Homework 1 Writeup

Introduction

Implementation of Zhang's method for camera calliberation

Given a number of views of a particular image, we first calculate the homography matrix by the optimization of the cost funcion of H(L).Using H, we then calculate the intrinsic parameter 'K' using optimization techniques. Extinsic parameters 'Rt' is obtained from the homography matrix and the intrinsic parameters. Maximum Likelihood Estimate is also obtained. My code snippet highlights how homography matrix is estimated using the singular value decomposition of its cost function (here L).

```
for i=1:numView
    [U1,S,V1] = svd(L(:,:,i));
    H=V1(:,9);
    H=H/H(9);
    homography(:,:,i)=transpose(reshape(H,3,3));
end
```

```
for i=1:numView
    z=((1/(norm(K1*h1(:,i)))) + (1/(norm(K1*h2(:,i)))))/2;
    r1 = z*(K1*h1(:,i));
    r2 = z*(K1*h2(:,i));
    t  = z*(K1*h3(:,i));
    r3 = cross(r1,r2);
    R = [r1,r2,r3];
    [A,B,C] = svd(R);
    R1= A*(transpose(C));
    Rt(:,1:3,i)=R1;
    Rt(:,4,i)=t;
end
```

Implementation of Plane Sweeping algorithm to estimate Depth

Given 2 rectified gray-images, we try to obtain the disparity map of by preprocessing, and then using cost aggregration. We obtain the depth map using the given camera parameters and the obtained disparity map.

```
d_vals = min_d : max_d;
num_d = length(d_vals);
C = NaN(size(leftImageGray,1), size(leftImageGray,2), num_d);
for i = 1 : length(d_vals)
    d = d_vals(i);
    I2t = imtranslate(rightImageGray, [d 0]);
    C(:,:,i) = abs(leftImageGray - I2t);
    C(:,:,i) = imfilter(C(:,:,i), kernel);
end
[C_min, D] = min(C, [], 3);
DisparityMap = D + min_d;
```

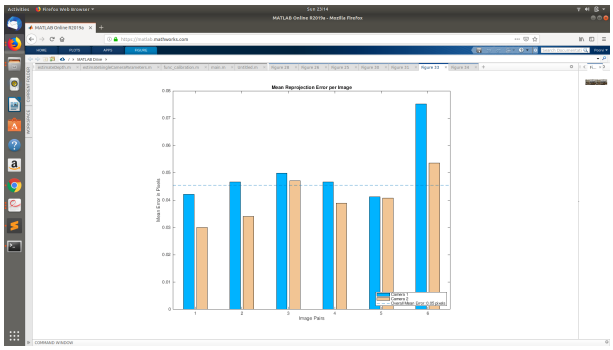
$$DepthMap(i,j) = (focal - length * baseline)/DisparityMap(i,j) \quad (1)$$

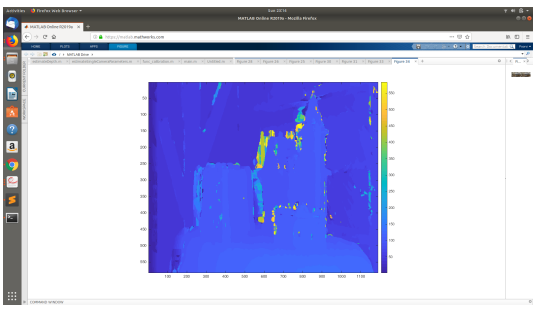
Discussion

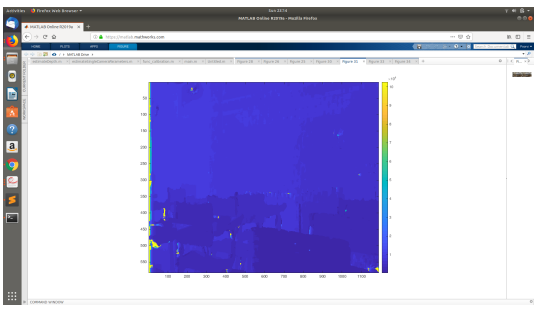
- We assume that the z component for every point is 0 in the world coordinates without any lossin generality
- For estimating the best rotation matrix from the computed one, we neglect the middle diagonal matrix in its singular value decomposition
- While estimating the disparity map, I chose the maximum disparity possible to be the width of the images i.e 583 and the window size to be 11.

Result

1. Camera Calibration
   (a) First evaluation
      i. original y-coordinate mean difference = 11.9712
      ii. rectified y-coordinate mean difference = 0.0563
   (b) Second evaluation
      i. original y-coordinate mean difference = 14.7440
      ii. rectified y-coordinate mean difference = 0.0275
2. Mean reprojection error per image, DepthMap and DisparityMap







3. Depth estimate
   (a) Scene1: depth mean difference=509.76mm
   (b) Scene 2: depth mean difference=1869.74mm