

Problem 1.(50pt)


Consider the emissive display device which is accurately modeled by the equation

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} a & b & c \\ d & e & f \\ g & h & i \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

where  $R$ ,  $G$ , and  $B$  are the red, green, and blue inputs in the range 0 to 255 that are used to modulate physically realizable color primaries.

- a) What is the gamma of the device?
- b) What are the chromaticity components  $(x_r, y_r)$ ,  $(x_g, y_g)$ , and  $(x_b, y_b)$  of the device's three primaries.
- c) What are the chromaticity components  $(x_w, y_w)$  of the device's white point.
- d) If  $(X, Y, Z) = (0, 1/2, 1/2)$ , then what can you say about the values of  $(R, G, B)$ ? (Hint: Draw a chromaticity diagram to find the answer.)
- e) Imagine that the values of  $(R, G, B)$  are quantized to 8 bits, and that you view a smooth gradient from black to white on this device. What artifact are you likely to see, and where in the gradient will you see it?

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**Problem 2.(50pt)**

Consider the following 2-D LSI systems. The first system has input  $x(m, n)$  and output  $y(m, n)$ , and the second system has input  $y(m, n)$  and output  $z(m, n)$ .

$$y(m, n) = \sum_{j=-N}^N a_j x(m, n - j) \quad \text{S1}$$

$$z(m, n) = \sum_{i=-N}^N b_i y(m - i, n) \quad \text{S2}$$

- a) Calculate the 2-D impulse response,  $h_1(m, n)$ , of the first system.
- b) Calculate the 2-D impulse response,  $h_2(m, n)$ , of the second system.
- c) Calculate the 2-D impulse response,  $h(m, n)$ , of the complete system.
- d) How many multiplies does it take per output point to implement each of the two individual systems? How, many multiplies does it take per output point to implement the complete system with a single convolution.
- e) Explain the advantages and disadvantages of implementing the two systems in sequence versus a single complete system.

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