# Assignment in Computer Graphics II

## – Assignment 10 –

**Computer Graphics and**
**Multimedia Systems Group**
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**Assignment 1** [2 Points] Arc length

Given the curve $\mathbf{C}(u) = \begin{pmatrix} u \\ \sqrt{1-u^2} \end{pmatrix}$ in $R^2$ for $u \in [0,1]$.

1. Sketch the shape of the curve.
2. Calculate the arc length function $l_C(u)$ with the help of $\mathbf{C}'(u)$. Use the equation

$$\frac{d}{dx} arcsin(x) = \frac{1}{\sqrt{1-x^2}}. \tag{1}$$

3. Curve $\mathbf{C}$ should be traversed with constant velocity in the time interval $t \in [0,1]$. Give the function $s(t)$, which describes the traveled distance for time interval $t \in [0,1]$. Calculate $\mathbf{C}(t)$ with the function $s(t)$.

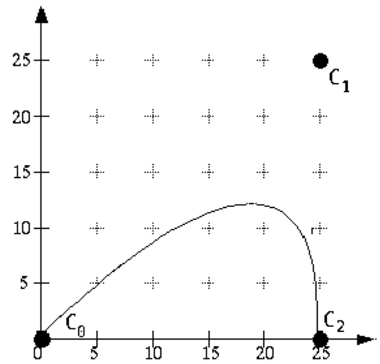
**Assignment 2** [2 Points] Camera coordinate system and up-vector

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 $\omega$ 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 3** [2 Points] Spline-based animation

Given the Bezier curve $\mathbf{C}(u)$ (shown in the figure) with control points
$\mathbf{C}_0 = \begin{pmatrix}0\\0\end{pmatrix}$, $\mathbf{C}_1 = \begin{pmatrix}25\\25\end{pmatrix}$ und $\mathbf{C}_2 = \begin{pmatrix}25\\0\end{pmatrix}$.




Also given curve points for $u_1 = 0.2,\ u_2 = 0.4,\ u_3 = 0.6,\ u_4 = 0.8$:

$$\mathbf{C}(u_1) = \begin{pmatrix}9\\8\end{pmatrix},\ \mathbf{C}(u_2) = \begin{pmatrix}16\\12\end{pmatrix},\ \mathbf{C}(u_3) = \begin{pmatrix}21\\12\end{pmatrix},\ \mathbf{C}(u_4) = \begin{pmatrix}24\\8\end{pmatrix}.$$

Two lookup tables with arc lengths have to be completed:

| $u_i$ | *Bogen* |
|---|---|
| $u_0 = 0$ | $l_0 = 0$ |
| $u_1 = 0{,}2$ | $l_1 =$ |
| $u_2 = 0{,}4$ | $l_2 =$ |
| $u_3 = 0{,}6$ | $l_3 =$ |
| $u_4 = 0{,}8$ | $l_4 =$ |
| $u_5 = 1{,}0$ | $l_5 =$ |

| *Bogen* | $u_i^*$ |
|---|---|
| $l_0^* = 0$ | $u_0^* = 0$ |
| $l_1^* =$ | $u_1^* =$ |
| $l_2^* =$ | $u_2^* =$ |
| $l_3^* =$ | $u_3^* =$ |
| $l_4^* =$ | $u_4^* =$ |
| $l_5^* =$ | $u_5^* =$ |

1. For Parameters $u_0, \ldots, u_5$ compute respectively the approximations $l_i$ between $\mathbf{C}(u_0)$ und $\mathbf{C}(u_i)$. Insert the values into the table.
2. Divide the total length into five equidistant parts and insert the interim values $l_1^*, \ldots, l_5^*$ into the table.
3. Determine for the arc lengths $l_1^*, \ldots, l_5^*$ the corresponding parameters $u_1^*, \ldots, u_5^*$, to get the curve points in equidistant distances.
   **Hint:** For every arc length perform a search in the left table. If the found value is between two table entries then use linear interpolation to obtain the new parameter.

**Hand in: 11.1.2015, at beginning of the lecture or until 12:00 in the mailbox of the chair (next to room H-A 7107)**