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Topology and Optimization

Exercise 1

Optimized Image Matching based on the Hungarian Algorithm (Kuhn-Munkres)

The two images showing almost the same features. The SIFT algorithm extracted the homologous points but still there is still certain of uncertainty of the procedure. In order to enhance the extraction we applied the Hungarian algorithm to get better accuracy.

The steps needed to apply the Hungarian algorithm as follows:

1. Load following data:
    a. image1, image2
    The images load by the Matlab code "*imread*"
    b. Coordinates of the SIFT-points of both images, feature vectors of the SIFT-points of both images and matches
    which we have to convert the text files which were provided by the tutor into an array to make it readable in the Matlab environment.
    c. Initial assignments of the SIFT-points
    our task here is to match the matches' matrix with the correct corresponding element in the coordinates' space of the images. It's important to mention that the matches' matrix has 200 rows and two columns. The elements in the first columns refer to the first image and the values refer to the number of the row in the Keypoints coordinates matrix of the first images, the same for the second one.

Fig.1 – The initialized matched points from the SIFT algorithm

2. Determine the cost values for the given assignments and create the cost matrix.
The cost value is the difference in the radiometry between the points that they are already been matched by the SIFT algorithm. The radiometry values of the images are in the Keypoints descriptive matrices. In order to visualize or to sense the difference of the radiometry we have to get the Euclidean distance of the matched points in the feature space.

$$\boldsymbol{D_{ij}} = \sqrt{(\boldsymbol{x_1^i} - \boldsymbol{x_1^j})^2 + (\boldsymbol{x_2^i} - \boldsymbol{x_2^j})^2 + \cdots + (\boldsymbol{x_{128}^i} - \boldsymbol{x_{128}^j})^2}$$

The cost matrix its size is the same size as the number of rows of the both images. The initial values of this matrix are "*Inf*". The cost values which are computed from the distance function should be replace by the corresponding element in the cost matrix.
Remark: The idea behind setting the initial values of the cost matrix by "*Inf*" is whenever we have a bigger distance that's mean we have bigger difference in the radiometry of the points which considered to be homologues. So when we have "*Inf*" that's indicates there is no matches between those points.

3. Apply the Hungarian algorithm and illustrate the resulting (optimized) assignments in the images.

The reason behind the Hungarian algorithm is to increase the accuracy of the matching. We apply the function on the cost matrix which made in the previous step. The number of matched points by the SIFT is 200 points. After applying the Hungarian algorithm the number is 149 points. Which means we have approx. 74,5% of the matched points. The output of this function is a logic matrix its values either zero or one. One indicates there are matching and vice versa. So we have to indicate each true value to its column and row number and connect them with the Keypoints Coordinates of the images, in order to plot the optimized points.

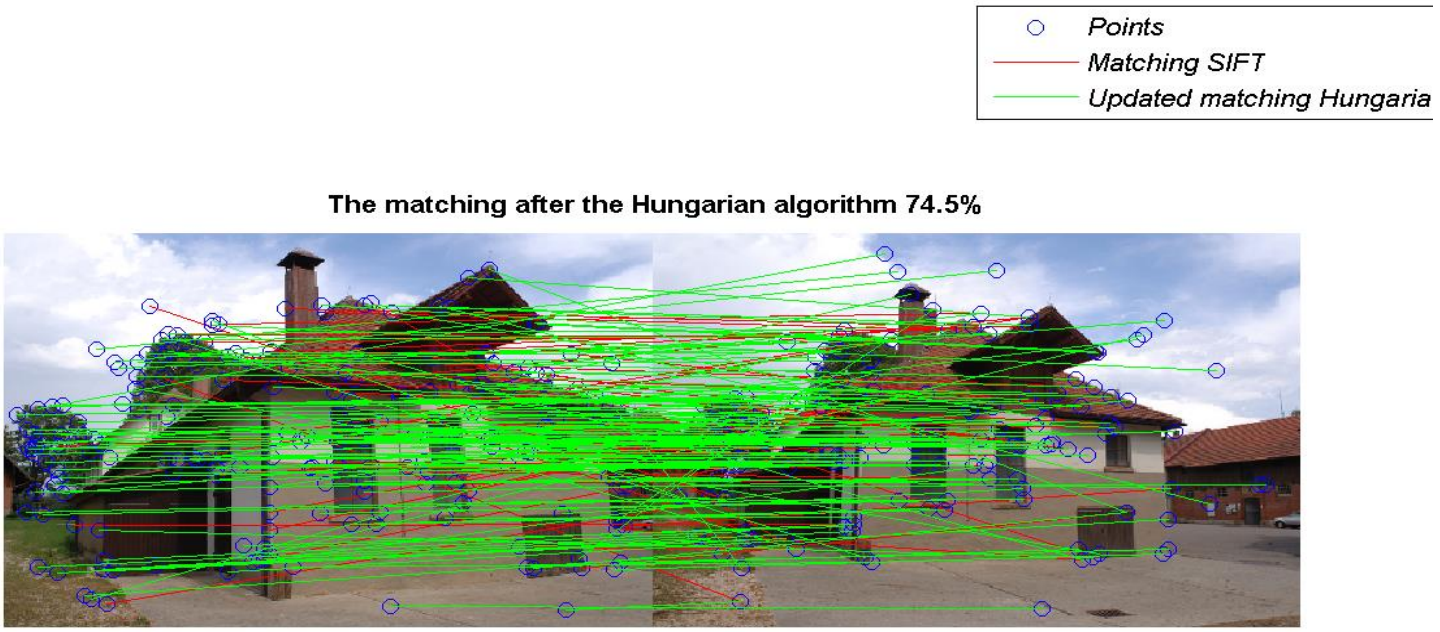

Fig.2 – The optimized matching

The figure shows that we get better results especially in the sky area. Even though, there is still some bad matching or, in other words, there is still failure in the matching. Which I think we can reduce this by additional constrains. Maybe like known points could be helpful or by changing the algorithm itself. Instead of considering the whole image, the image could be divided into several windows in order to help the algorithm to match in this window only.