

Realistic Nonparametric 3D Surface Completion

Automatic completion of partially known 3D scenes

Toby Breckon - Machine Vision Unit, Institute of Perception, Action and Behaviour

toby.breckon@ed.ac.uk

Issue: 3D scenes commonly have missing structure when captured from a single view. Our goal is the realistic completion of the missing parts so that these original and completed portion are indistinguishable.

Approach:

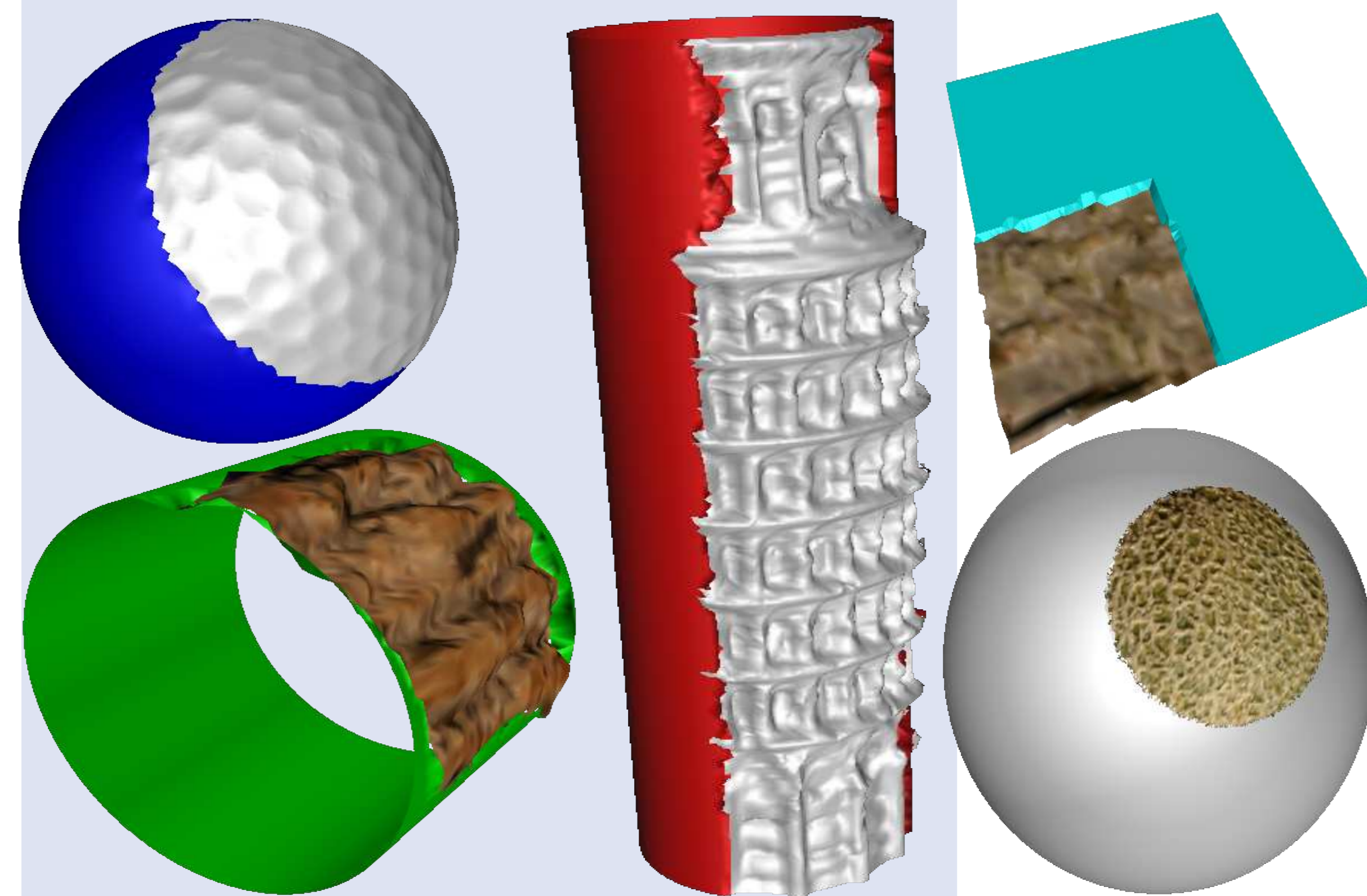
1. Complete the underlying surface geometry using geometric fitting.
2. Complete the localised surface structure (relief) and colour over the surface using non-parametric sampling.

Motivation



Common 3D capture techniques are realistically only $2\frac{1}{2}D$ in nature - this limitation means back facing and occluded structure cannot be recovered from a single view.

Geometric Completion

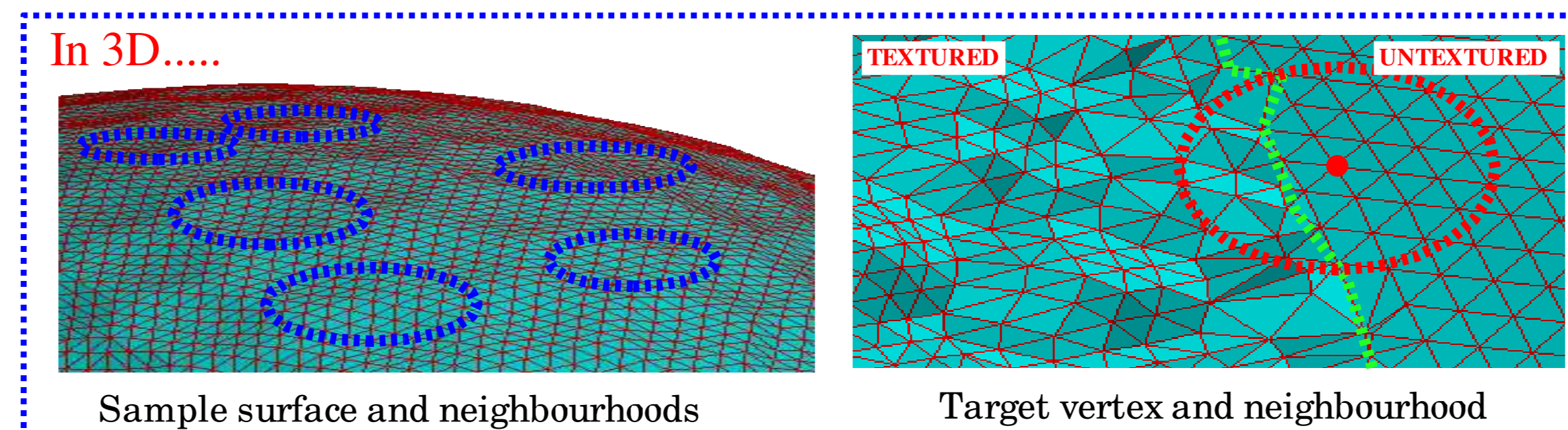


A Least Squares fit to the available $2\frac{1}{2}D$ surface data allows the recovery of the underlying surface geometry - however, a purely geometric completion is far from realistic!

Non-parametric Sampling

- Adapt 2D non-parametric texture synthesis to 3D surface relief.
- Minimise Sum of Squared Difference (SSD) over 3D region matches:

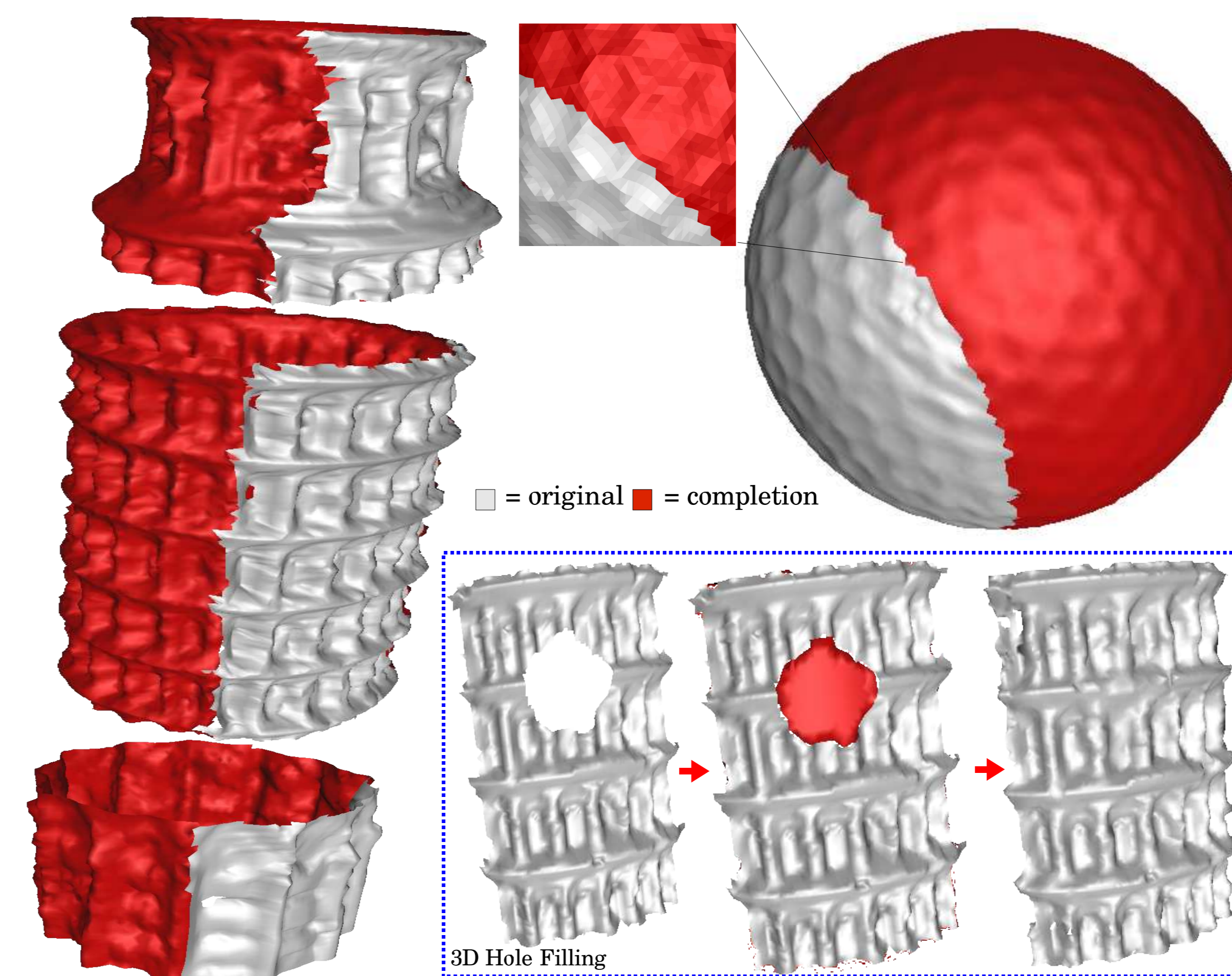
$$SSD_{shape} = \sum_{v_1}^{Nt(targets)} w_{v_1} \min_{\Delta_j \in \text{triangles}(v_2)} (dist(v_1, \Delta_j))^2$$



For each target:

- 1) Find all the samples with matching neighbourhoods
- 2) Choose a best match and propagate central vertex displacement to the target.

Results



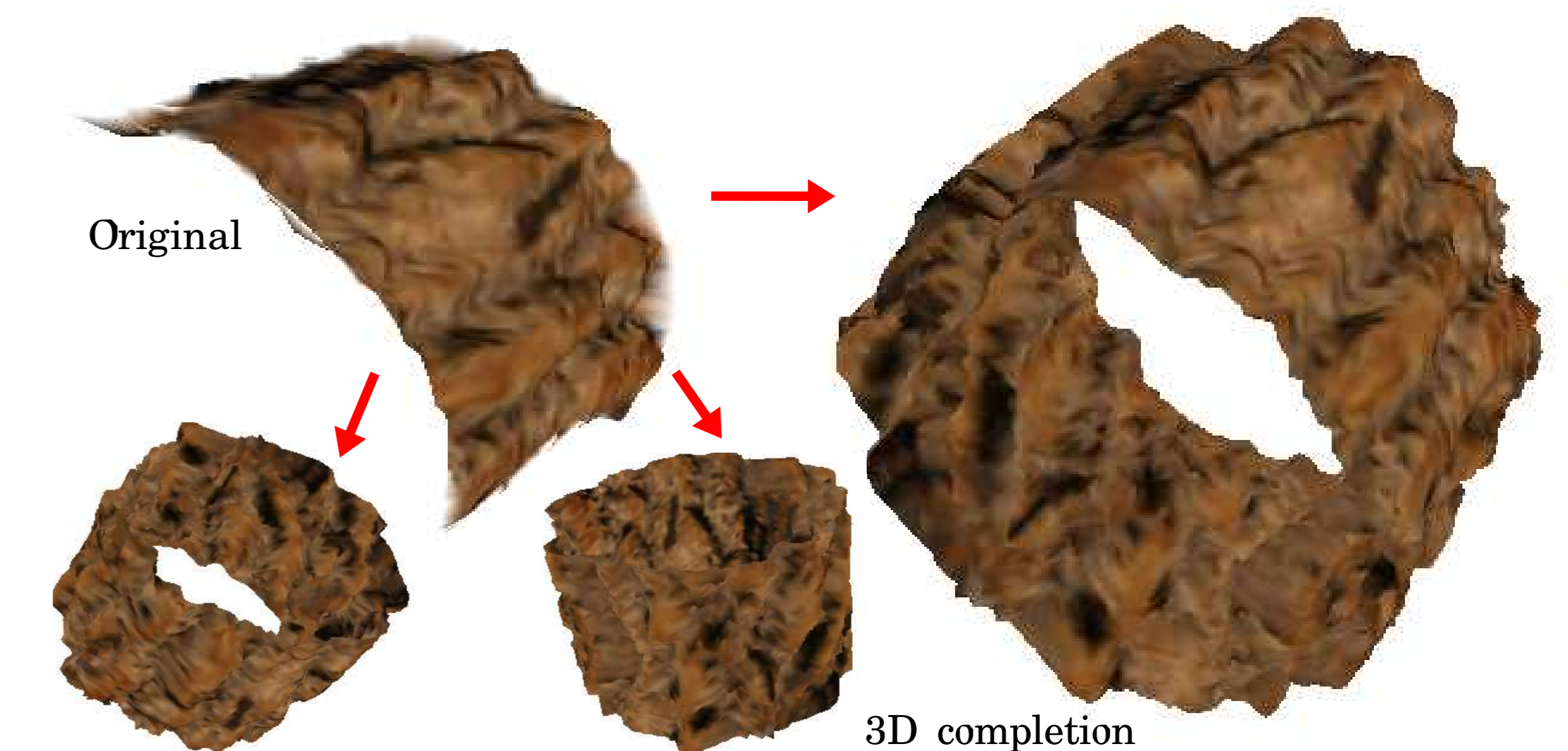
The realistic completion of 3D surface examples

Extension to Colour

The technique can be extended to include colour using a weighted 3D region and colour matching SSD:

$$SSD = (u)SSD_{shape} + (1 - u)SSD_{colour}$$

$$SSD_{colour} = \sum_{v_1}^{Nt(targets)} w_{v_1} \sum_c \frac{|c_{v_1} - c_{v_2}|}{3}$$



Combined completion of 3D surface form (relief) and colour.

Conclusions & Further Work

Realistic 3D surface completion can be achieved by combining non-parametric sampling over an initial geometric surface completion [1].

Future work in this area will focus on:

- Hierarchical completion processes to accumulative noise.
- Application to non-geometric surface types.

[1] Breckon, T.P. and Fisher, R.B. "Plausible 3D Colour Surface Completion using Non-parametric Techniques", Mathematics of Surfaces XI, (to appear).

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