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Enhancement of ECG signal

A thesis
Submitted in partial fulfillment for the requirements of the degree of Master of Science in Electrical Engineering

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STATEMENT

This thesis is submitted to Ain-Shams University in partial fulfillment of the degree of Master of Science in Electrical Engineering.

The work included in this thesis was carried out by the author in the department of electronics and communications engineering, Ain Shams University.

No part of this thesis has been submitted for a degree or a qualification at any other university or institute.

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To My Father,

To My Mother,

To My Husband,

I present this Thesis to you.

May I by this express my deepest gratitude and love

Thanks

Without you, I could not have reached any successful step in my life

ABSTRACT

An Electrocardiogram (ECG) signal is a recording of the electrical activity of heart. It is considered as an important source of vital diagnostic information. ECG signal is exposed to different types of noise. These noises change the nature of the ECG signal and provide difficulties on its analysis.

The one long Least Mean Squares (LMS) adaptive filter is an algorithm used to reduce the noise effect on the ECG signal. This algorithm is widely used in adaptive filter applications due to its simplicity and low computational complexity, but it suffers from low convergence speed.

This thesis tries to improve the one long LMS adaptive filter convergence speed using the multiple sub-adaptive filters. In the suggested algorithm, Simulation showed a saving in the required number of iterations by about $4.3*10^4$ times compared to the one long LMS adaptive filter at MSE of 0.04. Also, in terms of Signal to Noise Ratio (SNR) against the step size (μ) a comparison between them is performed. It is found that the suggested algorithm provides improvement in the SNR by 5 dB at μ=0.2.

The ECG samples are recorded from MIT-BIH database and an additive white Gaussian noise (AWGN) is added to the signal to examine the proposed technique and 2011a Mat-lab platform is used to simulate these results.

Key Words: Adaptive filter, Adaptive filter algorithms, LMS algorithm, ECG signal, Noise cancellation

DEDICATION

I would like to dedicate this thesis to my parents, who have been supportive for me for all my life. I wish to dedicate this thesis to my husband Hussein, my sisters Naglaa, Seham, Rabab and my brother Abd el hamid for their encouragement. Finally, I wish dedicate this thesis to my children Mai, Marwan, Malek.

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List of Symbols

$n_{60\text{Hz}}$	Noise of PLI
Ω	The phased of sinusoid
A	The average peak power of PLI
e(n)	The error signal
d(n)	The desired signal
y(n)	The output signal
x(n)	The input signal
w(n)	The filter coefficient vector
N	The number of iterations
T	The vector transpose
P	The filter order
Z^{-1}	The unit delay element
$h_i(n)$	The gain of FIR filter
$a_i(n)$	The gain of recursive part of IIR filter
$b_i(n)$	The gain of non-recursive part of IIR filter
Ø(n)	The pervious value of coefficient vector
ΔØ(n)	The value of coefficient adaptation
E{.}	The error signal expectation value
μ	The step size
M	The number of samples
∝	The normalize step size
G(.)	Particular vector that relate between the input signal, the error signal and the coefficient vector
$P_n(e)$	The probability density function of error

Abbreviations

AV:	Atria ventricular
AWGN:	Additive White Gaussian Noise
BW:	Base line Wandering
CSLMS:	Constrained Least Mean Squares
ECG:	Electrocardiograph
EMG:	Electromyography
FIR	Finite Impulse Response
IIR	Infinite impulse Response
IKF:	Improved Kalman Filter
KF:	Kalman Filter
LMS:	Least Mean Squares
LVH:	Left Ventricular Hypertrophy
MSE:	Mean Square Error
NLMS:	Normalized Least Mean Squares
PLI:	Power Line Interference
QR-RLS	Decomposition-Based Recursive Least Squares
RLS:	Recursive Least Squares
SA	Sino Atrial
SNR:	Signal-to-Noise Ratio
SSRLS:	Steady State Recursive Least Squares

Chapter 1: Introduction