CORK INSTITUTE OF TECHNOLOGY
INSTITIÚID TEICNEOLAÍOCHTA CHORCAÍ

MACHINE VISION.

Lab09: RANdom SAampling Consensus

BACKGROUND.

In this exercise you will refine the algorithm developed in Lab07 to be more robust towards outliers in the feature tracking using the RANdom SAmpling Consensus (RANSAC) algorithm. This approach will help identify outliers in the data and select the best point correspondences for the calculation of the image to image homographies used for stitching the image panorama.

Task 1.

Use your solution for Lab07 and replace the function for estimating the homographies in task 2. Instead of using all correspondences between the images, select 4 correspondences $\boldsymbol{x_i} \leftrightarrow \boldsymbol{x_i'}$ at random and calculate the Jacobians for these 4 correspondences

$$\boldsymbol{A_i} = \boldsymbol{x_i^T} \otimes \boldsymbol{S}[\boldsymbol{x_i}']$$

Using only the first two lines of each Jacobian and calculate the homography $\boldsymbol{H}$ using the Direct Linear Transformation (DLT) algorithm, i.e. calculate the null-space of all $\boldsymbol{A_i}$ using the singular value decomposition.

Task 2.

Now go through all correspondences $\boldsymbol{x_j} \leftrightarrow \boldsymbol{x_j'}$ not considered in task 1 and calculate the model function Jacobians

$$\boldsymbol{B_j} = \boldsymbol{S}[\boldsymbol{x_j'}]\boldsymbol{H}$$

$$\boldsymbol{B_j'} = -\boldsymbol{S}[\boldsymbol{H}\boldsymbol{x_j}]$$

Again, select the first two rows of these matrices and calculate

$$\boldsymbol{y_j = B_j x_j}$$

Now assume that the accuracy of each point is 1 pixel, i.e. that the covariance matrices for the point positions are

$$C_{x_j x_j} = C_{x'_j x'_j} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

and propagate the uncertainty according to

$$\boldsymbol{C_{y_j y_j} = B_j C_{x_j x_j} B_j^T + B'_j C_{x'_j x'_j} B'^T_j}$$

Finally, calculate the test statistics for each correspondence

$$T_j = \boldsymbol{y_j^T C_{y_j y_j}^{-1} y_j}$$

and decide if the correspondence is an inlier or an outlier with respect to the 4 points selected in task 1. Also, sum up the T_j for all inliers identified.

Task 3.

Iterate tasks 1-2 several times and retain the homography with the smallest number of outliers. Break ties using the one with the smallest sum of test statistics over all inliers.

Task 4.

Use the homography calculated in task 6 and replace it in the image panorama stitching procedure you implemented in Lab07. Compare the difference.