HW #2

Problem 1:

- Show the ACF of the 4.2-4.96 s segments of f3 and o1 channels (eeg1-f3.dat, eeg1-o1.dat,)
- Show Crosscorrelation of o1 and o2 during 4.72~5.71 secs (eeg1)
- Show Crosscorrelation of o1 and f3 during 4.72~5.71 secs (eeg1)

Problem 2:

- Apply three-point central-difference operator to the ECG with low-frequency noise (fs=1000 Hz)
- Calculate the noise levels of ECGs before and after filtering.
- Calculate bpm of the ECG signal

- Reference: Biomedical Signal Analysis, Rangaraj M. Rangayyan, Wiley

Due date: 10/24, 2019.

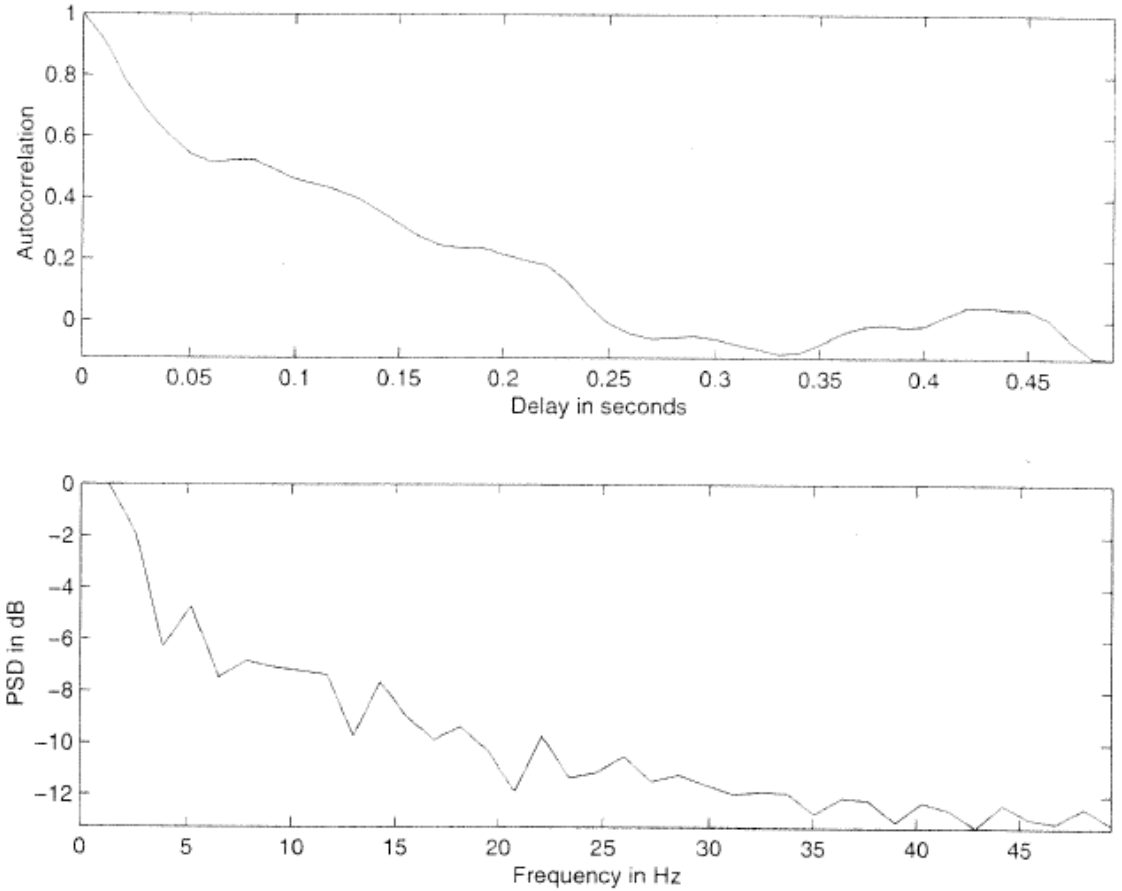

Figure 4.9 Upper trace: ACF of the $4.2 - 4.96$ s portion of the f3 channel of the EEG signal shown in Figure 1.22. Lower trace: The PSD of the signal segment in dB.

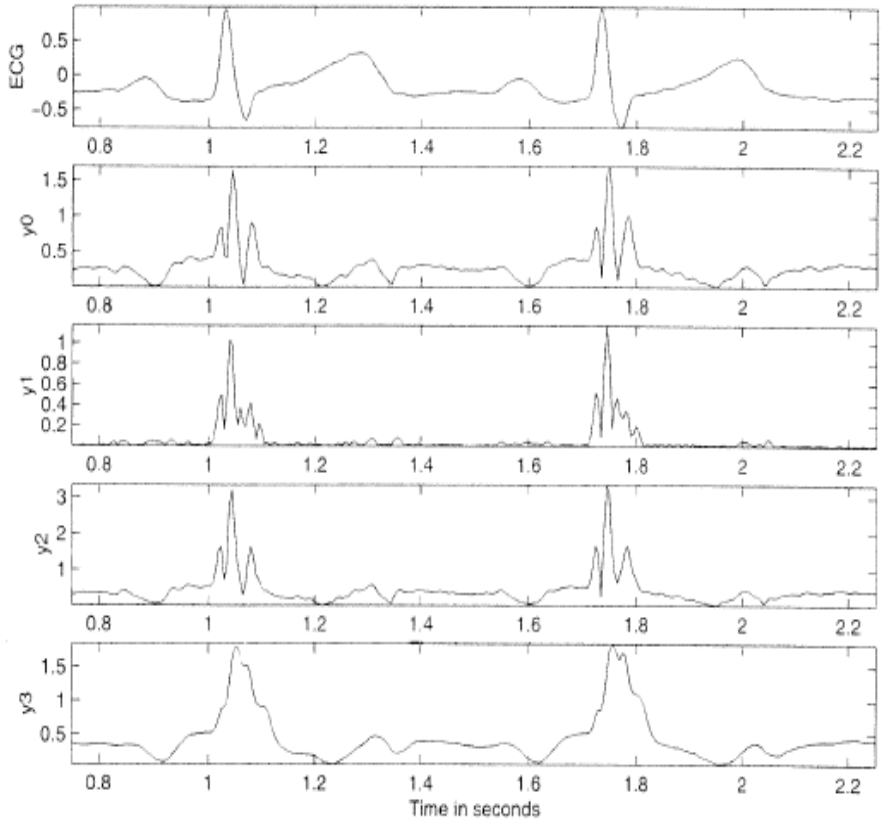

Figure 4.2 From top to bottom: two cycles of a filtered version of the ECG signal shown in Figure 3.5; output $y_0(n)$ of the first-derivative-based operator in Equation 4.1; output $y_1(n)$ of the second-derivative-based operator in Equation 4.2; the combined result $y_2(n)$ from Equation 4.3; and the result $y_3(n)$ of passing $y_2(n)$ through the 8-point MA filter in Equation 3.27.

Balda et al. [99] proposed a derivative-based algorithm for QRS detection, which was further studied and evaluated by Ahlstrom and Tompkins [100], Friesen et al. [101], and Tompkins [27]. The algorithm progresses as follows. In a manner similar to Equation 3.45, the smoothed three-point first derivative $y_0(n)$ of the given signal $x(n)$ is approximated as

$$y_0(n) = |x(n) - x(n-2)|. \tag{4.1}$$

The second derivative is approximated as

$$y_1(n) = |x(n) - 2x(n-2) + x(n-4)|. \tag{4.2}$$

The two results are weighted and combined to obtain

$$y_2(n) = 1.3y_0(n) + 1.1y_1(n). \tag{4.3}$$

The result $y_2(n)$ is scanned with a threshold of 1.0. Whenever the threshold is crossed, the subsequent eight samples are also tested against the same threshold. If at least six of the eight points pass the threshold test, the segment of eight samples is taken to be a part of a QRS complex. The procedure results in a pulse with its width proportional to that of the QRS complex; however, the method is sensitive to noise.

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