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VASAVI COLLEGE OF ENGINEERING *(Autonomous)*, HYDERABAD

M.E. (ECE: CBCS) I-Semester Main Examinations, Jan./Feb.-2017

(Communication Engineering & Signal Processing)

Adaptive Signal Processing

Time: 3 hours Max. Marks: 70

Note: Answer ALL questions in Part-A and any FIVE from Part-B

Part-A (10 × 2 = 20 Marks)

1 State the orthogonality principle.

2 Give the block diagram of an adaptive system.

3 Briefly discuss gradient algorithm.

4 Define LMS stochastic gradient algorithm.

5 What is an echo cancellation?

6 State the techniques in adaptive beam forming.

7 State Kalman filter theory.

8 Give examples of adaptive filtering.

9 Briefly discuss the application of Vector Kalman filter.

10 Draw the signal flow graph for Kalman filtering theory.

Part-B (5 × 10 = 50 Marks)

11\. a) State Wiener–Holf equation and derive the expression to calculate optimum weights in terms of correlation matrix R_{xx} and cross correlation vector P. [6]

b) Let $y(n) = w_0x(n)+w_1x(n-1)+w_2x(n-2)$ and $x(n)$ is a stationary signal. If $R_{xx}(0) = 1$, $R_{xx}(1) = 0.150$, $R_{xx}(2) = 0.250$, $R_{xy}(0) = 0.150$, $R_{xy}(1) = 0.25$ and $R_{xy}(2) = 0.20$ [4]

i) find the weights of the filter.

ii) What is minimum mean squared error produced by the filter.

12\. a) Describe qualitatively the transient behavior of the LMS algorithm when changing the step size of the algorithm (in terms of transient time and steady state mean error). [5]

b) Write the normalized LMS algorithm for the FIR filter with two parameters, w_o and w_1. How the algorithm will evolve if the input is $u(0) = 0$, $u(1) = 0$, $u(2) = 1$, $u(3) = 1$, $u(4) = u(5) = u(6) =.........= 0$ and the desired input is $d(0) = 0$, $d(1) = 0$, $d(2) = 0$, $d(3) = 1$, $d(4) = d(5) = d(6) = ... = 0$ (consider different situations for the initial weights). [5]

13\. a) Draw the structure of an adaptive noise canceller. Discuss the significance of each signal. [5]

b) Consider a FIR (1) filter $y(n) = w(n)\ u(n)$ where all quantities are scalars. We intend to minimize the time varying cost function [5]

$j(n) = e(n)^2 + \alpha w(n)^2$

where $e(n)$ is the estimation error

$e(n) = d(n) - w(n)\ u(n)$

$d(n)$ is the desired response, $u(n)$ is the input, and α is a constant. Show that the time update for the parameter vector $w(n)$ is defined by

$w(n+1) = (1-\mu\alpha)w(n)+\mu u(n)e(n)$

what is the role of the constant α (comment the cases of very large α and very small α)?

Contd... 2

14. a) Explain the drawbacks of Wiener filter and explain how these are over come in Kalman filter with the help of a neat block diagram. Discuss the role of each block with necessary equations. [6]

b) For an optimum Weiner filter the errors obtained by the minimizing filter orthogonal to the samples u(i) which are used to compute the filter output, $E[e_o(n)u(n-k)] = 0$. Starting from this find the Weiner-Hopf equations [4]

$$\sum_{i=0}^{\infty} w_{oi} r(i-k) = p(-k),\ k = 0,1,2,........ \text{ WEINER-HOPF}$$

15. a) Derive the radar range equation for target tracking using Kalman filter. [5]

b) Consider the following equations [5]

$x(t+1) = ax(t)+bu(t)$

$y(t) = x(t)+v(t)$

where v(t) is white noise. Determine the steady state innovation model if a = 1.

16. a) How can the optimal filter coefficients of the Weiner filter be calculated based on an input signal x(n) and a n output signal y(n) of an unknown system which should be identified. [5]

b) State the optimal Wiener filter problem. [5]

17. Answer any *two* of the following:

a) Extended Kalman filters [5]

b) Classify and explain the recursive least square estimation [5]

c) Target tracking of aircraft using Vector Kalman filtering. [5]

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