Implementation of an Embedded based Filtering Algorithm for Biomedical Signal Processing

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ABSTRACT
To improve the performance of the conventional least mean square (LMS) algorithm, variable step size LMS algorithm along with embedded dual core processor named ARM processor (Advanced RISC Machine) are used. This paper presents the use of time varying least mean square (TVLMS) algorithm for noise removal. Different evaluation parameters like MMSE, PSNR and Correlation coefficient are taken for performance analysis. The algorithm is used for efficient adaptive noise cancellation. The result shows the better performance of TVLMS on the basis of various performance parameters.

Keywords
Arm processor, TVLMS, PSNR, MSME and Correlation Coefficient

1. INTRODUCTION
Noise cancellation is a special case of optimal filtering which can be applied when some information about the reference noise signal is available. The noise cancellation technique has many applications, e.g. speech processing, echo cancellation, power line interference and so on. Many methods in the literatures have been used to study the noise cancellation problems. One of the fundamental noise cancellation methods is adaptive filtering. Adaptive filters have several applications in acoustics, controls, communications and coding [1].

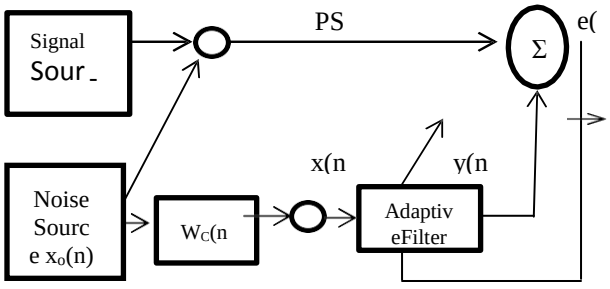

Fig. 1. Block diagram of adaptive noise cancellation system

Also band-stop analog filters cause distortion of the signal since can also remove the unwanted 60-Hz components of the actual ECG signal. An adaptive filter algorithm is effective in eliminating the 60-Hz interference without removing the 60-Hz components of the signal [4]. System-on-a-chip (Soc) solutions for medical electronics applications require more powerful computing capabilities, and low power consumption [5]. This algorithm essentially treats the ECG signal as transient noise superimposed on a 60-Hz signal (i.e. the cardiac signal is ignored) [4]. Adaptive filters are suitable for the systems in which the statistical characteristics of the signals to be filtered are either unknown prior or time variant.

A signal is transmitted over a channel and is received by the receiver i.e., Primary Sensor (PS) with uncorrelated noise $x_0(n)$. The signal $s(n)$ and noise $x_0(n)$ combine to form the desired signal $d(n) = s(n) + x_0(n)$. A second signal input to the adaptive filter received by the secondary sensor (SS) is noise $x(n)$, which is uncorrelated with the signal but correlated in some unknown way with noise $x_0(n)$. In this setup, we model the noise path from the noise source to secondary sensor as known as unknown FIR channel $w_C(n)$. The noise $x(n)$ applied as an input to the adaptive filter to produces an output $y(n)$, which is close enough to the replica of $x_0(n)$. In this system the signal $x(n)$ is processed by the filter that automatically adjust its weights through the TVLMS algorithms with respect to the error signal $e(n)$.

Large amount of efforts have been made for noise reduction and its cancellation and to compare various techniques which are being use for the same. Many new researches have proposed various simulators being used for simulation and performance analysis. In this paper, a TVLMS algorithm called as adaptive filter using simple embedded processor (ARM) is used for noise cancellation. Result shows that SNR level of the noisy data are improved after passing it through the proposed noise cancellation system. In the first experiment noise improvement was 20.00 dB and in the second experiment the noise was achieved 23.3 dB. This paper presents an adaptive noise cancellation using time varying least mean square algorithm (TVLMS). The major advantage of the proposed system is its ease of implementation and fast conversions. The proposed algorithm is applied for cancellation of power line interference in biomedical signals.

The performance analysis of the algorithm is done based on convergence time, correlation coefficients and signal to noise ratio. Observed that TVLMS performs the best in noise cancellation in terms of correlation coefficient, SNR and convergence time. An adaptive noise canceller will be presented and analysis is done over the biomedical signals. The proposed technique of adaptive noise cancellation is very useful in system applications like audio or video signal processing.

2. RELATED WORK
Yingrui Chen et.al presents implementation of an embedded dual-core processor for portable medical electronics applications. This paper present and implement an embedded dual-core processor, named dual-core processor unification (IMS-DPU).This system propose a symmetric multiprocessor with 16 bit data. This design implements FPGA Prototyping and form an instruction set to extend the medical electronics applications.In order to meet the

requirements of the embedded system ,it proposed the use of dual-core processor in this paper[1].

S. R. Sridhara, M. DiRenzo et.al presents Microwatt Embedded Processor Platform for Medical System-On-Chip applications. This paper presents an ultra low operation and a system on chip is presented with FFT co-processor. It also presents sensing electrodes to capture an EEG signal in digital samples. It also implements system on chip designing in detail [2].

J. Kwong and A. Chandrakasan present an energy efficient biomedical processing platform. This work presents the energy efficient sensor nodes designed to support biological signal such as EEG and EMG. This paper supports various algorithms for efficient complexity in terms of energy efficient manner through voltage and hardware accelerators.

Ketaki N. Patil and P. C. Bhaskar present Transmission of Arm Based Real Time ECG for Monitoring for Remotely Located Patients. This paper proposes real time wireless transmission. It also demonstrates the efficient ECG signal transmission to doctor workstation. This system uses ARM 7 processor named dual core system for the implementation [4].

Further K. Anusha, K. Balakrishna proposes the design of wireless sensor network with Zigbee. Zigbee is a technology used for 3g system for security proposes. More nearby instances of inner part of biotelemetry system are managed by single outer part of system are possible, but there exists mapping between patient and Zigebee network [5].

Jordan Bisaskyl, Houman Homayoun, et.al presents the design and implementation of 64 core platforms capable of performing biomedical signal processing applications. This paper presents a programmable many-core Platform containing 64 cores routed in a hierarchical network for biomedical signal processing applications. The paper also discusses some type of background on many core platforms for seizure detection and ultrasound [6].

3. PROPOSED METHOD

In this work, used an adaptive filtering noise cancellation using TVLMS algorithm and embedded processor. The experiment is performed and processed using MATLAB and DEV C++ software. Initially it has taken the ECG signal from MITBIH database and random noise is added to make it noisy. It have varied the noisy input with different Signal to noise ratio (SNR) at input. The noisy data is filtered out in DEV C++ coded algorithm. The generated output signal is fed to MATLAB to display filtered data. Further the evaluation parameters MSME, CC and PSNR are evaluated.

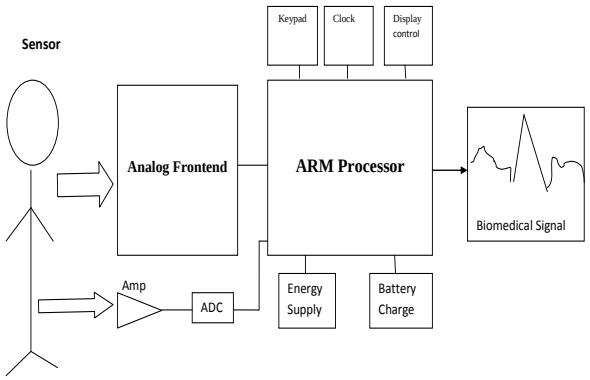

Fig2:-Block Diagram of Biomedical System

Above block diagram represents generalized structure of biomedical system, ARM processor is a 32- bit four stage RISC core.ARM processor has various operating modes:-I) user mode is the usual program execution state, ii) Interrupt mode is used for general purpose interrupt handling iii) Supervisor mode is protected mode for the operating system iv) Abort mode is enter after the data or instruction pre fetch abort. It has several peripheral components and two interfaces for external devices like ADC. To deal with multiple applications in medical electronics, some improvements in application software, system architecture, hardware implementation and other aspects should be done. For biomedical system, the major role is to make the possible arrangement for measurement of information communicated by this various level of the body such as cellular level or even molecular level.

4. SIMULATION RESULT

The simulation results of the algorithm are demonstrated in depicted waveforms. Various evaluation parameters such as PSNR, MSME and Correlation coefficient are evaluated in MATLAB. The clean ECG signal is corrupted by random power line interference or any noise interference.y(n)=s(n)+p(n)Where y(n) is the ECG signal corrupted with interference, s(n) is the clean ECG signal and p(n) is the added interference. The proposed algorithm is tested for various input noise levels. The execution is performed for 2000 samples and further extended to 50000 samples for analyzing the performance parameters.

Table 1. Output parameter for 50000 samples

SNRin	30 Db	40 dB	50 dB
PSNRout	24.7712 dB	26.026 dB	26.9897 dB
MSME	0.0033	0.0025	0.0020
CC	0.65	0.71	0.83

Table 2. Output parameter for 2000 samples

SNRin	5 dB	10 dB	20 dB
PSNRout	16.9897 dB	20 dB	23.0103 dB
MSME	0.0200	0.0100	0.0050
CC	0.996	0.8826	0.09296

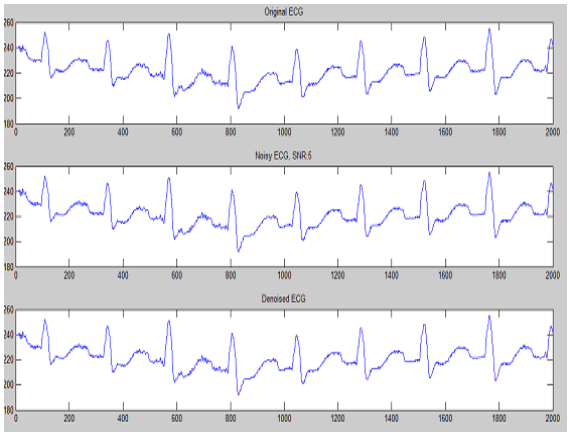

Fig.3. For SNR 5dB with 2000 samples

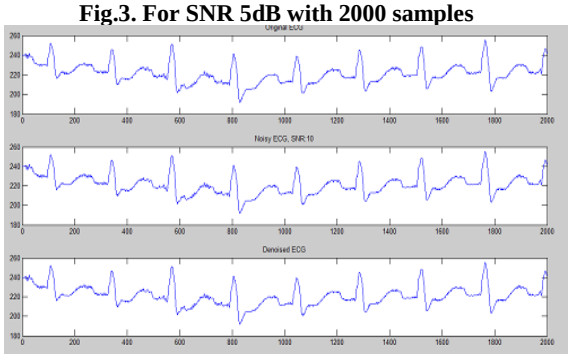

Fig.4:-For SNR 10dB with 2000 samples

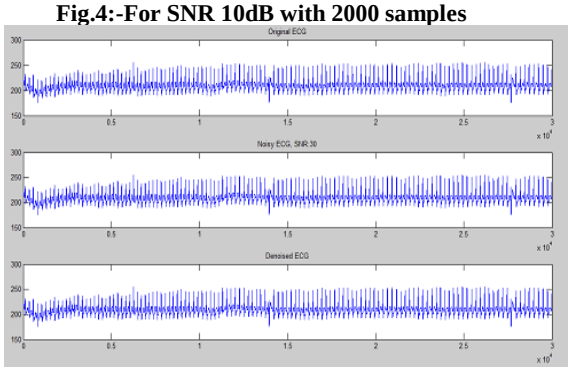

Fig.5:-For SNR 30dB with 50000 samples

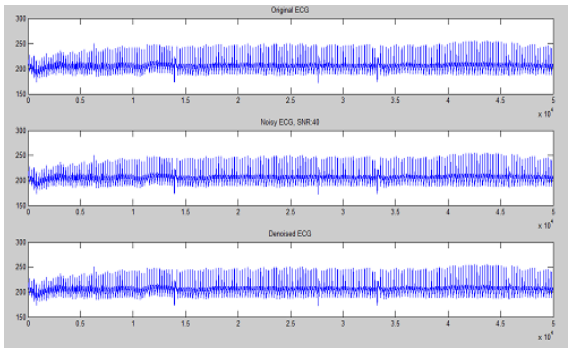

Fig.6.For SNR 50dB with 50000 samples

5. CONCLUSION

Going through all experimental works, the TVLMS algorithm showed improved performance over the conventional LMS algorithm. It also provides better SNR as compared to existing algorithms. The improved CC value indicates that it also maintains the original characteristics of clean ECG signal. The experimentation and validation proves the advantage of using adaptive noise cancellation using TVLMS algorithm along with embedded processor.

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