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:

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

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 \( P_0, P_1, P_2, P_3 \) of \( P \) have the following coordinates in this frame:

\[
\begin{align*}
P_0 &= -a - b \\
P_1 &= a - b \\
P_2 &= a + b \\
P_3 &= -a + b
\end{align*}
\]

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

\[
\begin{align*}
t_1 &= 2 \left( -a_s - b_s + a_s \frac{a_s + b_s - a_s - b_s}{a_s + b_s} \right) \\
t_2 &= 2 \left( -a_s - b_s + b_s \frac{a_s + b_s - a_s - b_s}{b_s + b_s} \right) \\
t_3 &= 2 \left( -a_s - b_x + a_s \frac{a_s + b_s + a_s + b_s}{a_s + a_s} \right) \\
t_4 &= 2 \left( -a_s - b_x + b_s \frac{a_s + b_s + a_s + b_s}{b_s + b_s} \right)
\end{align*}
\]

Hence, the length we are looking for is

\[ s = \min(t_1, t_2, t_3, t_4) \]

And the corresponding quadtree level is

\[ l = \lceil \log_2(1/l_c) \rceil \]