CS590G: Final Project – Create your own capture/model/render system

Out: October 28, 2004
Due: December 9, 2004

Objective

The goal of the final project assignment is to allow you to use your imagination to design, implement and experience your own capture system. The previous assignments have helped you to incrementally build up a complete system. For your project, you may either build upon the previous assignments and extend the system in a particular direction or implement a new system.

Each project will be performed by small teams of 1 to 3 people, all taking CS590G this semester. As part of the assignment, you will each need to present a relevant research paper, the group will present a project proposal, a mid-project demo, and during demo day at end of semester each group will give an exciting demo and presentation of their work. During the project proposal and demos, you must identify which component of the system each team member did. As with previous assignments, I much prefer a system that works well and fewer bells and whistles than a more complex system that does not work well.

Below is a list of projects. You may use these as starting points for your project proposal. Nevertheless, you may also present a completely new project proposal. All project proposals are pending my approval.

Capture

Camera Design Program. Create a design program to allow you to visualize a (synthetic) environment as seen by a simulated camera. This program should support camera and mirror arrangements for standard FOV and large FOV cameras.


Robust and Portable Camera Pose Estimation System. Create a system that allows you to quickly setup a scenario for fast but relatively accurate camera pose estimation. For example, deploy landmarks and from their projections compute pose. I have some initial code you can use as a starting point that ‘works’ but the objective is too significantly improve its robustness and to enable a wider range of pose estimation. Pose estimation
can be limited to certain areas, e.g. a table top, a room, etc. Let your imagination go wild here.


**Capture Device Survey.** Write a survey or give a complete presentation on a taxonomy of multiple capture devices and how they capture, model, and render environments (maybe not relevant enough to this course??).

**Static Modeling and Rendering**

*Automatic City Modeling.* Generate a city model using a set of urban and architectural rules (ideally rules obtained from a real city or neighborhood).

- Instant Architecture, Peter Wonka (Georgia Institute of Technology), Michael Wimmer (Vienna University of Technology), François Sillion (ARTIS/INRIA Rhône-Alpes), Bill Ribarsky (Georgia Institute of Technology), Proceedings of ACM SIGGRAPH, 2003.

*Self-calibration and Reconstruction.* Exploiting properties of epipolar geometry and laws of physics simultaneously do camera calibration and object reconstruction. You may also view this as “bypassing” the calibration phase and going straight to the reconstruction phase.

Lots of papers…

*4D Plenoptic Function Renderer with Dynamic Reparameterization.* Capture many images so as to sample a 4D plenoptic function. Use (a) a classical two-plane parameterization of (e.g., Lightfield/Lumigraph), (b) a viewpoint-centric parameterization (e.g., Sea-of-Images, Plenoptic Stitching), (c) make your-own parameterization. To help interpolate images use (a) more images (e.g., Lightfield), (b) a proxy (e.g., Lumigraph), (c) feature correspondences -- manually determined is ok (e.g., Sea of Images). Render novel views by extracting individual pixels from images or via image blending and image morphing. In addition, allow the images to be reparameterized so as to support apparent aperture changes and focal length changes.


Extract an Optimal 3D Point Set from the Features. Given a set of images and corresponded features (which may be determined manually), estimate a 3D position for each observed feature. Back project the feature onto each image and compute an error value. Perturb the 3D estimation until achieving a single optimum location for all images. Then, optionally, iterate between perturbing the 3D coordinates and the camera poses. This project may also be interpreted as computing the "depth" to a feature from n-images (as opposed to just 2 images as would be the case with classical stereo depth estimation).

- Three Dimensional Computer Vision, Olivier Faugeras, MIT Press, 1996.

Build a 3D Surface Model. In addition to the above, fit a surface though all the points.


Build a 3D Volumetric model. From the array of images, compute the contents of a volume of space in front of the cameras. Use a space-carving, voxel-coloring, or a new approach of your own.


Create a Model using a Level-Set Approach. Implement a level-set based method to extract the surface.


Compute a BRDF from the Image Dataset. Once you have a 3D model, compute multiple values per pixel, indexed by incoming/outgoing ray direction. This builds up a BRDF for the patch. This would then allow re-illumination, for instance.

Lots of papers…

Dynamic Modeling and Rendering
**5D Plenoptic Function.** Similar to the 4D Plenoptic Function Renderer but capture a rigid object undergoing simple periodic motion, e.g. rotating about an axis. Allow for novel views but also allow for selection of time parameter.

**Live Stereo Viewing.** View a scene that you have already (mostly) reconstructed but generate stereo views (e.g. for viewing using glasses) in real-time. This requires slightly changing the view for one eye. Really cool!

**Additional Papers**

**Image-Based Registration and Reconstruction Systems**


Real-Time 3D Model Acquisition, Szymon Rusinkiewicz, Olaf Hall-Holt, Marc Levoy, Transactions on Graphics (SIGGRAPH proceedings), 2002.


**From 2D Images to 3D Space**


**Generative Models**


Instant Architecture, Peter Wonka (Georgia Institute of Technology), Michael Wimmer (Vienna University of Technology), François Sillion (ARTIS/INRIA Rhône-Alpes), Bill Ribarsky (Georgia Institute of Technology), Proceedings of ACM SIGGRAPH, 2003.

**Systems for Managing Large Models**


**Miscellaneous**


Conferences and Journals


There are other acceptable conferences and journals. Email me to obtain approval if you wish to use material from another source.