Supplemental Material for SIGGRAPH 2014 Paper

Floating Scale Surface Reconstruction

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Emblem Dataset

The *Emblem* MVS dataset in Figure 1 has been reconstructed from 107 input images yielding a total of 16.5 million samples. We chose a dataset with a small extent for a comparison with Poisson Surface Reconstruction (PSR) [KH13]. On this dataset, we used an octree depth of 11 for PSR. This depth reconstructs the fine details but produces a very noisy result in the low resolution region. PSR on level 9 produces a smooth result in the low resolution region, but fails to reconstruct the high resolution details. Our algorithm properly handles both high and low resolution regions.

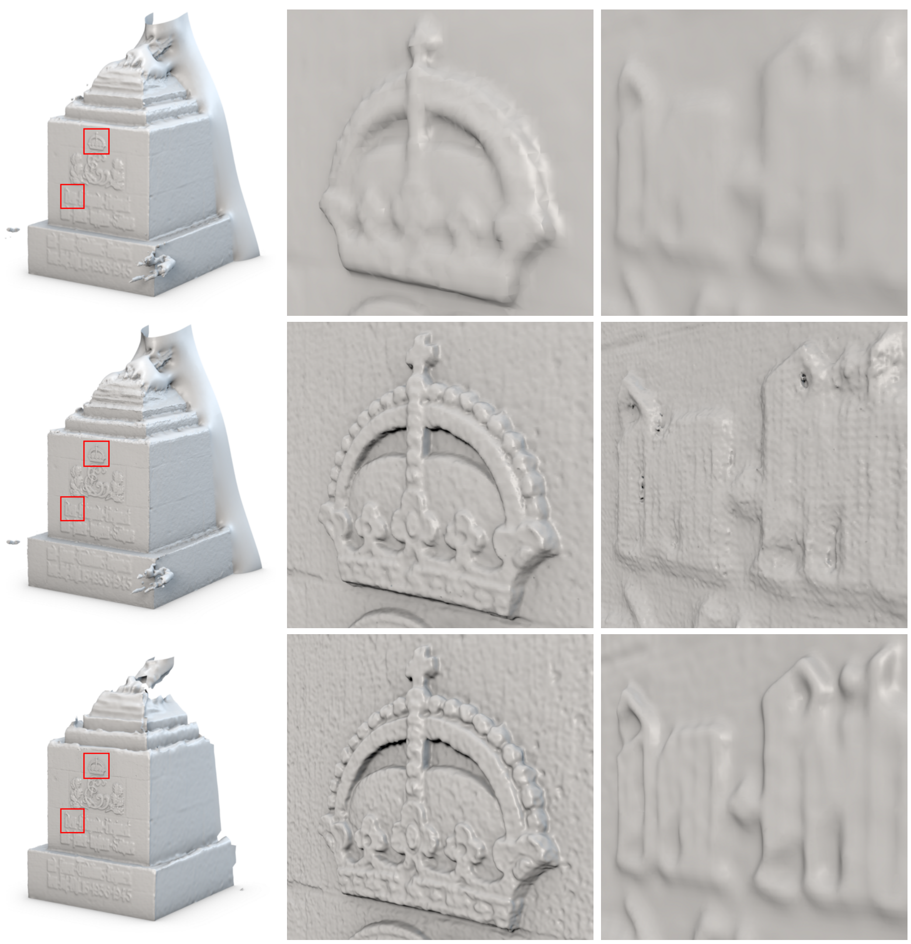

Figure 1: Comparison with PSR on the *Emblem* dataset. The reconstruction with PSR on level 9 (top), PSR on level 11 (middle), and our reconstruction (bottom).

Sculpture Dataset

Figure 2 shows 4 of 120 input images of the *Sculpture* MVS dataset as well as our reconstruction from a total of 10 million input samples. Many photos contain close-up details of cracks in the material of the sculpture which we aim to accurately reconstruct. Figure 3 compares our reconstruction of the detailed region with freely available multi-scale algorithms, namely *SurfMRS* [MKG11] and *DMFusion* [FG11]. The Poisson Surface Reconstruction [KH13] in Figure 4 at octree depth 12 (the maximum depth without crash on this dataset) yields washed-out geometry because high and low resolution samples are mixed, which degrades the surface. The low resolution regions, on the other hand, become quite noisy at octree depth 12 because PSR fits to the noise in the data.

Figure 2: Multi-scale reconstruction of the *Sculpture* dataset. The first row shows the reconstruction with color (left), with shading (middle) and with false coloring of the scale. The bottom row shows 4 of 120 input images with varying scale.

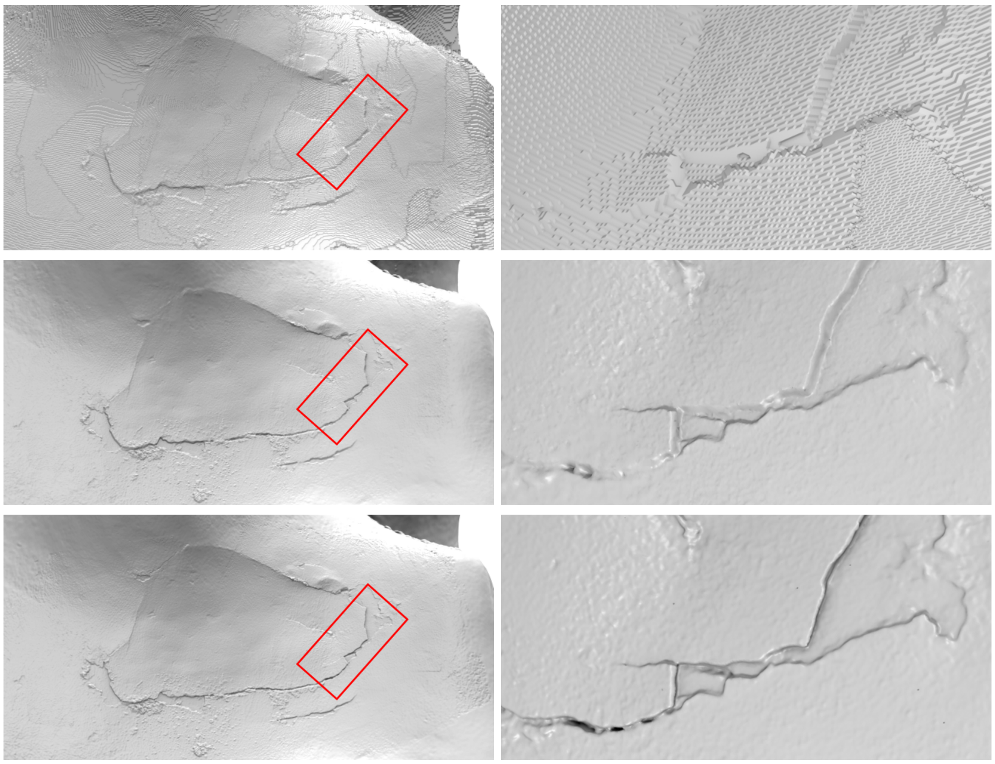

Figure 3: Close-up of details shown in the rightmost two images in Figure 2 (bottom). The images compare the reconstructions of Muecke et al. [MKG11] (top), Fuhrmann and Goesele [FG11] (middle), and our result (bottom).

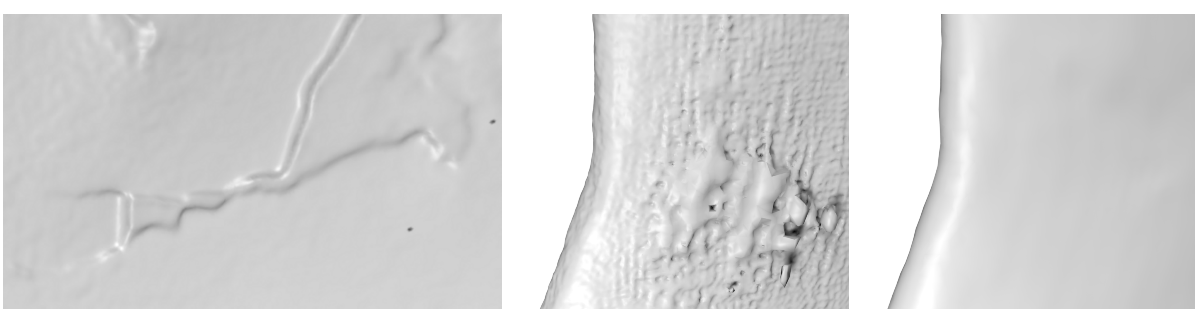

Figure 4: PSR reconstruction on the *Sculpture* dataset. An octree depth of 12 reconstructs blurred details (left) and fits to the noise in low resolution regions (middle). Our result is smooth in the low resolution region (right).

Limiting the Number of Samples

In this section we give more details on the effect of limiting the number of samples during reconstruction. Recall that, in order to evaluate the implicit function at $\boldsymbol{x}$, we advocate ignoring all samples i with a scale s_i larger than a threshold s_{max}. We set $s_{max} = 2 \cdot s_{10\%}$, i.e. we take the 10th percentile of all scale values affecting $\boldsymbol{x}$ multiplied by 2. In other words, we ignore low resolution samples if enough high resolution samples are available for reconstruction.

This sample selection has the following effects:

- Evaluation of the implicit function is faster because less basis functions need to be evaluated,
- intermingling high and low resolution samples can degrade the geometry of the reconstruction towards the low resolution surface.

The choice of our basis function already considers the negative effect of mixing samples at different scales. Inspired by Muecke et al. [MKG11], every basis function f contributes the same volume to the implicit function: High resolution samples will generate large values in a small radius, while low resolution samples yield small values in a larger region which barely influence the high resolution implicit function.

In Figure 5 we compare a reconstruction of a detailed region (which is part of a larger MVS dataset) with and without limiting the number of samples. Although the positive effect of the sample selection is barely visible in the geometry (because the basis function f_i quickly falls off to zero away from the sample i), the color reconstruction is less robust to these effects (as the color function $\boldsymbol{C}_i$ is constant, see Section 5.4 in the paper) and quickly loses contrast due to the smoothing effect caused by low resolution samples. Furthermore, processing is considerably faster and improves from 35.24 minutes (for the reconstruction using all samples) to 15.78 minutes (for the reconstruction that considers only a subset of the samples).

References

[FG11] Simon Fuhrmann and Michael Goesele. Fusion of Depth Maps with Multiple Scales. In *Proc. SIGGRAPH Asia*, pages 148:1 – 148:8, 2011.

[KH13] Michael Kazhdan and Hugues Hoppe. Screened Poisson Surface Reconstruction. *ACM Transactions on Graphics*, 32(3):29, 2013.

[MKG11] Patrick Muecke, Ronny Klowsky, and Michael Goesele. Surface Reconstruction from Multi-Resolution Sample Points. In *Proc. of Vision, Modeling, and Visualization*, pages 398 – 418, 2011.

Figure 5: Reconstruction of a detailed region from about 9 million samples. Limiting the number of samples (left) barely influences geometry, but significantly improves color reconstruction. Using all samples for reconstruction (right) does not only negatively influence the reconstruction but also more than doubles the reconstruction time (factor 2.23).