FETUS HEART BEAT DETECTION
Presentation of Project in Adaptive Signal Processing

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Objectives:

➢ The main intention in our project is to remove the noise signal using noise cancellation methods and to obtain the fetus heartbeat, taking thoracic as the input signal. This 50Hz noise signal is due to the input power supply unit.

➢ The main stream objective of signal processing is that we often encounter with an interference signal which is present along with the information or the data signal.

➢ So the basic need of this approach is to remove that interference.

➢ In fetal monitoring, output signal is a combination of mother ECG signal and fetal ECG signal.
INTRODUCTION

The clear EKG signal is obtained by removing mothers ECG signal using adaptive noise cancellation with four different algorithms. They are LMS, NLMS, LLMS and RLS.

The 50HZ noise signal from the power supply is removed by using ALE method.

The brief study of the above specified methods is give as follows
LMS ALGORITHM

LMS is based on stochastic gradient approach. It will not track in all situations and is used to minimize the mean square error.

It follows the principles of taking the gradient of the instantaneous error for every sample

Where weight vectors are updated from sample to sample as follows……

\[ W_{n+1} = W_n + \mu x(n) e(n) \]

\[ X(n) = \text{input signal} \]
\[ E(n) = \text{error signal} \]

The convergence of the LMS algorithm is: \(-O < \mu < 2/\lambda_{\text{max}}\)
LMS Algorithm its pros and cons

Advantages……..

- Efficient in terms of computations and storage
- Simplicity in terms of implementation

Disadvantages……..

- Poor convergence properties
- Susceptible to errors
- Simple due to update equation
The selection of step size in LMS design and implementation results error in some environment.

So in order to reduce these errors we select variable step size which converges slowly when it reaches optimum level.

The convergence of algorithm falls in the range

\[ 0 < \mu < 2 / X(n) \cdot HX(n) \]

The time varying step size becomes

\[ \mu = \beta / \| x(n) \|^2 \]

Where \( \beta \) is normalized step size within the range of \( 0 < \beta < 2 \)

By replacing the \( \mu \) value Lms becomes normalized Lms.
Pros and cons of NLMS Algorithm

ADVANTAGES OF NLMS ALGORITHM

- The noise amplification is diminished by using NLMS algorithm due to Normalized step size.
- Much faster convergence speed and minimum steady rate error.

DISADVANTAGES

- Calculations are high when compared to LMS algorithm.
- Requires knowledge of auto correlation of the input process and cross correlation between input and desired output.
Leaky LMS Algorithm

- Having eigen values close to zero leads to undamped modes in the LMS algorithm.

- So we stabilize these modes by introducing a leaky factor into the weight update equation of range \( 0<r<<1 \).

- Therefore the weight update equation and the convergence of the step size constraint is...

\[
W_{n+1} = (1-\mu\gamma)w(n) + \beta e(n)x^*(n)
\]

Where \( 0<\beta<2 \)

- The convergence of the step size constraint is...

\[
0<\mu<2/\lambda_{\text{max}}
\]

- Leakage factor is in range....... \( 0<\gamma<1 \)
Pros and cons of Leaky LMS Algorithm

ADVANTAGE

- It introduces more leaky value so that it gives more stability.

DISADVANTAGE

- Convergence rate is low when compared to RLS.
RECURSIVE LEAST SQUARE (RLS) ALGORITHM

- RLS algorithm is based on least square method.

- The algorithm updates the estimate of $W_n$ using each set of new data continuously without repeatedly solving the time consuming matrix inversion.

- A forgetting factor named $Y$ is introduced which typically falls between 0.98 to 1.00.
Pros and cons of RLS Algorithm

ADVANTAGES
- Large convergence speed
- No need to perform matrix inversion.

DISADVANTAGES
- Sensitivity to computer round off errors
- Greater computational complexity.
Adaptive Noise Canceller:

- It is the mostly used application in Adaptive Filter
- In this application by using the adaptive algorithm we can eliminate the noise that is interfere in the input signal
- Finally output signal is the desired signal

Adaptive Line Enhancer:

- Adaptive line Enhancer is also called as Adaptive Notch Filter
- Here in the above case a delayed input is given to adaptive filter and another input is error signal by using this we can eliminated the noise and get the desired output
ADAPTIVE NOISE CANCELLER.....

Mothers And Fetus Heartbeat
mum(n)+fet(n)

Mother’s heart beat mum(n)

ADAPTIVE FILTERS

err(n)=fet(n)
mun^(n)

ADAPTIVE ALGORITHM
ADAPTIVE LINE ENHANCER

\[ \text{Adaptive Filter} \]

\[ x(n + \Delta) \rightarrow \text{Adaptive Filter} \]

\[ \text{Adaptive Algorithm} \]

\[ \text{Decorrelation delay} \]

\[ \text{mum}(n) + \text{fet}(n) \]

\[ \text{err}(n) = \text{fet}(n) \]

\[ y(n) \]
Fetus Signal

Sum of mothers signal

\[ X(n) + Y(n) \]
POWER SPECTRUM ESTIMATION

- The power spectral density $P_{xx}$ of the input signal vector can be estimated using Welch method.

- The power spectral density is calculated in units of power Per radians per sample.
MATLAB SIMULATION

RESULT FOR ANC

RESULTS FOR ALE
RESULTS FOR ANC
In this paper we clearly presented the idea behind extracting the fetal ECG and detailed procedure on how to extract this signal included with mat lab simulation taken from the input signal provided.

We strongly conclude that this method can be universally used for generating clear signal from the noise signal.

The proposed scheme exhibits a great improvement in the output signal to noise ratio.

In these works, several cases of fetal ECG signals are observed in order to find the baby health conditions.
APPLICATIONS

- By detecting the accurate heartbeat of the fetus, the correct analysis can be achieved.
- Thereby a lot of diseases can be detected.
- Better health of the fetus can be achieved.

CONCLUSION:-

- Various Adaptive filter algorithms and their usage in different applications are studied and implemented using Matlab simulator as a platform.
THANK YOU