Report for Assignment - 1 (Computer Vision CSCI-GA.2271-001)

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1. Image Filtering

(a) 1. Valid

```
[[az+by+dx+ew        bz+cy+ex+fw]
 [dz+ey+gx+hw        ez+fy+hx+iw]]
```

2. Same

```
[[aw          ax+bw          bx+cw]
 [ay+dw       az+by+dx+ew    bz+cy+ex+fw]
 [dy+gw       dz+ey+gx+hw    ez+fy+hx+iw]]
```

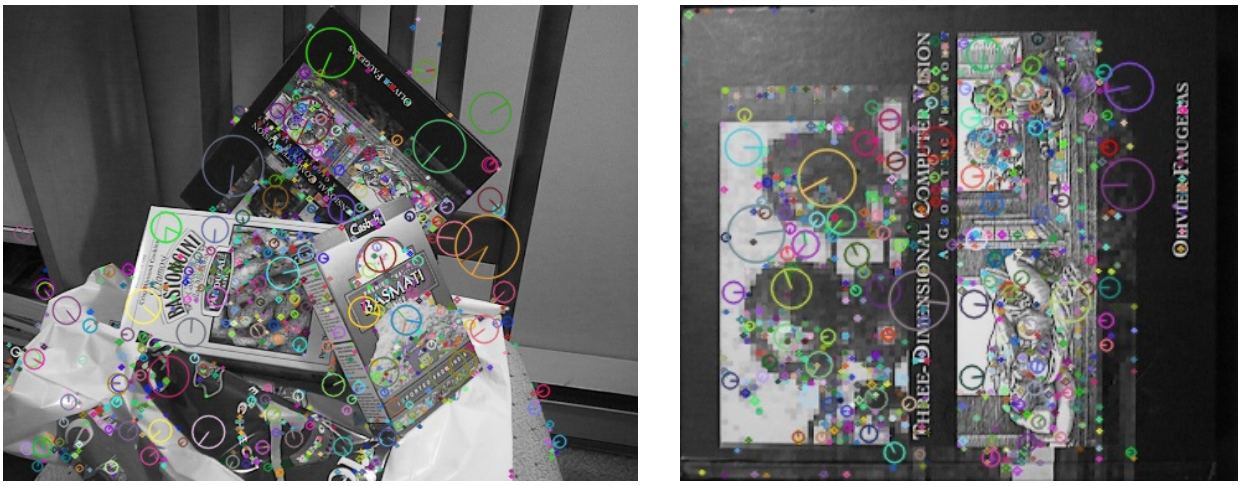
(b) Output dimension of image (h,w) convolved with filter (i,j) valid boundary conditions is (X,Y):
X = max([h-max(0,i-1)],0)
Y = max([w-max(0,j-1)],0)

Original Image

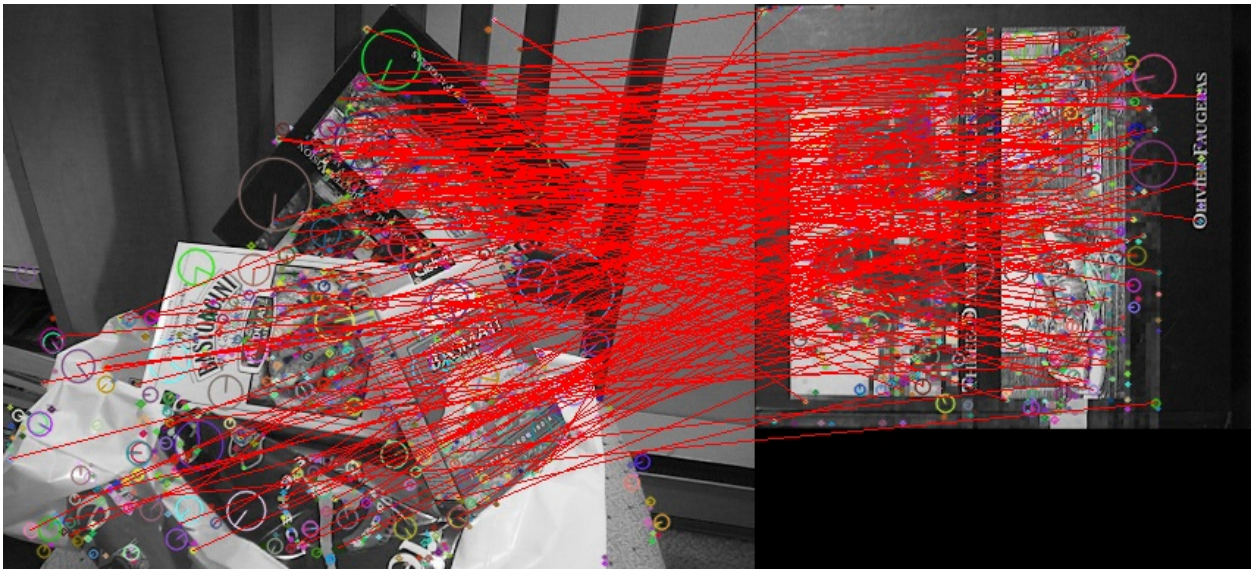
Blurred Image (width = 3)

Blurred Image (width = 5)

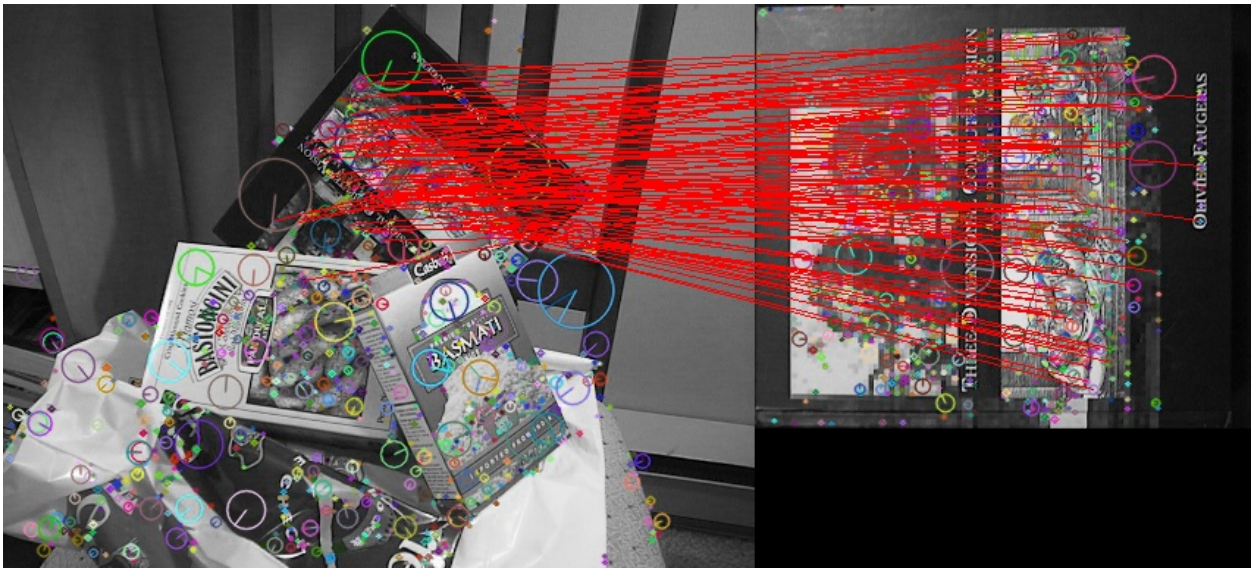
2. Image Alignment



SIFT keypoints of both images. Each keypoint is represented with its size and orientation(circle).



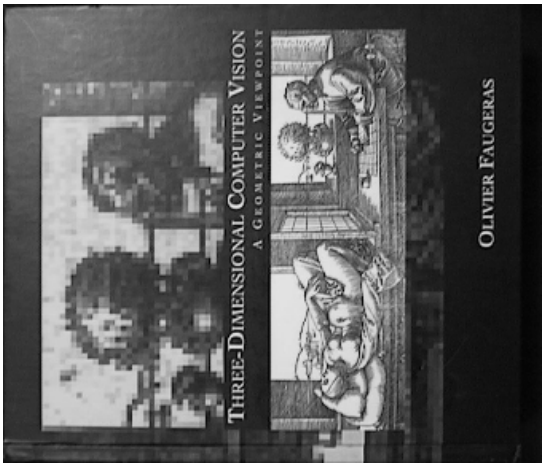
There were 248 good matches with a threshold of 0.9. The above image is before RANSAC.



Feature matching between the 119 inliers (48% of good matches). The above image is after RANSAC.

Final transformation (H) Matrix
[[1.1109896 -1.20025397 38.0034649]
[1.21704437 1.07267689 -330.64476206]]

As we can see below, the pose of the book is almost the same in both the images.



Real image

Warped image after affine transformation

3. Estimating the camera parameters

Camera matrix P
[[-1.27000127e-01 -2.54000254e-01 -3.81000381e-01 -5.08000508e-01]
 [-5.08000508e-01 -3.81000381e-01 -2.54000254e-01 -1.27000127e-01]
 [-1.27000127e-01 -1.11022302e-16 -1.27000127e-01   0.00000000e+00]]

Camera world coordinates (C) - 1st method
[[1.]
 [-1.]
 [-1.]]
Camera world coordinates (C) - 2nd method
[[1.]
 [-1.]
 [-1.]]

4. Structure from Motion

Translation vector of first camera (t_i)
[2.3684757858670008e-17, 8.2896652505345025e-17]

Affine camera matrix for first camera (M_i)
[[-7.50914219 3.30837904 -3.71763726]
 [-4.53754376 -1.57773527 7.74574759]]

3D coordinates(x,y,z) for the first 10 world points

[(0.0057716262048463658, 0.064606281983365529, -0.024976152508609656),
(0.00057609968845948717, 0.068853630512852607, -0.034581509689483828),
(-0.042935849081986235, 0.063304789701081735, 0.028617113082434188),
(0.047450383489819413, 0.049042065349057251, -0.012575472616124796),
(-0.042101860262101248, 0.067892392631770271, 0.011751637042498885),
(0.059619637747370981, 0.04605179976154497, -0.014383742867820598),
(0.009091667080625334, 0.06002048918269999, -0.012299970374395071),
(0.010394894790726692, 0.046020653847651312, 0.035292747610496743),
(-0.025890805334956506, 0.05702972054986153, 0.033373747525897966),
(0.017455976600106261, 0.040542636931378842, 0.047318593420524822)]

Scatter plot of the 3D world points (Final 3D object - Cube)