CS635: Assignment #3 –
Texture Mapped 3D Reconstruction

Out: February 23, 2010
Due: March 9, 2010

Objective

This objective of this assignment is to extend the previous assignment to also perform projective texture-mapping, resulting in colored and visually detailed 3D objects. This is not a large extension of the previous assignment but does complete the package and should produce intricate looking objects. In general, to improve the quality of your reconstruction you should increase the number of images captured. In this assignment, some simplifications are performed in the pipeline to make the overall task easier.

Detailed Description

Step 0 – Image Capture and External Pose Estimation

The process is similar to the previous assignment, however there are some simplifications. In the lab, I have setup a camera left-right translation pad so that you can place the camera on the track and only have to worry about left-right (i.e., x) translation. Moreover, it is ruled so you can actually estimate the translation amount by reading off the numbers. Thus you can still perform a full optimization but your translation and rotation guess will be quite accurate. This means you can easily capture "more images".

You must capture at least 10 pictures.

Step 1 – Reconstruction

The process is similar to the previous assignment, however there are some simplifications. Since the camera is moving left-right, and if you align the camera as best as you can to have an image plane parallel to the motion vector, then your "scene" will only move left/right: e.g., epipoles are points at infinity to the left and to the right and all epipolar lines are horizontal. Hence, it is much easier to correspond points.

The extra credit will be to detect and/or track features along these epipolar lines (e.g., horizontal lines). More on this later.

If you do not implement the extra credit, then you can do it manually as with the previous assignment (but, the task is easier).

The reconstruction should have at least 20 feature points at all times.

Step 2 – Triangulation

Same as with the previous assignment.

Step 3 – Visualization and Rendering

Same as with the previous assignment but now you should "texture-map" the captured image onto the object. In general a novel viewpoint will be near the translation vector and it will be bracketed by a captured image (and viewpoint) on the left side and on the right side of the novel viewpoint. You should texture both images onto the triangulation of the reconstructed points and linearly blend between the two based on the projected position of the novel viewpoint onto the line segment joining the associated the two captured viewpoints (e.g., if novel viewpoint is near the left-end, blend will be mostly of the left image and little of the right image). The texture coordinates for the triangles are just their corresponding pixel coordinates transformed to a normalized [0,1] space in x and in y.

Extra credit:

As mentioned above, the extra credit is:

1) to automatically detect strong "corner" features using the 2x2 matrix formulation we discussed in class. The top N of such features should then be used for correspondence.
2) to track the features from image A to image B. Since the epipolar lines are horizontal, the feature displacement should be nearly perfectly horizontal. This makes the correspondence searching problem must easier.

Grading/Demonstration

Your demonstration will consist of you showing me your program in short demo session to be arranged (in my office). On or before the due date, please provide me with a CD or a zip file with a single directory called **"<your-name>-asgn3**" containing:

- Windows PC Executable
- Data files (i.e., images)
- Other necessary files, DLLs, etc…

During your demo session, I will use the provided CD/zip-file to grade your program. Your grade will be influenced by how well your particular camera/object is reconstructed, by the presentation and usability of your program, and by how well you complete the assignment requirements.

In this assignment, you may collaborate only to help with the mechanics of the assignment (e.g., using the pad, your camera, etc). *Everybody must take their own pictures*! Practically speaking, this means that nobody should have the same pictures or calibration results.

If you have questions, please come see me ASAP – do not wait until the last moment. Have fun and good luck!