is an important in engineering works as it reduces noise level in corrupted signal. It will obtain clean signal from available noisy data.

Luk´aˇs Smital, Martin V´ıtek, Jiˇr´ı Kozumpl´ık, and Ivo Provazn´ık [1] improve the filtering performance, used adaptive setting parameters of filtering according to the level of interference in the input signal**,** but high error due to improper selection of filter parameters and coefficients.

HA. Kestler, M. Haschka, W. Kratz[2], applied a combination of the discrete wavelet transform and the Wiener filter to the noise-reduction of high-resolution ECG signals. The signal corrupted by higher noise.

Suyi Li, Jun Lin[3] used de-noising methods based on stationary wavelet transform (SWT), we adjust the signal-to-noise ratio (SNR) of the noisy signal, performance is low. The main objective of the paper is to suggest an optimized algorithm to select an effective parameter for filter banks with respect to minimum mean squared error to improve SNR.

Nikolaev, Z. Nikolov, A. Gotchev[4]A new two-stage algorithm for electrocardiographic (ECG) signal denoising has been proposed. It combines wavelet Shrinkage with Wiener filtering in translation-invariant wavelet domain. A time-frequency dependent thresholding has been proposed and grounded for obtaining a more adequate signal estimate in the first stage of the algorithm.

II. METHODS

A. TIWT

The signal is first decomposed using effective wavelet transform .In this study, TIWT is used(without down sampling)[4].The main parameter is the number of decomposition levels. On the detailed coefficients of each level, TIWT is applied again and again to reduce noise level. Here interpolation errors do not occur at reconstruction part due to transition invariant.

B. LTWF

Interference is separated from ECG signal with wavelet coefficients through any of the thresholding methods. The output of wavelet transformed to wavelet domain can be fed into wiener filter to obtain estimated noise-free coefficients.[1][5][6]

C. WF

Optimum linear filter minimized the average distance between the filtered output and expected signal.

III. PROPOSED WORK

A. HARMONY SEARCH ALGORITHM

HS is an optimization method that play a key role in various field related to engineering. It is implemented in denoising strategy to improvise the performance by selecting optimum coefficients to filter banks. It is an iterative algorithm; unlike other denoising algorithms it is convergent. New harmony is generated randomly considering memory operation either by re-initialization or pitch adjusting. Randomly generated parameters are stored in HMr. The worst harmony is replaced by new harmony comparing both updating HMr.

Fig. 1 A flow diagram shows how to select an optimal parameters

The basic operators used are HMr, HMrCR and PIARt. The procedure of algorithm follows:

- Specify optimization problem and parameters.
- Initialize harmony memory (HMr) to accomadate parameters.
- Randomly generate new harmony.
- Updating HMr in terms of fitness value.
- Repeat steps until termination criteria.

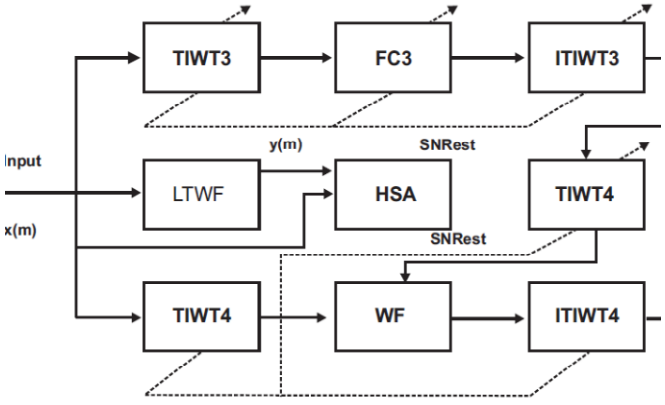

Fig. 2 A Block diagram of adaptive HSA algorithm s

In fig 2,input x(m) is the signal addup with white Gaussian noise .The corrupted signal is fed up into TIWT3 wavelet transform that decomposes upto level 3 obtaining modified detailed coefficients FC3,and reconstructed using ITIWT3.

The obtained coefficient y(m), are able to estimate noise-free coefficients applying LTWF that works on wiener filter concept with effective transform.ITIWT3 estimate approximate coefficient and modified detailed one to design WF, is wiener filter applied to TIWT4 to get de- noisy ECG signal. The proposed block is HSA need inputs: corrupted signal x(m) and noise reduced signal from LTWF, y(m). HSA is an iterative process.

- Intialised min,max,iter=40
- Random selection of harmony(threshold).
- From harmony estimate fitness function(MSE).
- To select best harmony, generate new harmony.
- Select optimal parameter value(MMSE).

With the MMSE ,estimate SNR(reciprocal of MSE),the suitable parameters of rest of the blocks set up by HSA.

IV. RESULT

The ECG signal used in experiment is from MIT-BIH Arrhythmia database of an old female (chest leads v5 signal quality and v2) with both rhythm signal quality clean and medication is digoxin.

Fig3 is the comparision of corrupted,noisy and noise free signal, from this can analyze MSE.We have taken one of the two ECGs (v5) and sampled into 2000 at 250Hz.The artificial noise added is AWGN on each samples with randomly generated values optimally MMSE is 47.45.The overall performance improved with SNR 20db.

IV. CONCLUSION AND FUTURE WORK

The proposed HSA algorithm provides better filtering results than another algorithm based on simple wavelet wiener filtering. HSA is fast converging iterative algorithm. It is evident from the results that the setting of suitable parameters value and their adaptation to the estimated noise level have a positive effect on the performance of the filtering algorithm. Improved performance of denoisy signal by 47.75db.

It is assumed that algorithm can be modified to implement in speech as well as image enhancement. In application level, implement on fetal ECG extraction.

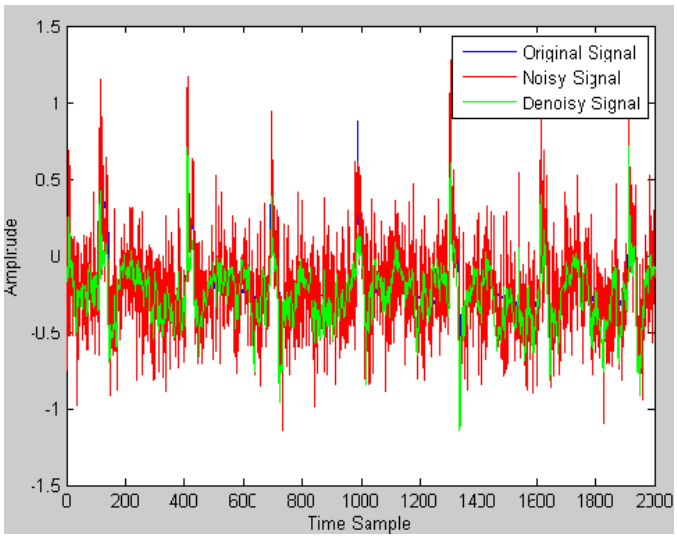

Fig. 2 Comparision of noisy, de-noisy signal

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