Ray Tracing Generalized Tube Primitives: Method and Application

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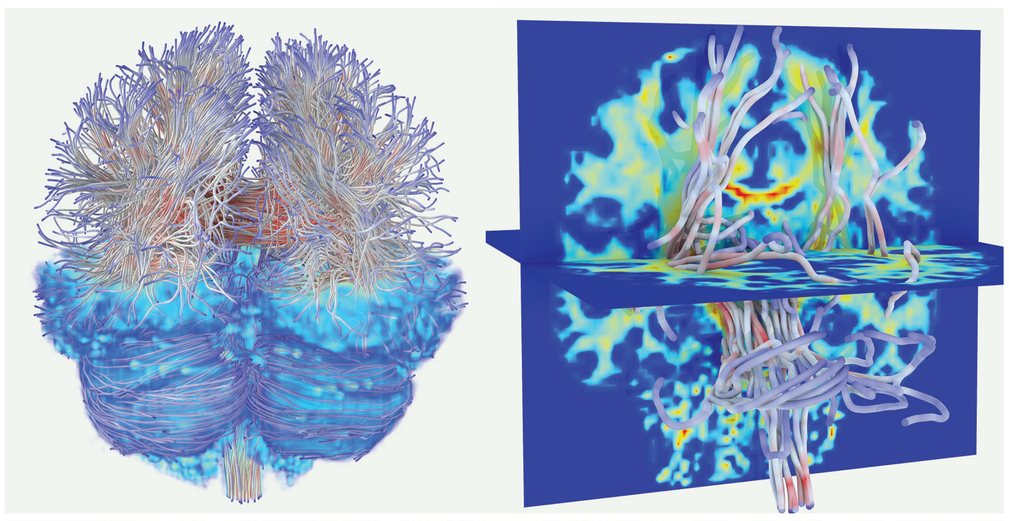
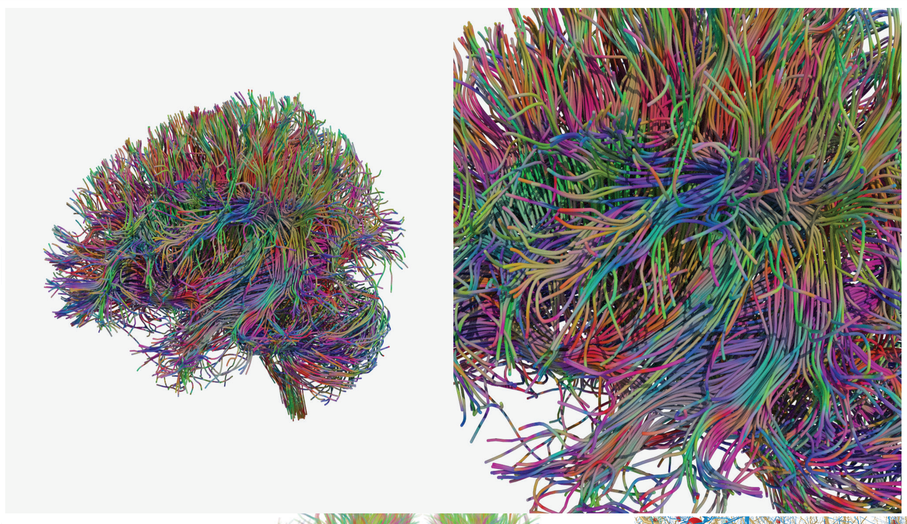
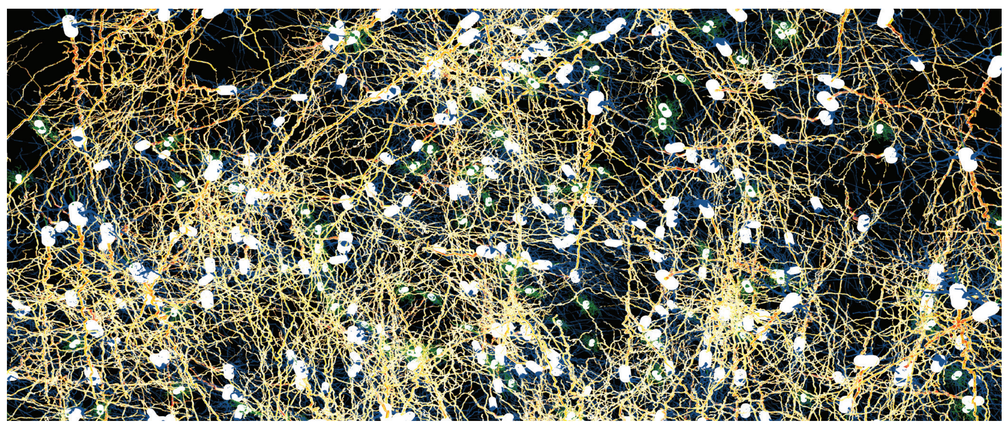
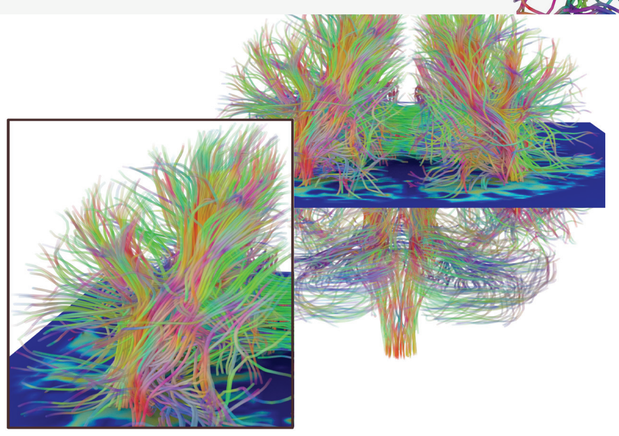
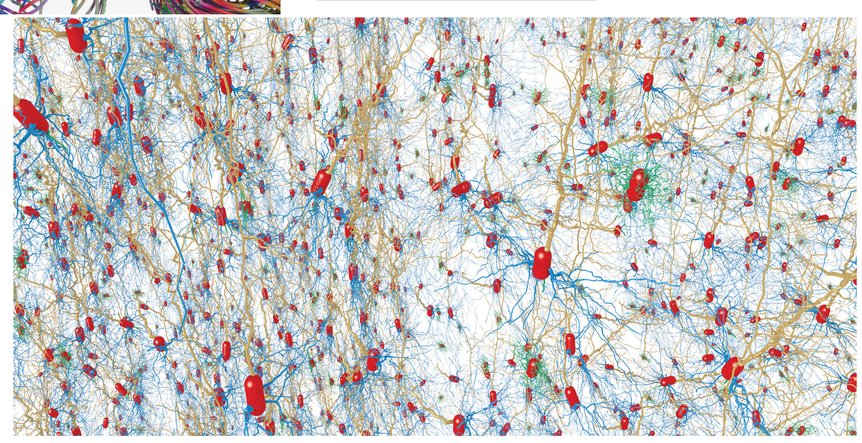
A new method for rendering 3D line primitives, supporting (1) varying radii, (2) bifurcations and (3) correct transparency



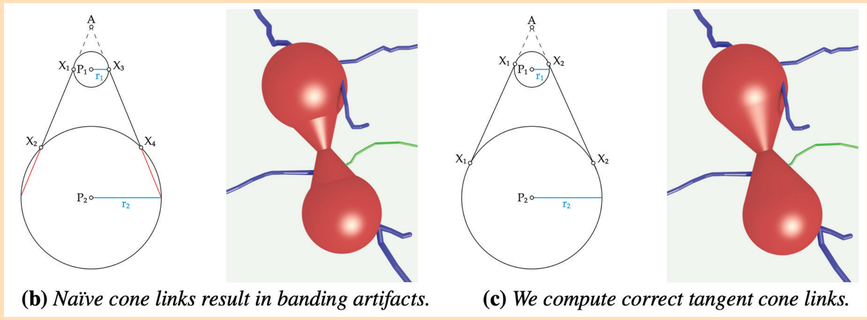






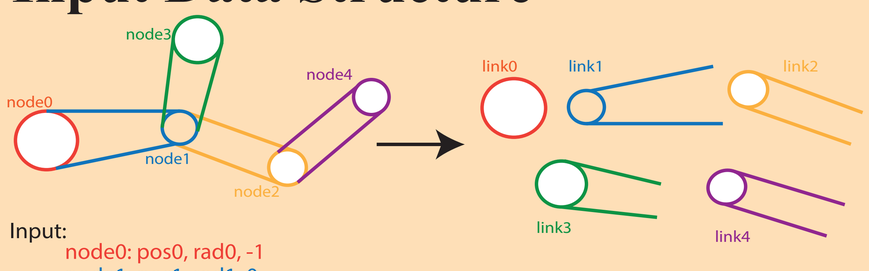


Choice of Representation



(b) *Naïve cone links result in banding artifacts.* **(c)** *We compute correct tangent cone links.*

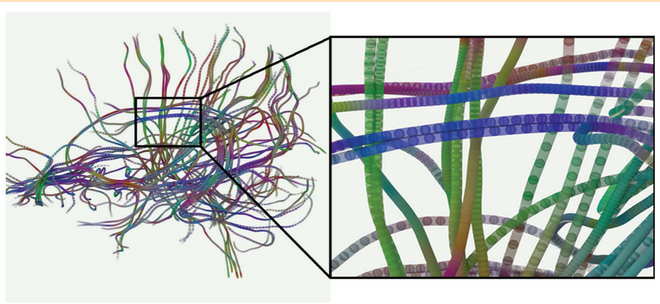
Input Data Structure



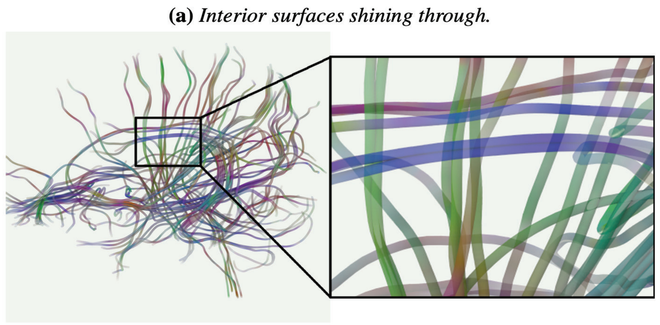
Input:
node0: pos0, rad0, -1
node1: pos1, rad1, 0
node2: pos2, rad2, 1
node3: pos3, rad3, 1
node4: pos4, rad4, 2

→ [pos0, rad0, -1, pos1, rad1, 0, pos2, rad2, 1, pos3, rad3, 1, pos4, rad4, 2]

Correct Transparency



(a) *Interior surfaces shining through.*



(b) *Our method removes interior surfaces correctly.*

Experiments and Results

Performance on Opaque Geometry

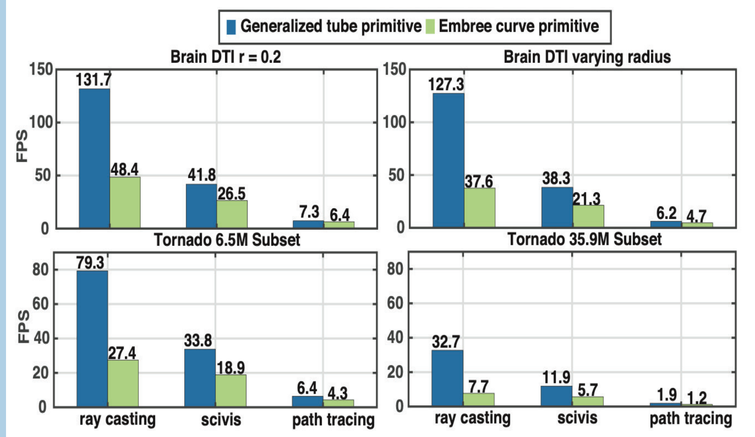
Table 2: *Performance on the* Desktop *with a* 1024^2 *framebuffer.*

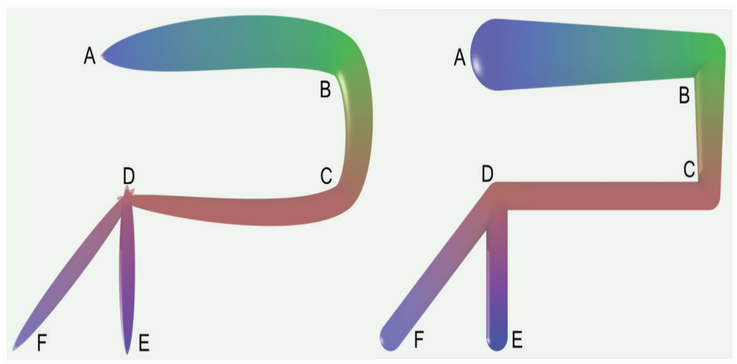
Dataset	Frame Rate (FPS)		
	Ray Casting	SciVis	Path Tracing
Neuron (a)	94.9	90.0	47.7
Neuron (b)	118.8	111.0	76.2
Neuron (c)	107.9	95.4	66.5
Neuron (d)	87.3	52.2	15.6
DTI ($r = 0.05$mm)	37.8	13.1	2.1
DTI ($r = 0.15$mm)	44.7	16.6	2.3
DTI ($r = 0.30$mm)	50.6	16.9	2.8

Compared to Triangulation

Dataset	Memory Use (GB)		Framerate (FPS)	
	Triangles	GT	Triangles	GT
DTI	35.4	0.13	38.9	131.2
Torus	*	1.8	*	134.5
10^3 Neurons	69.8	0.18	23.03	74.9
14^3 Neurons	*	0.36	*	52.3
Tornado 6.5M	*	1.7	*	79.2
Tornado 35.9M	*	8.8	*	33.5
DTI	35.6	0.16	117.6	259.4
Torus	678.0	1.8	31.29	271.2
10^3 Neurons	70.1	0.2	65.5	151.4
14^3 Neurons	191.8	0.36	38.5	107.78
Tornado 6.5M	673.1	1.8	12.7	171.4
Tornado 35.9M	*	9.0	*	75.8

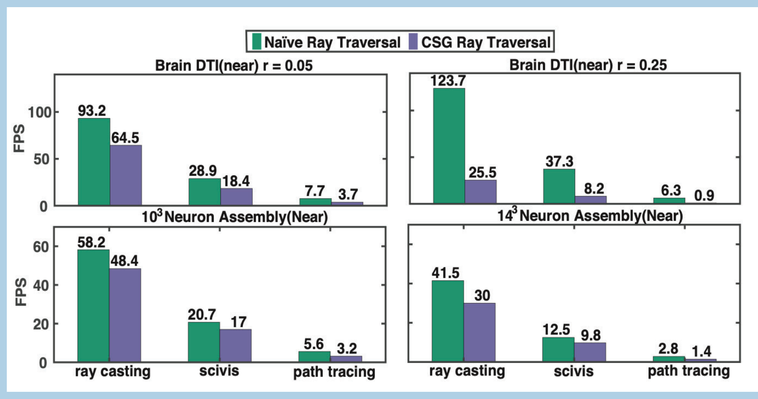
Performance Compared to Embree

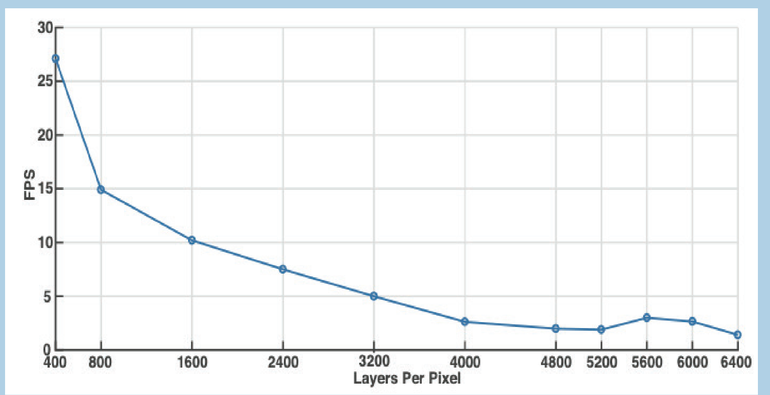




(a) *Embree's Bézier curve primitive.* **(b)** *Our generalized tube.*

Impact of CSG Intersection





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