

GPU Coroutines for Flexible Splitting and Scheduling of Rendering Tasks — Supplemental Materials

Submission ID: 0194

1 Path Tracing with GPU Coroutines

Fig. 11 in the main document briefly depicts the rendering time of scheduling path tracing kernels with GPU coroutines. Tab. 1 shows the detailed data (in seconds) to render 5 different scenes on RTX-2080Ti (11GB VRAM) on CUDA and DirectX backends, combined with 10 maximum bounces, Russian Roulette (RR) applied from the 2nd bounce (10, 2) and 24 maximum bounces, RR applied from the 5th bounce (24, 5). *Bathroom* is rendered at a resolution of 1024x1024; *Salle de Bain*, *Kitchen* and *White Room* at 1280x720; *Lone Monk* at 1920x1440. All scenes are rendered at 1024spp in spectral mode.

The wavefront scheduler is configured with 2^{24} coroutine instances per kernel dispatch, SoA frame layout, and frame buffer compaction. The persistent-threads scheduler is configured to use 2^{15} working threads, with 128 threads per block each fetching 16 coroutine instances on task acquisition. The global memory extension is also turned on for improved thread occupancy. However, the persistent-threads scheduler is not available on CUDA due to the absent support for thread block synchronization when ray tracing with OptiX.

Tab. 1: Rendering time comparison for the path tracing application using the original mega-kernel, hand-written wavefront scheduling, and our built-in coroutine schedulers.

Scene	Backend	Integrator	Scheduler	Depth	Time
Bathroom	CUDA	Mega-Kernel	/	(10, 2)	27.4s
Bathroom	CUDA	Wavefront	/	(10, 2)	12.8s
Bathroom	CUDA	Coroutine	Wavefront	(10, 2)	17.8s
Bathroom	DirectX	Mega-Kernel	/	(10, 2)	19.6s
Bathroom	DirectX	Wavefront	/	(10, 2)	11.3s
Bathroom	DirectX	Coroutine	Wavefront	(10, 2)	16.2s
Bathroom	DirectX	Coroutine	Persistent-Threads	(10, 2)	15.8s
Bathroom	CUDA	Mega-Kernel	/	(24, 5)	39.7s
Bathroom	CUDA	Wavefront	/	(24, 5)	22.8s
Bathroom	CUDA	Coroutine	Wavefront	(24, 5)	28.6s
Bathroom	DirectX	Mega-Kernel	/	(24, 5)	28.9s
Bathroom	DirectX	Wavefront	/	(24, 5)	19.9s
Bathroom	DirectX	Coroutine	Wavefront	(24, 5)	25.7s
Bathroom	DirectX	Coroutine	Persistent-Threads	(24, 5)	25.8s
Salle de Bain	CUDA	Mega-Kernel	/	(10, 2)	14.0s
Salle de Bain	CUDA	Wavefront	/	(10, 2)	6.9s
Salle de Bain	CUDA	Coroutine	Wavefront	(10, 2)	10.3s
Salle de Bain	DirectX	Mega-Kernel	/	(10, 2)	9.3s
Salle de Bain	DirectX	Wavefront	/	(10, 2)	5.3s
Salle de Bain	DirectX	Coroutine	Wavefront	(10, 2)	9.2s
Salle de Bain	DirectX	Coroutine	Persistent-Threads	(10, 2)	8.5s
Salle de Bain	CUDA	Mega-Kernel	/	(24, 5)	23.2s
Salle de Bain	CUDA	Wavefront	/	(24, 5)	14.8s
Salle de Bain	CUDA	Coroutine	Wavefront	(24, 5)	18.7s
Salle de Bain	DirectX	Mega-Kernel	/	(24, 5)	16.0s
Salle de Bain	DirectX	Wavefront	/	(24, 5)	10.9s
Salle de Bain	DirectX	Coroutine	Wavefront	(24, 5)	15.9s
Salle de Bain	DirectX	Coroutine	Persistent-Threads	(24, 5)	15.8s
Kitchen	CUDA	Mega-Kernel	/	(10, 2)	20.3s
Kitchen	CUDA	Wavefront	/	(10, 2)	9.1s
Kitchen	CUDA	Coroutine	Wavefront	(10, 2)	12.7s
Kitchen	DirectX	Mega-Kernel	/	(10, 2)	17.0s

Scene	Backend	Integrator	Scheduler	Depth	Time
Kitchen	DirectX	Wavefront	/	(10, 2)	7.4s
Kitchen	DirectX	Coroutine	Wavefront	(10, 2)	12.7s
Kitchen	DirectX	Coroutine	Persistent-Threads	(10, 2)	12.8s
Kitchen	CUDA	Mega-Kernel	/	(24, 5)	29.7s
Kitchen	CUDA	Wavefront	/	(24, 5)	17.6s
Kitchen	CUDA	Coroutine	Wavefront	(24, 5)	21.3s
Kitchen	DirectX	Mega-Kernel	/	(24, 5)	25.4s
Kitchen	DirectX	Wavefront	/	(24, 5)	14.4s
Kitchen	DirectX	Coroutine	Wavefront	(24, 5)	20.6s
Kitchen	DirectX	Coroutine	Persistent-Threads	(24, 5)	22.4s
White Room	CUDA	Mega-Kernel	/	(10, 2)	20.9s
White Room	CUDA	Wavefront	/	(10, 2)	8.3s
White Room	CUDA	Coroutine	Wavefront	(10, 2)	11.7s
White Room	DirectX	Mega-Kernel	/	(10, 2)	17.8s
White Room	DirectX	Wavefront	/	(10, 2)	6.9s
White Room	DirectX	Coroutine	Wavefront	(10, 2)	12.8s
White Room	DirectX	Coroutine	Persistent-Threads	(10, 2)	12.5s
White Room	CUDA	Mega-Kernel	/	(24, 5)	29.3s
White Room	CUDA	Wavefront	/	(24, 5)	15.6s
White Room	CUDA	Coroutine	Wavefront	(24, 5)	19.7s
White Room	DirectX	Mega-Kernel	/	(24, 5)	25.6s
White Room	DirectX	Wavefront	/	(24, 5)	12.7s
White Room	DirectX	Coroutine	Wavefront	(24, 5)	20.3s
White Room	DirectX	Coroutine	Persistent-Threads	(24, 5)	21.6s
Lone Monk	CUDA	Mega-Kernel	/	(10, 2)	48.6s
Lone Monk	CUDA	Wavefront	/	(10, 2)	27.6s
Lone Monk	CUDA	Coroutine	Wavefront	(10, 2)	33.6s
Lone Monk	DirectX	Mega-Kernel	/	(10, 2)	40.3s
Lone Monk	DirectX	Wavefront	/	(10, 2)	25.2s
Lone Monk	DirectX	Coroutine	Wavefront	(10, 2)	33.7s
Lone Monk	DirectX	Coroutine	Persistent-Threads	(10, 2)	34.3s
Lone Monk	CUDA	Mega-Kernel	/	(24, 5)	112.5s
Lone Monk	CUDA	Wavefront	/	(24, 5)	67.6s
Lone Monk	CUDA	Coroutine	Wavefront	(24, 5)	81.1s
Lone Monk	DirectX	Mega-Kernel	/	(24, 5)	88.1s
Lone Monk	DirectX	Wavefront	/	(24, 5)	62.8s
Lone Monk	DirectX	Coroutine	Wavefront	(24, 5)	79.7s
Lone Monk	DirectX	Coroutine	Persistent-Threads	(24, 5)	81.6s