EE 637 Midterm

March 31, Spring 2004

Name: _____

Instructions:

- Follow all instructions carefully!
- This is a 50 minute exam containing **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.

Name: _____

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 $(k,l) < (m,n)]$.

Name: _____

Name: _____

Problem 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($s, Y, ClassLabel$)
    $ClassLabel \leftarrow ClassLabel + 1$
  }
}

Subroutine:

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

Also consider 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]

[1]Pixels 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.

[2]Pixels 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.

Name: _____

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.

Name: _____

Name: _____

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.

Name: _____