

Computer Vision AI – Assignment 3

Structure from Motion

Thursday 30th April, 2015

The results, the analysis and the source code must be included in the final delivery. Students are supposed to work on this assignment for two weeks.

1 Structure from Motion

In the previous assignment, you have created the point-view matrix to represent point correspondences for different camera views. You will use this matrix for the affine structure from motion in this assignment. The point-view matrix is comparable to the measurement matrix used in factorization procedure of the affine structure from motion. If all the points appeared in all views, we could indeed factorize the matrix directly to recover the points' 3D configurations as well as the camera positions. However, in general, the point-view matrix is sparse, and we must find dense blocks (submatrices) to factorize and stitch. Remember to enable a sufficient number of points that persist throughout the sequence to perform factorization on a dense block. There is no need to fill in missing data for this problem now. Follow the general scheme described below:

1. Normalize the point coordinates by translating them to the mean of the points in each view (see lecture slides for details).
2. Select a dense block from the point-view matrix and construct the $2M \times N$ measurement matrix D . Each column contains the projection of a point in all views, while each row contains one coordinate of the projections of all the points in a view.
3. Apply SVD to the $2M \times N$ measurement matrix to express it as $D = U * W * V'$ where U is a $2M \times 3$ matrix, W is a 3×3 matrix of the top three singular values, and V is a $N \times 3$ matrix. Derive the structure and motion matrices from the SVD as explained in the lecture.
4. Plot the 3D structure. In the report, please include snapshots from several viewpoints to show the structure clearly. Discuss whether or not the reconstruction has any affine ambiguity and try to eliminate it.