Assignment in Computer Graphics II
– Assignment 12 –

Computer Graphics and
Multimedia Systems Group
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Assignment 1 [2 Points] Camera coordinate system and up-vector

A camera moves on the spiral path $\mathbf{C}(t) = \begin{pmatrix} cos(\omega t) \\ vt \\ sin(\omega t) \end{pmatrix}$, where v is the vertical speed and ω is the angular velocity (radians per second). The camera axis should always be aligned along the tangent direction.

1. Calculate the up vector. Assume that the up-vector remains the same for positive and negative direction of rotation.
2. How does the sign of its y component behaves?
3. Which value does the up vector take for $v = 0$?

Assignment 2 [3 Points] Tapering

Given the tapering function

$$r(u) = \frac{1}{5}(u+1)^2 + \frac{1}{5}$$

and a cubic Bezier curve $\mathbf{C}(t)$ with control points

$$\mathbf{C}_0 = \begin{pmatrix} 1 \\ -1 \end{pmatrix}, \mathbf{C}_1 = \begin{pmatrix} -1 \\ -1 \end{pmatrix}, \mathbf{C}_2 = \begin{pmatrix} -1 \\ 1 \end{pmatrix}, \mathbf{C}_3 = \begin{pmatrix} 1 \\ 1 \end{pmatrix}.$$

1. Scale the second coordinate of the given control points by using the tapering function $r(u)$. Using the new contol points, execute the De-Casteljau algorithm geometrically for $t = 0, 0.1, 0.25, 0.5, 0.75, 0.9, 1$. Sketch the curve.
   Hint: Utilize the symmetry of control points.
2. Given the curve points:
   $\mathbf{C}(0) = \begin{pmatrix} 1 \\ -1 \end{pmatrix}$, $\mathbf{C}(0.1) = \begin{pmatrix} 0.46 \\ -0.94 \end{pmatrix}$, $\mathbf{C}(0.25) = \begin{pmatrix} -0.125 \\ -0.6875 \end{pmatrix}$, $\mathbf{C}(0.5) = \begin{pmatrix} -0.5 \\ 0 \end{pmatrix}$, $\mathbf{C}(0.75) = \begin{pmatrix} -0.125 \\ 0.6875 \end{pmatrix}$,
   $\mathbf{C}(0.9) = \begin{pmatrix} 0.46 \\ 0.94 \end{pmatrix}$, $\mathbf{C}(1) = \begin{pmatrix} 1 \\ 1 \end{pmatrix}$.
   Scale the second coordinate of these curve points by using the tapering function $r(u)$. Sketch the corresponding curve and compare it with the result from subtask 1.
   Hint: Utilize the symmetry of the control points.

Assignment 3 [3 Points] Forward Kinematics

Given is the two-dimensional, three-tier (dreigliedrige) model (see Slide 9.6):$\phi_1 = 45°$, $\phi_2 = 270°$, $\phi_3 = 90°$ and

$$P_1 = \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \quad l_1 = 6,\ l_2 = 3,\ l_3 = 2$$

1. Evaluate the end effector X_1 geometrically.
2. Calculate the end effector X_1, by successively calculating the intermediate points P_2 and P_3 in global coordinates.
3. Specify the workspace of the end effector X_1 and explain briefly your claim.

Total points after sheet 11: 65 of 70.

Hand in: Until 12.07.2018 12:00 o'clock in mailbox of our chair (next to room 7115).