Super-Robust Multi-View Normal Field Integration

Computer Vision Group
(Prof. Bastian Leibe)

Osep A., RWTH Aachen University
osep@vision.rwth-aachen.de

RWTH AACHEN UNIVERSITY

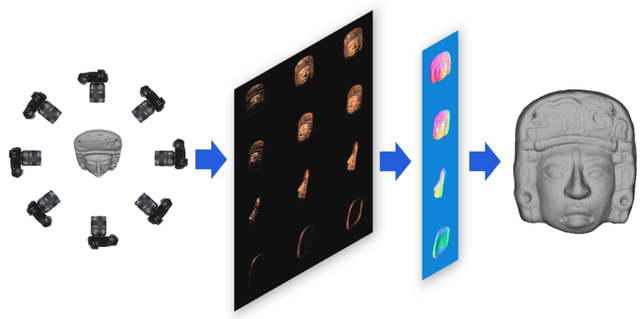
Abstract

The main novelty introduced in this work is the first multi-view normal field integration algorithm that robustly reconstructs a surface of an object from normal fields captured in a real-world setup. We fit a surface to the vector field, reconstructed from observed normals. The vector field and the surface consistency information are computed by feature space analysis of normal back-projections.

Main Idea

Motivation:

We investigated whether normal fields observed from several viewpoints can be robustly integrated for 3D reconstruction of objects and whether it is possible to reconstruct highly-specular objects this way.

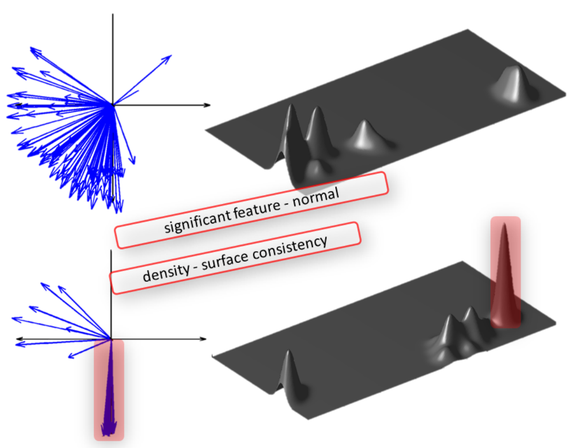


We propose:

A robust algorithm for 3D object reconstruction from multiple normal fields.

Vector Field Computation

- Back-project normal fields into volume V.
- Cluster back-projected normals using Mean-Shift algorithm
- Largest mode corresponds to vector field value, density corresponds to surface consistency.



Variational Approach

$$E(\gamma) = \lambda_1 \int_V \|\nabla\gamma\|\, dV - \lambda_2 \int_V (\nabla \cdot (c\mathbf{N})\,\gamma)\, dV$$

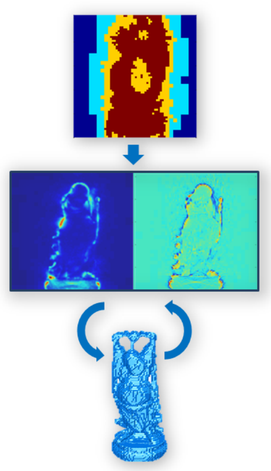
$$w.r.t.\ \gamma \mapsto [0,1]$$

- $\mathbf{N}(\mathbf{x})$ . . . vector field, reconstructed from normal fields
- $c(\mathbf{x})$ . . . scalar field, surface consistency

Optimization Framework

3D reconstruction pipeline

- Octree-based discretization.
- Initial refinement.
- Compute vector field $\mathbf{N}(\mathbf{x})$ and scalar field $c(\mathbf{x})$ in corners of octree nodes.
- Continuous Max-Flow based volume segmentation [1].
- Iteratively segment and refine surface.
- Post-processing step in spirit of [2] to get smooth reconstruction.

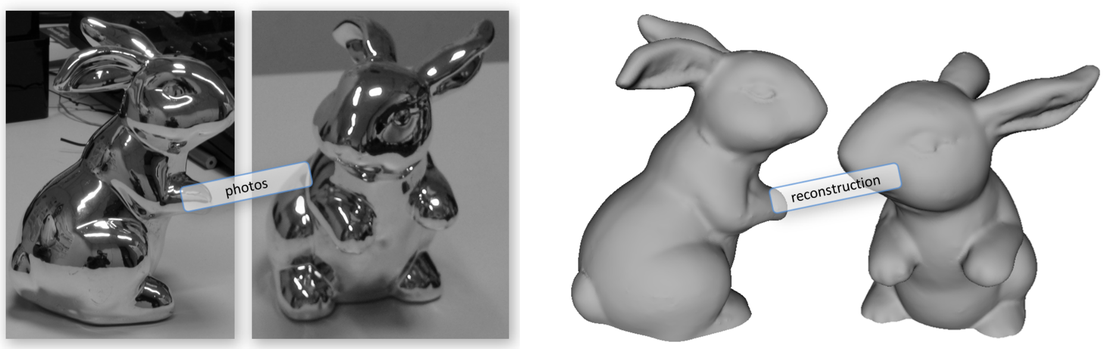


Results and Applications

Synthetic Data:

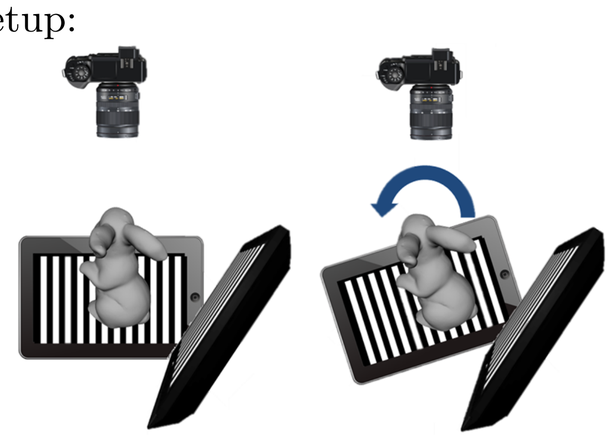
Photometric Stereo:

Multi-view Shape-from-Specularity:

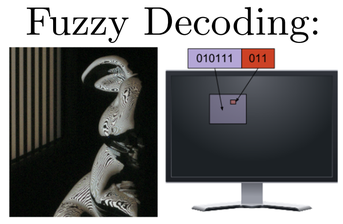


Data Acquisition and Setup

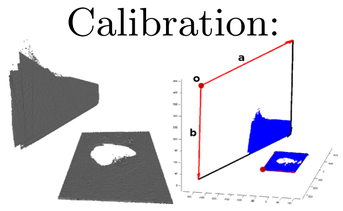
Setup:



Fuzzy Decoding:



Calibration:



Conclusions

- First algorithm that can integrate multiple normal fields, captured in a real-world setup.
- State-of-the-art results on 3D reconstruction of mirroring objects.
- Results published in [3].

References

[1] J. Yuan, E. Bae, X. Tai A study on continuous max-flow and min-cut approaches In *CVPR*, 2010.

[2] F. Calakli, G. Taubin SSD: Smooth Signed Distance Surface Reconstruction In *Comput. Graph. Forum*, 2011.

[3] M. Weinmann, A. Osep, R. Klein Multi-View Normal Field Integration for 3D Reconstruction of Mirroring Objects In *ICCV*, 2013.