EE 637 Midterm March 31, Spring 2004

Name:			
Instruct	ions:		

- Follow all instructions carefully!
- \bullet This is a 50 minute exam containing ${\bf four}$ problems.
- You may **only** use your brain and a pencil (or pen) to complete this exam. You **may not** use your book, notes or a calculator.

Good Luck.

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Problem 1.(34pt)

Let X(m,n) be a 2-D random field (i.e. random process) where m indexes the column number and n indexes the row number. Assume that the samples of X(m,n) are i.i.d. Gaussian random variables with mean 0 and variance 1,

Let Y(m, n) be given by

$$Y(m,n) = X(m,n) + \sum_{(k,l)>0} h(k,l)Y(m-k,n-l)$$

were the ">" operation is based on the use of raster ordering (i.e. the non-symmetric half plane), and the coefficients h(k, l) are chosen so the filter is stable.

- a) Calculate the power spectral density $S_x(e^{j\mu}, e^{j\nu})$ for X(m, n).
- b) Calculate an expression for the frequency response $H(e^{j\mu},e^{j\nu})$ of the system.
- c) Calculate the power spectral density $S_y(e^{j\mu}, e^{j\nu})$ for Y(m, n).
- d) Calculate E[Y(m,n)|Y(k,l) for (k,l) < (m,n)].

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Problen	2. (20pt)	

Consider the following main program and subroutine.

Main Routine: ClassLabel = 1 Initialize $Y_r = 0$ for $r \in S$ For each $s \in S$ in raster order $\{$ if $(Y_s = 0)$ $\{$ ConnectedSet $(s, Y, ClassLabel) \in ClassLabel \leftarrow ClassLabel + 1$ $\}$

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Subroutine:
```

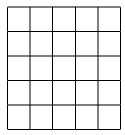
Also con-

```
ConnectedSet(s_0, Y, ClassLabel) {
B \leftarrow \{s_0\}
While B is not empty {
s \leftarrow \text{ any element of } B
B \leftarrow B - \{s\}
Y_s \leftarrow ClassLabel
B \leftarrow B \cup \{r : r \in c(s) \text{ and } Y_r = 0\}
}
return(Y)
}
```

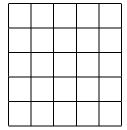
sider the following binary image

0	1	0	0	1
1	0	0	1	1
0	1	1	0	0
0	1	1	0	0
0	1	0	0	1

a) Calculate the output when the binary image is process by the main routine using a 4-pt neighborhood. Wright your result in the table below.¹



b) Calculate the output when the binary image is process by the main routine using an 8-pt neighborhood. Wright your result in the table below.²



¹Pixels on the image edge should be consider to have only 3 neighbors, and pixels in image corners should be considered to have only 2 neighbors.

²Pixels on the image edge should be consider to have only 5 neighbors, and pixels in image corners should be considered to have only 3 neighbors.

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Problem 3.(12pt)

A color image is transformed to XYZ coordinates and stored as a color raster TIFF image using the C-subroutines provided in class. It is then read, transformed to sRGB, and displayed on a monitor with calibrated sRGB input. What defects would you expect to see in such an image? Be specific.

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Problem 4.(34pt)

Specify a system based on a simple image fidelity model for achromatic images. The systems should:

- Have two inputs consisting of two γ -corrected images, with $\gamma = 2.2$.
- Account for the MTF of the human visual system.
- Account for perceptual sensitivity to contrast.
- Have a single scalar output.
- a) Give a block diagram for this system, and specify each block's operation.
- b) Explain why each major component is required. When appropriate, give examples of what would go wrong if a component was not used.
- c) Give examples of an application where this system might be useful.