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Computer Vision

Report on Assignment 2 - 1

For part one, we begin by reading the input files and calculating their SIFT descriptors.

Next, a set of matches are found using Euclidian distance. Comparing every point in the first set to every point in the second, and both the shortest distance and second shortest are recorded. If the ratio between these is less than 0.775, then we keep the match. Then this match set is passed through an algorithm to remove outliers. Slope between every match is calculated with an offset added to the x-coordinate of the second set of length equal to the width of the first image. For this the average slope is generated, and then we start back at the top of our matches. This time around, we throw out any matches differing from the average slope by more than 0.15. The second part of our match processing performs a very similar action, but uses the x-coordinate difference of matches. This will remove pairs which are anchored on the left side of the first image, but the right side of the second - happens frequently since most structures in images are symmetric. Using the optimization we get pretty good results. Finally, we draw the remaining matches and lines between them on a merged image.



In the following sections of the question, the above processes are reused. However, we now perform an extra step when creating a match. Only those with a Euclidian distance of less than 250 are considered (points that are logically close), and a value equal to 400 minus this distance is added as a match property (Creating a maximization metric). This will soon become important! Instead of just using the total number of matches between two images as the indicator of similarity (which is non-linear), we use a sum of this special Euclidian factor (maximization metric defined above). It allows for a balance between the strength of matches, and the number of them. A perfect match - of Euclidian distance zero - will score highly towards the image correlation. The worst possible match - of distance 250 - will still score 150. This algorithm has yielded satisfactory results using the provided part1_images library. Before this we tried many approaches

- Number of SIFT match points
- Number of SIFT match points / (Total SIFT points in the query image)
- Pearson's Correlation between x,y points of SIFT matches
- Closest Eculidian Maximization Metrix

The Closest Eculidian Maximization Metric worked the best for us, as descibed above.

Our tests on given Images :

Image : bigben_14.jpg

Image : bigben_8.jpg-----matched by 7157.71 Euclidian factor

Image : bigben_12.jpg-----matched by 6979.03 Euclidian factor

Image : londoneye_13.jpg-----matched by 4808.26 Euclidian factor

Image : bigben_2.jpg-----matched by 4711 Euclidian factor

Image : tatemodern_13.jpg-----matched by 4569.14 Euclidian factor

Image : notredame_19.jpg-----matched by 4379.32 Euclidian factor

Image : tatemodern_9.jpg-----matched by 4239.79 Euclidian factor

Image : sanmarco_14.jpg-----matched by 4199.62 Euclidian factor

Image : bigben_6.jpg-----matched by 4081.16 Euclidian factor

Image : bigben_10.jpg-----matched by 3952.53 Euclidian factor

Above bigben_14 scored a five out of ten on precision, and netted the top two spots with significantly higher factors.

Image : trafalgarsquare_15.jpg

Image : tatemodern_9.jpg-----matched by 6267.15 Euclidian factor
Image : trafalgarsquare_5.jpg----matched by 5986.51 Euclidian factor
Image : trafalgarsquare_22.jpg---matched by 5388.94 Euclidian factor
Image : trafalgarsquare_20.jpg---matched by 5032.36 Euclidian factor
Image : notredame_25.jpg-----matched by 4517.23 Euclidian factor
Image : trafalgarsquare_25.jpg---matched by 4153.59 Euclidian factor
Image : tatemodern_13.jpg-----matched by 4116.17 Euclidian factor
 Image : bigben_12.jpg-----matched by 4041.7 Euclidian factor
 Image : empirestate_12.jpg-----matched by 4022.56 Euclidian factor
 Image : londoneye_13.jpg-----matched by 4003 Euclidian factor

Trafalgarsquare_15 scored a 4/10 precision with 3/4 top spots.

Image : colosseum_4.jpg

Image : colosseum_5.jpg-----matched by 21415.5 Euclidian factor
Image : sanmarco_3.jpg-----matched by 3865.92 Euclidian factor
Image : colosseum_11.jpg-----matched by 3523.17 Euclidian factor
Image : tatemodern_14.jpg-----matched by 3508.7 Euclidian factor
Image : trafalgarsquare_22.jpg---matched by 3158.41 Euclidian factor
Image : colosseum_15.jpg-----matched by 3154.5 Euclidian factor
Image : colosseum_6.jpg-----matched by 3142.06 Euclidian factor
 Image : louvre_10.jpg-----matched by 3089.69 Euclidian factor
Image : colosseum_8.jpg-----matched by 3012.62 Euclidian factor
Image : trafalgarsquare_25.jpg---matched by 2922.56 Euclidian factor

Colosseum_4 also scores a 4/10 precision, but holds the top spot in this case. In fact, it was such a strong match that nearly all remaining matches are outweighed.

Image : louvre_16.jpg

Image : louvre_14.jpg-----matched by 6488.24 Euclidian factor
Image : louvre_11.jpg-----matched by 5250.99 Euclidian factor
Image : louvre_4.jpg-----matched by 4804.46 Euclidian factor
Image : colosseum_15.jpg-----matched by 4757.53 Euclidian factor
Image : eiffel_15.jpg-----matched by 4683.65 Euclidian factor
Image : tatemodern_14.jpg-----matched by 4456.24 Euclidian factor
Image : trafalgarsquare_25.jpg---matched by 4401.24 Euclidian factor
Image : notredame_19.jpg-----matched by 4363.32 Euclidian factor
Image : bigben_8.jpg-----matched by 4203.44 Euclidian factor
Image : sanmarco_20.jpg-----matched by 4127.89 Euclidian factor

Here we see louvre_16 scored a 3/10 precision, but those three hits couldn't have been better!

Image : notredame_4.jpg

Image : notredame_5.jpg-----matched by 18187.2 Euclidian factor
Image : notredame_3.jpg-----matched by 15262.2 Euclidian factor
Image : notredame_1.jpg-----matched by 6836.02 Euclidian factor
Image : sanmarco_3.jpg-----matched by 6613.42 Euclidian factor
Image : bigben_8.jpg-----matched by 5872.89 Euclidian factor
Image : londoneye_16.jpg-----matched by 5821.86 Euclidian factor
Image : trafalgarsquare_25.jpg---matched by 5585.83 Euclidian factor
Image : eiffel_5.jpg-----matched by 5585.63 Euclidian factor
Image : louvre_14.jpg-----matched by 5358.28 Euclidian factor
Image : tatemodern_9.jpg-----matched by 5325.8 Euclidian factor

Same situation with notredame_4!

Image : eiffel_3.jpg

Image : tatemodern_13.jpg-----matched by 3995.48 Euclidian factor
Image : eiffel_22.jpg-----matched by 3939.64 Euclidian factor
Image : louvre_4.jpg-----matched by 3830.3 Euclidian factor
Image : empirestate_25.jpg-----matched by 3322.9 Euclidian factor
Image : eiffel_1.jpg-----matched by 3311.05 Euclidian factor
Image : louvre_10.jpg-----matched by 3298.97 Euclidian factor
Image : tatemodern_14.jpg-----matched by 3243.98 Euclidian factor
Image : eiffel_7.jpg-----matched by 3027.49 Euclidian factor
Image : londoneye_13.jpg-----matched by 3000.9 Euclidian factor
Image : trafalgarsquare_5.jpg----matched by 2950.8 Euclidian factor

Eiffel_3 has three solid hits for a 3/10 precision.

Image : londoneye_9.jpg

Image : bigben_14.jpg-----matched by 11220.8 Euclidian factor
Image : londoneye_2.jpg-----matched by 7440.78 Euclidian factor
Image : sanmarco_13.jpg-----matched by 6764.91 Euclidian factor
Image : notredame_19.jpg-----matched by 6558.63 Euclidian factor
Image : londoneye_21.jpg-----matched by 5985.66 Euclidian factor
Image : eiffel_3.jpg-----matched by 5358 Euclidian factor
Image : bigben_2.jpg-----matched by 5341.06 Euclidian factor
Image : londoneye_23.jpg-----matched by 5148.72 Euclidian factor
Image : empirestate_22.jpg-----matched by 5145.99 Euclidian factor
Image : louvre_14.jpg-----matched by 4648.94 Euclidian factor

Same for londoneye_9.

Image : sanmarco_14.jpg

Image : sanmarco_13.jpg-----matched by 8400.98 Euclidian factor
Image : louvre_4.jpg-----matched by 8144.74 Euclidian factor
Image : londoneye_22.jpg-----matched by 7731.55 Euclidian factor
Image : notredame_25.jpg-----matched by 7702.7 Euclidian factor
Image : sanmarco_1.jpg-----matched by 7586.25 Euclidian factor
Image : trafalgarsquare_25.jpg---matched by 7498.32 Euclidian factor
Image : colosseum_13.jpg-----matched by 7356.8 Euclidian factor
Image : bigben_8.jpg-----matched by 7292.19 Euclidian factor
Image : trafalgarsquare_15.jpg---matched by 6924.49 Euclidian factor
Image : sanmarco_5.jpg-----matched by 6689.99 Euclidian factor

Sanmarco_14 strikes three times, and holds the top spot on this list.

Image : empirestate_16.jpg

Image : notredame_19.jpg-----matched by 13498 Euclidian factor
Image : sanmarco_13.jpg-----matched by 12073.9 Euclidian factor
Image : bigben_8.jpg-----matched by 8516.4 Euclidian factor
Image : trafalgarsquare_15.jpg---matched by 5608.14 Euclidian factor
Image : trafalgarsquare_22.jpg---matched by 5269.85 Euclidian factor
Image : bigben_6.jpg-----matched by 5127.16 Euclidian factor
Image : empirestate_22.jpg-----matched by 5065.03 Euclidian factor
Image : empirestate_12.jpg-----matched by 4977.88 Euclidian factor
Image : empirestate_27.jpg-----matched by 4840.03 Euclidian factor
Image : trafalgarsquare_25.jpg---matched by 4710.92 Euclidian factor

Empirestate_16 was in the empire state of mind here for a 3/10 precision.

Image : tatemodern_2.jpg

Image : tatemodern_8.jpg-----matched by 7873.41 Euclidian factor
Image : louvre_4.jpg-----matched by 3908.22 Euclidian factor
Image : sanmarco_1.jpg-----matched by 3700.26 Euclidian factor
Image : tatemodern_9.jpg-----matched by 3637.87 Euclidian factor
Image : londoneye_13.jpg-----matched by 3610.88 Euclidian factor
Image : tatemodern_14.jpg-----matched by 3262.48 Euclidian factor
Image : empirestate_10.jpg-----matched by 3226.45 Euclidian factor
Image : trafalgarsquare_25.jpg---matched by 3090.49 Euclidian factor
Image : bigben_12.jpg-----matched by 3052.4 Euclidian factor

Finally, tatemodern_2 scores a 3/10 while holding the top match by a significant margin.

In conclusion, Big Ben seems to be the easiest landmark in this library to identify with computer vision. We had many other cases where it scored fives and fours and one with a seven, while the average for the library is right around three. We believe this is due to sharp nature of its architecture. Virtually no curves are found on it - except for the clock itself - and even the flat areas are segmented into squares. This generates lots and lots of SIFT points. Notre Dame is also easily recognized. Many of the reasons apply. While this building does have many more curves, there are even more sharp features to make up for them. One of the harder attractions was the London Eye. Its generally round nature does not help generate too many feature points, and the vantage points in this series varied greatly. Another tough one was the Empire State Building.

Below are several other examples of our algorithm in action. Combined with the above, there are 21 tests which have an **average precision of 3.23.**

Image : bigben_8.jpg

Image : bigben_6.jpg-----matched by 34648.9 Euclidian factor
Image : bigben_14.jpg-----matched by 8742.56 Euclidian factor
Image : bigben_3.jpg-----matched by 5287.84 Euclidian factor
Image : trafalgarsquare_25.jpg---matched by 4970.43 Euclidian factor
Image : louvre_14.jpg-----matched by 4678.65 Euclidian factor
Image : bigben_16.jpg-----matched by 4605.29 Euclidian factor
Image : sanmarco_5.jpg-----matched by 4553.41 Euclidian factor
Image : sanmarco_4.jpg-----matched by 4458.17 Euclidian factor
Image : tatemodern_2.jpg-----matched by 4455 Euclidian factor
Image : sanmarco_19.jpg-----matched by 4301.71 Euclidian factor

Image : bigben_3.jpg

Image : bigben_2.jpg-----matched by 8469.76 Euclidian factor
Image : trafalgarsquare_15.jpg---matched by 5083.4 Euclidian factor
Image : bigben_12.jpg-----matched by 4371.78 Euclidian factor
Image : bigben_14.jpg-----matched by 4027.06 Euclidian factor
Image : trafalgarsquare_25.jpg---matched by 3569.59 Euclidian factor
Image : sanmarco_5.jpg-----matched by 3419.96 Euclidian factor
Image : bigben_7.jpg-----matched by 3101.78 Euclidian factor
Image : bigben_6.jpg-----matched by 3056.94 Euclidian factor
Image : bigben_8.jpg-----matched by 3027.42 Euclidian factor
Image : bigben_16.jpg-----matched by 3012.22 Euclidian factor

Image : eiffel_5.jpg

Image : eiffel_2.jpg-----matched by 14754.9 Euclidian factor
Image : tatemodern_14.jpg-----matched by 4618.01 Euclidian factor
Image : bigben_12.jpg-----matched by 3748.92 Euclidian factor
Image : bigben_8.jpg-----matched by 3564.18 Euclidian factor
Image : trafalgarsquare_22.jpg---matched by 3496.91 Euclidian factor

Image : empirestate_27.jpg-----matched by 3298.6 Euclidian factor
Image : eiffel_6.jpg-----matched by 3297.03 Euclidian factor
Image : louvre_15.jpg-----matched by 3053.89 Euclidian factor
Image : colosseum_8.jpg-----matched by 3021.96 Euclidian factor
Image : tatemodern_24.jpg-----matched by 2876.74 Euclidian factor

Image : londoneye_22.jpg

Image : empirestate_12.jpg-----matched by 6569.76 Euclidian factor
Image : notredame_4.jpg-----matched by 6420.71 Euclidian factor
Image : trafalgarsquare_8.jpg----matched by 5672.96 Euclidian factor
Image : londoneye_13.jpg-----matched by 5113.67 Euclidian factor
Image : londoneye_23.jpg-----matched by 4736.1 Euclidian factor
Image : notredame_19.jpg-----matched by 4218.4 Euclidian factor
Image : eiffel_15.jpg-----matched by 3998.46 Euclidian factor
Image : louvre_8.jpg-----matched by 3737.17 Euclidian factor
Image : louvre_14.jpg-----matched by 3627.8 Euclidian factor
Image : sanmarco_18.jpg-----matched by 3223.38 Euclidian factor

Image : trafalgarsquare_20.jpg

Image : trafalgarsquare_5.jpg----matched by 44492.9 Euclidian factor
Image : trafalgarsquare_1.jpg----matched by 10243.7 Euclidian factor
Image : tatemodern_13.jpg-----matched by 7801.87 Euclidian factor
Image : tatemodern_9.jpg-----matched by 7511.57 Euclidian factor
Image : trafalgarsquare_25.jpg----matched by 6665.51 Euclidian factor
Image : londoneye_13.jpg-----matched by 6295.83 Euclidian factor
Image : tatemodern_14.jpg-----matched by 6216.91 Euclidian factor
Image : sanmarco_1.jpg-----matched by 6134.56 Euclidian factor
Image : louvre_4.jpg-----matched by 5698.34 Euclidian factor
Image : empirestate_15.jpg-----matched by 5659.49 Euclidian factor

Image : colosseum_4.jpg

Image : colosseum_5.jpg-----matched by 21415.5 Euclidian factor
Image : sanmarco_3.jpg-----matched by 3865.92 Euclidian factor
Image : colosseum_11.jpg-----matched by 3523.17 Euclidian factor
Image : tatemodern_14.jpg-----matched by 3508.7 Euclidian factor
Image : trafalgarsquare_22.jpg----matched by 3158.41 Euclidian factor
Image : colosseum_15.jpg-----matched by 3154.5 Euclidian factor
Image : colosseum_6.jpg-----matched by 3142.06 Euclidian factor
Image : louvre_10.jpg-----matched by 3089.69 Euclidian factor
Image : colosseum_8.jpg-----matched by 3012.62 Euclidian factor
Image : trafalgarsquare_25.jpg---matched by 2922.56 Euclidian factor

Image : sanmarco_3.jpg

Image : sanmarco_5.jpg-----matched by 4402.33 Euclidian factor
Image : trafalgarsquare_22.jpg---matched by 4234.83 Euclidian factor
Image : bigben_14.jpg-----matched by 3998.58 Euclidian factor
Image : sanmarco_22.jpg-----matched by 3919 Euclidian factor
Image : notredame_19.jpg-----matched by 3859.62 Euclidian factor
Image : notredame_8.jpg-----matched by 3291.36 Euclidian factor
Image : bigben_12.jpg-----matched by 3247.93 Euclidian factor
Image : trafalgarsquare_15.jpg---matched by 3060.38 Euclidian factor
Image : bigben_3.jpg-----matched by 2860.74 Euclidian factor
Image : notredame_25.jpg-----matched by 2441.81 Euclidian factor
Image : sanmarco_4.jpg-----matched by 2438.38 Euclidian factor

Image : louvre_9.jpg

Image : sanmarco_1.jpg-----matched by 3044.97 Euclidian factor
Image : eiffel_6.jpg-----matched by 2705.72 Euclidian factor
Image : londoneye_22.jpg-----matched by 2445.3 Euclidian factor
Image : louvre_3.jpg-----matched by 2373.82 Euclidian factor
Image : sanmarco_3.jpg-----matched by 2314.69 Euclidian factor

Image : notredame_19.jpg-----matched by 2252.04 Euclidian factor
Image : empirestate_23.jpg-----matched by 2237.72 Euclidian factor
Image : louvre_16.jpg-----matched by 2236.81 Euclidian factor
Image : londoneye_21.jpg-----matched by 2203.63 Euclidian factor
Image : louvre_4.jpg-----matched by 2176.56 Euclidian factor

Image : notredame_24.jpg

Image : notredame_19.jpg-----matched by 51746.7 Euclidian factor
Image : notredame_14.jpg-----matched by 8200.69 Euclidian factor
Image : tatemodern_13.jpg-----matched by 7728.32 Euclidian factor
Image : londoneye_13.jpg-----matched by 7586 Euclidian factor
Image : bigben_12.jpg-----matched by 7261.96 Euclidian factor
Image : tatemodern_6.jpg-----matched by 7208.38 Euclidian factor
Image : trafalgarsquare_22.jpg----matched by 6659.94 Euclidian factor
Image : notredame_3.jpg-----matched by 6587.2 Euclidian factor
Image : louvre_4.jpg-----matched by 6167.11 Euclidian factor
Image : eiffel_5.jpg-----matched by 6017.68 Euclidian factor

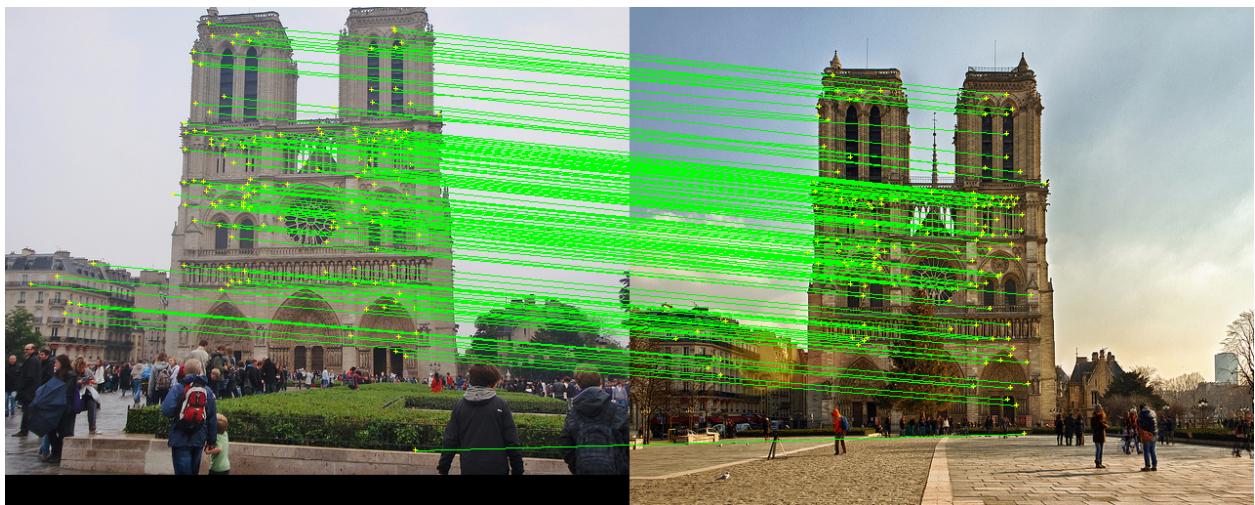
Image : tatemodern_9.jpg

Image : sanmarco_1.jpg-----matched by 9427.11 Euclidian factor
Image : tatemodern_2.jpg-----matched by 7339.54 Euclidian factor
Image : londoneye_13.jpg-----matched by 7141.14 Euclidian factor
Image : eiffel_7.jpg-----matched by 7015.75 Euclidian factor
Image : trafalgarsquare_15.jpg----matched by 7009.74 Euclidian factor
Image : trafalgarsquare_25.jpg---matched by 6834.32 Euclidian factor
Image : sanmarco_4.jpg-----matched by 6666.48 Euclidian factor
Image : tatemodern_14.jpg-----matched by 6589.33 Euclidian factor
Image : louvre_10.jpg-----matched by 6529.57 Euclidian factor
Image : londoneye_21.jpg-----matched by 6498.45 Euclidian factor

Image : empirestate_10.jpg

Image : sanmarco_1.jpg-----matched by 9204.71 Euclidian factor
Image : eiffel_15.jpg-----matched by 7792.78 Euclidian factor
Image : empirestate_12.jpg-----matched by 7738.1 Euclidian factor
Image : empirestate_15.jpg-----matched by 7463.76 Euclidian factor
Image : bigben_14.jpg-----matched by 7328.41 Euclidian factor
Image : tatemodern_9.jpg-----matched by 7229.14 Euclidian factor
Image : bigben_8.jpg-----matched by 6975.03 Euclidian factor
Image : bigben_10.jpg-----matched by 6840.01 Euclidian factor
Image : tatemodern_16.jpg-----matched by 6293.12 Euclidian factor
Image : louvre_4.jpg-----matched by 6142.99 Euclidian factor

Some More Image Comparisons : When It Worked





Some More Image Comparisons : When It Did Not Worked Worked

