COMPUTER VISION ASSIGNMENT 2

Zhuoli Lu

1. EXERCISE 1

When checking keypoints found on the image "scene", 1021 keypoints are found. The array keys size is 1021×128, which means every keypoint contains a 128 dimension vector. This matches the description in the paper.
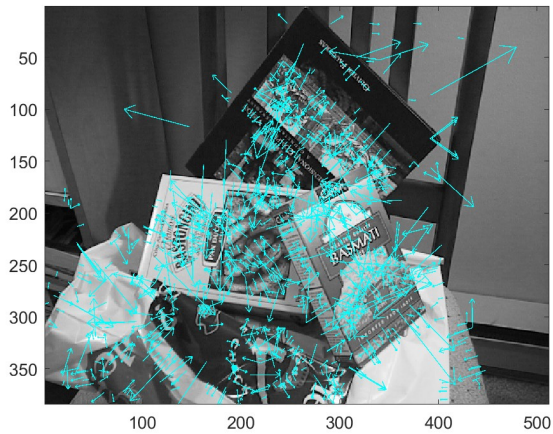

Fig. 1. Keypoints detected and its orientations on the image

As shown on Fig.1, the keypoints are detected more frequently on objects with rich textures, such as the book covers, and less frequently on smooth or uniform surfaces like the wall and the cloth. The keypoint orientations vary. This indicates the robustness of SIFT in capturing local gradient directions.
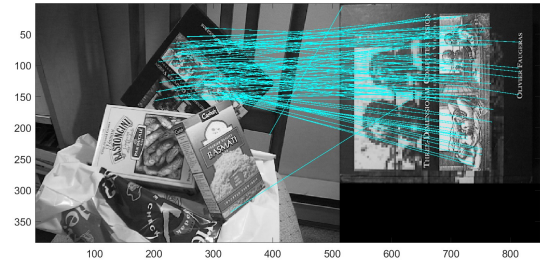
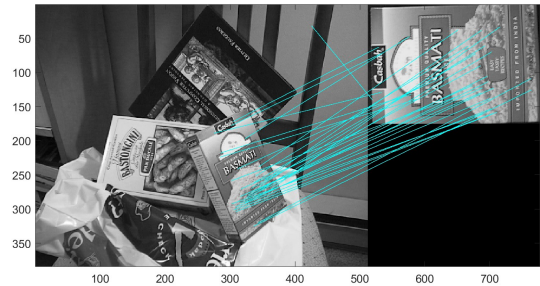**Fig. 2**. Keypoints matching results on between the scene and the specific book

Fig. 3. Keypoints and matches detected on "basmati.pgm"

Table 1. Matching Results between Indoor scene and Indoor Objects

Image Pair	Matches	Match %
Scene vs. Book	98	9.60% / 11.11%
Scene vs. Basmati	34	3.33% / 5.87%

While we match keypoints between the scene image with several books on it and the specific book image (Fig.2), 98 keypoints matches are found with the object recognized successfully. The percentages of matched keypoints are around 9.6 and 11.1 respectively on each image. Not all matches are correct, it can be observed that there are two significant mismatch lines. They are reasonable. Because SIFT lacks globle constraints, which may cause mismatched points with similar local patterns around them. Fig.3 demonstrates similar good

results with few mismathes when we change the object to be detected. Table1 shows the overview results.

Table 2. Matching Results between Outdoor scene and Outdoor Objects

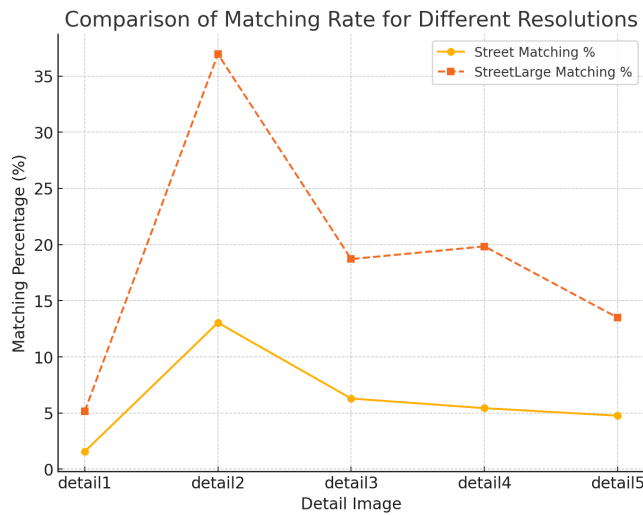| Image Pair	Matches	Match %
Street vs. Detail1	25	1.72% / 1.57%
Street vs. Detail2	6	0.41% / 13.04%
Street vs. Detail3	37	2.55% / 6.29%
Street vs. Detail4	20	1.38% / 5.43%
Street vs. Detail5	6	0.41% / 4.76%
Large vs. Detail1	82	1.54% / 5.15%
Large vs. Detail2	17	0.32% / 36.96%
Large vs. Detail3	110	2.07% / 18.71%
Large vs. Detail4	73	1.37% / 19.84%
Large vs. Detail5	17	0.32% / 13.49%

Fig. 4. Detail Images Keypoint Matching Percentage For Different Resolutions

When exploring the keypoint matching with different image resolutions, we obtain the results shown in Table2 and Fig4. From them, it is observed that in general, the image with high resolution has a higher match rate than the lower one, as higher resolution usually provides more feature points and improves the number of matches. However, in detail 5, the mismatched points occur compared to the lower resolution as more features may appear, but they are not always distinct or may cause mismatched results.

2. EXERCISE 2

Try to match outdoor scene and indoor objects and vice-versa, we obtain Table.3 and Table.4 respectively. For the situation in Table.3, there is seldom points matched, and higher resolution still increases the mistakenly matched points as discussed above. Slightly different in Table.4, most matched amounts are 0, with one 1 match and one 2 matches.

While in Table 2 and Table 3, the matching point numbers both contain 6, which represents related and unrelated objects respectively, it can be observed that the number of matches is dependent on image resolution or feature density. Thus it may be better to use the percentage of matches as a threshold. Table1 and Table2 show the match rate of the scene image is dependent on the image itself, however, the match rate of the object image increases when correct keypoints become more. We can conclude from all four tables that, the match rate of the object image can be the best choice as threshold. As a result, the minimum percentage of matches on object image to see if the object is detected can be around 5%. Additionally, the threhold of unrelated detection is from 0% to 1%.

Table 3. Matching Results between Outdoor Scene and Indoor Objects

Image Pair	Matches	Match %
StreetLarge vs. Book	6	0.11% / 0.68%
Street vs. Book	1	0.07% / 0.11%
StreetLarge vs. Basmati	3	0.06% / 0.52%
Street vs. Basmati	1	0.07% / 0.17%

Table 4. Matching Results between Indoor Scene and Outdoor Objects

Image Pair	Matches	Match %
Scene vs. Detail1	1	0.10% / 0.06%
Scene vs. Detail2	0	0.00% / 0.00%
Scene vs. Detail3	0	0.00% / 0.00%
Scene vs. Detail4	2	0.20% / 0.54%
Scene vs. Detail5	0	0.00% / 0.00%