SC303 - Mid-Semester Examination

Curves and Surfaces for Computer Graphics

Indian Institute of Information Technology, Vadodara

February 18, 2016

1. (Reparametrization of curves) In computer graphics, moving an object (or camera view point) along a parametrized curve with constant speed is an obvious requirement. The method to do this requires the curve to be reparametrized by arc length.

   Let $C_1(s)$, $s \in [0, L]$ where L is length of the curve, be an arc-length parametrized curve and $C_2(t)$, $t \in [t_{min}, t_{max}]$, be another parametrization of the same curve[1]. This provides a relationship between t and s (time and distance), which is defined by a pair (t, s) for which $C_2(t) = C_1(s)$. Applying chain rule results in,

   $$\frac{dC_2}{dt} = \frac{dC_1}{ds}\frac{ds}{dt}, \tag{1}$$

   furthermore,

   $$\left|\frac{dC_2}{dt}\right| = \left|\frac{dC_1}{ds}\right| \left|\frac{ds}{dt}\right| = \frac{ds}{dt}. \tag{2}$$

   To obtain relationship between s and t, let us integrate the above equation, we obtain s as a function of t,

   $$s = g(t) = \int_{t_{min}}^{t} \left|\frac{dC_2(\tau)}{d\tau}\right| d\tau. \tag{3}$$

   From above, given the time t, we can determine the corresponding arc length s from the integration.

   (a) Given an arc length s, determine t at which this arc length is achieved.

   (b) Begin with a parametrized curve $C_3(u)$ for $u \in [u_{min}, u_{max}]$, and determine a parametrization by time t, say, $C_2(t) = C_3(u)$ for $t \in [t_{min}, t_{max}]$, so that the speed at time t is a specified function $\sigma(t)$.

   Implement functions to numerically solve above state problems. Select an arbitrary curve in $\mathbb{R}^3$ (cubic B-Spline with at least three segments) and demonstrate reparametrization. If possible, provide user with an interface to input control points.

   [20 Points]

2. (Walk Through) Create geometric model of a rectangular room with a center table and a geometric object[2] on the table. These are minimum requirements, you can

[1] Here, *same curve* indicates that both curves have same graph.

[2] You may use your imagination, make this object as interesting as possible.

definitely add more objects to your room. Use Blender to create .obj file containing all the information about objects in terms of meshes.

Provide a user interface which will allow user to walk through the room with the help of arrow keys (front, back, right, left). To begin with the user points in the direction of the centroid of the geometric object on table. The user should also be able to rotate his view point (up, down, right, left). Assume that the user is 6 unit tall. Height of table is 3 units. Ceiling height is 10 units.

Do not apply illumination, shading or texture to objects. Objects must be displayed as meshes. You may use different colored meshes to represent different objects. Caution: user can not walk through walls.

[30 Points]