Assignment 1: Title of the assignment

Vincent Matthys

vincent.matthys@ens-paris-saclay.fr

QIA.1: (i) Why is it important to have a similarity co-variant feature detector? (ii) How does this affect the descriptors computed at these detections? (iii) How does this affect the matching process?

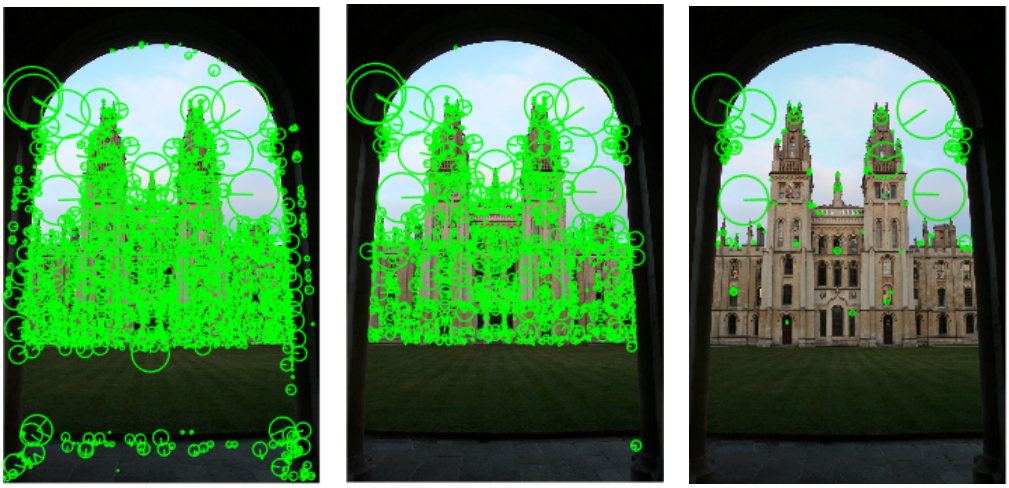
(i) It is important to have a similarity co-variant feature detector in order to extract the same regions of interest regardless of translations, rotations or scales, *i.e.* regardless of viewpoints.
(ii) The fact that the feature detector is co-variant causes the descriptors computed at these detections to undergo the same tranformations than the image.
(iii) Having feature detectors with similarity co-variance and feature descriptors with this and that other property affects the matching process in this way.

QIA.2: Show the detected features in the two images for three different values of the peakThreshold option

The detected features for $peakThreshold \in \{0.0001, 0.001, 0.01\}$ are shown in Figure 1 for the all_souls_000002.jpg image, and in Figure 2 for the all_souls_000015.jpg image. As expected, the number of keypoints decreses with the threshold. Moreover the keypoints are fewer in the darker regions, wich leads to asymetric density in the Figure 2, especially because of the building shadow.

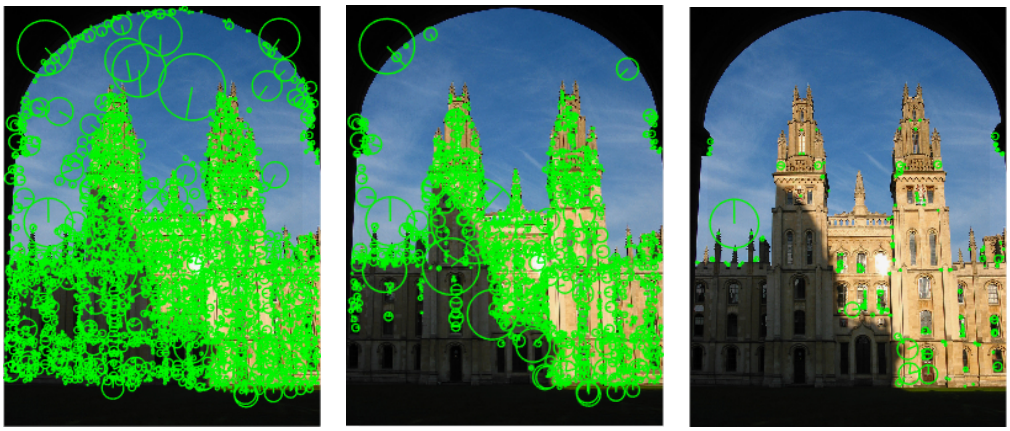
QIA.3: Note the change in spatial density of detections across images, for a given value of peakThreshold. (i) Is the density uniform? If not, why? (ii) Which implications for image matching can this have? (iii) How can it be avoided?

(i) In Figures 1a and 2a. The density is clearly not uniform between the two images. In both, the top-center of the image is very dense, but, in the first one, the grass admits no detection, which leads to a gap in the density, with some detections in the bottom limit of the grass.
(ii) This can lead to error matching the correspondances with local features
(iii) To avoid it we can proceed to a spatial verification relying on global geometric relations.



(a) $peakThreshold = 0.0001$ (b) $peakThreshold = 0.001$ (c) $peakThreshold = 0.01$

Figure 1: Feature detectors with three different values of $peakThreshold$ for all_souls_000002.jpg



(a) $peakThreshold = 0.0001$ (b) $peakThreshold = 0.001$ (c) $peakThreshold = 0.01$

Figure 2: Feature detectors with three different values of $peakThreshold$ for all_souls_000015.jpg

QIB.1: Note the descriptors are computed over a much larger region (shown in blue) than the detection (shown in green). Why is this a good strategy?

The larger regions are shown in Figure 3. It is a good strategy to be insensitive to small geometric deformations, and small variations of illumination, by taking the average over a larger region

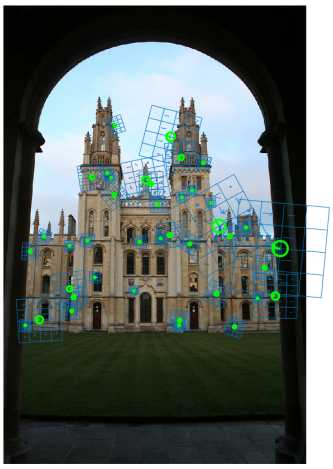


Figure 3: Computation of SIFT descriptors over 4x4 grid arround the keypoint

QIB.2: Examine carefully the mismatches and try to understand the different causes of mismatch. (i) In your report, present at least 3 of them and explain why the mistakes are being made. For example, is the change in lighting a problem? (ii) What additional constraints can be applied to remove the mismatches?

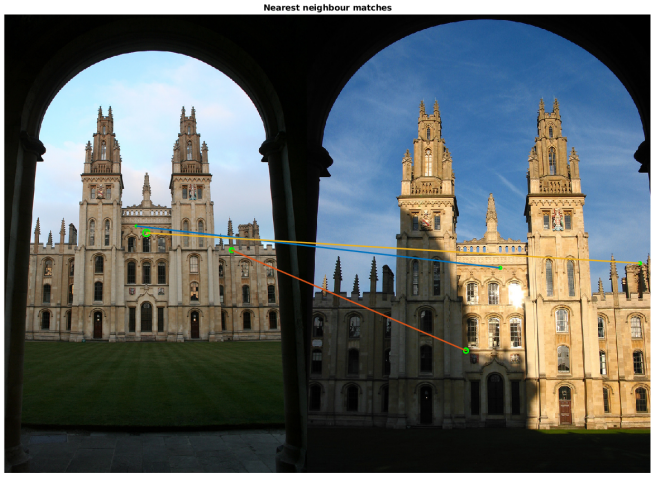


Figure 4: Three missmatches with SIFT features descriptors

(i) Three types of mismatch are presentend in Figure 4

- repetitive pattern (in blue)
- constant local change in lighting leading to similarity between two different keypoints (in red)
- ambiguities between two nearest neighbors (in yellow)

A global change in lighting is irrelevant for matching, because of the gradient nullifying the constant component

(ii) Geometric verification with global constraints can discard those mismatches.