

THE FETAL HEART RATE SIGNAL PROCESSING BASED ON THE ADAPTIVE NOISE CANCELING

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Abstract: Fetal Heart Rate signal is an objective index which reflects the physiological activity of foetus heart electricity, The abstraction and processing of the signal of foetus' rhythm of the heart enclose the key technology which the foetus guards in childbirth period. For dealing with this kind of non- steady random signal of foetus' rhythm of the heart. Through adjusting weight value the adaptive filter can make square error become more and more minimum, realize the adaptive filter result bestly. This paper is on the basis of various kinds of the adaptive algorithms, the clipped- error LMS algorithm with variable step size of segmenting type is proposed ,using the adaptive noise canceling system , and it realized foetus rhythm of the heart signal abstraction. through MATLAB computer emulation analyse , make SNR raise 30dB , the operation time is very much little , it took about 2s only , it is obvious that the algorithm has the speed of convergence quickly.

Keywords: FHR, the clipped-error LMS algorithm with variable step size of segmenting type, the adaptive noise canceller, SNR

Introduction: The Fetal Heart Rate signal is a kind of typical biomedical signal, belong to the non- steady random signal^[1].To dealing with this kind of signal, Wiener filters and Kalman filters restrain, they demand to know in advance that the priori of the signal count the characteristic, The adaptive filtering theory and technology is main content that count signal processing and non-steady random signal processing, it has the optimum filtering performance of Wiener filters and Kalman filters. The adaptive filtering may be under the condition of the signal unknown its statistics characteristics, approach gradually the optimum filtering result and adapt to the change of the random environment of outside through self-adaptation. This paper makes a research on various kinds of the adaptive noise canceling algorithms^[2]. In the end the author proposed the algorithm of clipped-error LMS algorithm with variable step size of segmenting type. And it was applied the system of the adaptive noise canceling, thus it realized the abstraction of the signal of Fetal Heart Rate.

Results: This paper regards the adaptive filtering principle as the foundation at first, using the system of the adaptive noise canceling, according to SNR appraise criterion, square error appraise criterion and misadjustment appraise criterion, to the algorithm of Normalized LMS, Modified LMS and clipped-data and clipped-error LMS and some other improved LMS algorithms with variable step size^[3] , Table 1 shows the corresponding data of the various kinds of adaptive filter on the SNR degree and the operation amount. through simulation experiment , the author compared and analysed on the degree of improving SNR and the noise filtering result degree, drawing that the clipped-error LMS algorithm may reach best noise canceling compared with other algorithms, SNR has improved 11dB. But the clipped-error LMS with variable step size adopts variable step size, therefore its operation times is not the shortest compared with the clipped-error LMS, this proves that the operation time of the clipped-error LMS is the most minimum , this is unanimous with the argumentation in theory .Clipped-error LMS algorithm reduces the calculating amount, but at the convergence rate and step the algorithm of LMS with variable step size for Sigmoid function is more slowly compared with other algorithms. This needs us to explore the better algorithm or improve the clipped-error LMS, in order to realize that the algorithm can accelerate the convergence rate as well as improving the operation time .

Table1 SNR and Time

Algorithm name	SNR	SNRF	Improvement value of SNR	time(s)
Arithmetic1	-9.5064	0.9427	10.4491	5.43
Arithmetic2	-9.3158	0.8365	10.1523	5.55
Arithmetic3	-9.2886	2.2395	11.5281	5.33
Arithmetic4	-9.2480	0.9180	10.1660	7.14
Arithmetic5	-9.2468	0.8342	10.0810	6.20
Arithmetic6	-9.4138	1.1244	10.5382	5.61
Arithmetic7	-9.3205	2.4147	11.7352	5.88

Among them, the serial number of the algorithm name is expressed as follows respectively:

- Arithmetic1: Express regular LMS algorithm ;
- Arithmetic2: Express the normalization LMS algorithm;
- Arithmetic3: Express that clipped- error LMS algorithm;
- Arithmetic4: Express that the error normalization of clipped-error LMS algorithm with variable step size;
- Arithmetic5: Express that the improvement LMS algorithm with variable step size of the step of Sigmoid function;
- Arithmetic6: Express that improved LMS algorithm of the power controlled with variable step ;
- Arithmetic7: Express that the clipped-error LMS algorithm with variable step size ;

Discussion: On the basis of the discussion above, this paper has put forward a new algorithm of LMS algorithm with variable step size of segmenting type. LMS algorithm with variable step size of segmenting type deals with the number of iterations by step, at the first adapting step, the author adopts greater step to make fast convergence, with the going on of adaptive course, selecting less step value gradually. Thus the step changes lighter and lighter after it enters steady stage, in order to get the misadjustment value as little as possible . Expressed the number of iteration with N , the boundary value with N_j , step value in the step with μ_j , variable step size can express as follow:

$$\mu(n) = \begin{cases} \mu_0 & N_0 \sim N_1 \\ \mu_j & N_j \sim N_{j+1} \\ \mu_{N-1} & N_{N-1} \sim N \end{cases} \quad (1)$$

among them, $j=1,2,\dots,(N-1) \square N_0 \square 1 \square$ The algorithm had reach better result on SNR improve degree ,convergence rate and the result of filtering compared with the clipped-error LMS algorithm and the clipped-error LMS with variable step size.

Conclusions: On the basis of the adaptive noise canceling system principle ,the author combined the prediction filtering with the adaptive filtering ,forming the new-type adaptive noise canceling system. The adaptive noise canceling system need two input signal: one is main input ,another is the reference input.

Among them, the main input signal d adopts the Doppler supersound sensor to gather and store the computer through PCL-818L^[4] data gathering. The reference noise signal input obtains acquisition of x_n . according to predicting the square of error and minimum criterion. First the author estimated the step of AR model of the auto-regression prediction filtering , then predicted

the coefficient of AR model of the auto-regression prediction filtering through the Levinson-Durbin algorithm. the predicting reference passway signal act as the noise signal estimated value of main input in order to offset the noise signal from main channel and realize the abstraction of the Fetal Heart Rate signal. The institute show that the adaptive noise adopted actually offsets the systematic structure block diagram as follows:

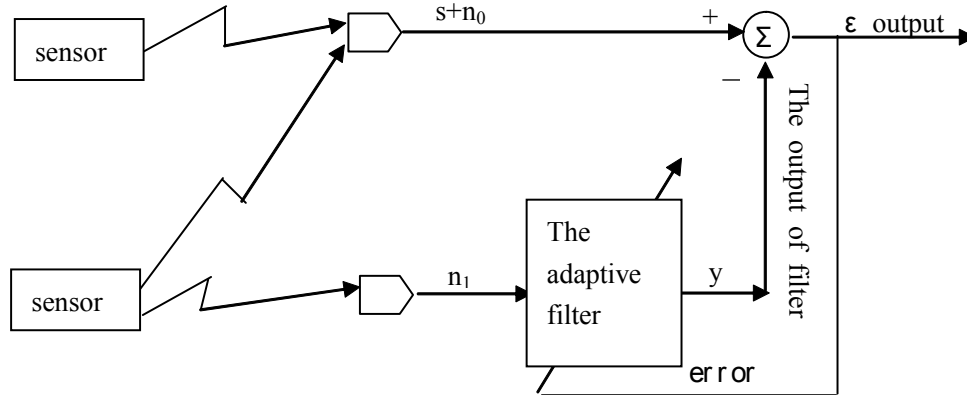


Fig.1 the adaptive noise canceling system

The author adopted the transversal filter in the adaptive filter of the adaptive noise canceling system. The algorithm of clipped-error LMS with variable step size of segmenting type was adopted ,through computer simulation experiment, SNR improved about 30db. the author realized the abstraction of Fetal Heart Rate signal and proved its validity and superiority. Now show the experimental result as follows by way of figure :

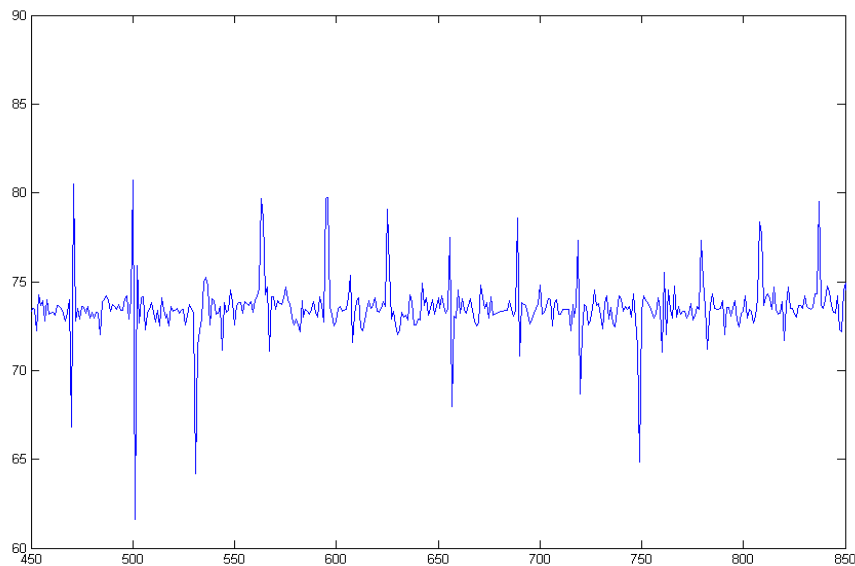


Fig.2 the heart rhythm of main input gathered

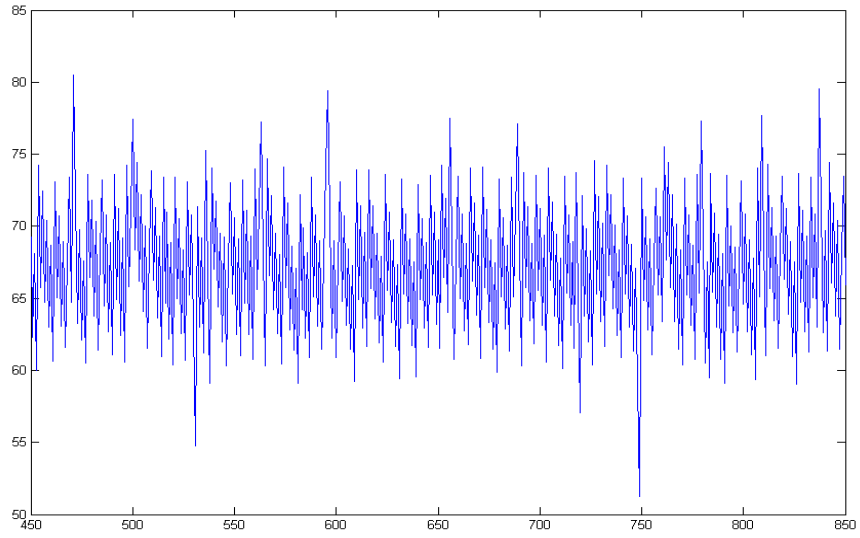


Fig.3 the reference noise signal of abstraction

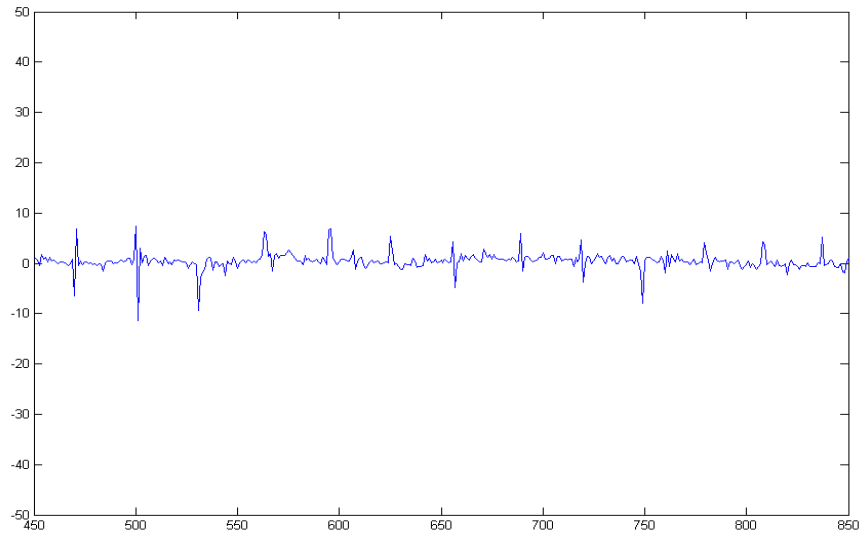


Fig.4 the heart rhythm of cancelled

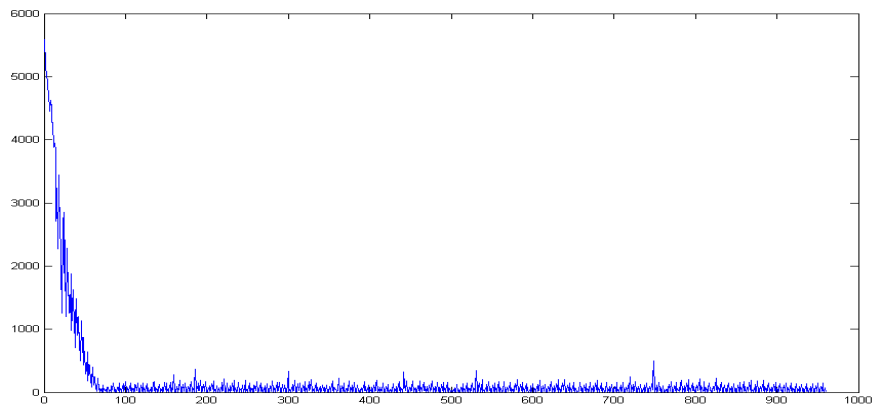


Fig.5 the study curve of the adaptive filter

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