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An Efficient Trim Structure for Rendering Large B-Rep Models Supplemental Material

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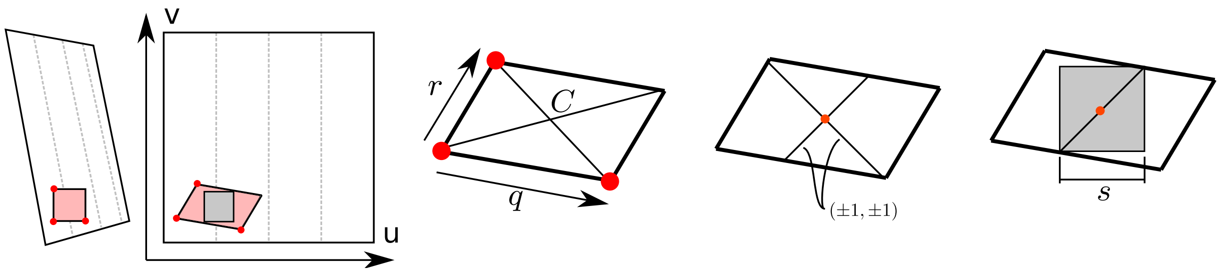

1. Multiresolution access

To find a quadtree node covering less than a screen pixel (see the above Figure), we approximate the footprint of the pixel in parametric space with a parallelogram P defined by the two following vectors:

$$q = \left(\frac{\partial u}{\partial x}, \frac{\partial v}{\partial x}\right) \text{ and } r = \left(\frac{\partial u}{\partial y}, \frac{\partial v}{\partial y}\right)$$

We are searching for the largest side length s of an axis aligned square in parametric space that fits inside P. Such a square can be defined with the following properties:

- its center C is at the intersection of the diagonals of P
- its half diagonal length is equal to the shortest length of segments that start from C, in one of the four direction $(\pm 1, \pm 1)$, stopping at the intersection with P

Let C be the frame center, with coordinates $(0,0)$. The four points $P_0, P_1,_2, P_3$ of P have the following coordinates in this frame:

$$\begin{aligned} P_0 &= -a-b \\ P_1 &= a-b \\ P_2 &= a+b \\ P_3 &= -a+b \end{aligned}$$

with $a = .5q$ and $b = .5r$. We derive the intersection computation and after simplification we obtain that the side lengths of the cubes corresponding to the four intersecting segments are

$$\begin{aligned} t_1 &= 2\left|-a_x - b_x + a_x \frac{a_x+b_x-a_y-b_y}{a_x-a_y}\right| \\ t_2 &= 2\left|-a_x - b_x + b_x \frac{a_x+b_x-a_y-b_y}{b_x-b_y}\right| \\ t_3 &= 2\left|-a_x - b_x + a_x \frac{a_x+b_x+a_y+b_y}{a_x-a_y}\right| \\ t_4 &= 2\left|-a_x - b_x + b_x \frac{a_x+b_x+a_y+b_y}{b_x-b_y}\right| \end{aligned}$$

Hence, the length we are looking for is

$$s = min(t_1, t_2, t_3, t_3).$$

And the corresponding quadtree level is

$$l = \lceil \log_2(1/l_c) \rceil$$