Tutorial 3: Texture Mapping

This tutorial concerns texture mapping onto polygons. We will consider the case of a terminal in which individual pixels can be set to any intensity in the range $[0..I_{max}]$.

Suppose that the following function is used to define a texture:

$$I = I_{max}(\alpha+\beta)/2$$

I is the intensity that the pixel of a quadrilateral, corresponding to position $[\alpha,\beta]$ in texture space, will be set to.

The quadrilateral is projected onto the screen, and its four corners appear at coordinates: **P1**=[5,5], **P2**=[15,30], **P3**=[50,50] and **P4**=[40,10]. Assuming that **P1** corresponds to $\alpha=0,\beta=0$, **P2** to $\alpha=0,\beta=1$, **P3** to $\alpha=1,\beta=1$ and **P4** to $\alpha=1,\beta=0$, calculate the corresponding $[\alpha,\beta]$ and hence the intensity to be applied to the point **Pt**=[30,30], using the bi-linear interpolation method given in the lectures. (ie solve for $[\alpha,\beta]$ using $\mathbf{p}=\alpha\beta(\mathbf{c}-\mathbf{b}) + \alpha\mathbf{a} + \beta\mathbf{b}$ where **p**=**Pt**-**P1**, **a**=**P4**-**P1**, **b**= **P2**-**P1** and **c**=**P3**-**P4**)

Computing every pixel by using bi-linear interpolation is very time consuming, since the solution of a quadratic is required. By doing the calculations differentially, much computation time can be saved.

Consider the line from **P1** to **P2**, since at **P1** $\beta=0$ and at **P2** $\beta=1$, and there are 26 pixels on the line, the differential change in β from one pixel to the next is 1/25. Thus, we can find the values of β at each pixel simply by adding the differential as we move from one pixel to its neighbour.

What are the differentials in α and β for the four lines bounding the quadrilateral?

Now consider the horizontal line through the point [30,30]. Using the differential method above, find the values of α and β at the points where it intersects the sides of the quadrilateral, and hence find the differentials in α and β along the line. Use these values to compute α and β at the point [30,30] and check your result with the first part. Can you suggest why the two methods do not give exactly the same result?

Notice that with the differential method, calculating α and β for most of the pixels in the quadrilateral requires only two additions, and hence is much faster.