Introduction

Phonocardiograms

A Phonocardiogram (PCG) is a recording of the heart sounds. Some of the important features of the PCG incluc intensities of the heart sounds, the intensity patterns of murmurs, and the timing sequence of the heart sounds a

Heart sounds are caused by the acceleration or deceleration of blood in the heart's chambers. There are two ma is due to ventricular contraction, and occurs at the same time as the QRS complex in the ECG signal. (See Sect frequency band of about 10-120 Hz.

The closure of the semilunar (pulmonary and aortic) valves gives rise to the second heart sound (S2). S2 occurs usually higher than that of S1, in the range of about 10-200 Hz.

The intervals between S1 and S2 of a cardiac cycle, and between S2 of a cycle and S1 of the next cycle (corres (see Fig. 1). Murmurs, caused by certain cardiovascular defects and diseases, may occur in these intervals. Mu blood becomes high due to an irregularity, orifice, or defect through which the blood flows.

"Many pathological conditions of the cardiovascular system are reflected in heart sound signals, which makes it way of analyzing heart sounds is to use a Spectrogram, which is a method to visually represent the spectrum of

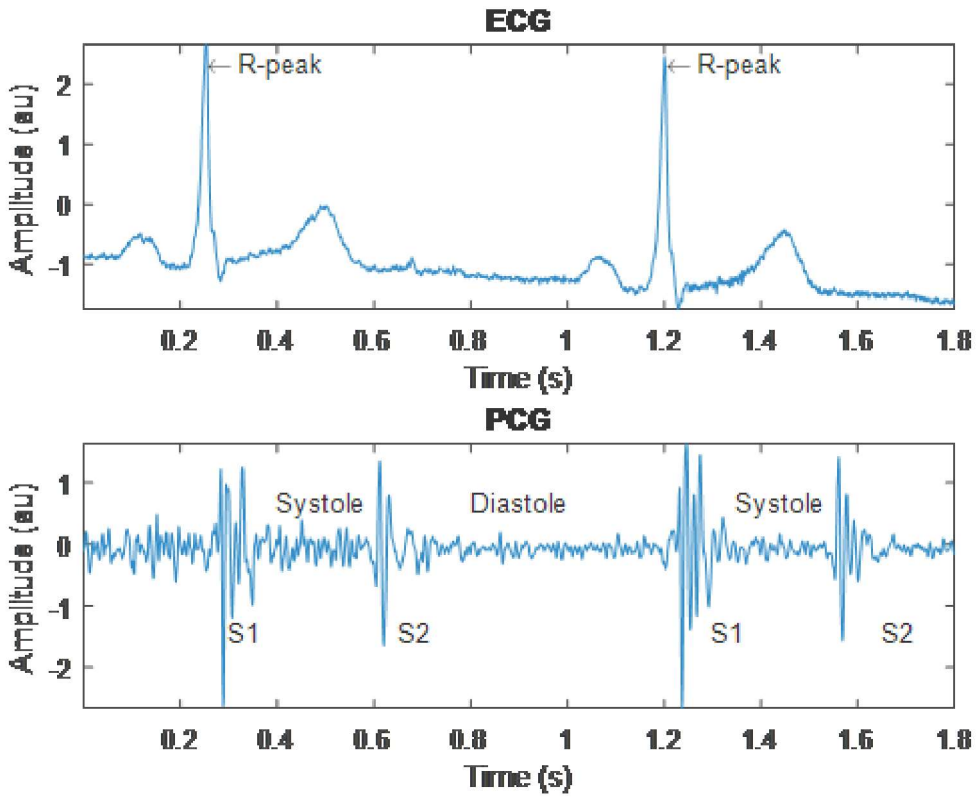

Figure 1. Simultaneously recorded ECG and PCG and the four states of the PCG recording; S1, S heart chamber contracts.

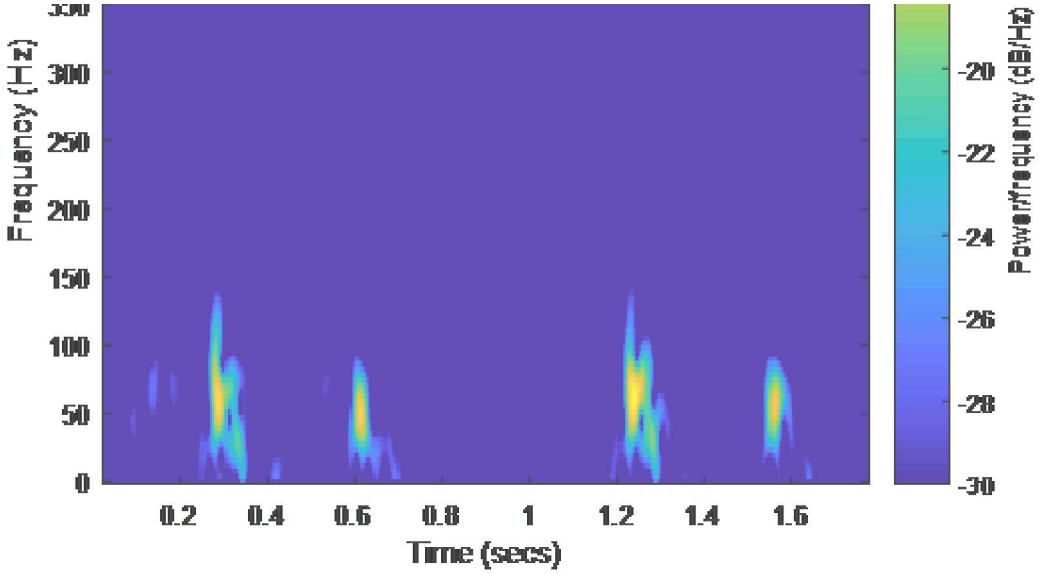

Figure 2.Spectrogram corresponding to the PCG signal in Fig. 1. Frequency is displayed on the ver map.

Power Spectral Density

The Power Spectral Density (PSD) of a signal is given by the squared magnitude of the Fourier transform (FT) c associated signals causes variation in the frequency content from one heart beat (cardiac cycle) to another. The an accurate representation of the PSD of the signal. In order to overcome this limitation, we could extract PCG s signal, compute the PSD of each segment, and average the PSD's over several cardiac cycles. In such a proce cardiac cycle. The procedure may be applied to derive separate PSD's for the different distinct parts of the PCG segment after S2 (until the next S1). The averaged PSD's may then be characterized in terms of quantitative fea

Useful MATLAB commands:

load, subplot, title, xlabel, ylabel, spectrogram, resample, pwelch, mean, meanfreq, numel

Data

The data is given in one file ('`data6.mat`') containing the phonocardiograms (PCG) and electrocardiograms (EC the previous assignment, the signals are available in a `1x5 struct` (for the five patients), which has the followir

- `t`: the time points for the signals
- `ECG`: the ECG signal of the patient
- `PCG`: the PCG signal of the patient
- `label`: pathological information

The full data is in the above format struct called `data`, and two cycles are pre-extracted for you in the struct calle `data(2).ECG` is the ECG signal from the second patient, `data(5).PCG` is the PCG signal of the fifth patient, anc

The first and second signals belong to normal subjects. the third and fourth belong to two subjects with *ventricu* the left ventricle to the right ventricle during systole), causing systolic murmur in the PCG. The fifth signals are fi incomplete opening of the valve and constrained ejection of blood into the aorta during ventricular systole), caus MATLAB *sound* function in case you are interested.

In addition, you are supplied with two functions - `QRSDetection` and `detectPeaks` - that are based on Assign and you only need to directly call the aforementioned one. The calling syntax is `[QRSOnsets, QRSOffsets] =`