

# Supplementary Material:

## Real-time Rendering on a Power Budget

Rui Wang<sup>1\*</sup> Bowen Yu<sup>1</sup> Julio Marco<sup>2</sup> Tianlei Hu<sup>1</sup> Diego Gutierrez<sup>2,3</sup> Hujun Bao<sup>1\*</sup>

<sup>1</sup> State Key Lab of CAD&CG, Zhejiang University <sup>2</sup> Universidad de Zaragoza <sup>3</sup> I3A Institute

### A Scalability Settings in Unreal Engine

Unreal Engine provides a wide range of predefined parameters to adjust the quality of different rendering features in order to improve performance. However, the combinatorial explosion of all possible parameters with all possible values makes it intractable to explore the full variable space. Conveniently, Unreal Engine provides predefined scalability settings with multiple quality levels. Each scalability setting level represents a group of commonly used rendering parameters set to a certain level or resolution. For our Unreal Engine demos *Elven Ruins* and *Sun Temple* we made use of these predefined scalability settings to generate all possible configurations to explore. We briefly describe the types of scalability settings we used, and refer to the Unreal Engine documentation for more details [UnrealEngine 2015]. The numbers in parentheses represent the discrete quality levels of every scalability setting.

**Anti-Aliasing (0, 2, 4, 6)** This setting tunes the quality of the anti aliasing method used in the game (FXAA in our tested scenes).

**Post Processing (0-3)** It represents a group of post processing effects such as ambient occlusion, depth of field, or bloom. Every quality level represents a combination of different parameter values for these effects.

	Post Processing Level			
	0	1	2	3
Motion Blur (disabled)	0	0	0	0
Blur G-Buffer	0	0	-1	-1
Ambient Occlusion Levels	0	1	2	3
A.O. Radius Scale	1.7	1.7	1.5	1.0
DOF Quality	0	1	2	2
Render Target Pool Min	0	0	-1	-1
Lens Flare Quality	0	0	2	2
Bloom Quality	4	4	5	5
Upscale Quality	1	2	2	3

**Shadows (0-3)** Four levels of quality for shadows, tuning parameters such as the shadow map resolution and interpolation quality.

	Shadows Level			
	0	1	2	3
Shadow Quality	0	2	5	6
Max. Cascaded Maps	1	1	2	4
Max. Resolution	512	1024	1024	1024
Radius Threshold	0.06	0.05	0.04	0.03
Distance Scale	0.6	0.7	0.85	1.0
Cascade Transition Scale	0	0.25	0.8	1.0

\*Corresponding authors: Rui Wang (rwang@cad.zju.edu.cn), Hujun Bao (bao@cad.zju.edu.cn)



**Figure 1:** A smartphone with 2.2 GHz 8-core ARM Cortex-A53 CPU and PowerVR G6200 GPU, and a Keithley A2230-30-1 sourcemeter

**Textures (0-3)** This setting limits the anisotropic sample count when filtering textures, caps the texture pool size, and the level of detail in mip-mapping.

	Texture Level			
	0	1	2	3
Mipmap Bias	2.5	1	0	0
Max. Anisotropy	0	2	4	8
Pool Size	200	400	700	1000

**Effects (0-3)** Tunes the quality of other effects such as translucency, refraction, material quality, or the minimum detail level guaranteed for the user.

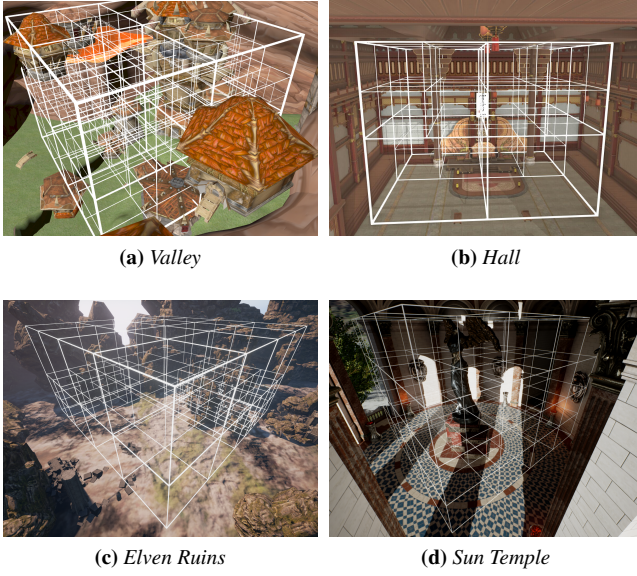
	Effects Level			
	0	1	2	3
Refraction Quality	0	0	2	2
Screen-Space Reflection	0	0	0	1
Detail Mode	0	1	1	2
Material Quality Level	0	1	1	1

**Resolution scale (70%, 80%, 90%, 100%)** Renders the scene in lower resolution and up-samples it to the target resolution.

**View distance (0.1, 0.4, 0.7, 1.0)** Culls the objects based on the (per-unit) distance to the viewer, where maximum 1.0 applies no culling.

### B Mobile measurements setup

For the measurements on mobile, we used a smartphone with a 2.2 GHz 8-core ARM Cortex-A53 CPU and a PowerVR G6200 GPU. We removed the battery of the smartphone and used a source meter Keithley A2230-30-1 as both power supply and measurement unit



**Figure 2:** Visualization of adaptive subdivided camera view-spaces for all demos.

(see Figure 1).

### C Adaptive subdivision of the demo scenes

Figure 2 shows the octree resulting from the adaptive subdivision of the four demos shown in our paper, using the power and error thresholds shown in Table 2 of the paper.

### References

UNREALENGINE, 2015. Unreal Engine Scalability Reference. <https://docs.unrealengine.com/latest/INT/Engine/Performance/Scalability/ScalabilityReference/index.html>.