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Spatial Adjacency Maps for Translucency Simulation under General Illumination Appendix

1. Introduction

In this appendix we aim to provide additional results that could not be presented in the accompanying paper. The focus will be on cases that did not already provide satisfactory results but we will also present new examples where our algorithm matches the ground truth. We will show in Appendix Sec. 2 images of the *Milk* model with full illumination and provide a different light source configuration for this scene. The critical cases mentioned in the accompanying paper are discussed in more detail in Appendix Sec. 3. In Appendix Sec. 4 we propose a modification of the presented algorithm and show that this modification can improve image quality in the critical cases mentioned.

2. Additional Results

Besides the results presented in Sec. 5 of the accompanying paper we produced further data to show the visual quality of SAMs. We have several additional results using the proposed 3 samples on the meshes back side as well as results showing convergence in cases where our algorithm does not produce satisfactory results. Furthermore we show visual results and PSNR values using a lower tessellated mesh for finding samples on the back side as described in Appendix Sec. 4.

The *Milk* model in Sec. 5 of the accompanying paper was rendered to show only the translucency effect. In Fig. 1 we added the images showing complete illumination of these renderings and a different configuration of the lighting. Our results match the ground truth closely while the algorithm by Jimenez et al. [JZJ*15] produces results with an incorrect color and intensity of the translucency effect.

3. Critical Cases

Similar to the *Happy Buddha* model presented in Sec. 5 of the accompanying paper the *Chinese Dragon* model has a high tessellation. Additionally the spatial size of the model is chosen to be small with respect to the mean free path. So we will achieve high translucency while keeping the material properties constant. These two conditions together are a theoretical worst case for our algorithm for several reasons. As stated in Sec. 5.3 of the accompanying paper the time needed to precalculate the samples and form factors is very high (23.83h). Also the area which the translucency effect would gather the irradiance from is too large to be covered by 3 small triangles so the effect is not visible using only 3 samples. Fig. 2 shows this and also images with 100 and 200 samples. These images show a tendency to converge towards the ground truth. Fig. 4 shows a plot of this convergence. In this case though, 200 samples might still not be enough as the images show a noticeable difference to the GT.

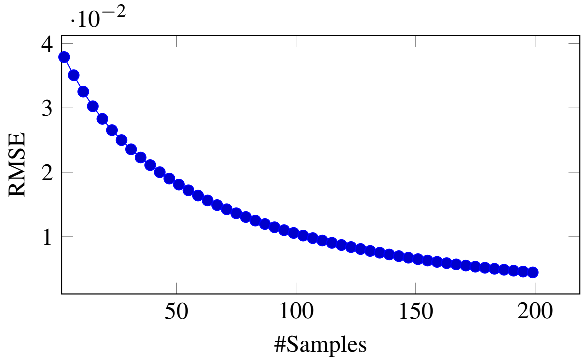

Figure 4: *Convergence of the root mean squared error (RMSE) with different sample counts (3-200) when comparing the* Chinese Dragon *model to our ground truth (see Fig. 2).*

4. Lower Resolution Meshes for Back Sides

As shown in Sec. 5 of the accompanying paper meshes with a high tessellation as for example the *Happy Buddha* model and also the *Chinese Dragon* model shown in Appendix Sec. 2 leave room for improvements when using only 3 samples. This is due to the area covered by the triangles around these samples being too small to cover the area that has a relevant impact on the translucency effect. One solution would be to use more samples, but this will also affect the rendering times. A second solution we want to present here is to use the high resolution mesh for rendering while using a lower resolution mesh for finding the vertices on the meshes back side and calculating the form factors. This has another positive effect as the time needed to find the correct samples is reduced using this approach. Reusing the original mesh's vertices, this modification would not have any impact on rendering performance or memory usage. We just prototyped this technique (using an actual second mesh that was remeshed externally) so we can not provide any meaningful performance data. Our approaches' visual results are

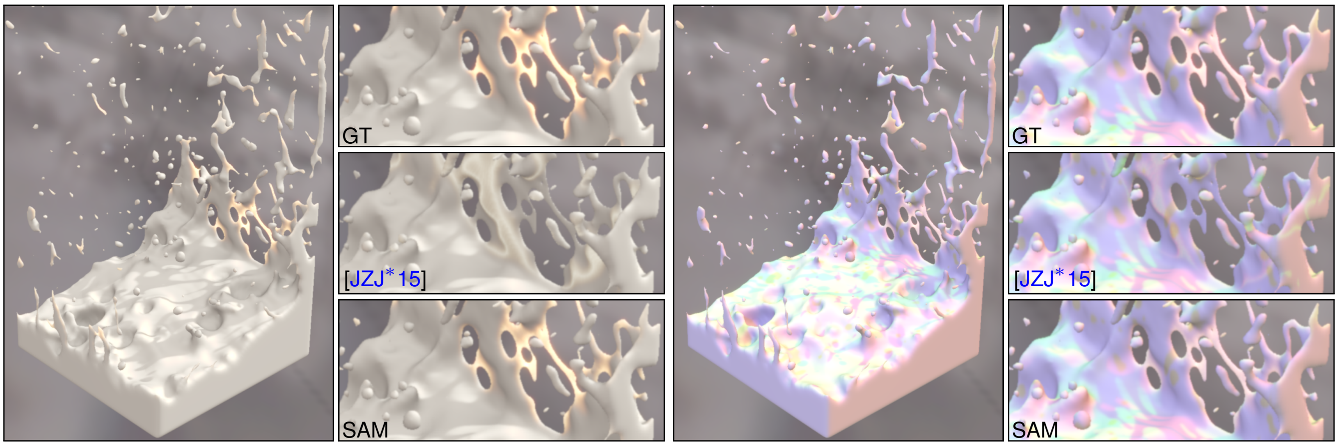

Figure 1: *The* Milk *model with two different lighting configurations. The left images show illumination by a single white light and the environment map, while the right images show illumination of three differently colored lights. All our results match the ground truth (GT) closely while the algorithm by Jimenez et al. [JZJ*15] shows very obvious differences.*

still very convincing. For the *Happy Buddha* and *Chinese Dragon* models we tested the approach described here.

The *Happy Buddha* model was downsampled to 18,975 vertices for this approach. The results in Fig. 5 match the ground truth and even using more samples does not improve the image quality. We also plotted the root mean squared error compared to the number of samples taken in Fig. 6. In this plot we see the error gets slightly larger using more samples. This is due to the approximations done for our approach which will always leave a small error compared to the ground truth even if the complete area of influence of the translucency effect is covered by the samples. Using more samples in this case can result in fluctuation of the error that can be seen in this plot.

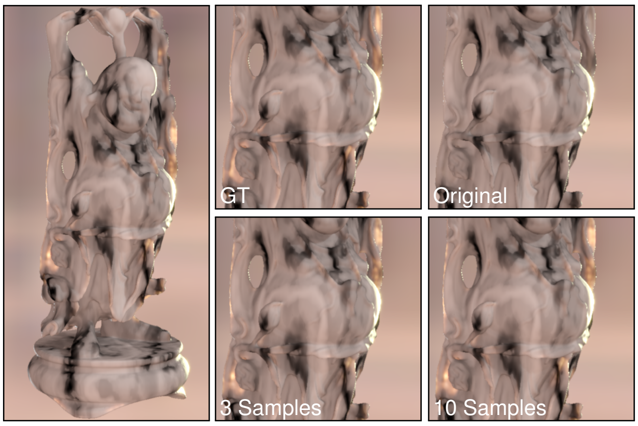

Figure 5: *The* Happy Buddha *model using a lower tessellated mesh for finding the samples on the back side. The results look a lot better than the original renderings presented in Sec. 5 (Original). We also included usage of multiple samples in this technique but the differences between the resulting images are only small in this case.*

The *Chinese Dragon* model was downsampled to 7519 vertices. In Fig. 3 we show the results of this adjustment of our technique. The coloring of the translucency effect now matches the ground truth even closer than the image created using 200 samples (see Fig. 2). In this case using more samples improves the image quality further. This can also be seen in Fig. 6 where the root mean squared error is shown compared to the number of samples taken with this approach.

References

[JZJ*15] JIMENEZ J., ZSOLNAI K., JARABO A., FREUDE C., AUZINGER T., WU X.-C., VON DER PAHLEN J., WIMMER M., GUTIERREZ D.: Separable Subsurface Scattering. *CGF 34*, 6 (Sept. 2015), 188–197. 1, 2

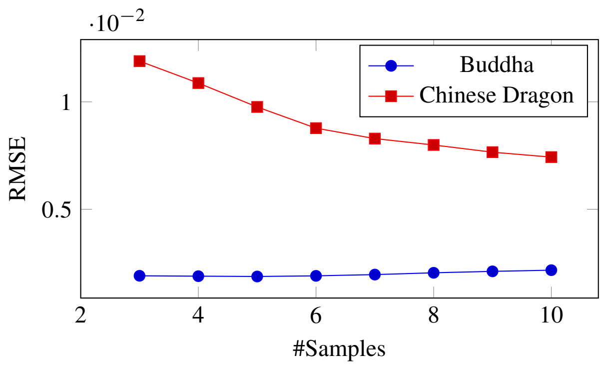

Figure 6: *Convergence of the root mean squared error (RMSE) with different sample counts (3-10) when comparing the* Happy Buddha *(see Fig. 5) and* Chinese Dragon *(see Fig. 3) model to our ground truth. We used a lower tessellated model for finding the samples and form factors on the meshes back sides for these results.*

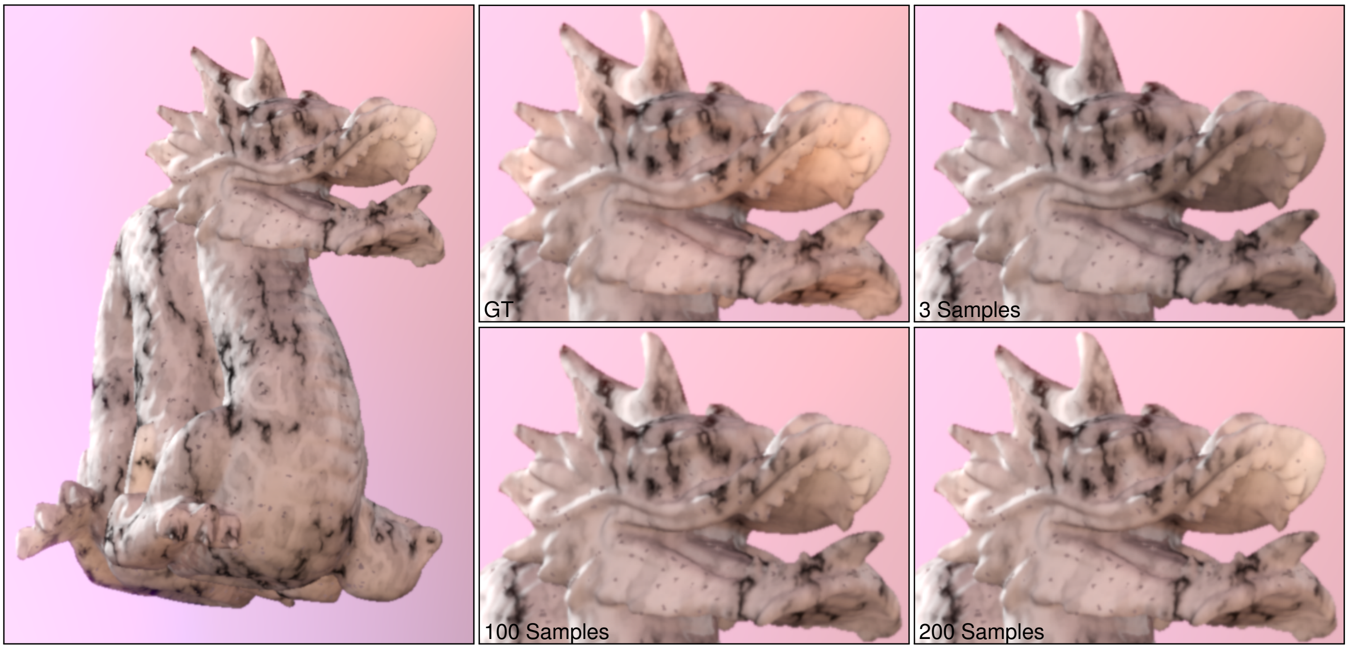

Figure 2: *Renderings of the* Chinese Dragon *model with different numbers of samples. The detail image with only 3 samples does not show any visible translucency result. Using more samples the result seems to converge towards the ground truth (GT) but even with 200 samples there is a visible difference.*

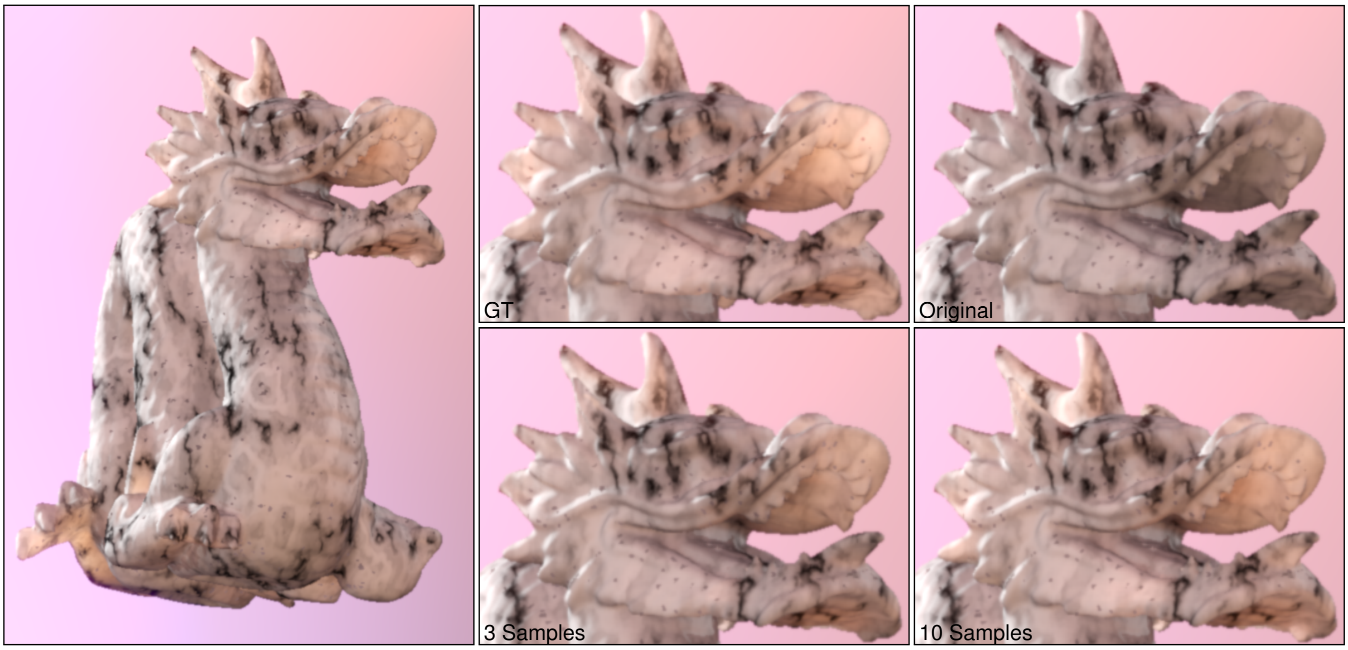

Figure 3: *The* Chinese Dragon *model using a lower tessellated mesh for finding the samples on the back side. While there is still a small difference to the ground truth (GT) the results using this adjusted technique are a lot more convincing compared to the original renderings presented in Sec. 5 of the accompanying paper (Original). Using more than 3 samples will in this case improve the visual quality further.*