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Comparability of Power Spectral Density Estimation of EMG Signals Using Non-Parametric Methods

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Abstract: ***The purpose of this paper is to focus on the issue of EMG amplitude and spectral estimation with algorithms based on nonparametric methods. As EMG has many non parametric methods, we had a practical approach to consider a perfect signal with comparison of different models like Welch, Bartlett, Period gram and Blackman turkey method. The basic idea was taken to give a feedback process through which signal is best depending upon the terms of raw signal and smoothing signal.***

Keywords: EMG, Motor Unit Action Potential (MUAP**),** Power Spectral Density, Non- Parametric Techniques

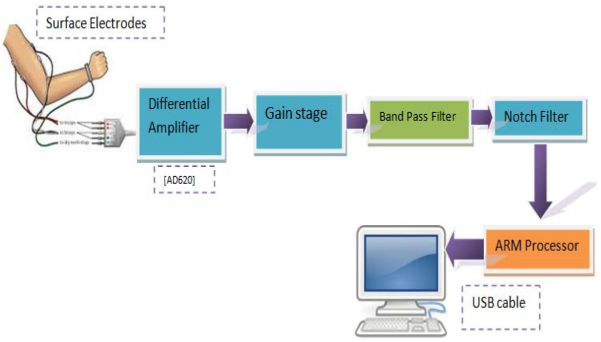
1. Introduction

EMG stands for electromyography. It is the study of muscle electrical signals. Electromyography (EMG) records and analyzes the electrical activity of a contracting muscle.

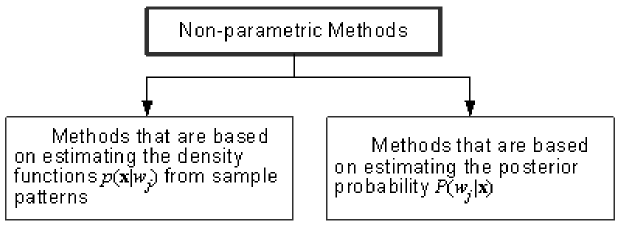
It is used in the diagnosis of neuromuscular diseases that affect the muscle tissue itself (myopathic disorders) and those affect the nerves that activate the muscle (neurogenic disorders). An electronic copy Electromyography (EMG) is an experimental technique concerned with the development, recording and analysis of my electric signals. Myoelectric signals are formed by physiological variations in the state of muscle fibre membranes. Recordings of muscle action during movements are useful for nervous system, as well as the instrumentation used for detection of the EMG signal and the process used to record the EMG signals. Variations in any of these processes can affect the character of the signal and the analysis and conclusions drawn from the data. The motor unit action potential is the spatial and temporal summation of the individual muscle action potentials for all the fibres of a single motor unit. Therefore, the EMG signal is the algebraic summation of the motor unit action potentials within the pick-up area of the electrode being used.

2. Block Diagram

The Block Diagram Indicates the clear vision of how to handle with step by step process by utilizing ARM processor



Power spectral density describes how the power density of a signal or time series is distributed with frequency. It detects periodicities in data by observing peaks at frequencies corresponding to those particular periodicities. The performance of various power spectral density estimation techniques; Non-parametric methods and parametric methods are compared for different epoch. But our main consideration is non parametric method. In maximum likelihood and Bayesian parameter estimation, we treated supervised learning under the assumption that the forms of the underlying density functions were known. In most pattern recognition applications, the common parametric forms rarely fit the densities actually encountered in practice. In particular, all of the classical parametric densities are uni-modal (have a single local maximum), whereas many(have a single local maximum). Whereas many practical problems involve multimodal densities. We shall examine nonparametric procedures that can be used with arbitrary distributions and without the assumption that the forms of the underlying densities are known.



Non-parametric methods in pattern recognition

There are several types of nonparametric methods of interest in pattern recogni-tion. one consists of procedures for estimating the density functions p(x|wj) from sample patterns. if these estimates are satisfactory, they can be substituted for the true densities when designing the classifier. another consists of procedures for directly estimating the posterior probabilities p(wj|x). this is closely related to non para-metric design procedures such as the nearest-neighbour rule, which bypass probability estimation and go directly to decision functions.

3. Non Parametric methods

It is based on fewer assumptions like wide sense stationarily hence their applicability is much wider than parametric methods

3.1 Welch

pxx = pwelch(x) returns the power spectral density (PSD) estimate, pxx, of the input signal, x, found using Welch's overlapped segment averaging estimator. When x is a vector, it is treated as a single channel. When x is a matrix, the PSD is computed independently for each column and stored in the corresponding column of pxx. If x is real-valued, pxx is a one-sided PSD estimate. If x is complex-valued, pxx is a two-sided PSD estimate. By default, xis divided into the longest possible sections to obtain as close to but not exceed 8 segments with 50% overlap. Each section is windowed with a Hamming window. The modified periodograms are averaged to obtain the PSD estimate. If you cannot divide the length of x exactly into an integer number of sections with 50% overlap, x is truncated accordingly.

Pxx = pwelch (x);
*Plot (10*log10 (Pxx))*

3.2 Period gram

Pxx = periodogram (x) returns the power spectral density (PSD) estimate, pxx, of the input signal, x, found using a rectangular window. When x is a vector, it is treated as a single channel. When x is a matrix, the PSD is computed independently for each column and stored in the corresponding column of pxx. If x is real-valued, pxx is a one-sided PSD estimate. If x is complex-valued, pxx is a two-sided PSD estimate. The number of points, nfft, in the discrete Fourier transform (DFT) is the maximum of 256 or the next power of two greater than the signal length. Create a sine wave with an angular frequency of π/4 rad/sample with additive N (0, 1) white noise. The signal is 320 samples in length. Obtain the periodogram using the default rectangular window and DFT length. The DFT length is the next power of two greater than the signal length, or 512 points. Because the signal is real-valued and has even length, the period gram is one-sided and there are 512/2+1 points.

```
n = 0:319;
x = cos (pi/4*n) +randn (size (n));
[Pxx, w] = periodogram(x);
Plot (w, 10*log10 (Pxx))
```

3.3 Blackman Turkey Method

W=Blackman (N) returns the N-point symmetric Blackman window in the column vector w, where N is a positive integer's = Blackman (N, SFLAG) returns an N-point Blackman window using the window sampling specified by 'SFLAG' which can be either 'periodic' or 'symmetric' (default).

The 'periodic' flag is useful for DFT/FFT purposes, such as in spectral analysis. The DFT/FFT contains an implicit periodic extension and the periodic flag enables a signal windowed with a periodic window to have perfect periodic extension. When 'periodic' is specified, Blackman computes a length N+1 window and returns the first N points. When using windows for filter design, the 'symmetric' flag should be used.

L = 64; Wvtool (Blackman (L))

The main text for your paragraphs should be 10pt font. All body paragraphs (except the beginning of a section/sub-section) should have the first line indented about 3.6 mm (0.14").

3.4 Bartlett

Bartlett creates a handle to a Bartlett window object for use in spectral analysis and filtering by the window method. Object methods enable workspace import and ASCII file export of the window values

$$w(n) = \begin{cases} \frac{2n}{N-1} & 0 \le n \le N/2 - 1 \\ 2 - \frac{2n}{N-1} & N/2 \le n \le N-1 \end{cases} \quad (1)$$

For N odd, the equation for the Bartlett window is

$$w(n) = \begin{cases} \frac{2n}{N-1} & 0 \le n \le (N-1)/2 \\ 2 - \frac{2n}{N-1} & (N-1)/2 + 1 \le n \le N-1 \end{cases} \quad (2)$$

Generate length N = 128 Bartlett window, return values, and write an ASCII file with window values H = sigwin.bartlett(128);

```
% Return window with generate
win = generate(H);
% Write ASCII file in current directory
% with window values
winwrite(H,'bartlett_128')
```

3.5 Tables

Comparison of non parametric methods when it is in active position of EMG signal.

Table 1: Active Position of EMG

Name of the Method	*Variability*	*Resolution*
Periodogram	1	1.107484
Bartlett	0.25	0.43665
Welch	0.28125	0.1256
Blackman-Tukey	1.26042	2.1896

3.6 Sections headings

Section headings:
1. Introduction
2. Block Diagram
3. 3.1 Welch
   3.2 Periodgram
   3.3 Blackman Turkey Method
   3.4 Bartlett
   3.5 Tables
4. Graphs
5. Acknowledgement

6. Conclusion
7. References

4. EMG generated Graphs

The power spectral density signal are generated by the EMG values.

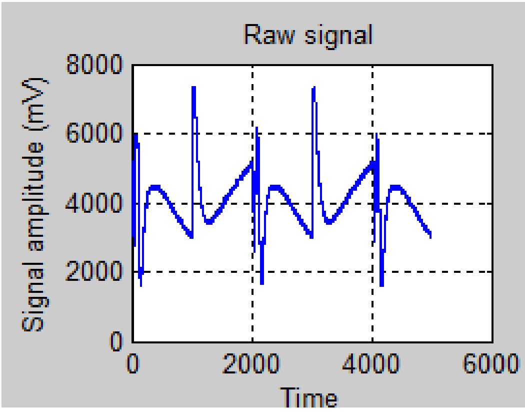


Figure 1: Raw Signal

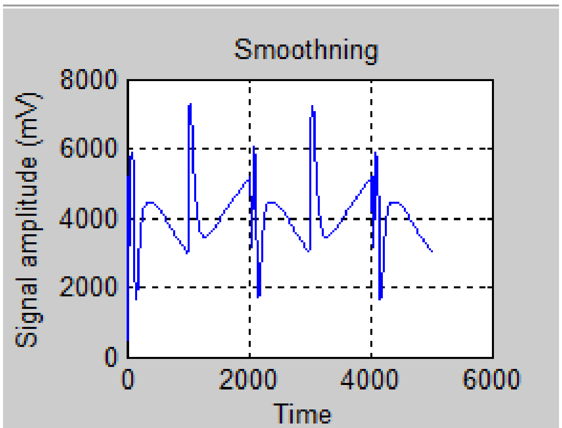


Figure 2: Smoothing the signal

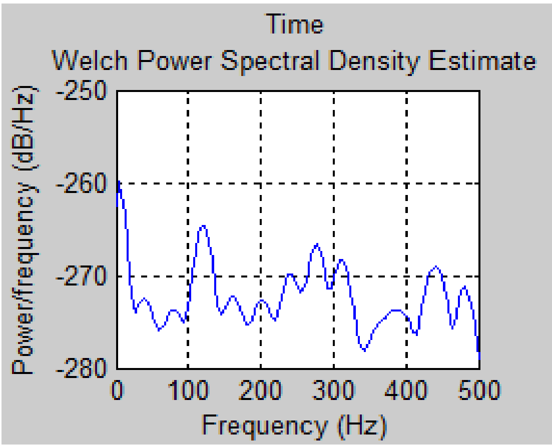


Figure 3: Welch Power Spectral Density

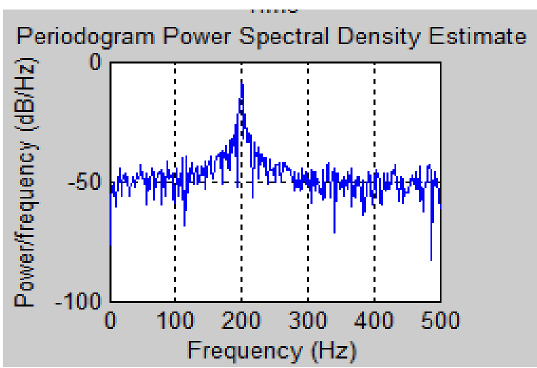


Figure 4: Periodgfram Power Spectral Density

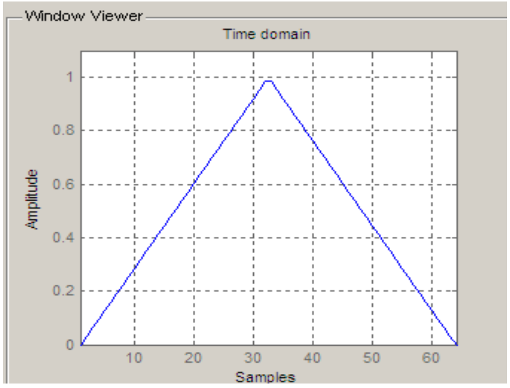


Figure 5: Bartlett Time Domain

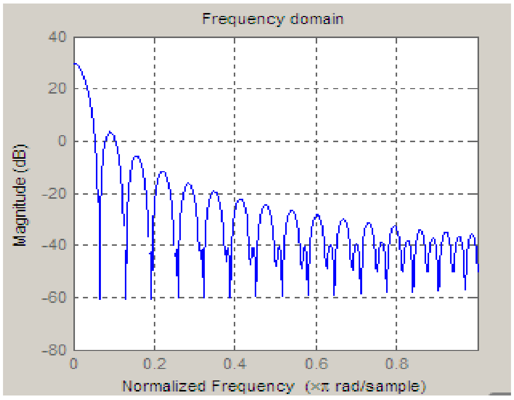


Figure 6: Bartlett Frequency Domain

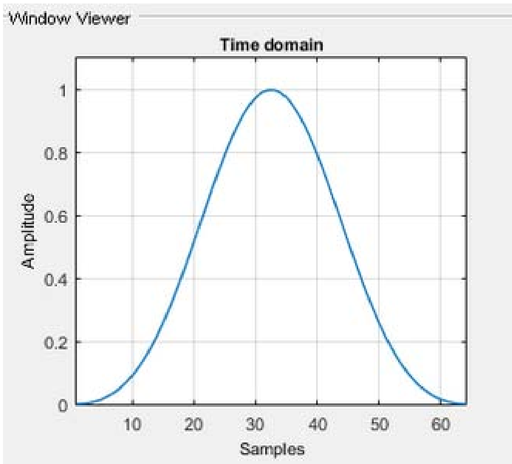


Figure 6: Blackman TurkeyTime Domain

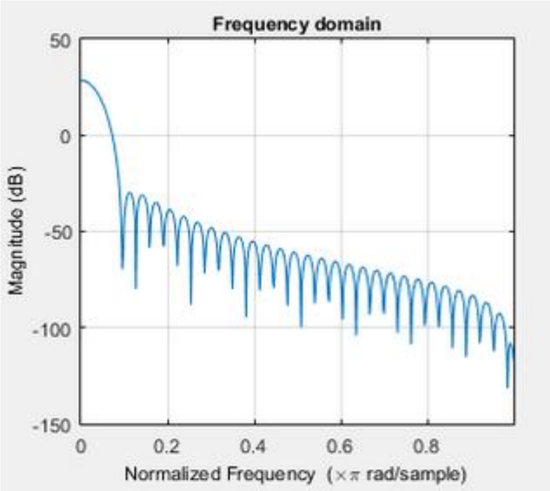


Figure 6: Blackma Turkey Frequecny Domain

5. Acknowledgement

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2) My College Laboratory was helpful to me to fulfill the application.

6. Conclusion

Hardware software co-design requires less area and hardware resources than hardware implementations with EMG signals whereas it takes less time than other implementations as it is compared in result tables. The comparison with other methods shows that software co-design is middle way to overcome.So the BlackmanTurkey gives the exact Results when compared to other methods.

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