Computational Vision

Laboratory for descriptors

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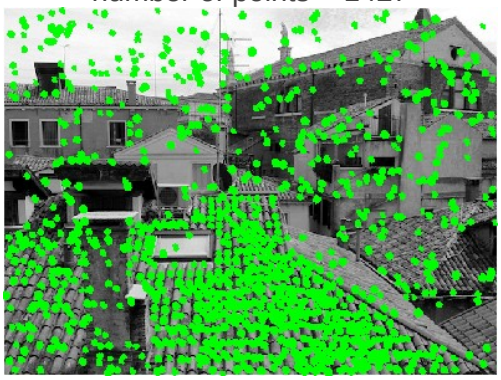
2 Feature detection

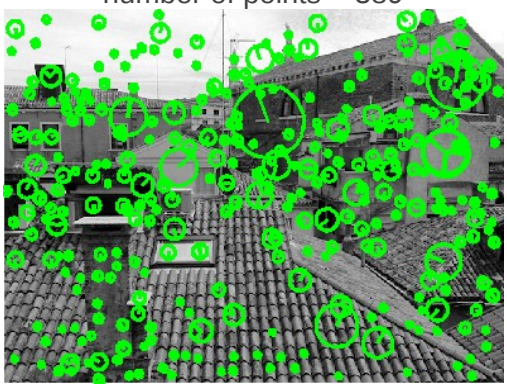
Question: Where in the image have most of the keypoints been detected ? Can you comment why ?

Most of the little points are in the tiles, in this region it is easy to see good details for the proximity of the camera. On the other hand if we see the picture with lower resolutions we can see larger points that corresponds to big surfaces like walls or windows.
The sky does not have many points because do not have sufficient texture.

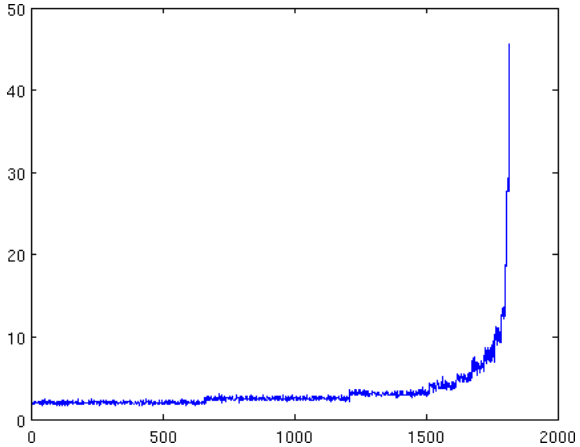
Smaller or equal than the average
number of points = 1427



Larger than the average
number of points = 389



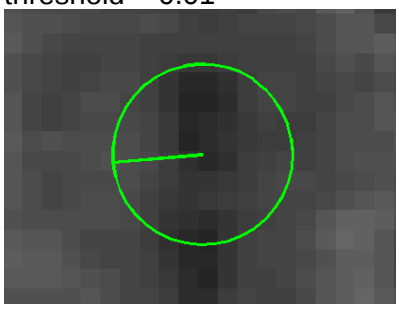
An other important point is that it seems to be a power law in the size of the points, then there are a huge number of little points versus some large points.



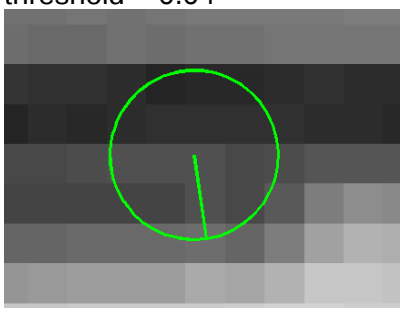
Question: Try to slowly increase the threshold and analyze the keypoints that are detected. What can you say about the keypoints that are discarded with the threshold ?

The peak selection threshold decides which peaks are valids for the descriptors, larger is the value of threshold, more strict is the selection algorithm.
In the descriptors below, we can try to identify the peaks that are selecteds in each threshold, in the first descriptor we can see a vertical line crossing the image, one crossing line is not a good descriptor because this lines would be in a lot of places.
In the second descriptor there is a 90 degrees peak in white, and in the last image I must supose that the descriptor is the white or the black line that finish at the right side, doing a peak of more than 270 degrees.

threshold = 0.01



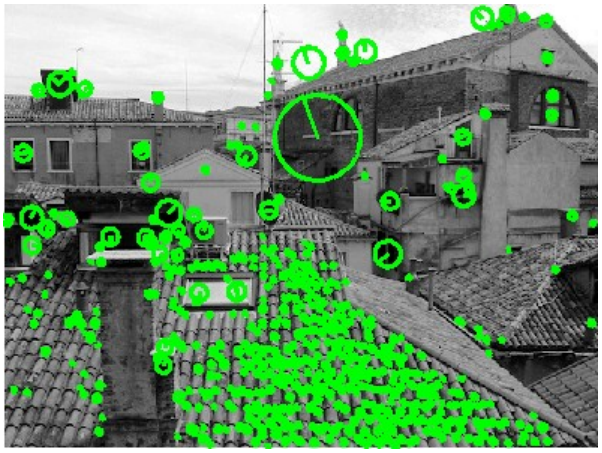
threshold = 0.04



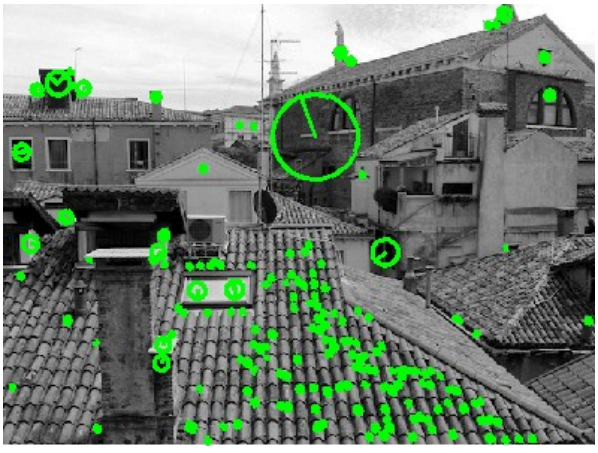
threshold = 0.09

threshold	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10
#keypoints	1626	1414	1164	771	259	32	10	5	2	0

threshold = 0.04



threshold = 0.05

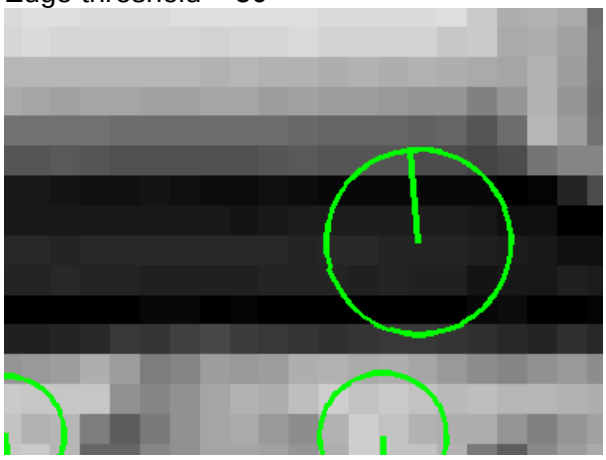


Question: Comment on the effect of the edge threshold on the detection of the keypoints. What happens if you increase or decrease the threshold ? What type of keypoints are discarded with the threshold ?

The edge threshold loos for descriptors with a high contrast, with a small threshold there are less descriptors and then the contrast of these are bigger.
We can see below two images, the first corresponds to a edge threshold of fifty and the right image with eighty. We can see that the left descriptor have less contrast than the right, for that reason from one image to the other this descriptor disappear.

EdgeThresh	#descriptors	mean(size)
10	771	2.8973
20	838	2.9084
30	851	2.9024
40	861	2.897
50	863	2.9003
60	867	2.9021
70	869	2.9033
80	871	2.901
90	871	2.901
100	871	2.901

Edge threshold = 50



Edge threshold = 80

3 Feature matching

> Question: try to modify the previous threshold. What is the effect of this threshold ? Why do results improve as the threshold is increased ? Comment your response.

This threshold controls that that all the matched descriptors satisfies that:

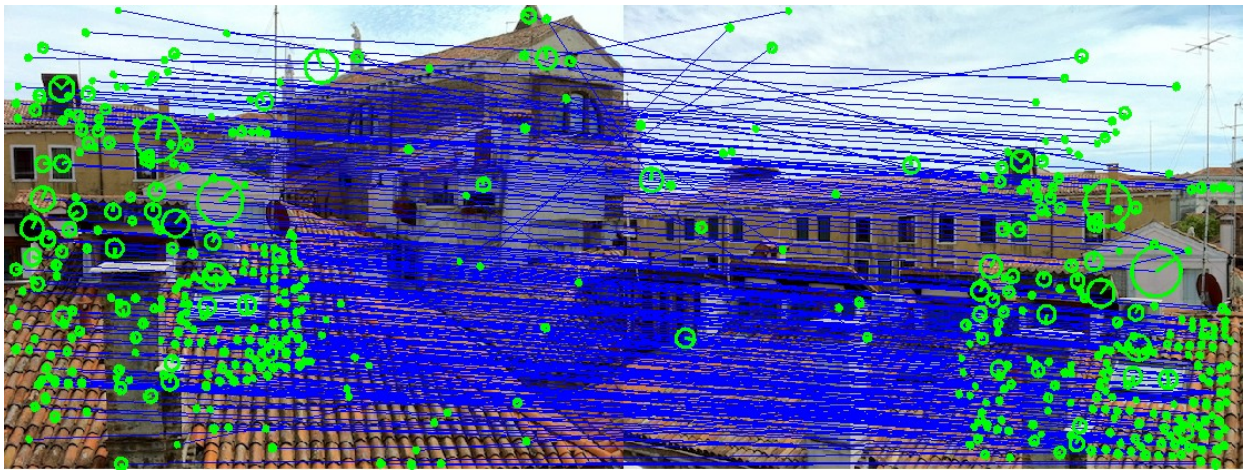
$$(D1,D2) \Leftrightarrow \ \forall\, x\, d(D1,D2)*Threshold \leq d(D1,Dx)$$

This implies that will be the best in the all possible combinations, and will regect the points that are much ambiguous.
We can see in the table the number of matches with different threshold values, the mean of scores (squared euclidian distances) between the matches and the variance of this distances.
Largest the threshold is, smaller is the number of matches and conseqüently for the rule smaller are the distances and the variance in these.

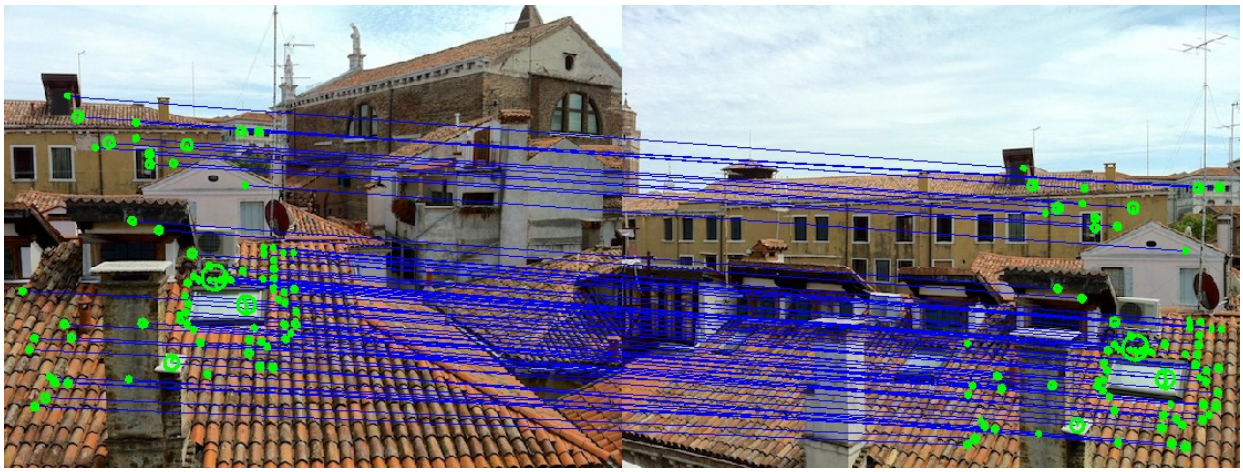
threshold	match	mean_scores	variance	threshold	match	mean_scores	variance
		x10^4	X10^8			x10^4	X10^8
1.5	335	2.50	4.53	**5.5**	131	0.85	0.27
2.0	254	1.67	1.77	**6.0**	122	0.82	0.27
2.5	229	1.44	1.13	**6.5**	109	0.73	0.18
3.0	208	1.27	0.78	**7.0**	101	0.69	0.15
3.5	185	1.13	0.58	**7.5**	91	0.65	0.13
4.0	168	1.02	0.43	**8.0**	87	0.63	0.13
4.5	156	0.94	0.32	**8.5**	84	0.63	0.13
5.0	145	0.92	0.32				

Here we have two different matchings, the first correspond to a threshold value of one and half. In this picture there are a lot of matchings with arbitrary directions. These matchings usually are not good for our purpose, because we know that it is only an horizontal translation.
In the second case with a threshold of eight, all the points have almost the same distance between the two descriptors. This is better for our case.

threshold = 1.5



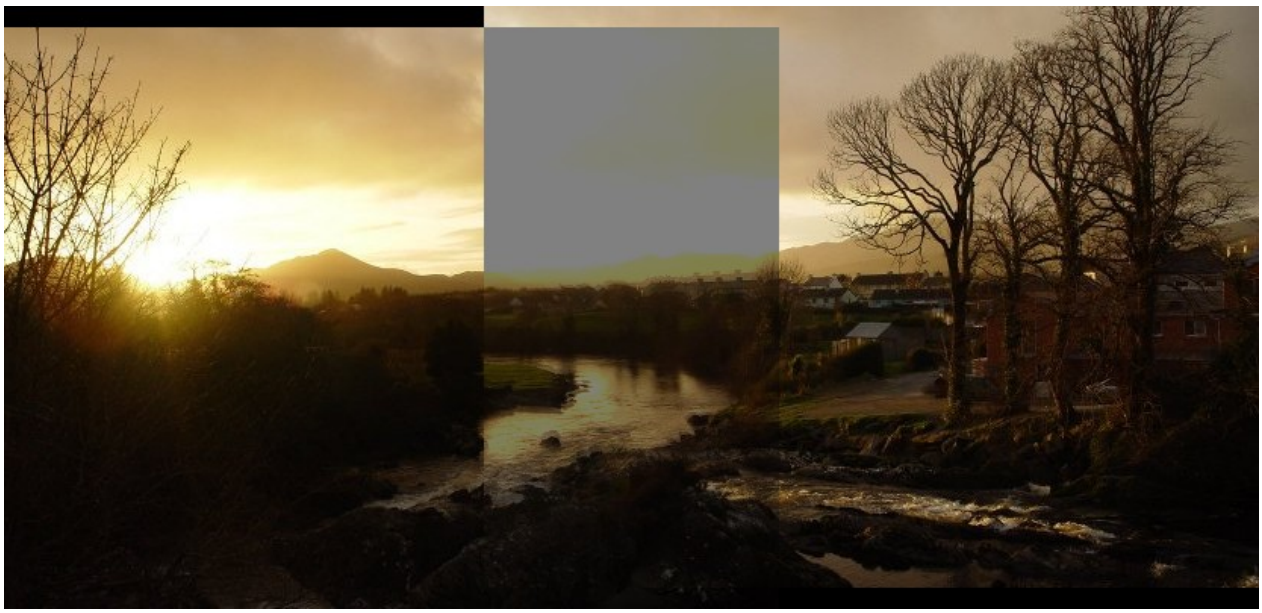
threshold = 8



4 Application: mosaic creation

In this section we can see the different results with the implemented application for mosaic creation.
We have used the threshold values:
peak threshold = 0.06
edge threshold = 40
match threshold = 6.5
One of the approaches for merging the images is to put one in front of the other, but we thought that it will be a good idea to put the mean value within the two images in this intersection. After try this it seems that is not a good approach because it makes the intersection darker.
An other approach would be trying to remove the points in the sky clustering the sky in some manner and removing all the descriptors in this zone.

Average in the intersection:



One in front of the other: