13.003
Computational Geometry and Visualization

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Problem Set 3

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Due: February 28, 2000

In this problem set, we will look at various forms of representing a 3D curve in space, as well as continue our work with C and the graphics library OpenGL to visualize the deck of our yacht tender as a wireframe model. A skeleton program *ps3*, which displays a 3D cube, and allows the user to manipulate it, can be copied from the 13.003 course locker.

With the course locker and the *glut* locker attached you will have access to the library files needed to compile *ps3*. The code needed for this problem set is in the *ProblemSets/PS3/* directory in the course locker.

1. Download the files *Makefile, and ps3.c* to your directory. Examine the source code, compile it, run it, and observe what it does.

2. (12 Pts) Recall from Problem Set 1 that the sheer line (edge of deck) of our yacht tender is represented by two cubic planar parametric curves $\mathbf{r}_1(u) = \{x_1(u), y_1(u), z_1(u)\}$ and $\mathbf{r}_2(v) = \{x_2(v), y_2(v), z_2(u)\}$, where $0 \leq u, v \leq 1$:

$$\mathbf{r}_1(u) = \begin{bmatrix} x_1(u) \\ y_1(u) \\ z_1(u) \end{bmatrix} = \begin{bmatrix} -105.3372u^3 + 257.0999u^2 + 232.2372u \\ 57.0275u^3 - 279.1296u^2 + 392.1021u \\ 38.7212u^3 - 19.1985u^2 - 92.5227u + 170 \end{bmatrix}$$

$$\mathbf{r}_2(v) = \begin{bmatrix} x_2(v) \\ y_2(v) \\ z_2(v) \end{bmatrix} = \begin{bmatrix} -2.9684v^3 - 3.4848v^2 + 390.4533v + 384 \\ 10.7240v^3 - 68.9430v^2 + 5.2191v + 170 \\ -14.3627v^3 + 47.3284v^2 - 25.9656v + 97 \end{bmatrix}$$

   (a) (1 Pt) Write the equations in the matrix form of Ferguson representation.

   (b) (3 Pts) Convert them to Hermite-Coons curves using matrix operations (use MATLAB for the actual matrix operations).

   (c) (2 Pts) Explain why the Hermite basis functions satisfy the boundary conditions stated in Section 4.3.2 in the course notes.

(d) (6 Pts) Using MATLAB (or C), draw the sheer line represented by the Hermite-Coons formulation derived above. Change the magnitude of the tangent vectors at $u = 0$ and $v = 1$ (experiment with a few different values of the tangent vectors), and see what happens. Hand in the plots of the sheer line and two new curves created by changing the tangent vectors. Draw the tangent vectors specified at the two end points.

3. (8 Pts) Use the skeleton code in *ps3.c* to create a simple wireframe model of the deck of the yacht tender by drawing the 3D sheer line described by the above equations (or the Hermite-Coons formulation derived above), reflecting the sheer line across the XZ plane, and connecting the ends of the two curves with a straight line.

   You will only need to replace the part which draws a cube in *displayCB()* with code to draw the wireframe model of the deck.

   Hand in your plots which include the wireframe model of the deck and a new model created by scaling the old one.