ASSIGNMENT 1
CS4186 VISION AND IMAGE

The first method I implemented for instance matching was SIFT, all files related to this method including the generated txt file are contained in the folder named 'method1' in the zipped folder.

The second method I implemented for instance matching was ORB, all files related to this method including the generated txt file are contained in the folder named 'method2' in the zipped folder.

Method 1 - SIFT

SIFT (Scale Invariant Feature Transform Algorithm) was proposed by David Lowe. This method of instance matching is suitable for different situations such as illumination changes, rotation, geometric change, angular change, resolution and even object size and thus it is a widely used method for feature extraction, target recognition, robotics etc. The common feature-based image recognition methods usually fail to create a perspective projection transformation, however SIFT is invariant to illumination changes, which is very suitable for remote sensing images.

SIFT finds out the extreme point in the spatial scale and extracts its position, scale, and rotation in the image as descriptors. This process is done in four steps:

1) Extreme value detection in scale space

2) Key point location

3) Direction assignment

4) Eigenvector generation

Once the feature vectors are created, any distance measure function such as Euclidean distance or cosine similarity can be used to find the keypoints similarity in the two images. If the distance between two keypoints is less than some set threshold, then the pair of keypoints can be accepted as a match.

Applications
· Target detection

· Model reconstruction

· Motion estimation

· Feature matching

· Tumor detection

· Geological exploration

· Arial recognition

Top 10 query results

Query number: 1258: 2403, 1148, 4342, 1906, 596, 2127, 4002, 3029, 2474, 1701

Query number: 1656: 2003, 934, 1227, 839, 991, 3875, 2490, 1452, 3897, 2950

Query number: 1709: 2857, 79, 3005, 2402, 2683, 1603, 2701, 3628, 2726, 83

Query number: 2032: 770, 3660, 4277, 4346, 426, 1295, 3643, 4986, 2442, 2806

Query number: 2040: 2666, 1127, 1076, 4912, 2226, 4867, 4537, 2860, 1348, 131

Query number: 2176: 4018, 3144, 2604, 126, 4535, 4494, 1390, 977, 3184, 556

Query number: 2461: 1044, 3791, 3362, 2870, 4002, 1452, 2967, 2127, 4313, 4386

Query number: 27: 3457, 2450, 4610, 2604, 1148, 2950, 2798, 596, 42, 3153

Query number: 2714: 4256, 670, 2399, 4967, 3188, 1130, 2966, 3908, 3297, 596

Query number: 316: 3113, 3399, 1169, 1592, 2684, 2489, 184, 584, 4494, 3153

Query number: 35: 86, 3544, 1860, 4249, 2082, 1192, 930, 1238, 630, 4523

Query number: 3502: 3331, 990, 584, 4228, 4576, 739, 3493, 2127, 4002, 1517

Query number: 3557: 4325, 810, 716, 3897, 3166, 4362, 2876, 1970, 750, 2756

Query number: 3833: 1038, 4871, 2450, 1658, 3688, 596, 3897, 943, 2798, 269

Query number: 3906: 456, 3144, 3184, 2584, 3579, 822, 4097, 3643, 3781, 4165

Query number: 4354: 2, 943, 1977, 1687, 3688, 4681, 227, 208, 1964, 2289

Query number: 4445: 1276, 1164, 116, 3956, 623, 649, 862, 1452, 1710, 2477

Query number: 4716: 4286, 4332, 1784, 518, 1884, 4170, 1459, 2807, 4184, 1028

Query number: 4929: 3259, 672, 2389, 1876, 2901, 83, 3643, 803, 4796, 936

Query number: 776: 2575, 1799, 4918, 2473, 173, 1323, 3688, 2967, 1148, 2427

Method 2 - ORB

ORB is built on the FAST keypoint detector and the BRIEF descriptor, hence it is called Oriented FAST and Rotated BRIEF (ORB). Both these techniques have a much less computational ask than SIFT and hence can be used for more real time object matching purposes.

The ORB algorithm is generally divided into three steps. The first step is feature point extraction. In this step, the thought process is that if a pixel is significantly different from its neighbours then it is very likely to be a corner pixel for that object in the image. Feature point extraction is carried out as follows:

1) Image feature point detection

2) Feature point screening

3) Constructing image scale pyramids

4) Determining feature point detection

The second step is generating feature point descriptors. After the first step, ORB uses the improved BRIEF to calculate the descriptors for each point. This step is preceded by gaussian filtering to reduce the noise in the image. At the end of this step a N-dimensional vector consisting of N binary strings is obtained.

The third step is called feature point matching. Once the feature points of both the images are detected, their similarities must be matched to determine if the two images match. The easiest way to do this is a brute force matching of the features, however faster and more computationally intensive methods such as FLANN also exist.

Top 10 query results

Query number: 1258: 2403, 4937, 3689, 3800, 3065, 4731, 2009, 3632, 2227, 4480

Query number: 1656: 2003, 1227, 934, 2490, 1337, 37, 1536, 3368, 4952, 4003

Query number: 1709: 2857, 3005, 2402, 79, 2726, 1603, 2683, 2444, 2701, 1358

Query number: 2032: 770, 4734, 4696, 274, 1760, 2009, 2084, 2317, 4822, 1604

Query number: 2040: 2666, 4532, 2660, 4991, 3145, 2155, 4509, 4189, 742, 3048

Query number: 2176: 4018, 1025, 407, 4176, 672, 1748, 67, 2529, 4569, 2892

Query number: 2461: 4386, 2959, 1775, 4418, 4870, 3179, 4932, 3530, 3864, 3226

Query number: 27: 392, 4974, 2998, 2660, 5017, 3457, 2641, 1604, 4608, 971

Query number: 2714: 4256, 3188, 1130, 3456, 268, 4696, 2084, 274, 1468, 1760

Query number: 316: 3113, 3399, 2684, 1592, 1169, 355, 4730, 2854, 2704, 2097

Query number: 35: 86, 3544, 2082, 1860, 4249, 1238, 930, 4523, 630, 1192

Query number: 3502: 3331, 3370, 990, 4569, 4228, 3493, 4576, 584, 2349, 3141

Query number: 3557: 4325, 810, 716, 544, 4823, 3940, 3938, 3140, 3041, 3891

Query number: 3833: 1038, 589, 2862, 985, 2695, 2959, 3256, 3850, 2654, 4072

Query number: 3906: 456, 1697, 732, 3098, 4416, 3391, 138, 3749, 3390, 2101

Query number: 4354: 2, 173, 2432, 4979, 969, 257, 3529, 4697, 3667, 2007

Query number: 4445: 1164, 649, 1276, 116, 756, 862, 3559, 2790, 2999, 4436

Query number: 4716: 4286, 4332, 2807, 1459, 4184, 1784, 518, 1884, 4170, 1028

Query number: 4929: 3259, 672, 1200, 4456, 2529, 67, 3048, 5017, 1575, 1157

Query number: 776: 2575, 1799, 2656, 4918, 4456, 1323, 2427, 2488, 173, 2473

Method 3 – SIFT + ORB

There are two ways I thought of to mix these two methods, first was to aggregate the results of these two and find the average distance of every image in the gallery to the query. In this method, I have calculated the average distance of each image from the query image and the smaller the distance, the more similar the images. Hence if I can calculate the average distance based on the two separate implementation, the code will perform something similar to a random forest, where it will take a vote from both the algorithms, find the average and then rank the images in terms of similarity.

Another method that I came up with was to generate keypoints using ORB and descriptors using SIFT, this would lead to a good mix of the two algorithms.

References:

1) Guo, F., Yang, J., Chen, Y., & Yao, B. (2018). Research on image detection and matching based on SIFT features. 2018 3rd International Conference on Control and Robotics Engineering (ICCRE). https://doi.org/10.1109/iccre.2018.8376448

2) Luo, C., Yang, W., Huang, P., & Zhou, J. (2019). Overview of image matching based on Orb algorithm. Journal of Physics: Conference Series, 1237(3), 032020. https://doi.org/10.1088/1742-6596/1237/3/032020