ECTE301: Digital Signal Processing

Report

Due date: Thursday, May 16, 2013, 11:30AM (Week 10)

Assessment weight: 8% **Marks**: 8

Instructions:

- Submit the report with a coversheet to the '300'-level box, located outside office 35.132A.
- Reports will be marked based on correctness and presentation quality. Typed reports are preferred; hand-written reports are also acceptable but ensure that the handwriting is intelligible.
- This is an individual assessment, not group work. Each student must ensure that the submitted report is his or her own creation. Cheating, copying or plagiarising will result in a mark of 0 and other penalties according to the University rules.

Question 1: [4 marks]

Consider two digital sequences:

$$x(n) = \begin{cases} a^n, & \text{if } M \le n \le N \\ 0, & \text{otherwise} \end{cases}$$

$$y(n) = b^n u(n)$$

Here, M and N are two positive integers, and a and b are two values in the interval $(0,1)$.

a) Using the time-domain approach, determine the closed-form expression of the crossscorrelation sequence $r_{xy}(\ell)$.

b) Using the z-domain approach, determine the closed-form expression of the crossscorrelation sequence $r_{xy}(\ell)$.

c) Suppose that $M = 50, N = 100, a = 0.2,$ and $b = 0.5$. Use MATLAB to compute and plot the crosscorrelation sequence $r_{xy}(\ell)$. Compare the results with the answers in part (a) and (b).

Question 2: [4 marks]

Consider the template signal $s(n) = \{1, -1, 0, -1, 1, -1, 1\}$. Let the signal $x(n)$ be a delayed and noise-corrupted version:

$$x(n) = \alpha s(n - D) + w(n),$$

where $w(n)$ is a zero-mean white noise sequence and D is the delay in number of samples.

a) Assume that $D = 5$, $\alpha = 0.7$, and the white noise has variance equal to 0.25. Generate and plot the signal $x(n)$ for $0 \le n \le 20$. Can you identify the delay D from the plot of $x(n)$?

b) Compute and plot the cross-correlation $r_{xs}(\ell)$ and determine the time delay of $x(n)$.

c) Compute and plot the matched filter impulse response $h(n)$.

d) Compute and plot the response $y(n)$ of the matched filter to $x(n)$. Compare $y(n)$ to $r_{xs}(\ell)$. Can you determine the time delay of $x(n)$ from the output of the matched filter $y(n)$?