Homework #3

1. Let
   • \( f \) be an image;
   • \( h > 0 \);
   • \( 0 < \Delta x < 1 \) and \( 0 < \Delta y < 1 \).

   Also let \( P_{(x_0, y_0, z_0), (x_1, y_1, z_1)}(x, y) \) denote the line passing through \((x_0, y_0, z_0), (x_1, y_1, z_1)\).

   Given \( x \) and \( y \), compute
   
   • \( f_1 = P_{(x, y, f(x, y)), (x+h, y, f(x+h, y))}(x + h\Delta x, y); \)
   • \( f_2 = P_{(x, y+h, f(x, y+h)), (x+h, y+h, f(x+h, y+h))}(x + h\Delta x, y + h); \)
   • \( P_{(x+h\Delta x, y, f_1), (x+h\Delta x, y+h, f_2)}(x + h\Delta x, y + h\Delta y). \)

   Show the last quantity, when simplified, has the same formula as that given in class for bilinear interpolation.

2. Resize, using bilinear interpolation, the image of “fish.bmp” or “flower.bmp” or “bee.bmp” or “cow.bmp” into an image with width 500 and aspect ratio:
   
   (a) 4 : 3  
   (b) 16 : 9  
   (c) 2.39 : 1

   Print out the resulting images and turn them in.

3. Resize, using cubic interpolation, the 4 \times 4 pixel image

\[
\begin{bmatrix}
0.75 & 0.75 & 0.25 & 0.25 \\
0.75 & 0.75 & 0.25 & 0.25 \\
0.75 & 0.75 & 0.25 & 0.25 \\
0.75 & 0.75 & 0.25 & 0.25 \\
\end{bmatrix}
\]

into a 100 \times 100 pixel image. Use first order von Neumann boundary conditions at the boundaries of the image.

   (a) Print out the resulting image.
   
   (b) Given \( j \), are there oscillations in the intensity values at pixels \((i, j)\), as \( i \) ranges from 0 to 99?

4. Use “fish.bmp” or “flower.bmp” or “bee.bmp” or “cow.bmp” in the following: Resize, using cubic interpolation, with first order von Neumann boundary conditions, to get a 500 \times 500 image. Print out the resulting image.