

CITY UNIVERSITY OF HONG KONG

Course code & title : EE4146 Industrial Electronics
Session : Semester B 2005/06
Time allowed : Two hours

This paper has FIVE pages (including this cover page).

1. This paper consists of **4** questions only.
2. Each question carry equal marks.
3. Answer **ALL** Questions.

Q1.

- i. A LMS algorithm is used to implement a dual-input, single-weight adaptive noise canceller as shown in Figure Q1. Use LMS rule to adjust the weight w of the adaptive filter. Set up the updating equation relating $w(n+1)$ to $w(n)$, $y(n)$, $x(n)$ and the learning rate η . (9 marks)

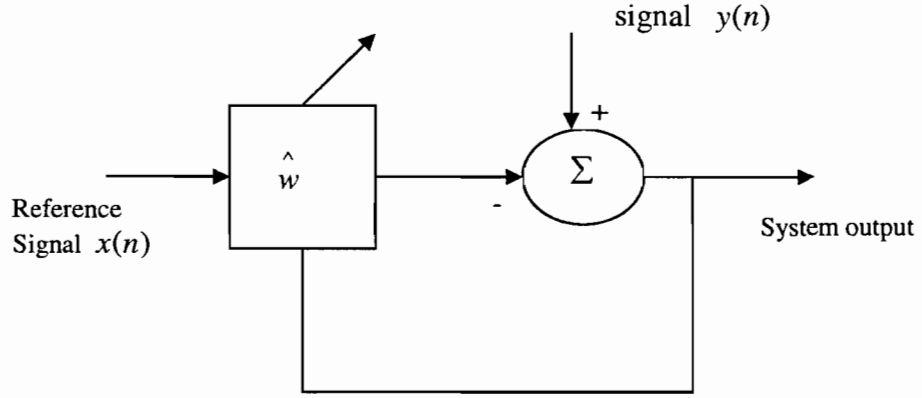


Figure Q1

- ii. In a neural network learning rule, the learning algorithm using gradient descent method is given as

$$W(k+1) = W(k) - \eta \nabla J(k),$$

where $W(k+1)$ denotes the weightings at the $(k+1)^{st}$ iteration, $\nabla J(k)$ denotes the gradient of the performance surface at the k^{th} iteration, and η is the learning rate. Use a two-dimensional convex error surface to explain two main differences between the gradient descent method and the LMS method. (6 marks)

- ii. The gradient vector of a function, $g(x_1, x_2) = 12x_1^2 + 3x_2^2$, is defined by a column vector $\nabla g = \left[\frac{\partial g}{\partial x_1} \frac{\partial g}{\partial x_2} \right]^T = c$. It is given that the normalized gradient

vector $\bar{c} = \frac{c}{\sqrt{c^T c}}$. Use gradient descent method to search the minimum for

$g(x_1, x_2)$ with a given initialization of $x(0) = [1 \ 3]^T$. Show and find the updated values $x(1)$, and $x(2)$, with a step size, $\eta = 0.5$. (10 marks)

Q2. This question describes the design of a neural network based *Head Counting System*. Figures Q2a shows a typical image taken at Paris underground. Figure Q2b shows its processed image from the *Head Counting System*.

- i. Briefly describe your design considerations including possible problems and the required inputs. (8 marks)
- ii. Describe the way of extracting the input features. What are the features and why are they required? (6 marks)
- iii. Describe how the extracted features are transformed into numerical input vector as Neural Network inputs. (6 marks)
- iv. Use flow diagram to describe the training of the Neural Network with the input vectors obtained in part iii. (5 marks)



Figures Q2a

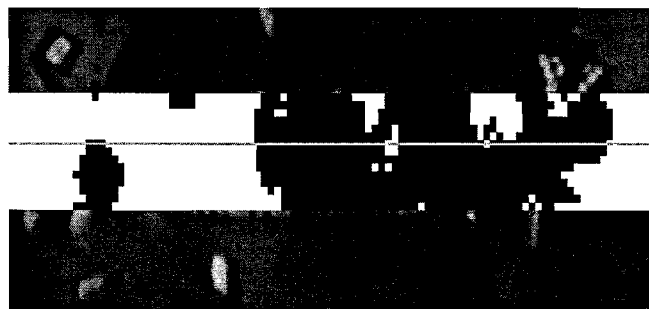


Figure Q2b

Q3.

- i. Figure Q3a shows the simple McCulloch and Pitts (MCP) model for modelling a logic function “AND”. Figure Q3b shows the separation line with a gradient of -0.7, which intersects the y-axis at 1.3, where x_1 is denoted by the y axis, and x_2 is denoted by the x axis. Assuming the threshold, T , is 1, determine the weights w_1 , and w_2 .

(9 marks)

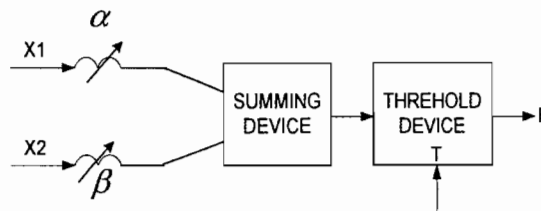


Figure Q3a

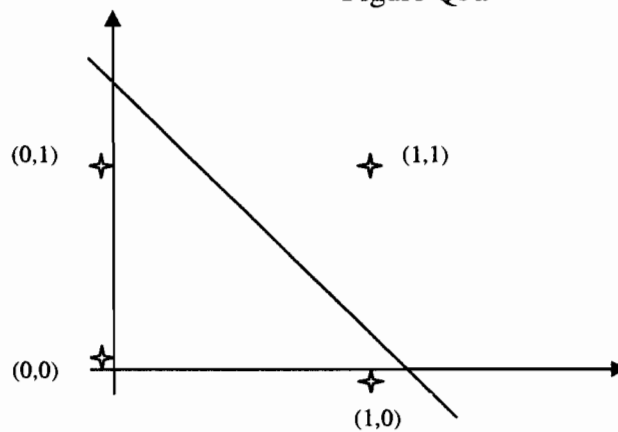


Figure Q3b

- ii. Show why a simple perceptron model cannot model the “exclusive or” logic function. (6 marks)
- iii. Two-input binary neuron shown in Fig. Q3c has a unit step activation function with bias = 0.5. In a 2-dimensional space, where β is denoted as y axis and α is denoted as x axis. Determine the space of the possible values of weights α , β for the neuron inputs x_1, x_2 respectively, if the neuron is
- OFF for input (1.0, 1.0)
 - OFF for input (-0.5, 0.5)
 - ON for input (-0.5, 1).

(10 marks)

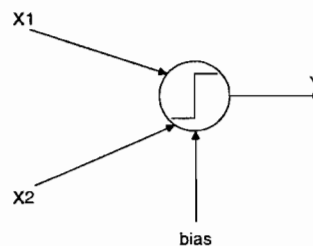


Figure Q3c

Q4.

A) The East Railway, Ma On Shan railway, and West railway of KCR all use 25KV a.c supply and d.c traction system, while many other European railways use a.c traction system. Compare and describe 3 main aspects between these two systems. (9 marks)

B)

i. In an electric power plant fault diagnostic system, the following table shows 9 data points of a 8-attribute + 1 class-label attribute data file. The whole data file consists of over 10000 different fault instances collected in the past year.

Circuit ID	Weather type	Phases	Loading type	Season	plant	Cust off time	Duration in min	Fault Causes
1	o	R	5 (High)	S	c4	13:45	10	F1
1	o	R	5 (High)	S	c4	14:45	10	F2
2	o	R	3 (Medium)	A	c4	9:40	20	F3
2	1	Y	5 (High)	A	x	11:00	45	F4
3	10	Y	5 (High)	A	x	20:00	20	F1
3	2	Y	1(Low)	W	c4	19:43	60	F4
3	3	R	4 (Quite high)	W	c4	17:32	20	F3
5	3	R	3 (Medium)	W	c4	16:44	13	F3
6	3	R	4 (Quite high)	W	c4	11:33	7	F2

A senior engineer of the power plant uses a Self-Organising Map to perform power plant fault diagnosis. Which of the above attributes should not be used in the SOM training? Justify your suggestions. (4 marks)

ii. There are only 6 types of fault, i.e., ice, animal, lightning, human, tree, and deterioration as denoted F1, F2, F3, F4, F5 and F6 under the attribute of fault causes. These six types of fault are found to be nicely discriminated by a SOM using 10x10 neurons. Sketch a typical SOM map to show the possible result. In this case, what is the factor affecting the output visualization of the SOM map? (4 marks)

C The weight adaptation of the SOM learning rule uses a competitive learning method as follows:

$$w_k(t+1) = w_k(t) + \Delta w_k(t),$$

where $w(t+1)$ is the weight at $(t+1)^{st}$ iteration, $\Delta W(t)$ depends on η , the learning rate, and h , the neighbourhood function. To simplify the calculation, assume $h=1$ for the winner neuron, and $=0.5$ for all other neurons, and $\eta=0.5$. In a data set, the current input data $x_1=[2, 3]$, and the following input data are $[1, 4]$, and $[3, 1]$, the initial weights of three neurons are $w_1=[-1, 2]$, $w_2=[2, 0]$ and $w_3=[1, 1]$, respectively. Show how the weights are updated for one iteration. (8 marks)

END