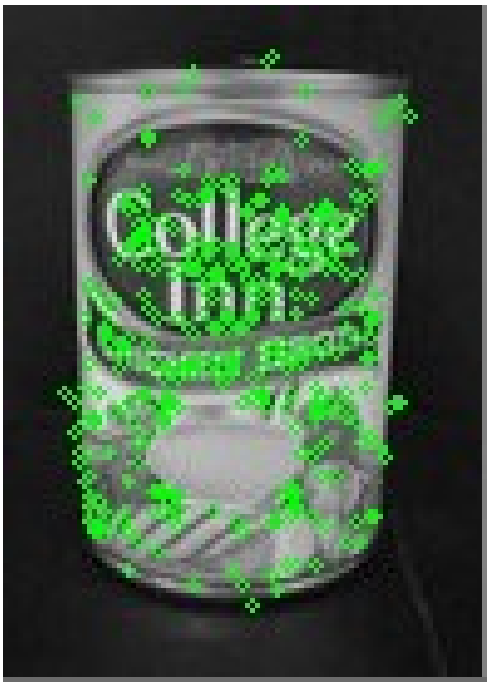
16720A: Computer Vision

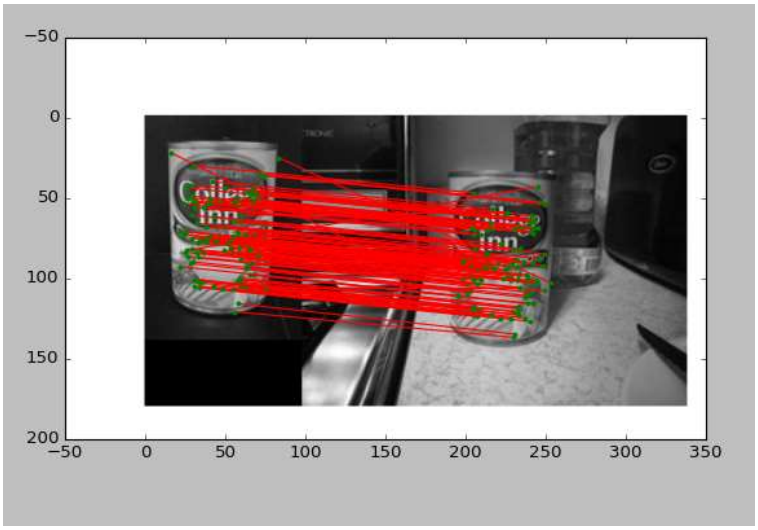
[redacted]

1.5 Keypoint detector

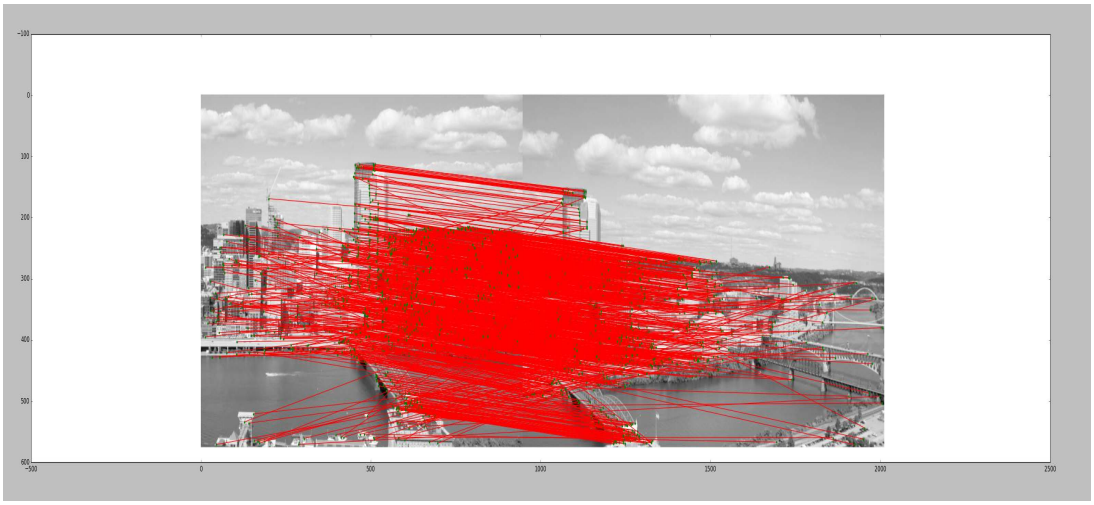


2 Brief Descriptor

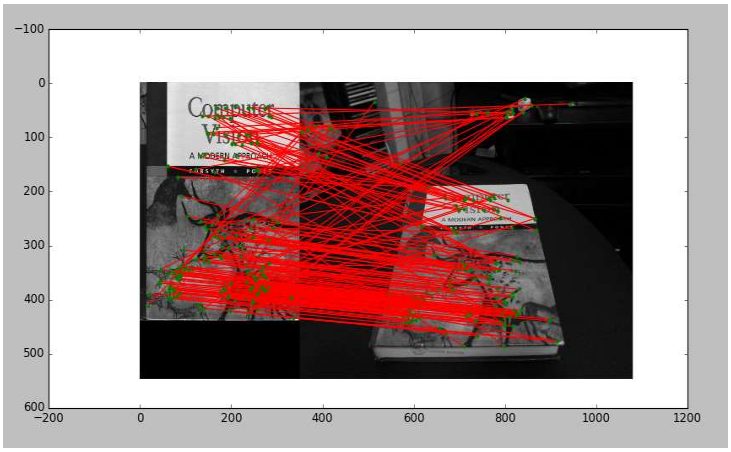
2.4



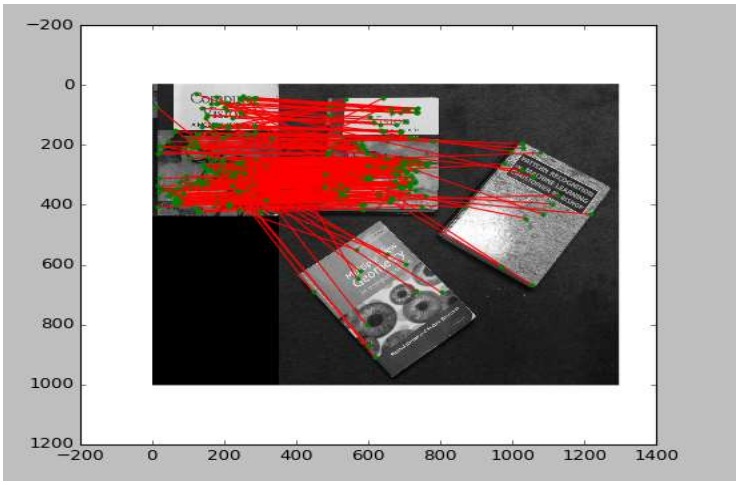
Matches between chicken broth images



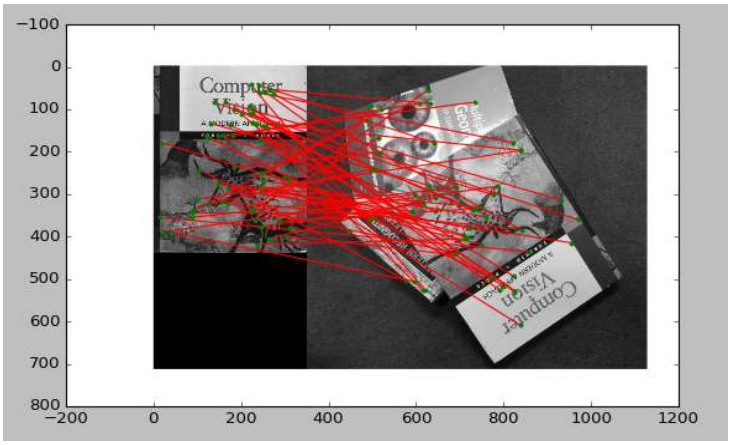
Matches between incline_L and incline_R



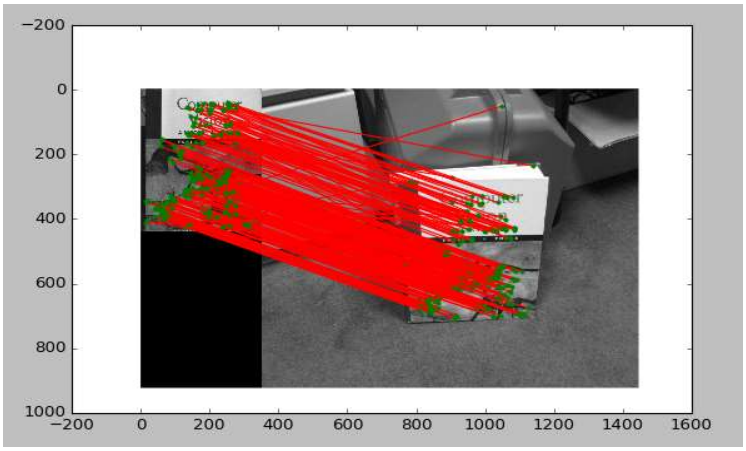
Matches between pf_scan_scaled and pf_desk



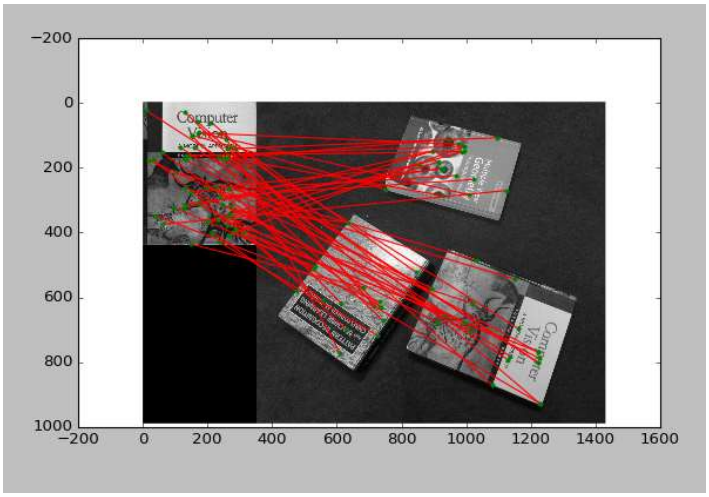
Matches between pf_scan_scaled and pf_floor



Matches between pf_scan_scaled and pf_pile

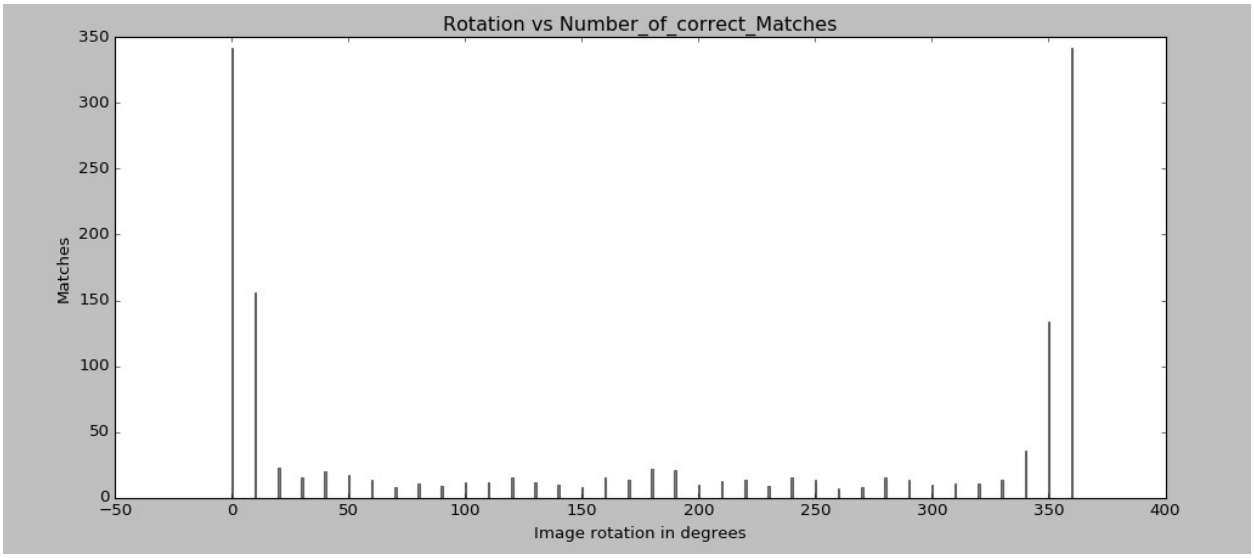


Matches between pf_scan_scaled and pf_stand



Matches between pf_scan_scaled and pf_floor_rot

2.5



The performance of the brief descriptor decreases substantially i.e. the number of matches decreases as the angle of rotation increases until it starts approaching 360 degrees or the original image again. This means that the BRIEF descriptor reacts poorly to features at different rotations leading to fewer match correspondences. As the image approaches 360 degrees, it basically corresponds to features at zero degree rotation and hence the BRIEF descriptor picks up performance.

3 Planar Homographies: Theory

3.1 a

$$\lambda_n x_n = H u_n$$

$$\begin{bmatrix} \lambda x_2 \\ \lambda y_2 \\ \lambda \end{bmatrix} = \begin{bmatrix} h_1 & h_2 & h_3 \\ h_4 & h_5 & h_6 \\ h_7 & h_8 & h_9 \end{bmatrix} \begin{bmatrix} u_1 \\ v_1 \\ 1 \end{bmatrix}$$

Dividing first row by the third and second row by the third

$$h_1 u_1 + h_2 v_1 + h_3 = x_2 h_7 u_1 + x_2 h_8 v_1 + x_2 h_9 \quad \text{....(1)}$$

$$h_4 u_1 + h_5 v_1 + h_6 = y_2 h_7 u_1 + y_2 h_8 v_1 + y_2 h_9 \quad \text{....(2)}$$

Substituting (1) and (2) in Ah = 0

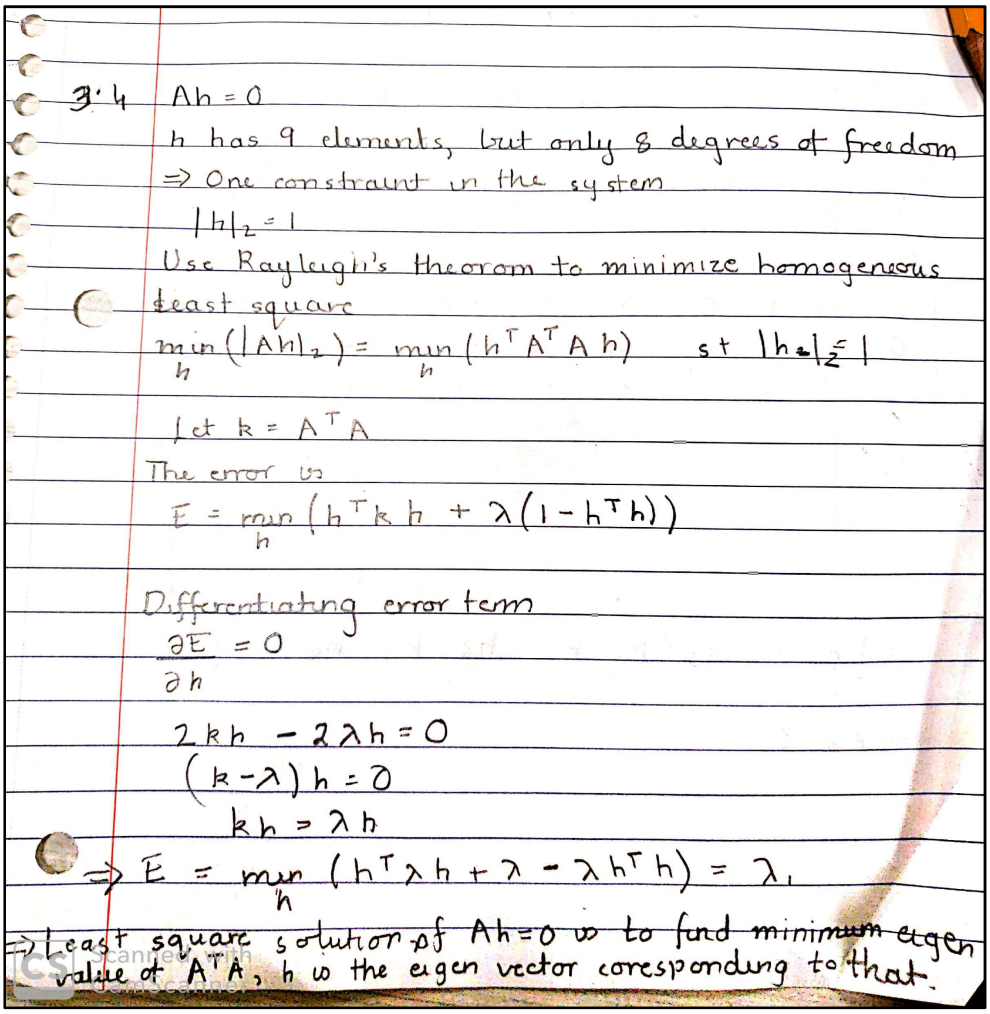
$$A = \begin{bmatrix} u_1 & v_1 & 1 & 0 & 0 & 0 & -x_2 u_1 & -x_2 v_1 & -x_2 \\ 0 & 0 & 0 & u_1 & v_1 & 1 & -y_2 u_1 & -y_2 v_1 & -y_2 \\ . & . & . & . & . & . & . & . & . \\ . & & & & & & & & \\ . & & & & & & & & \\ . & & & & & & & & \\ . & & & & & & & & \\ . & & & & & & & & \end{bmatrix}$$

$$h = \begin{bmatrix} h_1 \\ h_2 \\ h_3 \\ h_4 \\ h_5 \\ h_6 \\ h_7 \\ h_8 \\ h_9 \end{bmatrix}$$

3.1b There are 9 elements in h

3.1c H has 9 elements but 8 degrees of freedom. This implies that there is a single constraint on the system. 4 point pairs or correspondences are required to solve the system. Each point pair gives rise to 2 equations and 2 elements of the h matrix.

3.1d



3.4 $Ah = 0$

h has 9 elements, but only 8 degrees of freedom

$\Rightarrow$ One constraint in the system

$|h|_2 = 1$

Use Rayleigh's theorem to minimize homogeneous least square

$$\min_h (|Ah|_2) = \min_h (h^T A^T A h) \quad s.t \ |h_2|_2 = 1$$

Let $k = A^T A$

The error is

$$E = \min_h (h^T k h + \lambda(1 - h^T h))$$

Differentiating error term

$$\frac{\partial E}{\partial h} = 0$$

$$2kh - 2\lambda h = 0$$

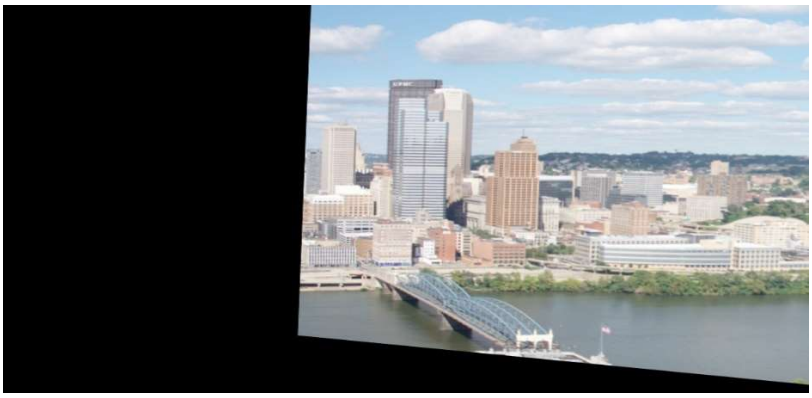
$$(k - \lambda) h = 0$$

$$kh = \lambda h$$

$$\Rightarrow E = \min_h (h^T \lambda h + \lambda - \lambda h^T h) = \lambda_1$$

$\Rightarrow$ Least square solution of $Ah = 0$ is to find minimum eigen value of $A^T A$, h is the eigen vector corresponding to that.

6.1



6.2

6.3

Final panorama view. With homography estimated using RANSAC.