Homework 1: Zhang's Method and Plane Sweep

Instructions

- Describe any interesting decisions you made to write your algorithm.
- Show and discuss the results of your algorithm.
- Feel free to include code snippets, images, and equations.
- There is no page limit.

1 In the beginning...

The aim of this assignment was to implement Zhang's method for 'camera calibration' and then use 'Plane sweep stereo' technique for stereo matching.

2 For camera calibration

The homography is the result of a nonlinear optimization. To solve it, we first optimise a function which is not physically meaningful, but can give us a closed-form solution which serves as a starting point for the nonlinear optimization with the physically meaningful cost function.

The workflow for the first part consists of calculating homography using SVD, finding intrinsic parameters using matrices B and V, and then updating scale for every view to calculate extrinsic parameters. The rotation matrix estimated does not satisfy the properties of a rotation matrix in general. Hence, R is estimated using SVD. Finally, performing the nonlinear optimisation(MLE) concludes the portion of camera calibration.

3 For Plane Sweep Stereo

This part basically consists of 5 steps. First, obtain grayscale images. Second, form cost volume length * height $*(max_d - min_d)$. Third, aggregation using imfilter function. Fourth, obtaining disparity map and finally, obtaining depth map from disparity.

See Equation 1.

$$depth = f * T/disparity \tag{1}$$

Interesting Implementation Detail

I have attached the code snippet I wrote for Plane sweep stereo. I varied window size to find the one with best performance. Setting it to 13 gave the best performance.

```
for d = 1 : length(d_vals);
  I2t = imtranslate(I2, [d 0]);
  C(:,:,d) = abs(I1 - I2t);
  C(:,:,d) = imfilter(C(:,:,d), window);

end

[C_min, D] = min(C, [], 3);
disparityMap = D + min_d;
for i=1:size(disparityMap,1)
    for j=1:size(disparityMap,2)
        depthMap(i,j) = focalLength*baseline/
           disparityMap(i,j);
    end
end
```

4 Disparity and Depth maps for the two cases

Original y-coordinate mean diff	Rectified y-coordinate mean diff
11.9712	0.0563
14.7440	0.0274

Table 1: Y coordinate mean difference

Test no.	Depth Mean Difference(in mm)
Test 1	485.87
Test 2	1471.74

Table 2: Depth mean difference

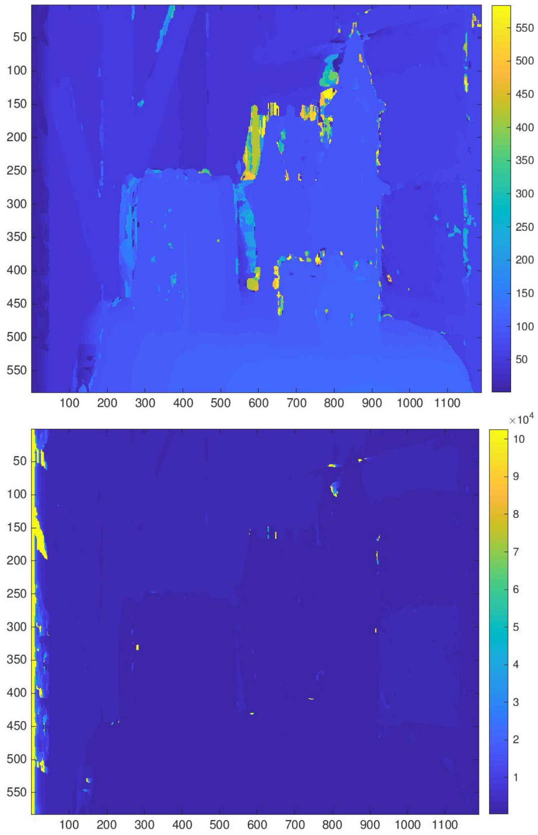

Figure 1: *Top:* DisparityMap1 *Bottom:* DepthMap1

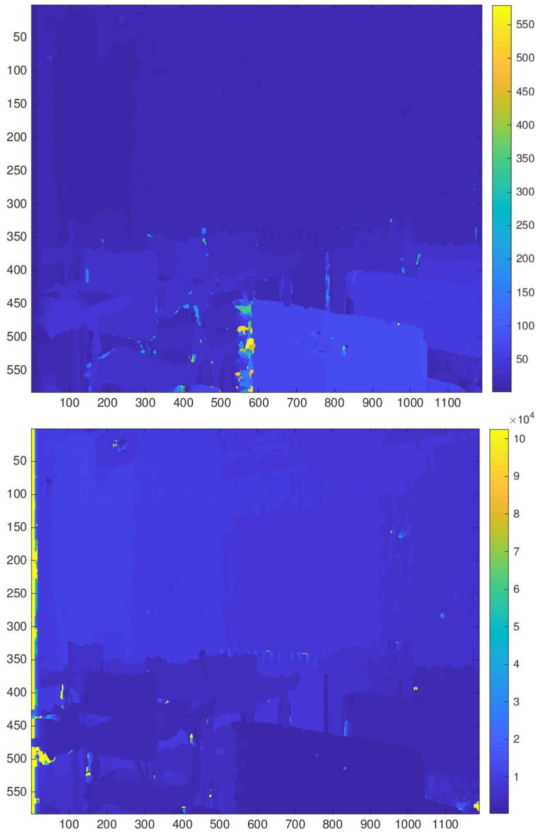

Figure 2: *Top:* DisparityMap2 *Bottom:* DepthMap2

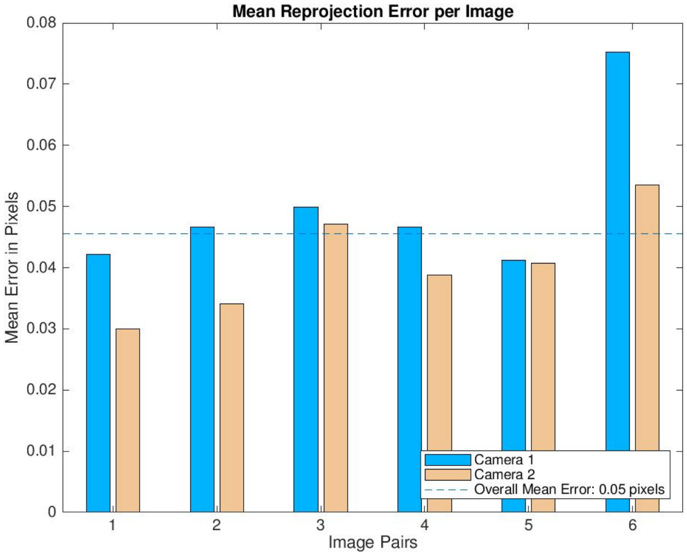

Figure 3: Mean reprojection errors