Patch-based Synthesis of Geometry Textures with Point-set Surfaces

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Abstract

As high-quality geometrical models become necessary for realistic applications, the creation of sophisticated surface details quickly becomes a crucial bottleneck to modeling. Geometry texture synthesis can alleviate this problem. We propose to combine geometry texture synthesis with point-set surfaces. Point-set surfaces form a powerful and flexible representation to encode intricate surface details. Our algorithm incrementally builds up a final geometry texture by fitting patches from an initial geometry texture, according to a distance field-based metric applied to a point neighborhood. An automatic point pairing scheme is used to warp the most similar patch with a thin-plate spline interpolation to make it concordant with its neighborhood. The point-set representation frees us from coping with explicit connectivity, while offering trivial manipulation for cutting, merging, and fitting portions of a surface. An appropriate blending corrects for any remaining small texture gaps. Experimental results are provided to illustrate the generality and the efficiency of our approach.

Context

- Patch-based geometry texture synthesis
- Point-set surfaces avoid dealing with stitching
- No topological constraints on geometry
- Automatic pairing for thin-plate spline interpolation of surfaces
- Fast processing time

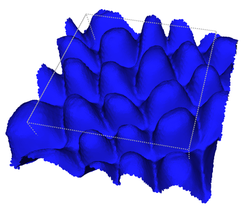
Synthesis Algorithm

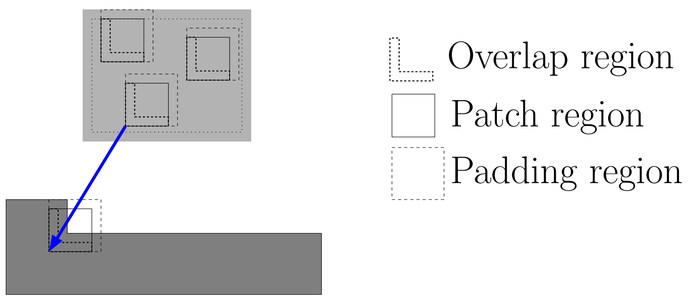
- Random seed patch
- While texture not completed:
  1. Find a patch with similar neighborhood
  2. Warp
  3. Blend
  4. Cut
- Cut out padding

1 Find a Patch with Similar Neighborhood

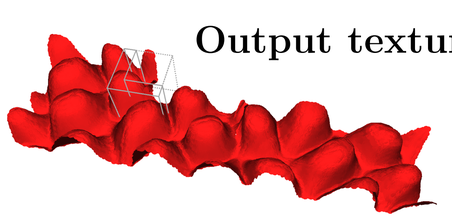
Input texture

- Point-set surface(s)
- Bounding box: dimensions
- Reference plane: orientation



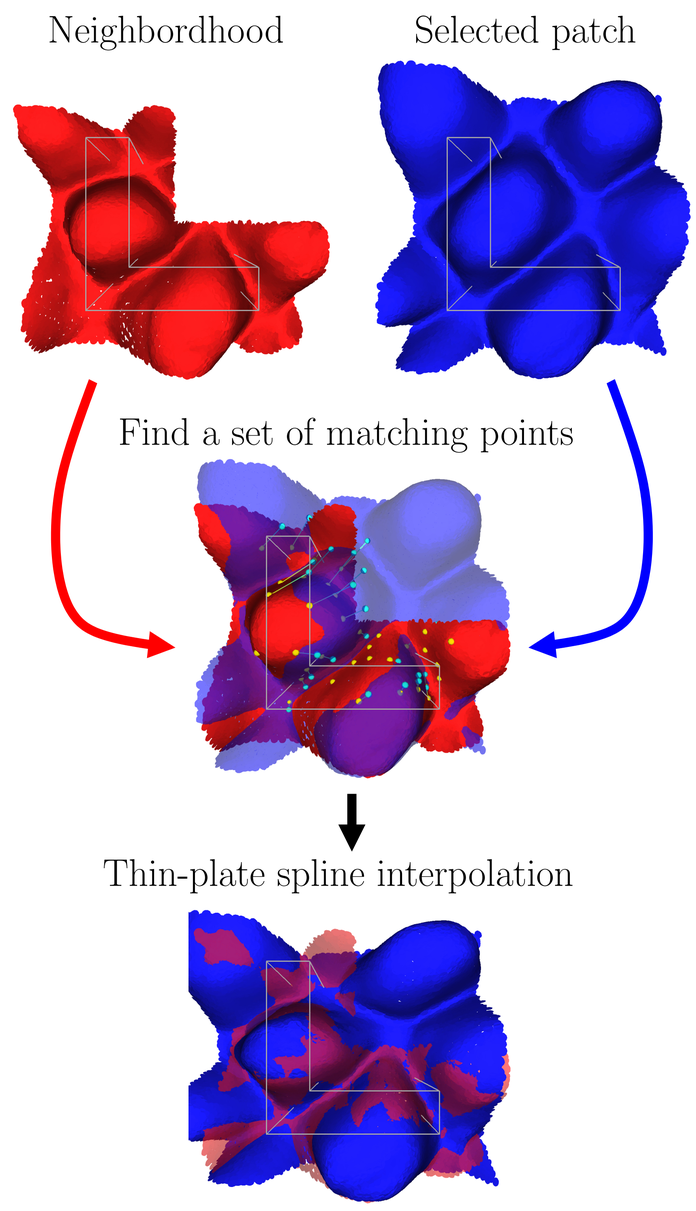


Output texture



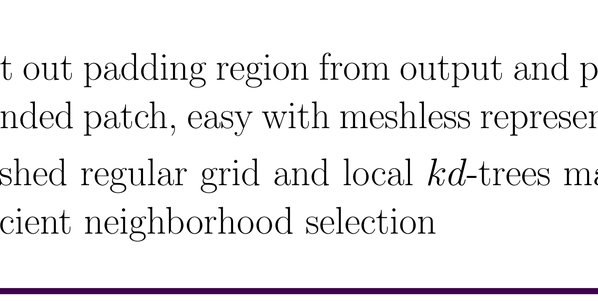
1. Find a set of best matching candidates with current neighborhood
   - Overlap region converted to distance field for comparison
   - Distance field resolution discretizes the search space
2. Random choice among best candidates
3. Copy and translate to target region
   ↪ Trivial operation with point sets

2 Warp

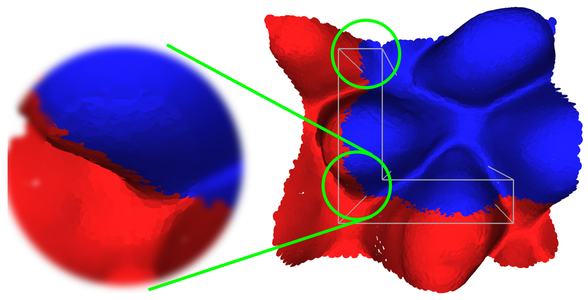


3 Blend

Cracks and local mismatches may remain after warping



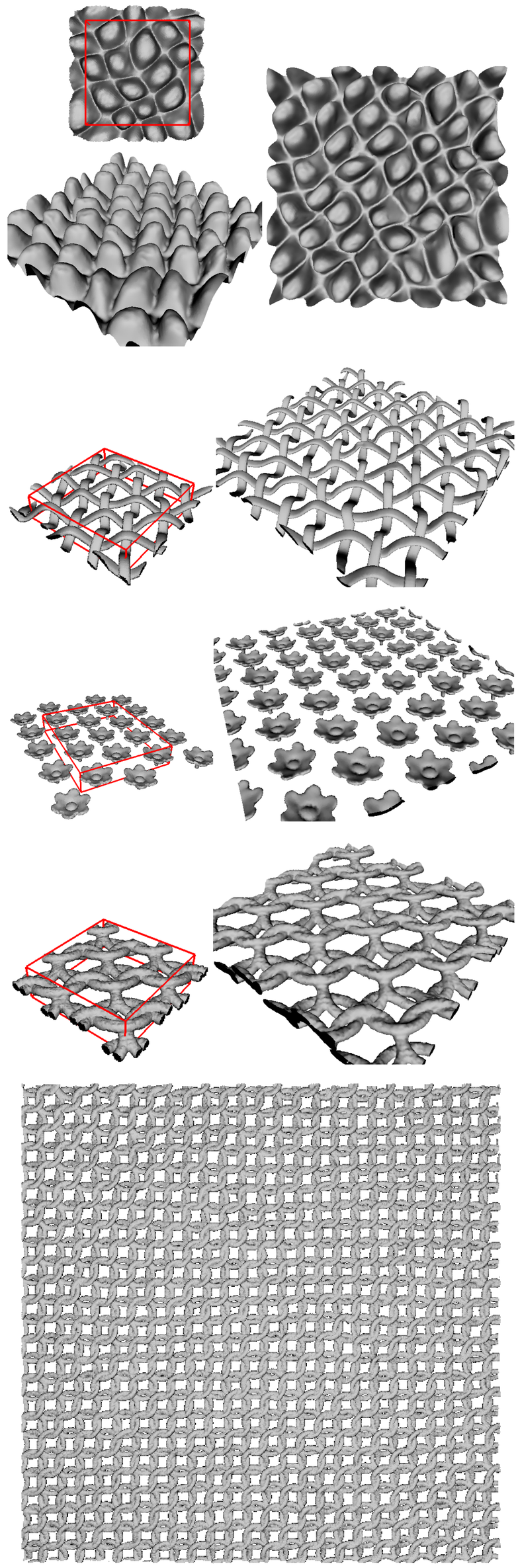
Blending positions and their projection on the neighborhood corrects those artifacts



4 Cut

- Cut out padding region from output and paste in blended patch, easy with meshless representation
- Hashed regular grid and local *kd*-trees make for efficient neighborhood selection

Results



	Point-set size		Synthesis time (seconds)				
	Input	Output	Search	Warp	Blend	Other	Total
Height field	33194	87101	6.7	11.2	10.8	2.0	30.7
Weave	43592	126139	5.7	7.7	12.0	2.6	28.0
Flowers	37473	68290	11.0	14.9	7.4	2.7	36.0
Chain mail	71454	197282	8.5	7.3	18.4	3.8	38.0
Chain mail (large)	71454	2947085	147.5	201.3	316.2	45.8	710.8

Acknowledgments

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