Programming #1: Part IV (4190.504)

Due: April 23, 2014

A cubic Bézier curve $C(t) = \sum_{l=0}^{3} \mathbf{b}_l B_l^3(t) = \sum_{l=0}^{3}(x_l, y_l) B_l^3(t) = (x(t), y(t))$, $0 \le t \le 1$, can be bounded by a hierarchy of unions of AABBs or OBBs, each bounding the curve segment $C_i^h(t) = C(t)$, $((i-1)/2^h \le t \le i/2^h)$, for $i = 1, \cdots, 2^h$.

Part I: Design an interactive system that can show the BVH structure (i.e., the AABB tree and the OBB tree) for the Bézier curve $C(t)$, $(0 \le t \le 1)$.

Part II: Design an interactive system that can control the position of a query point $\mathbf{Q}$ and the shape of $C(t)$ by dragging the four control points $\mathbf{b}_l$. Moreover, implement a recursive algorithm for computing the projection line from $\mathbf{Q}$ to the nearest point on the curve $C(t)$. Display the bounding volumes that have been deleted in the search for the nearest point $C(\hat{t})$ by the recursive algorithm.

Part III: Design an interactive system that can control the shape of two cubic Bézier curves $C(t)$ and $D(s)$ by dragging their control points. Moreover, implement an algorithm for computing the shortest distance between the two curves. Display the bounding volumes that have been used in the search for the nearest points between the two curves.

Part IV: Given a set of points $\mathbf{p}_i$, $(i = 1, \cdots, N)$, try to fit a curve $C(t)$ to the point cloud by interactively editing the curve to the skeleton of the shape formed by the points. Each point $\mathbf{p}_i$ can be bound to to its foot point $C(t_i)$ on the curve. Now the displacement d_i of along the normal of $C(t)$ can be used to control the shape of the point cloud by interactively manipulating the shape of $C(t)$.