FAKULTÄT FÜR !NFORMATIK
Faculty of Informatics

Diplomarbeitspräsentation

INTERACTIVE MEDIA SYSTEMS
Vienna University of Technology

Evaluation of a 3D Reconstruction System Comprising Multiple Stereo Cameras

Masterstudium:
Computational Intelligence

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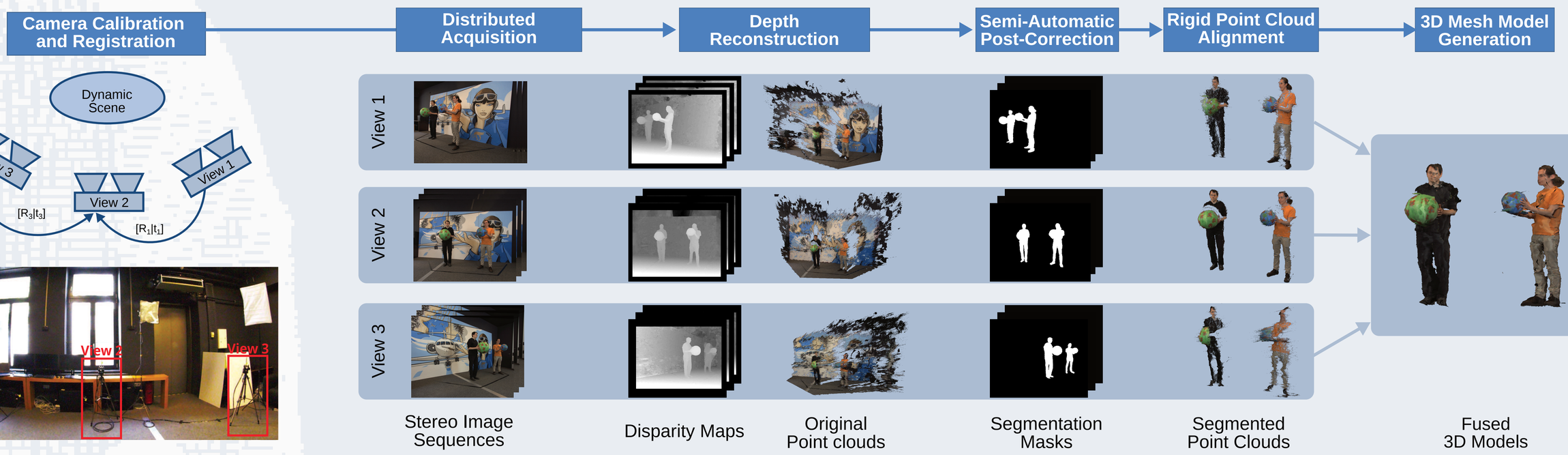
Motivation

Recent advances in the fields of virtual reality and media production have generated an increasing demand for high-quality 3D models, for instance to mix real world objects with synthetic content that motivates the need for high-quality 3D reconstruction techniques. A common practice in 3D reconstruction is an evaluation based on ground truth data sets. This method, however, has some shortcomings. First, ground truth based evaluation relies on available annotated data sets, while the assessment of self-recorded data is often desirable, especially when targeting dynamic scenes. Second, quantitative results are often of limited significance when it comes to qualitative user experience.

Problem Statement

This diploma thesis is concerned with evaluating the quality and accuracy of 3D models acquired with a 3D reconstruction system that obtains textured mesh models of dynamic scenes with three stereo cameras. The system's products are examined with three complementary quantitative and qualitative methods. An evaluation of validation objects determines the system's geometric reconstruction accuracy. An image-based novel view evaluation assesses the accuracy of acquired point clouds and meshes. A subjective user study compares the subjective model quality of several approaches to model generation.

Evaluation Framework



Validation Object Evaluation

Determines geometric reconstruction accuracy

- ➜ Create geometrically simple objects (spheres, cuboids)
- ➜ Acquire and reconstruct object point clouds
- ➜ Use known object dimensions for least-squares shape fitting
- ➜ Measure deviations from ideal shapes

Novel View Evaluation

Determines accuracy of obtained point clouds and meshes

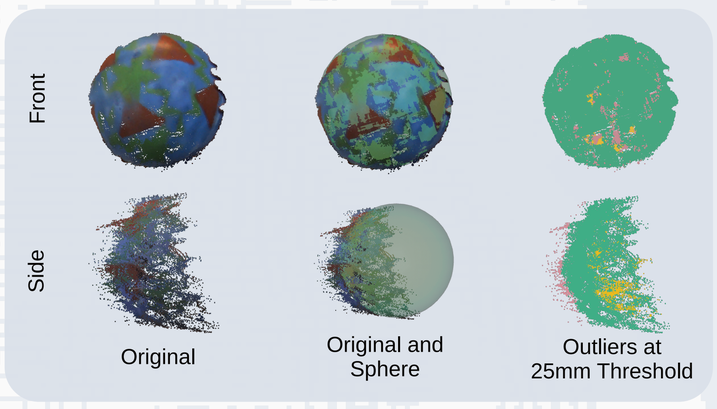
- ➜ Compare novel views of models against original images [1]
- ➜ Fuse models from outer ward views 1 and 3
- ➜ Project result into the view-point of view 2
- ➜ View 2 acts as an independent source of validation
- ➜ Measure accuracy as Normalized Cross Correlation similarity

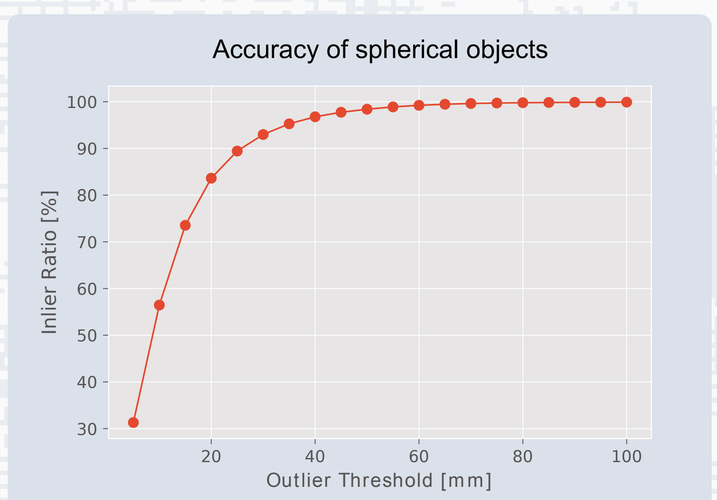
Subjective User Study

Determines subjective model quality

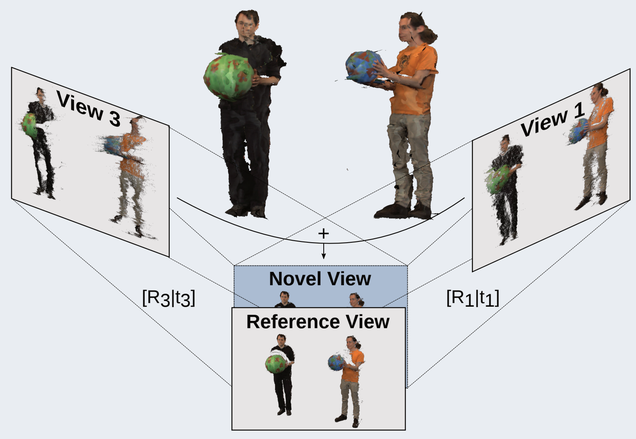
- ➜ 10 Participants in pair comparison based trials
- ➜ 5 Textured 3D mesh models shown as videos
- ➜ 3 Compared depth reconstruction methods: Cost volume filtering [2] with/without depth refinement, PatchMatch [3]
- ➜ 2 View fusion methods: before/after model generation

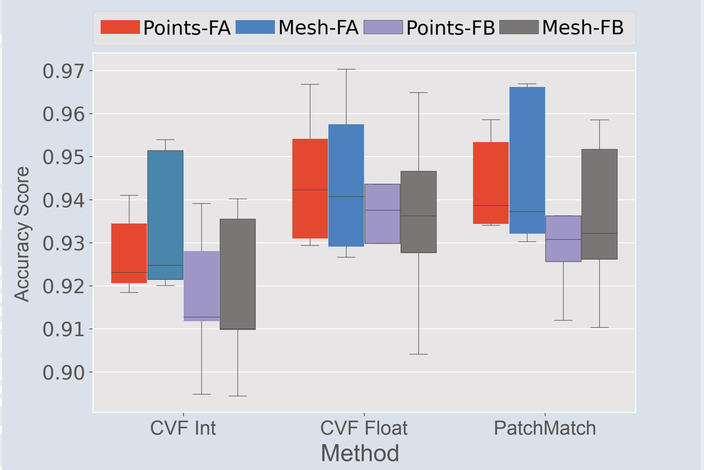
Results - Validation Objects



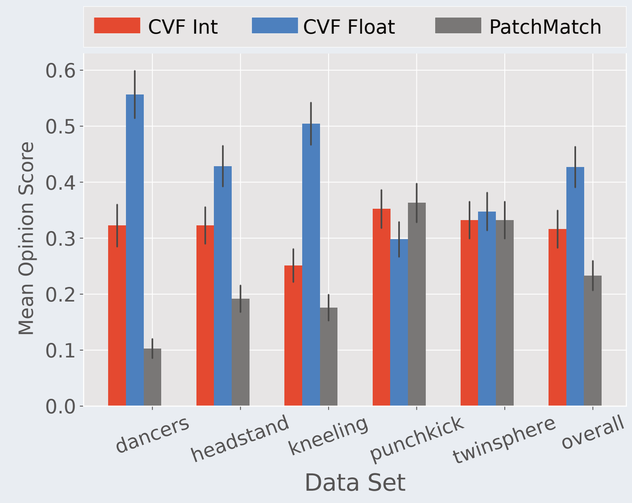


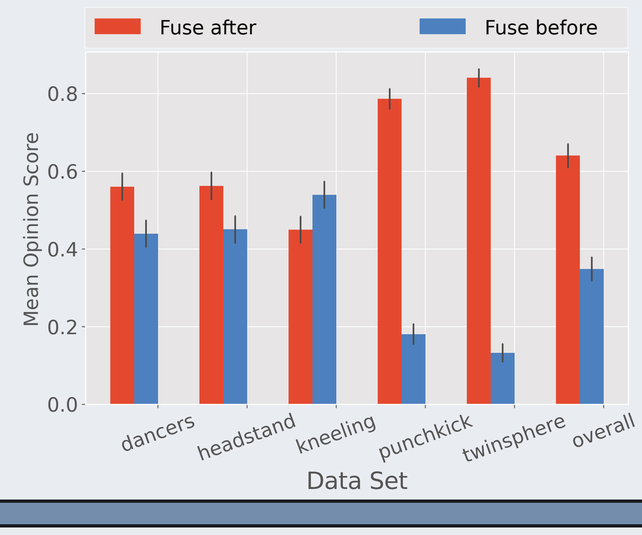
Results - Novel Views





Results - User Study





Conclusions and Future Work

- ➜ Scene and camera setup have a larger influence on model quality than the choice of a particular depth reconstruction algorithm.
- ➜ Inconsistent results of novel view evaluation and user study confirm the need for combined quantitative and qualitative evaluation.
- ➜ Future work may include the incorporation of stereo confidence measures in the reconstruction process in order to reduce the amount of erroneously reconstructed points.

Acknowledgements

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References

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