Computer Vision CS 543/ECE 549
Homework 4

Due date: May 4th 2010

Answer the following questions and explain all solutions. Write down all steps of each solution as a pseudo code or algorithm. Note that code is not an explaination.

Problem 1. Image stitching

Figure 1: Keble Images

For the given pair of keble images (Figure 1):

1. Manually mark appropriate number of matching points in the two images and compute the homography matrix H between the two views. Show the matching image points used for this part. Instructions for plotting matches are included below.(5 points)

2. Use the set of matched points provided to you in prob1.mat matlab workspace to estimate homography H automatically using RANSAC. Write down RANSAC algorithm, give the threshold used for deciding inlier vs outlier. Show the

matching image points provided to you initially and matching image points that are RANSAC inliers.(10 points)

3. Stitch the two images together using the homography matrix computed above. Display the resulting stitched image.(10 points)

(25 points)

The file prob1.mat has the detected Harris corners row-column positions in variables *r1 c1* for the first image; variables *r2 c2* for the second image; and the corresponding matched pairs in the variable *matches*. Use the function plotmatches.m provided to you. e.g. *plotmatches(im1,im2,[c1 r1]',[c2 r2]',matches')*)

Problem 2. Epipolar Geometry

Figure 2: Chapel Images

For the given pair of chapel images (Figure 2):

1. Manually mark appropriate number of matching points in the two images and compute the Fundamental matrix F using 8 point Algorithm. Write down 8 point algorithm, print F and show the matching points used for this part.(7 points)

2. Use the set of matched points provided to you in prob2.mat matlab workspace to estimate the fundamental matrix F automatically using RANSAC. Give the threshold used for deciding inlier vs outlier. Print F. Show the point matches provided to you initially and matched points that are RANSAC inliers.(7 points)

3. Pick a set of 5 points well separated from each other in each image find and display the corresponding epipolar line in the other image. Show this for fundamental matrix F estimated in part 1 and part 2. (4 points)

4. Show how to compute cameras matrices corresponding to a pair of canonical cameras where one camera is at origin and has projection matrix as $P1 = [I|\bar{\mathbf{0}}]$ and other is rotated and translated with respect to it. Compute such a camera pair for the fundamental matrix computed in part 1 and part 2.(7 points)

The file prob2.mat has detected Harris corners row-column positions in variables *r1 c1* for the first image; variables *r2 c2* for the second image; and the corresponding matched pairs in the variable *matches*. Use the function plotmatches.m provided to you. (e.g. *plotmatches(im1,im2,[c1 r1]',[c2 r2]',matches')*)
(25 points)

Problem 3**. Multiview Reconstruction**

1. Give two examples of Homography i.e describe two camera and scene settings which result in homography between the two views. (Provide example images taken from such a setting or draw figures describing such settings) (5 points)

2. Prove that under pure translation motion of camera epipole lies at vanishing point of direction of the motion.(10 points)

3. Write a short discussion on how to resolve projective ambiguity in reconsturction from two views using additional cues. Describe those cues. (10 points)

Problem 4**. Tracking**

We have a linear dynamical system with states X_i. X_i is a normal random variable with mean $\mathcal{D}X_{i-1}$ and covariance Σ_d. At each step the measurement Y_i is drawn from a distribution with two gaussian components $\mathcal{N}(\mathcal{M}X_i, \Sigma_m)$ and $\mathcal{N}(0, \Sigma_n)$. $P(X_1)$ is gaussian.

1. Show that if $P(X_{i-1}|Y_1, \ldots, Y_{i-1})$ is a mixture of k Gaussians then $P(X_i|Y_1, \ldots, Y_{i-1})$ is also a mixture of k Gaussians.(5 points)

2. Show that if $P(X_i|Y_1, \ldots, Y_{i-1})$ is a mixture of k gaussians and the measurements Y_i are drawn only from the first component $\mathcal{N}(\mathcal{M}X_i, \Sigma_m)$ then $P(X_i|Y_1, \ldots, Y_i)$
is also a mixture of k Gaussians. (10 points)

3. Show that the posterior $P(X_i|Y_1, \ldots, Y_i)$ is a mixture of gaussian with 2^i components.(5 points)

4. We can not use an exact representation of the posterior in this case there are too many componenets. Suggest a strategy to manage this problem.(5 points)