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# Multichannel sEMG signal analysis using Hilbert-Huang Transform to identify time-frequency features

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**Abstract**— Surface EMG signals have important characteristics that could be useful to anticipate user's movements for orthotic & prosthetic devices. To perform a real-time analysis over these signals is important to simplify the processing method and reduce time-computing; applying Empirical Mode Decomposition (EMD) method we obtain the Intrinsic Mode Functions (IMFs) for a multichannel signal to filter, discard and identify frequencies. Results are considered to simplify the sEMG signal processing for real-time analysis.

## I. INTRODUCTION

sEMG signals provide information about muscular activity in a non-invasive way becoming an effective source for prosthetic control [1]. Appropriate algorithms and methods for EMG signal analysis are available [2] [3] [4].

This work reports the process to analyze multichannel sEMG signals using Hilbert-Huang Transform (HHT) as a technique to decompose signals into a sets of elemental signals, Intrinsic Mode Functions (IMFs), and get their instantaneous frequencies to identify patterns.

## II. METHODOLOGY

Using an acquisition system with four differential channels [5] with a high common mode rejecting ratio in the circuit (94 dB) and applying adaptive filters (band-pass filters from 20 Hz to 450 Hz), we take out noising signals, from the original signal. We saved the resulting signal into a matrices: 1,000 records from 20 non-amputee users. Matrices were divided in 3 segments: repose, transitory and stabilized contraction.

Empirical Mode Decomposition is a technique to decompose a given signal into a set of elemental signals called IMFs; is the base of the HHT.

Given any signal,  $x(t)$ , the IMFs were found by an iterative procedure called *sifting algorithm*. Spectral estimation is the second step of the HHT, consists in a computing of the instantaneous frequency for each IMF using the Hilbert Transform (HT) and the analytic signal concept.

## III. EXPERIMENTAL RESULTS

For each channel we calculated their IMFs to extract the main components of the signal. AM/FM components from

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channels were found and presented the following conditions:

- Resolution: 45dB between Signal and Bias energy.
- Residual energy: 45dB between Signal/Residual.
- Each channel presented 8 IMFs to 10 IMFs.
- Reconstruction of the signal with the obtained IMFs is the same as the original one.
- IMFs could be filtrated or treated with hard thresholds to eliminate undesirable frequencies in lower and higher orders.

## IV. CONCLUSION

New ways could be taken to reveal the information contained in a raw EMG; those from filter, de-noising, decomposition, time changes, frequency behavior, etcetera.

HHT method could remain as a valuable detail of the signal, because it can make prevention of energy leak and the energy is centralized in the spectrum.

HHT method could help to find intrinsic features of the EMG signals for real-time analysis; avoiding all traditional calculations, only identifying the main frequencies involved the hand movements.

The goal is to control a hand prosthetic device in real-time to improve its performance, reducing the time respond and improving resolution.

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