Computer Vision Homework-2

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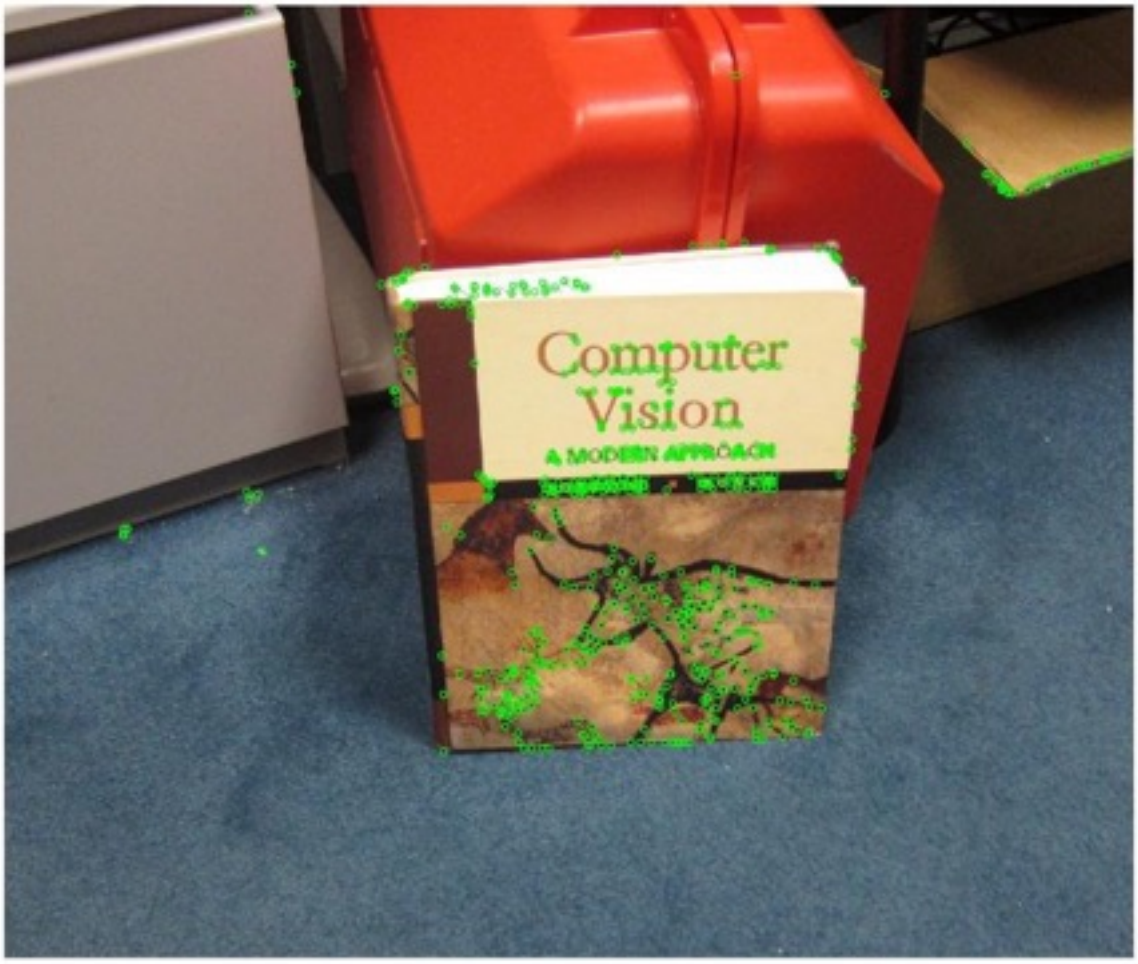
1. Key point detector



2.4. Descriptor Matching

- Chicken broth image matches well compared with other images. One observation is that the chicken broth image does not differ much in background and the objects are placed almost in the same angle.
- Incline image: I got a lot of interest points around 4000 for the left image and around 2000 interest points for the right image. And I got 2100 matches using BRIEF descriptor. And from the figure

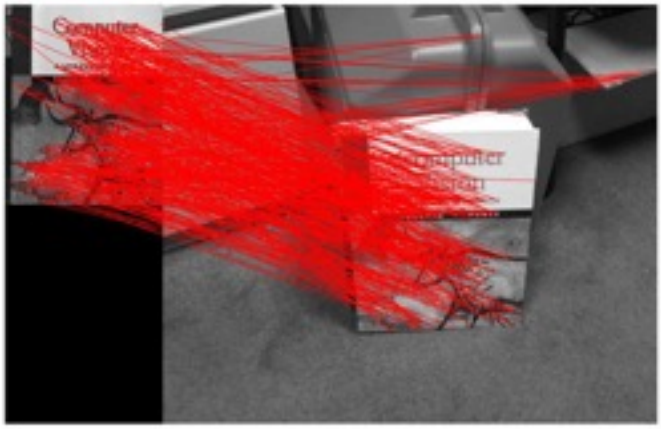
below, it was very obvious that it has a lot of outliers. The reason could be that the building structure looks same at a greater distance, and has a lot of repeated patterns in them.

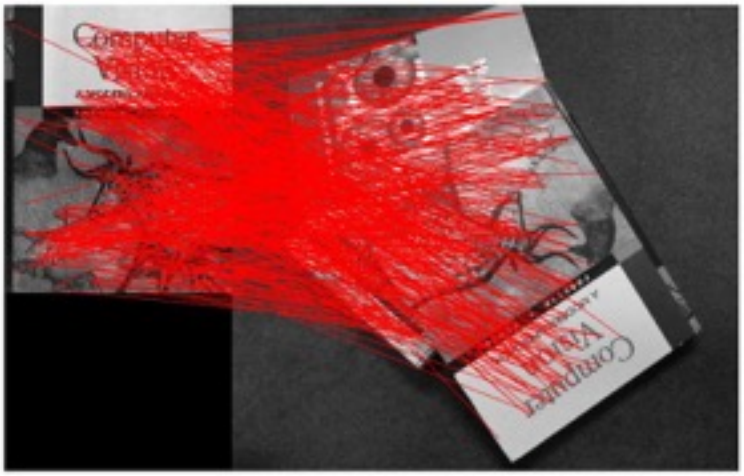
- Computer Vision textbook: It performed well when the test is made as in desk / floor / stand images. Either if the book is rotated, or if the environment had similar objects the outliers are more.

1. Chicken-broth

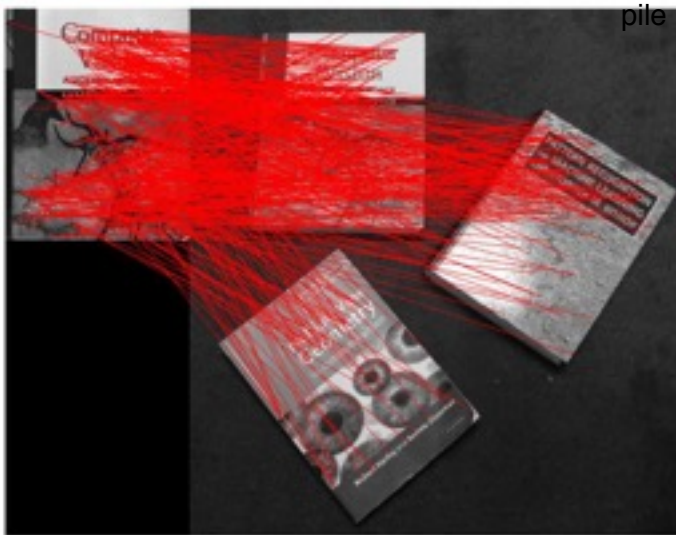
2. Incline

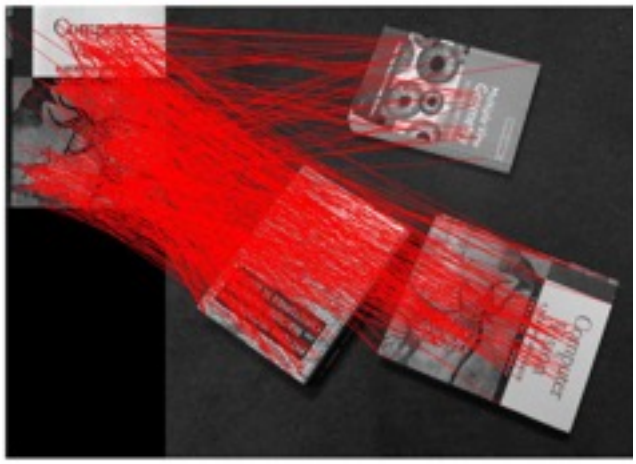
3. computer vision textbook cover page

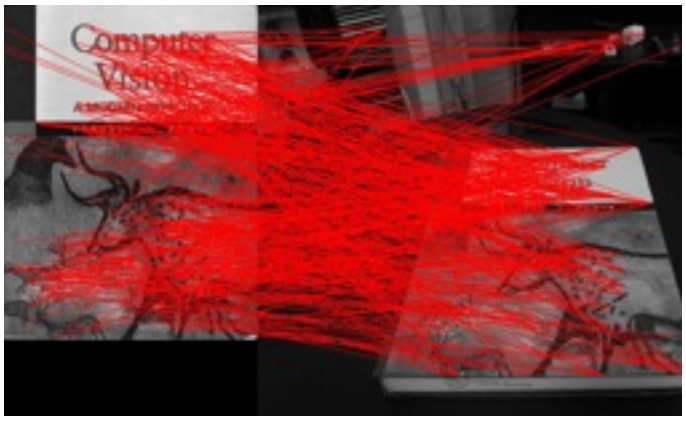




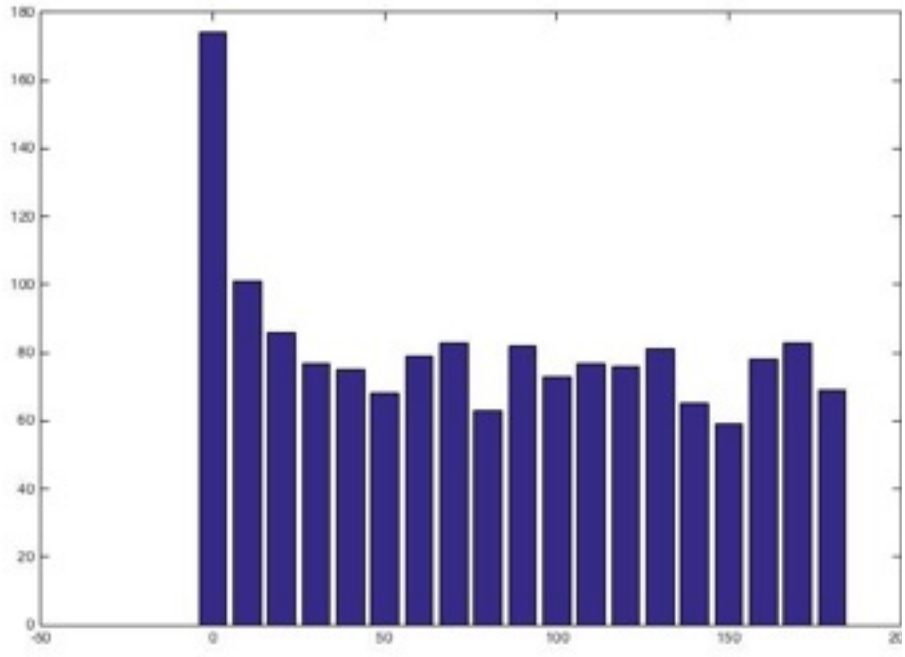
pile







2.5 BRIEF and rotations



The number of matches decreased for the rotated images. But it remained around the same level for any degree of rotations.
Possible reason could be:

- The 9x9 patch used in BRIEF descriptor is square, and while comparing images in different orientation, the descriptor that is used to compare are not created with the same pixel around it. This may increase the distance(hamming) between them.

3 Extra credit

Rotation Invariant:

- One way to obtain rotation invariance could be to identify the angle of rotation using some of the key points detected using DoG-Detector.

Scale Invariant:

- Key points detected can be matched with multiple levels in Gaussian to reduce the effect of scale

4. Planar Homographies

4.1

a) Ah=0

$$p^i \equiv Hq^i$$

Since p and Hq lies on the same plane, the cross product is zero.

$$p \times Hq = 0$$

$$\begin{pmatrix} p_x \\ p_y \\ 1 \end{pmatrix} \times \begin{pmatrix} h_1^T q \\ h_2^T q \\ h_3^T q \end{pmatrix} = 0$$

$$\begin{pmatrix} p_y h_3^T q - h_2^T q \\ -p_x h_3^T q + h_1^T q \\ p_x h_2^T q - p_y h_1^T q \end{pmatrix} = 0$$

Making linear equations out of it,

$$\begin{pmatrix} 0 & -q & p_y q \\ q & 0 & -p_x q \\ -p_y q & p_x q & 0 \end{pmatrix} \begin{pmatrix} h_1^T \\ h_2^T \\ h_3^T \end{pmatrix} = 0$$

Since the system is homogenous and only has 2 degrees of freedom, we can select first two linear equations alone.

$$Ah = 0$$

will contain 2 linearly independent equation for 1 correspondence in p and q.

b) h has nine elements in it. h1, h2, … h9

c) Four point pairs are required to solve this system, which would result in eight linear equations.

d) Steps

i. According to Rayleigh Quotient theorem, to determine the least square solution for Ah = 0, find the Eigen vector of A^TA corresponding to the least Eigen value. The error will be minimum at the lowest Eigen value.

ii. To find the least Eigen vector, Use SVD decomposition, and find the last column of V matrix which is the Eigen vector for lowest Eigen value.

5. Implementation