

A MULTISCALE FREQUENCY ANALYSIS OF PHONOCARDIOGRAM DISCRIMINATES NORMAL AND EXTRA HEART SOUND

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ABSTRACT

Introduction: Phonocardiogram (PCG) signals contain very important information regarding the heart condition. Recently, several automatic detection algorithms have been explored to profile the characteristics of heart sounds to aid in disease diagnosis such as heart murmur, presence of extra heart sound such as extra systole etc. These methods are often limited in performance in presence of various noises and motion artifacts due to sensor movement during PCG recordings. A more robust method to characterize PCG is required that can aid in discriminating normal and diseased heart conditions such as PCG with extra systolic heartbeat.
Hypothesis: A multiscale frequency (MSF) analysis of PCG can discriminate normal PCG and PCG with extra heart sound with the presence of extra systolic beat based on their varying frequency content.
Methods: 19 samples of normal PCG and PCG with extra heart sound from Peter Bentley Heart Sounds Database sampled at 44.1 kHz were used for analysis. A 4^{th} order Butterworth lowpass filter was designed with cutoff frequency at 200 Hz to remove higher frequency noise and MSF estimation was performed on the filtered PCG dataset using custom MATLAB software. Mann-Whitney test was performed for statistical significance at $p < 0.05$.
Results: The mean MSF for normal PCG was 91.8±29.75 Hz and the mean MSF for PCG's with extra heart sound was 111.44±26.36 Hz. MSF was significantly different between normal and extra sound PCG with $p = 0.015$ ($p < 0.05$). Validation of this technique with larger dataset is required.
Conclusions: MSF technique can discriminate normal PCG and PCG's with extra heart sound.

Keywords: Phonocardiogram, PCG, multiscale frequency, ECG, biomedical signal, signal processing.

INTRODUCTION

Cardiovascular diseases are the leading cause of death globally and in the United States affecting several million people annually and on the rise [1]. Depending on the biomedical signal used and methods used to characterize heart conditions, challenges still exist in accurately profiling variety of diseases due to the sensitivity and specificity of the methods used, although many advanced methods are