CSE 333 - Monsoon 2023

Assignment 01: Bezier curves

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1) **Strategy to create the interpolating piecewise Bezier curve and to enforce C^1 continuity.**

   Control points will be specified by the user, and since the piecewise cubic Bezier curve is interpolating, it should pass through all user-specified control points, hence these control points are the end point of the curve. We need two more control points in order to draw a cubic Bezier curve (Since we need 4 control points for a cubic Bezier curve). Suppose four control points to be x_0, x_1, x_2, and x_3. We already have x_0 and x_3 and we need to write a strategy for x_1 and x_2 control points. (since x_0 and x_3 are user-specified control points).

   To ensure C^1 continuity we need to ensure tangents have equal direction and length and segments have equal first derivatives in interpolations points i.e. if p_0, p_1, p_2, p_3 and q_0, q_1, q_2, q_3 are the control points of two cubic Bezier curves, in order to have C^0 continuity we need $\mathbf{p_3 = q_0}$ and for C^1 continuity $\mathbf{p_3 - p_2 = q_1 - q_0}$.

   For the first set of control points, we can determine x_1 by adding (distance between x_0 and x_3)/3 to x_0. For the rest of the cases, x_1 will be calculated by ensuring c_1 continuity at joins. Using the above equations, we will get $x_1 = 2 * x_0 - p_x$ where p_x denotes the previous endpoint.

   We can directly determine x_2 using midpoint formula($(x_3+x_1)/2$).
   Now we have all four control points and need to plot a Bezier curve for this set of control points. We can use the equation of the Bezier curve to plot the Beizer curve for the control points i.e.

$$B^3(t)=(1 - t)^3 . x_0 + 3(1 - t).t^{2.} x_1 + 3(1 - t)^2 .t.x_2 + t^3 .x_3. \quad - i)$$

   We need to vary t in order to get different points of the curve, we can define the number of samples per curve and then can create these numbers of points for the curve. Now we will have all points to create a cubic piecewise Bezier curve with C^1 continuity.

2) Implement drawing of interpolating piecewise cubic Bezier curve from points taken progressively (i.e, even while the user is adding control points).

   As described in 1) we will generate all control points i.e. x_0, x_1, x_2, and x_3 and then draw interpolating piecewise cubic Bezier curve using the cubic Bezier equation i.e i) . Like the implementation of piecewise Bezier curve we will create necessary binding, cleaning functions , drawing functions, etc for cubic Bezier. Also we will change things such as toggle of linear and cubic Bezier curve, in order to draw interpolating piecewise cubic Bezier curve. User input

is handled by default and we need not to change or implement something in that. Also, we will set the z coordinate of each point to be 0 i.e. (x_i, yi, 0). Also, we need to add the last point at the end.(Since, except the last endpoint every endpoint of the remaining curve will be added at the next iteration.

Output Screenshot: