Tutorial 9: Warping and Morphing

1. Explain what is meant by the following equation:

   morphing = (warping)^2 + blending

2. In the algorithm developed by Beier and Neeley pairs of lines are used to specify the warping. In a concrete example two pairs of lines specify a 2D warping: In the source image the line L_1 starts at (1, 1) and ends at (1, 9). The line L_2 starts at (9, 2) and ends at (9, 8). In the target image the corresponding line L_1' starts at (1, 1) and ends at (1, 9) while L_2' starts at (3, 2) and ends at (9, 2). Calculate where the pixel **p** = (5, 5) in the source image would map to in the target image. Assume that the constants controlling the warping are $a = b = p = 1$.

3. An image with 300 x 175 pixels is warped using a two-dimensional free-form deformation based on linear B-splines defined by a 6 x 6 mesh of control points.

   a. Calculate the spacing between control points in pixels.

   b. Calculate the pixel coordinates for the following B-spline integer lattice coordinates *i, j* and the fractional lattice coordinates *u, v*:

      i. (i, j) = (1, 1) and (u, v) = (0, 0)
      ii. (i, j) = (1, 1) and (u, v) = (0.5, 0.5)
      iii. (i, j) = (1, 3) and (u, v) = (0.75, 0.2857)

   c. Calculate the B-spline integer lattice coordinates i, j and the fractional lattice coordinates u, v for the following pixels:

      i. (x, y) = (120, 140)
      ii. (x, y) = (100, 100)
      iii. (x, y) = (150, 130)

   d. Calculate the new location of a pixel (x,y) = (135, 122.5) after warping. The matrix of control points looks as follows:

(1, 4)	(-3, 7)	(3, 8)	(4, 7)	(0, 1)	(2, 3)
(-3, 7)	(-2, 9)	(2, 7)	(3, 1)	(2, -2)	(2, 2)
(4, 2)	(3, 8)	(2, 1)	(4, 2)	(2, 1)	(3, 1)
(3, 2)	(2, 9)	(-3, 8)	(6, 8)	(3, 4)	(3, 5)
(-1, 3)	(-2, 3)	(1, 3)	(2, 3)	(8, 3)	(-4, 2)
(0, 0)	(-2, 1)	(1, 1)	(-2, 2)	(1, 2)	(0, 0)