Photogrammetric Computer Vision

WS 2020/21

Exercise 2

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Theory

1.) Which conditions on the image acquisition have to be fulfilled in order to model the image transformation successfully as a 2D homography?

A 2D Homography can transfer the information of an image into another, stitching them together as if they were one. In order to merge images in such a way, perspectivity and the camera model may not be contradicted and therefor the images needs to either be planar and of slightly overlapping scenes, or ideally they were taken with the camera rotating around the optical center, again with overlapping sections.

2.) 2. How many corresponding point pairs do you need to reconstruct a 2D homography?

Since there are 8 unknowns(DOF) needed to solve the 2D Homography and each point has 2 coordinates, at least 4 point-pairs are required to solve the homography.

3. Why should the homogeneous points be normalized before creating the design matrix?)

In order to determine the design matrix to transfer the images from one space to another, the homogenous points need to be normalized. Without normalization, u and v would have different magnitude compared with w, which means that the elements in design matrix would have even larger difference, the solution of SVD of design matrix would be extremely divergent. The general idea of normalization is to let every element of every homogeneous point pair to have the same impact on the final solution.

On a related note, normalizing the vectors to unit length also leads to calculating the values in a magnitude that maximizes the numerical accuracy of the computer.

4.) What are possible reasons why the images don't align perfectly ?

An (almost) perfect stitch of two images can be achieved, if they are taken with the same camera while rotating the camera around the projection center (the optical center of the lense) between shots. This ensures that the relative orientations and size of the objects are compatible between the images and the illusion of a continuous image can be achieved, simulating the extention of the sensor/image plain of the same camera. In reality, this is seldom the case, reasons being (minute) changes in camera position and orientation between shots but also distortion caused by the lense.

Also, the different depth information of the objects in the image will also cause the imperfection of the final result, it is reasonable because in the 2D homogeneous transformation, we assume all the objects align in a plane or in a similar range, which is not the case in many situations.