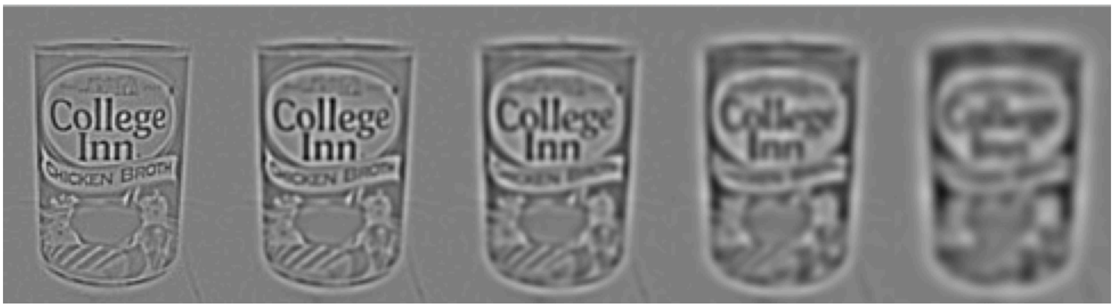
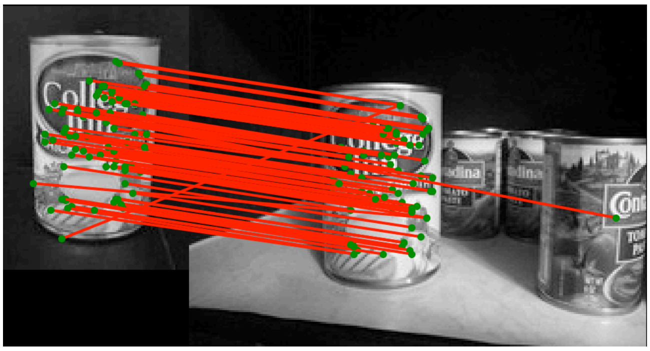
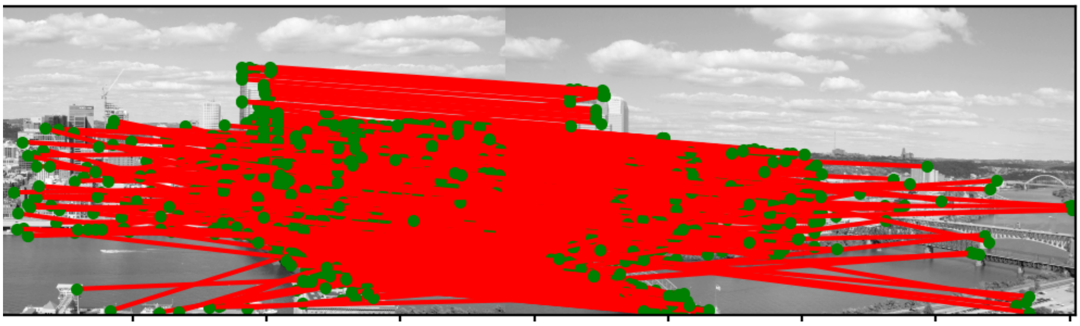
Q1.2 The DoG Pyramid of model_chickenbroth.jpg

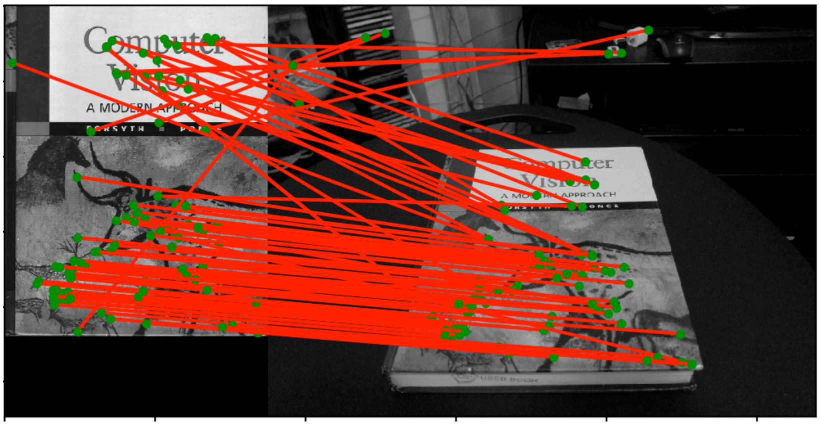


Q1.5 The image with the detected keypoints

Q2.4

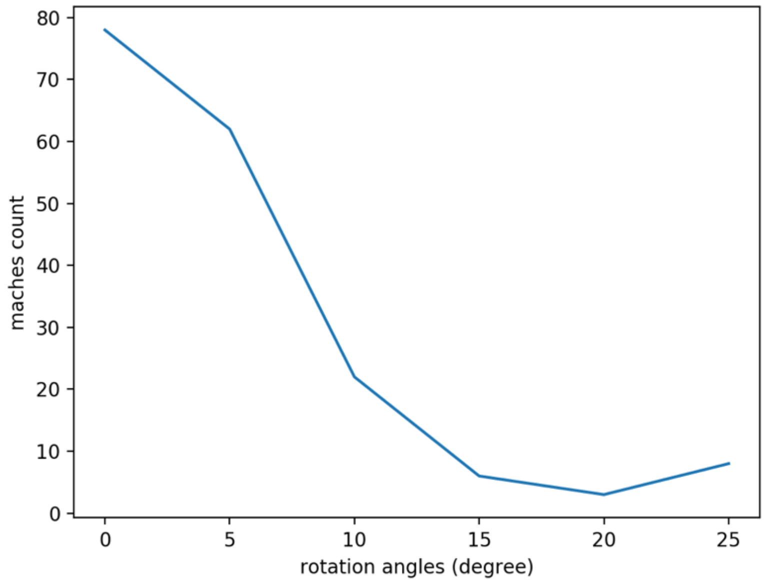






Q2.5

The BRIEF descriptor is not rotation-invariant since it matches the key points using the binary pattern whose values may vary if the image is rotated. Therefore, as the rotation angles increasing, the matches count decreases.



Q3.1

1.

From the given equation 8, we can re-write it in the matrix form as follow:

$$\lambda \begin{pmatrix} x \\ y \\ 1 \end{pmatrix} = \begin{pmatrix} h_{11} & h_{12} & h_{13} \\ h_{21} & h_{22} & h_{23} \\ h_{31} & h_{32} & h_{33} \end{pmatrix} \begin{pmatrix} u \\ v \\ 1 \end{pmatrix}$$

So, we can express our coordinates (x, y) as the following form:

$$\lambda x = h_{11}u + h_{12}v + h_{13}$$
$$\lambda y = h_{21}u + h_{22}v + h_{23}$$
$$\text{Where} \quad \lambda = h_{31}u + h_{32}v + h_{33}$$

We can also make the equations above more similar to our target form Ah = 0:

$$x(h_{31}u + h_{32}v + h_{33}) - h_{11}u + h_{12}v + h_{13} = 0$$
$$y(h_{31}u + h_{32}v + h_{33}) - h_{21}u + h_{22}v + h_{23} = 0$$

Since we have N correspondences of both x and y, we can form 2N linear equations in the following matrix form:

$$\begin{bmatrix} 0 & 0 & 0 & -u_1 & -v_1 & -1 & y_1u_1 & y_1v_1 & y_1 \\ u_1 & v_1 & 1 & 0 & 0 & 0 & -x_1u_1 & -x_1v_1 & -x_1 \\ 0 & 0 & 0 & -u_2 & -v_2 & -1 & y_2u_2 & y_2v_2 & y_2 \\ u_2 & v_2 & 1 & 0 & 0 & 0 & -x_2u_2 & -x_2v_2 & -x_2 \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & -u_N & -v_N & -1 & y_Nu_N & y_Nv_N & y_N \\ u_N & v_N & 1 & 0 & 0 & 0 & -x_Nu_N & -x_Nv_N & -x_N \end{bmatrix} \begin{bmatrix} h_{11} \\ h_{12} \\ h_{13} \\ h_{21} \\ h_{22} \\ h_{23} \\ h_{31} \\ h_{32} \\ h_{33} \end{bmatrix} = \mathbf{0}$$

2. 9

3. We need 4 correspondences to solve this system. Since the degrees of freedom in H are 8, so we need 8 equations to solve this linear system, that is, 4 correspondences.

4. The procedures are listed as below:

(a) Apply SVD method on A matrix A as we derive in 3.1.1 to get the V transpose matrix (Vt).

(b) Since Vt is the transpose matrix, we need to get the h_{ij} values from the last row of Vt, where i and j are both in range of [1,3]

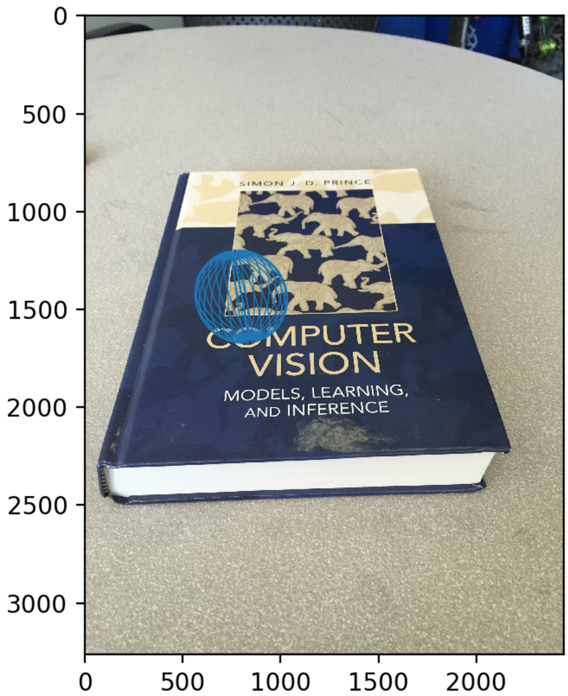
(c) Re-shape the 9 elements (h_{ij}) to a 3x3 matrix H and divide H by h_{33} to make sure the degrees of H equal to 8.

Q6.1

Q6.2

Q6.3

Q7.2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