Real-time Rendering of High-quality Effects using Multi-frame Sampling

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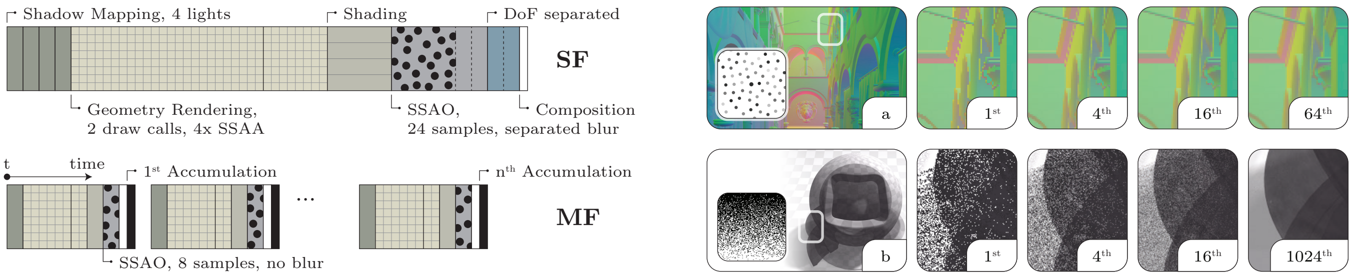

Figure 1: *Left: Illustration of a single-frame composition (SF) transformed to multi-frame (MF): Only 1 shadow pass instead of 4 and 8 SSAO samples instead of 24 are used. DoF and AA are inherently available due to camera and NDC space shifting. Right: (a) anti-aliasing via sub-pixel shifting using an ordered, tilable pattern of 64 poisson-distributed samples and (b) binary per-fragment transparency thresholding.*

Abstract

In a rendering environment of comparatively sparse interaction, e.g., digital production tools, image synthesis and its quality do not have to be constrained to single frames. This work analyzes strategies for highly economically rendering of state-of-the-art rendering effects using progressive multi-frame sampling in real-time. By distributing and accumulating samples of sampling-based rendering techniques (e.g., anti-aliasing, order-independent transparency, physically-based depth-of-field and shadowing, ambient occlusion, reflections) over multiple frames, images of very high quality can be synthesized with unequaled resource-efficiency.

Keywords: Accumulation, Sampling, Progressive Rendering

Concepts: •**Computing methodologies** → **Rasterization;**

1 Introduction

Real-time rendering usually provides a continuous stream of individual high-quality images. However, this strict continuity is only required for frequent input changes (e.g., virtual camera movement, dynamic objects). Even though most non-gaming applications are faced by less frequent data changes (e.g., previews in CAD, DCC, and data visualization tools), they prefer to apply rendering techniques designed for single-frame execution. These techniques usually increase the computational complexity and resources requirements in order to produce high-quality frames. With *multi-frame sampling*, instead of rendering a single frame in response to changed inputs, multiple frames are rendered and accumulated in order to reduce the computational complexity [Haeberli and Akeley 1990]. The accumulation result is immediately displayed while the frame quality progressively increases (Figure 1). Even though this approach is well-known, it is neglected or at least could be better exploited in most of todays rendering systems. In this work, optimized sampling strategies for common rendering effects (Figure 2) are discussed in detail to ease the adoption of efficient and responsive high-quality rendering [Limberger et al. 2016]. Therefore, underlying sampling characteristics such as (1) number of samples, (2) spatial or value-based distribution, (3) sample regularity and completeness, and (4) temporal convergence constraints, w.r.t. finite quality convergence and resource demands are discussed and compared to similarly capable single-frame techniques.

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2 Results

By favoring interactivity in terms of low response times over per-frame quality, multi-frame sampling facilitates scalable resource demands and an increases overall image quality. In our implementations we achieved resource reductions and frame rate increases of within an order of magnitude. Furthermore, the presented techniques are well suited for implementation in mobile devices.

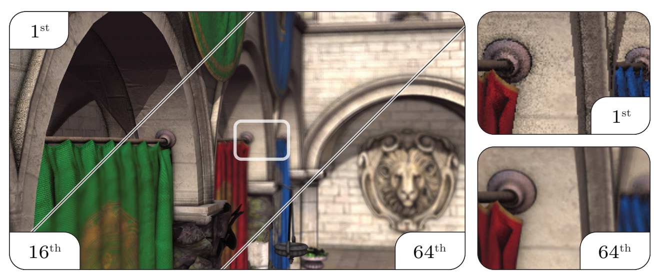

Figure 2: *Convergence of AA, DoF, soft shadows, area light, and SSAO effects in (fltr) 1, 16, and 64 frames depicting Crytek Sponza.*

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References

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