Project 4

Augmented Reality with Planar Homographies

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Feature Detection, Description and Matching

The Configuration I used for this task is as follows:
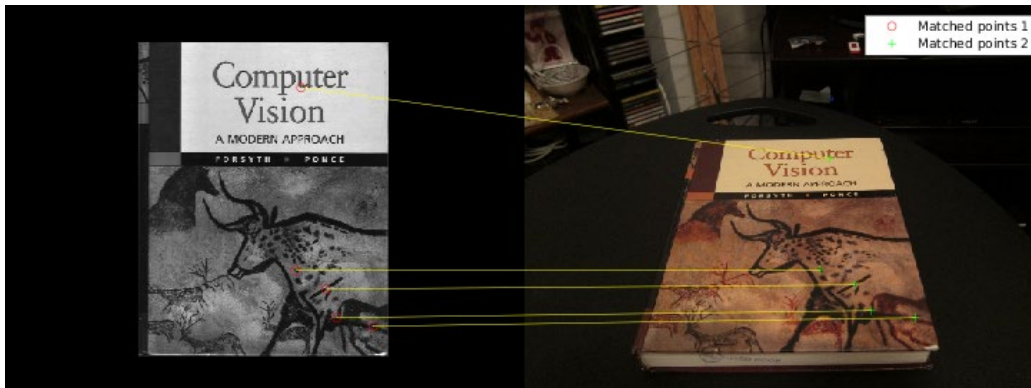
- MaxRatio: 0.8
- MatchThreshold: 100.0

Figure 1: Matched (FAST) features using BRIEF descriptor

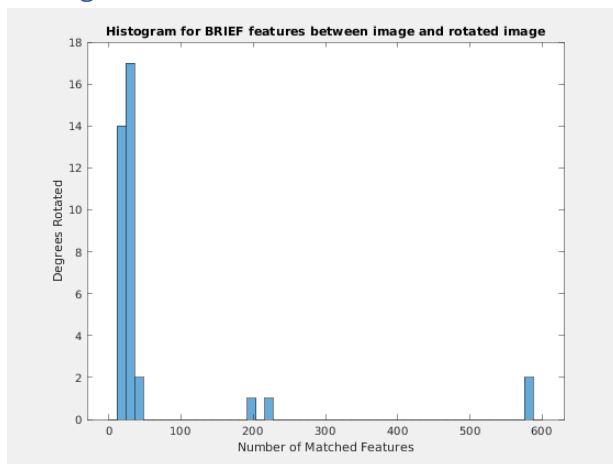## BRIEF and Rotations

Histograms

Figure 2: Number of matched features (using BRIEF descriptor) at rotation steps of 10 degrees
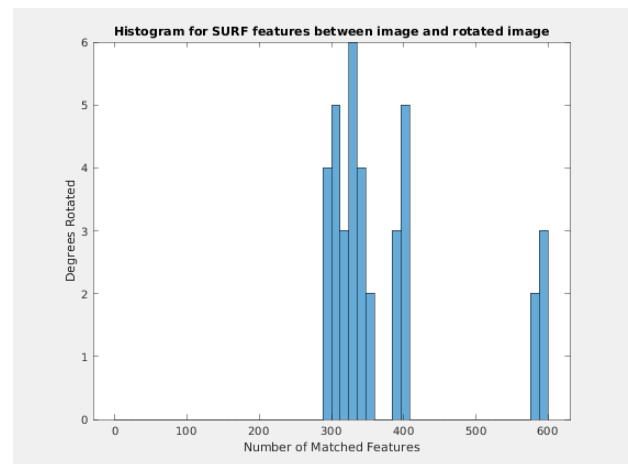

Figure 3: Number of matched features (using SURF descriptor) at rotation steps of 10 degree
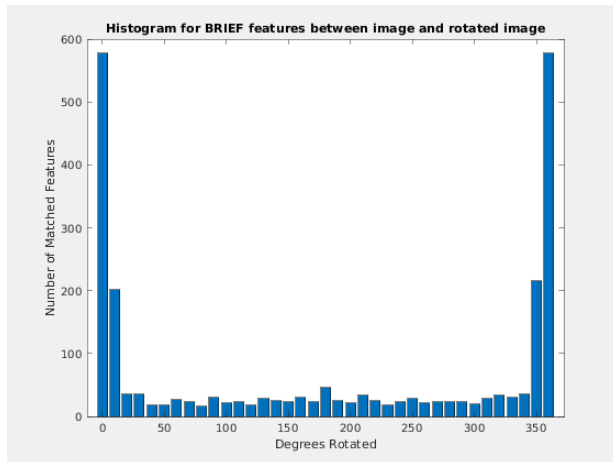
Bar Charts

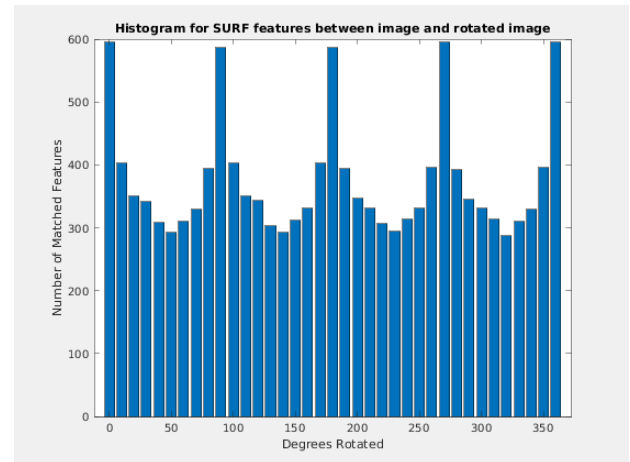Figure 4: Number of features (BRIEF descriptor) at each rotation step of 10 degrees

Figure 5: Number of features (SURF descriptor) at each rotation step of 10 degrees

Table 1: Number of Matched Features at each rotation step of 10 degrees (for both descriptors)

Degree	BRIEF	SURF	Degree	BRIEF	SURF	Degree	BRIEF	SURF	Degree	BRIEF	SURF
0/360	579	595	90	31	587	180	25	587	270	24	595
10	202	404	100	22	404	190	46	394	280	24	392
20	36	350	110	23	350	200	22	347	290	23	346
30	35	342	120	19	343	210	34	332	300	20	331
40	18	309	130	28	304	220	25	307	310	29	314
50	19	293	140	25	293	230	19	295	320	34	288
60	27	310	150	23	313	240	23	314	330	31	311
70	24	329	160	31	332	250	28	331	340	35	329
80	17	394	170	23	403	260	22	397	350	216	396

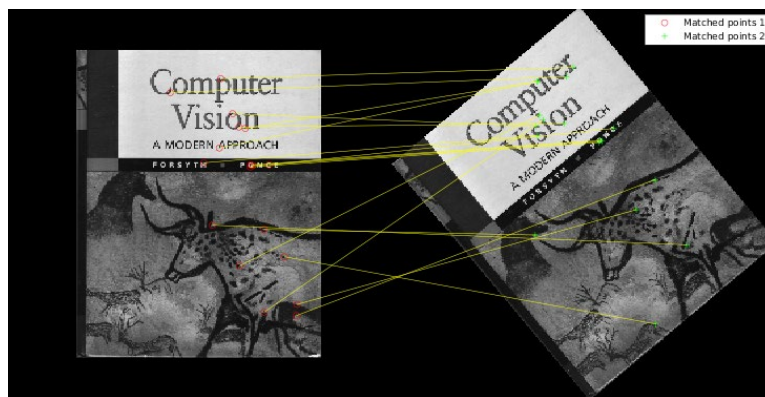## Visualizations

BRIEF Descriptor

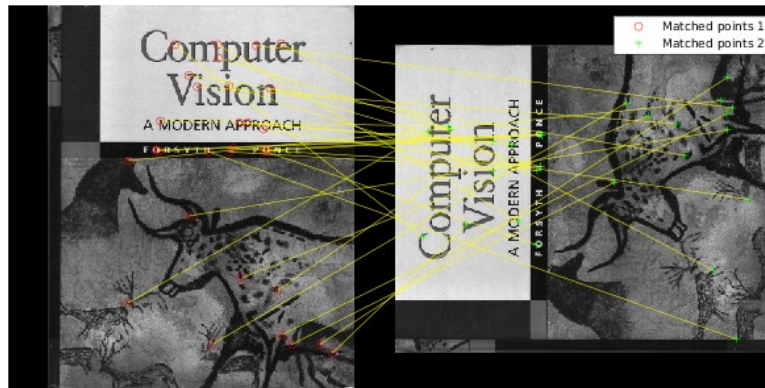Figure 6: Matched (FAST) features using BRIEF descriptor (at 40 degrees)

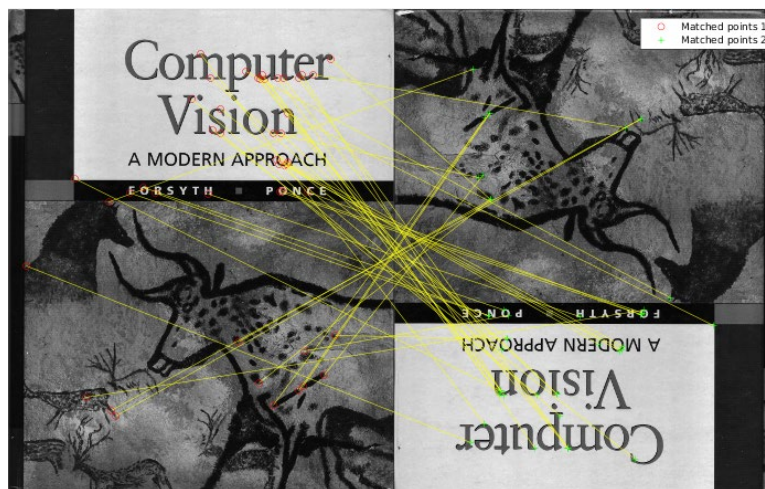*Figure 7: Matched (FAST) features using BRIEF descriptor (at 90 degrees)*

Figure 8: Matched (FAST) features using BRIEF descriptor (at 180 degrees)
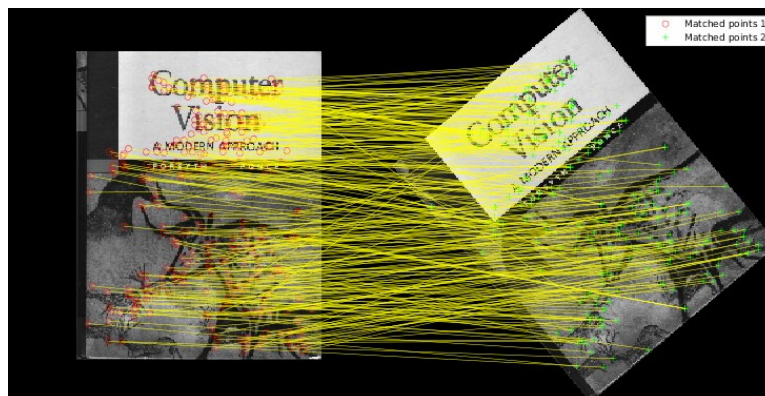
SURF Descriptor

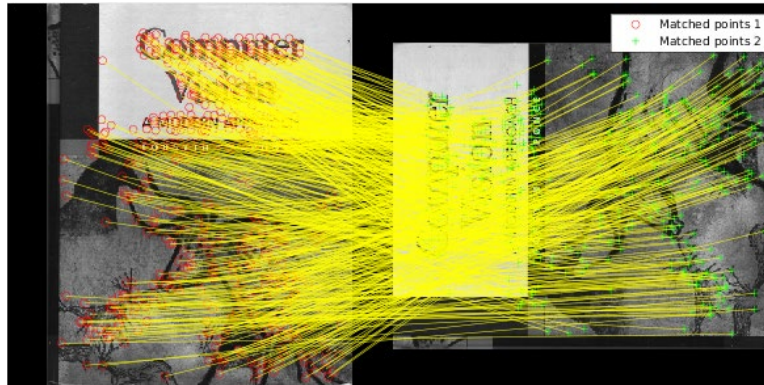*Figure 9: Matched (FAST) features using SURF descriptor (at 40 degrees)*

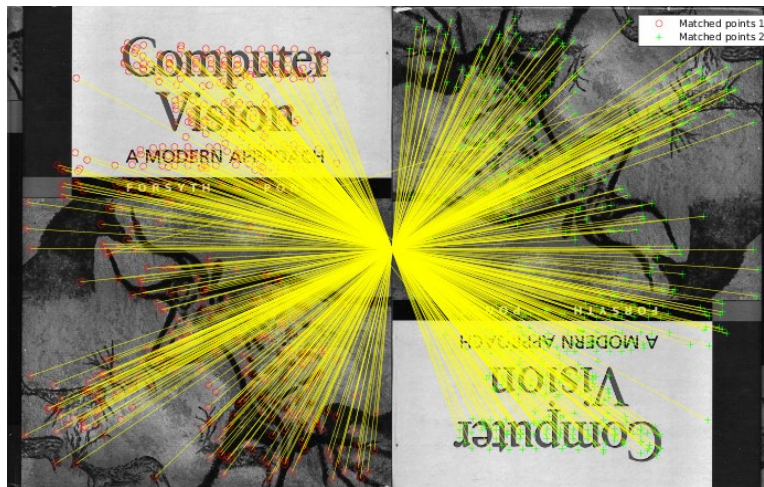*Figure 10: Matched (FAST) features using SURF descriptor (at 90 degrees)*

Figure 11: Matched (FAST) features using SURF descriptor (at 180 degrees)

Explanation

BRIEF descriptor is a very efficient and fast feature detector given that there is not a lot of in-plane rotation. Therefore, we see that when we rotate the image even by 10 degrees the number of matched features decreases to less than half (579 -> 202). Rotating the image decreases the number of matched features even more as it is visible in the Bar chart (Figure 4, Table 1), and it goes up when the image is rotated by 360 degrees (which is the original image).

SURF descriptor works much better for this task, as it calculates the Hessian (second derivative matrix) of the original space and makes the original image match the new image, hence it gives much more matched features. Having such a feature detector almost makes it rotational invariant. This detector is based on approximation using the SIFT feature detector, which is "reasonably invariant to changes in rotation, scaling and slight changes in viewpoint and illumination"[1].

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[1] Lecture 6, on Point Feature Detection and Matching (Part 2), by Davide Scaramuzza [Slides]

Homographic Computation

Figure 12: Planar Homography

Homography Normalization

Figure 13: Planar Homography Normalized

RANSAC

The configuration I used for calculation of important correspondences between the two images is as follows:

- Threshold: 1
- Iterations: 1000

Figure 14: Point-Pairs that produce the greatest number of inliers (RANSAC).

HarryPotterizing a Book

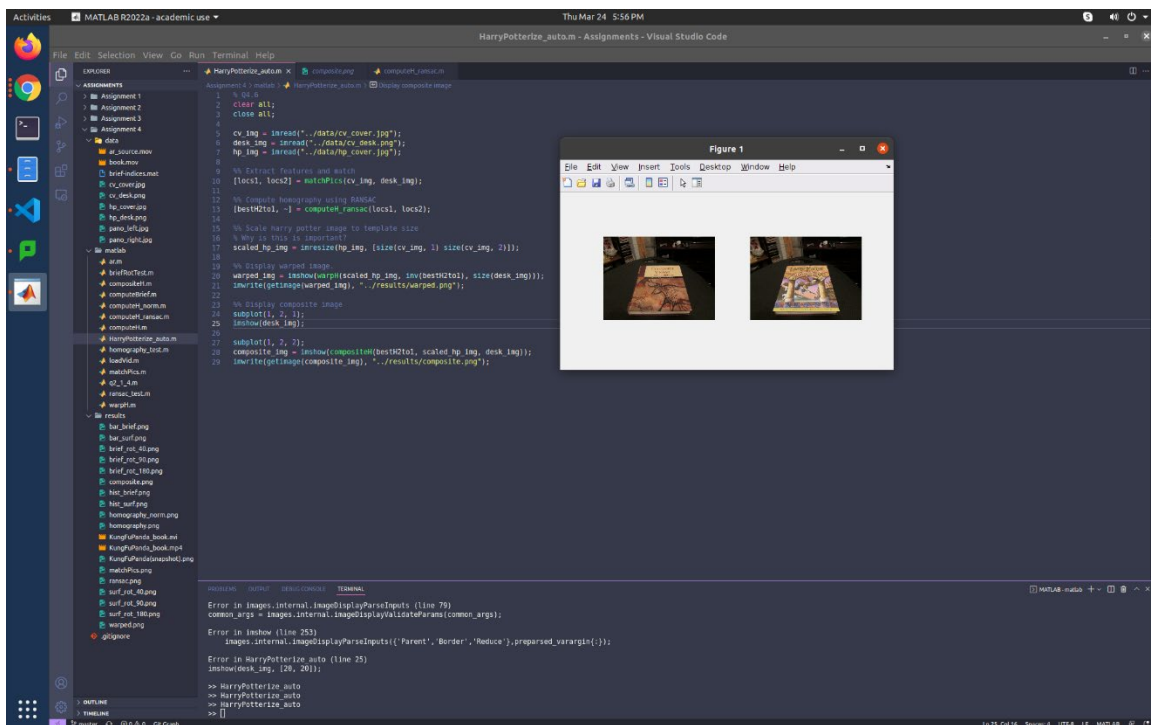Here are the results I received upon running the script "HarryPotterize_auto.m":
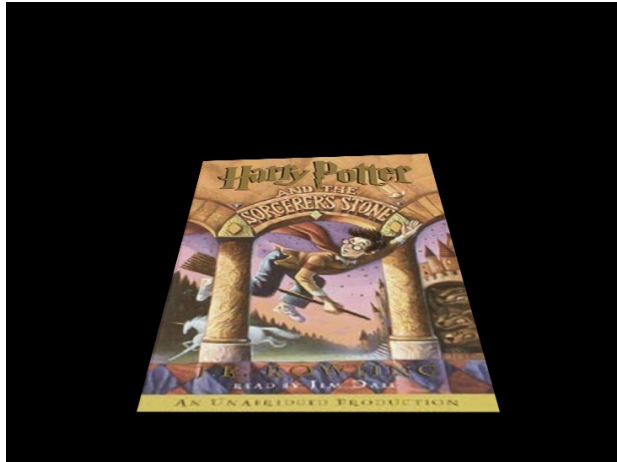

Figure 15: Desktop Screenshot

Figure 16: Harry Potter book cover warped in dimensions of Computer Vision book
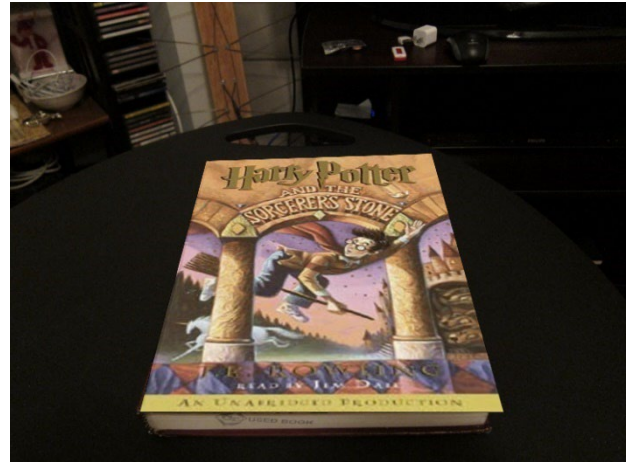

Figure 17: Harry Potter warped image overlayed onto the Computer Vision book

Augmented Reality Video

The video is included in the results folder. A snapshot from the video is provided. The profile used for this is "MPEG-4" or "Motion JPEG AVI", both of them should work just fine (KungFuPanda_book.mp4 vs KungFuPanda_book.avi).

Figure 18: A snapshot from the generated video