Project 1 - 2D Parametric Curves

Computer Graphics Course

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1. Description of Program Inputs

Vertex Attributes

Name	Type	Description
`a_idx`	float	Index of each vertex sample (from 0 to `u_nsamples-1`). Used to compute parameter t for curve generation.

Uniform Variables

Name	Type	Description
`u_tmin`	float	Lower bound of parameter t (start of the curve).
`u_tmax`	float	Upper bound of parameter t (end of the curve).
`u_nsamples`	int	Number of samples used to draw the curve (controls smoothness).
`u_type`	int	Defines which curve family is drawn (1–6).
`u_coef[3]`	float[3]	Coefficients (a, b, c) used in the parametric equations.
`u_scale`	float	Global zoom/scale factor for the scene.
`u_offset`	vec2	Translation offset (for panning).
`u_aspect`	float	Aspect ratio of the viewport (width/height).
`u_hue`	float	Normalized hue value (0–1) defining the curve color.

2. Extra Functionality: Dynamic Color Control

A custom color control was added using a hue slider (`<input type="range">`) in the HTML interface.

- The user can manually change the color of the curve in real time by adjusting the hue slider.

- The hue value (in degrees, 0–360) is converted to a normalized float (0–1) and passed to the fragment shader as `u_hue`.
- When the animation is active (Space key), the hue slider hides automatically and the color hue cycles smoothly over time, producing a continuous rainbow-like transition.
- When the animation stops, the hue slider reappears and manual color control becomes available again.

Color Interpolation Method

The color is computed from the hue using a cosine-based interpolation that smoothly transitions between the RGB components. Let the hue value be $u_{\text{hue}} \in [0, 1]$. The color vector is calculated as:

$$\textbf{color} = 0.5 + 0.5 \cdot \cos\left(2\pi\, u_{\text{hue}} + \begin{bmatrix} 0 \\ \frac{2\pi}{3} \\ \frac{4\pi}{3} \end{bmatrix}\right)$$

where the phase shifts of $0, \frac{2\pi}{3}, \frac{4\pi}{3}$ correspond to the red, green, and blue channels respectively. This cosine interpolation ensures that all color components vary sinusoidally and remain within $[0, 1]$, creating a continuous and visually smooth transition across the full color spectrum.