Supplemental Material for the Siggraph Sketch "Nice and Fast Implicit Surfaces over Noisy Point Clouds"

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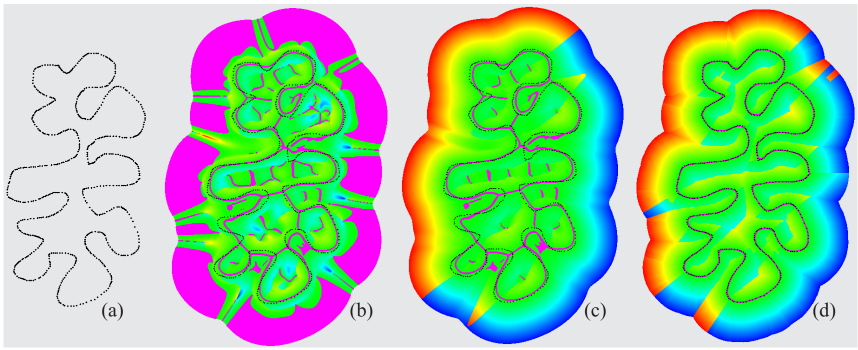

Figure 1: Visualization of the implicit function $f(\mathbf{x})$ over a 2D point cloud. The kernel for the moving least squares is based on Euclidean distance or, resp., one of the proximity graphs shown in Figure 2. Points $\mathbf{x} \in \mathbb{R}^2$ with $f(\mathbf{x}) \approx 0$, i.e., points on or close to the surface, are shown magenta. Red denotes $f(\mathbf{x}) \gg 0$ and blue denotes $f(\mathbf{x}) \ll 0$. (a) point cloud; (b) reconstructed surface using a Euclidean kernel and the covariance matrix defined as $B_{ij} = \sum_{k=1}^{N} \theta(\|\mathbf{x} - \mathbf{p}_k\|)(p_{k_i} - x_i)(p_{k_j} - x_j)$; (c) utilizing a covariance matrix centered at $\mathbf{a}(\mathbf{x})$ instead of $\mathbf{x}$ produces a better surface, but it still has several artifacts; (d) surface and function $f(\mathbf{x})$ based on our more geodesic kernel using the sphere-of-influence graph.

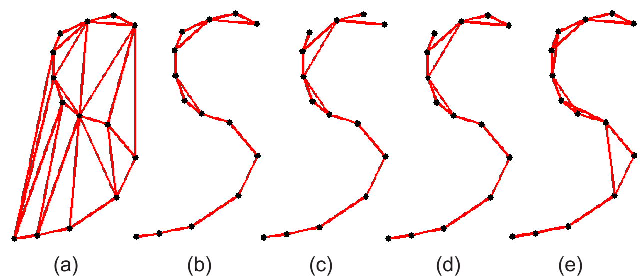

Figure 2: Different proximity graphs. (a) Delaunay graph $DG(\mathscr{P})$, (b) $DG(\mathscr{P})$ where edges are pruned according to a global sample density, (c) pruning by first quartile, (d) pruning by second quartile, (e) sphere-of-influence graph $SIG(\mathscr{P})$.

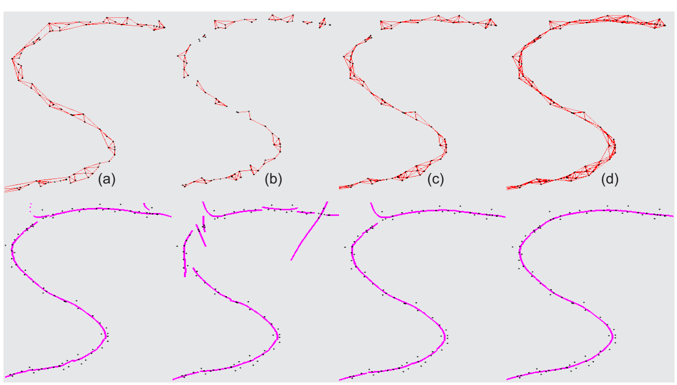

Figure 3: If the proximity graph is too thin or too dense, artifacts can occur. On the one hand, we prune the standard Delaunay graph. On the other hand, we augment the standard $SIG(\mathscr{P})$ by edges, in order to prevent too many, unreasonably unconnected components. Therefore, we increase the influence of the nodes in the graph based on the radius r of the k-th nearest neighbor, which reflects local point density. Top row: (a) $DG(\mathscr{P})$ where edges are pruned by second quartile, (b)$1-SIG(\mathscr{P})$, (c) $2-SIG(\mathscr{P})$, (d) $3-SIG(\mathscr{P})$. In our experience, $k=3$ or $k=4$ has always worked quite well. Bottom row: the surfaces resulting from these proximity graphs.

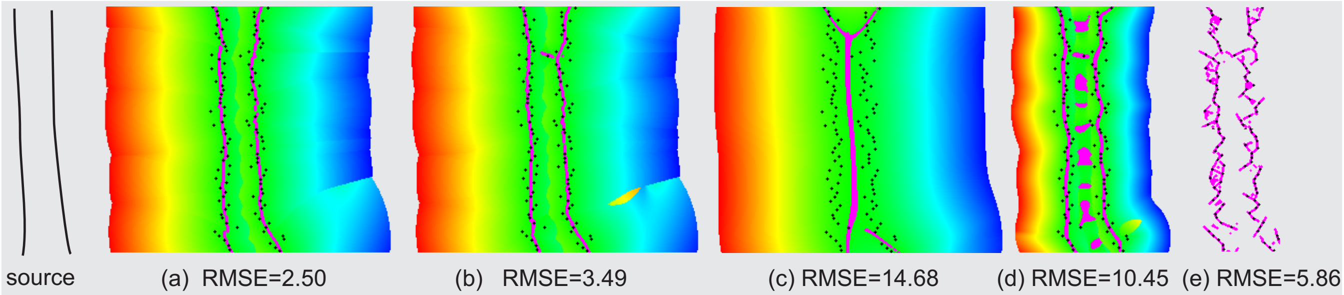

Figure 4: Root mean square error (RMSE) for a noisy point cloud (left: original surface). (a) $DG(\mathscr{P})$ with edges larger than second quartile are pruned, (b) $2-\mathrm{SIG}(\mathscr{P})$, (c) Euclidean distance kernel, (d) same with reduced bandwidth h, (e) Euclidean distance kernel with optimal bandwidth h that yielded the minimum RMSE; notice the inferior surface quality.

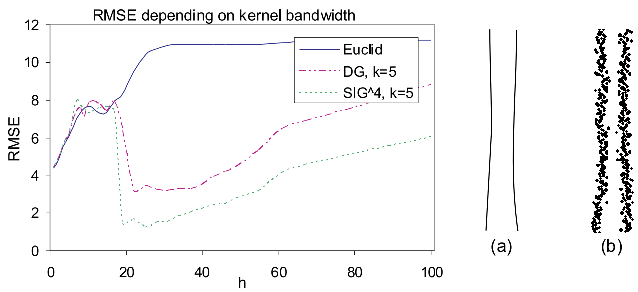

Figure 5: Left: RMSE depending on the kernel bandwidth (h) of the points. The $4-\mathrm{SIG}(\mathscr{P})$ allows for the best results (lowest RMSE). Right: (a) original surface, (b) corresponding noisy point cloud.

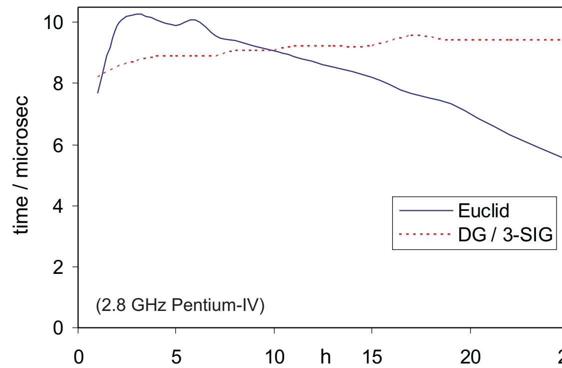

Figure 6: Average evaluation time of $f(\mathbf{x})$ depending on the kernel bandwidth h (size of point cloud: ¿1500 points). The timings for 3-SIG and DG are nearly identical (therefore, we omit one curve). Please note that our implementation is not yet fully optimized.

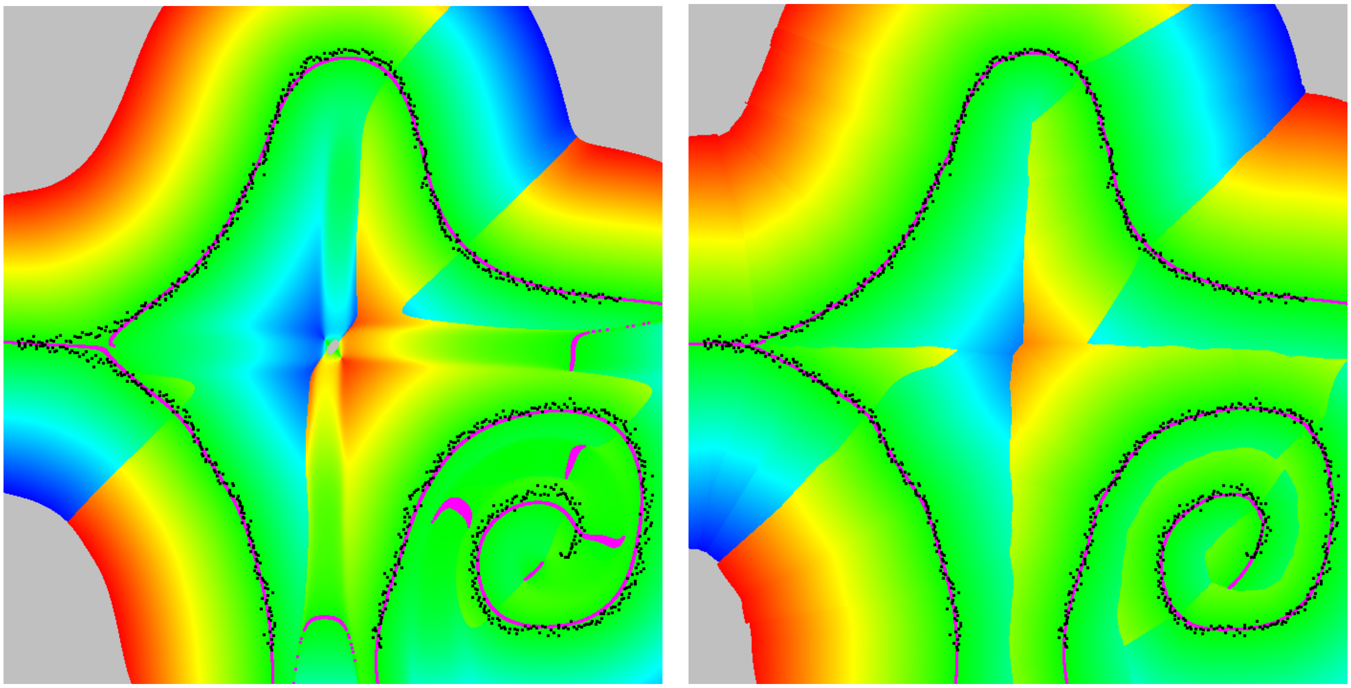

Figure 7: More examples. Left: Euclidean kernel; right: egodesic kernel.

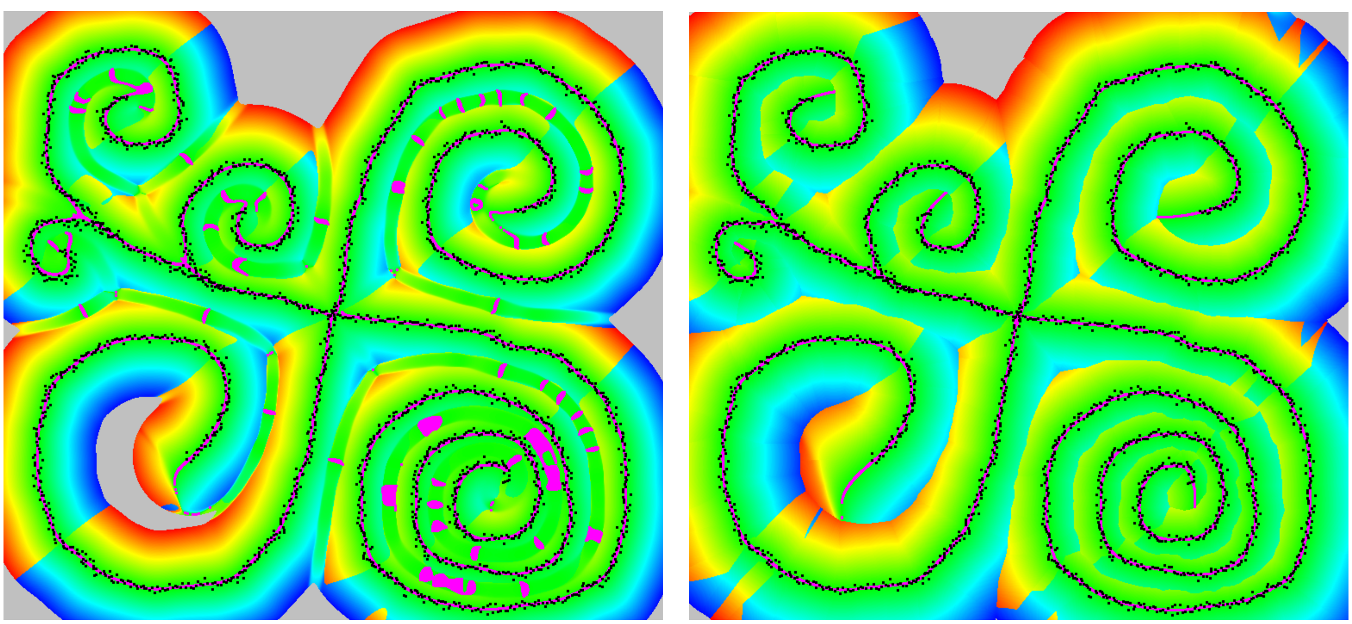

Figure 8: More examples. Left: Euclidean kernel; right: egodesic kernel.