Multi-user Immersive 3D Reconstruction Environment

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Abstract

A tool for user driven 3D reconstruction is presented in this poster together with ideas of tool extension for a work in immersive environment with multi-user editing possibility. The main purpose of the tool is cultural heritage and architecture reconstruction with direct visualization.

Categories and Subject Descriptors (according to ACM CCS): I.4.5 [Image Processing And Computer Vision]: Reconstruction—I.3.7 [Computer Graphics]: Virtual reality—I.3.5 [Computer Graphics]: Computational Geometry and Object Modeling—I.3.8 [Computer Graphics]: Applications—

1. Introduction

The improvement of 3D reconstruction techniques based on photogrammetry brings new opportunities in fields like architecture or archeology where these techniques are started to be widely used. Now it is necessary to create easily controlled environments for people who are not familiar with all photogrammetry methods to give them the possibility to benefit from this field of science. Unfortunately photogrammetry methods need a lot of well-conditioned photos what can be problem in architecture and excavation reconstruction (lack of texture on reconstructed objects, windows and reflections, little space for taking distant photos or hidden and non-accessible parts of reconstructed objects). For this reason we have decided to create a user driven 3D reconstruction tool where user can assist the geometry reconstruction process and can overcome the weaknesses of the data sets. For this we would like to create a tool combining visualization with 3D reconstruction even in immersive environment with possibility of multiple users cooperating.

2. Reconstruction core, the current state

In the last year we have developed a sketch based 3D reconstruction tool focused mainly on architecture reconstruction. This tool works with calibrated scenes (known camera positions) and sparse pointcloud (only points reconstructed during camera calibration phase are used). We use the Bundler [SSS06] project as a calibration engine.

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The core of our reconstruction is a fitting of planes based on source photo segmentation. The graph-cut [BK04] image segmentation is driven by inaccurate user strokes, see Figure 1. The image segmentation is than propagated to close photos and also to the points of sparse pointcloud. The planar primitives are then fitted on these labelled points, see Figure 2. Although our tool is mainly focused on user driven reconstruction, we have also implemented the Poisson [KBH06] reconstruction from dense pointclouds [FP10] which we use on irregular shapes like ground.
The tool is also used as fast visualization and annotation instrument for archaeologists. We can say that archaeologists, who use our tool, prefer to make annotations on dense pointcloud and they create a dense mesh using Poisson algorithm for visualisation, but for the final documentation they prefer piecewise planar model with known hierarchy.

3. Immersive reconstruction

Currently we are working on separation of reconstruction core and visualisation for the purpose of higher immersivity during the reconstruction. We would like to be able to perform the reconstruction process on the standard PC-tablet device, while the visualisation will be performed on more immersive device like stereo projection or even systems like CAVE, see Figure 3. We would also like to add a possibility of visualisation on more devices together or even long distance presentation. For this purpose we have started to develop a fast synchronization protocol based on broadcast the changes to all connected clients.
We have suggested the following protocol actions necessary for this kind of work: Synchronization of pointclouds and

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Figure 1: *Sketch based segmentation interface.*

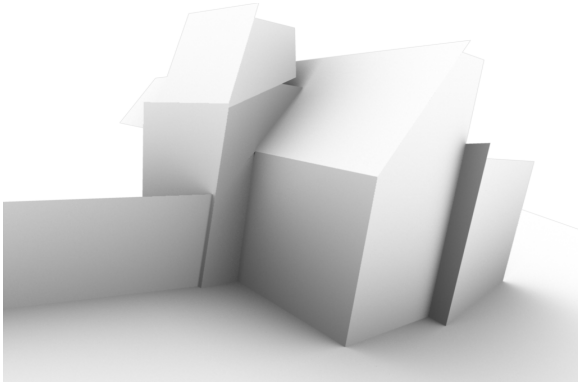

Figure 2: *Geometry reconstructed from one segmented photograph, see Fig. 1.*

geometry, camera view synchronization and camera control without 3D view.

4. Distributed 3D reconstruction

The final step in our research will be a distributed user driven 3D reconstruction. Three categories of problems have to be solved. Firstly, direct application of existing solutions: Scene recalibration thanks to new photographs, what is no problem in our framework. Secondly, separation of user interaction from the reconstruction core: This would enable us to have multiple users, possibly using devices without much processing power, providing inputs to the reconstruction process simultaneously. The reconstruction process itself would then run on dedicated server, providing higher performance and synchronization among users. Thirdly, user interaction in immersive environment: Allowing users to modify the reconstruction directly in an immersive environment would introduce more natural interface to the reconstruction process, but it also brings new challenges for the user interface.
For this reason, we intend extending protocol actions by additional functionality: Synchronization of input sets of photographs, user stroke (sketch) propagation.
Up to now, the only protocol applicable for our purposes we are aware of is Verse network protocol `http://www.quelsolaar.com/verse/`. We are currently evaluating possibility of using it for client-server communication.

Figure 3: *User flying through reconstruction space in CAVE.*

5. Conclusions

We have presented current state of our architecture reconstruction tool. We have also discussed planed updates to achieve possibility of immersive 3D reconstruction and ideas how to realize multi user reconstruction environment independent on visualisation device.

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