EECS 203A: HW #1 Solution, Spring 2022

1. For $b = 5$, the minimum jump in gray level is 00000000 to 00001000 or 8 which is jagged. Therefore, $b \geq 6$.

For $N = 32$, the pixel-to-pixel jump in gray level along the ramp is 8 which is jagged. Therefore, $N \geq 64$.

If we try $b = 6$ and $N = 64$ we have the samples $0, 4, 8, \ldots$ which is OK. Therefore, we require $b \geq 6$ and $N \geq 64$.

2. a) $H[af(x,y) + bg(x,y)] = 2af(x,y) + 2bg(x,y) + 4$
$aH[f(x,y)] + bH[g(x,y)] = 2af(x,y) + 4a + 2bg(x,y) + 4b$
Operator is not linear.

b) Let H be the median operator. Let $f(x,y)$ be an image with the 9 pixels $\{0, 0, 1, 4, 5, 9, 10, 10, 10\}$. Let the corresponding 9 pixels in image $g(x,y)$ be $\{0, 0, 0, 0, 4, 7, 2, 2, 2\}$. Define the constants $a = b = 1$.

$H[af(x,y) + bg(x,y)] =$ median of $\{0, 0, 1, 4, 9, 16, 12, 12, 12\} = 9$.

We have $H[f(x,y)] = 5$ and $H[g(x,y)] = 2$.

$H[af(x,y) + bg(x,y)] \neq aH[f(x,y)] + bH[g(x,y)]$ so H is nonlinear.

3. a) $b(x,y) = c_1x + c_2y + c_3xy + c_4$

$$\begin{aligned} 16 &= c_1 + c_2 + c_3 + c_4 \\ 11 &= c_1 + 2c_2 + 2c_3 + c_4 \\ 12 &= 2c_1 + c_2 + 2c_3 + c_4 \\ 8 &= 2c_1 + 2c_2 + 4c_3 + c_4 \end{aligned}$$

Solution is $c_1 = -5, c_2 = -6, c_3 = 1, c_4 = 26$

$b(x,y) = -5x - 6y + xy + 26$

b) $b(1.3, 1.7) = 11.51$

4. number of vertical samples $= 1125 * \frac{16}{9} = 2000$

$24 * 2000 * 1125 * 30 * 60 * 120 = 1.1664 \times 10^{13}$ bits