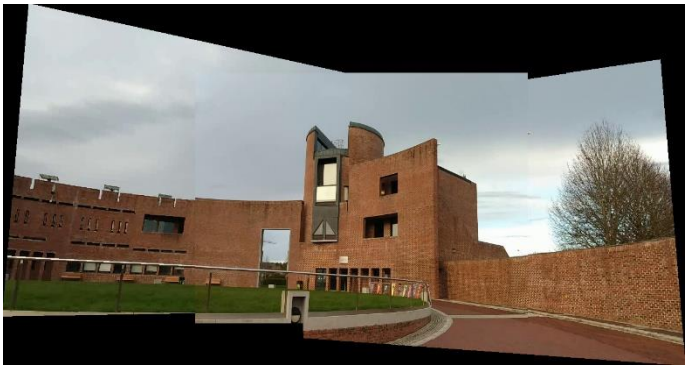
CORK INSTITUTE OF TECHNOLOGY
INSTITIÚID TEICNEOLAÍOCHTA CHORCAÍ

MACHINE VISION.

Lab10: Maximum-likelihood parameter estimation

BACKGROUND.



In Lecture 9 we discussed the Gauss-Helmert-Model for calculating maximum likelihood parameter estimates using a model function. In this exercise you will further refine the algorithm developed in Lab06, Lab07, and Lab09 to find the optimal maximum likelihood estimate of the homographies and use them for stitching an image panorama that minimises reprojection error.

Task 1.

Use your solution for Lab09 and estimate initial homographies and inlier correspondences using RANSAC. Add a function to refine the homography estimates using the Gauss-Helmert model procedure to be implemented in the following tasks.

Task 2.

Make copies $\boldsymbol{x_{0i}, x'_{0i}}$ of the correspondence observation vector $\boldsymbol{x_i, x'_i}$ to be used as linearization point. Calculate the Taylor expansion matrices $\boldsymbol{A}$ and $\boldsymbol{B}$ of the model function as well as the current value of the model function $\boldsymbol{g_0}$ at the linearization point $\boldsymbol{x_0, x'_0}$ and $\boldsymbol{h_0}$. Also build the observation covariance matric $\boldsymbol{C}$ and the current residual vector $\boldsymbol{r}$ from $\boldsymbol{x_0 - x}$ and $\boldsymbol{x'_0 - x'}$ as outlined in Lecture 9**.**

Task 3.

Build and solve the normal equation system

$$\begin{pmatrix} \boldsymbol{\Delta h} \\ \boldsymbol{\mu} \end{pmatrix} = \begin{pmatrix} \boldsymbol{A^T(BCB^T)^{-1}A} & \boldsymbol{2h_0} \\ \boldsymbol{2h_0^T} & \boldsymbol{0} \end{pmatrix}^{-1} \begin{pmatrix} \boldsymbol{A^T(BCB^T)^{-1}(Br - g_0)} \\ \boldsymbol{-(h_0^T h_0 - 1)} \end{pmatrix}$$

Also calculate the observation update $-\boldsymbol{r} - \boldsymbol{C}\boldsymbol{B}^{\boldsymbol{T}}(\boldsymbol{B}\boldsymbol{C}\boldsymbol{B}^{\boldsymbol{T}})^{-1}(\boldsymbol{g}_{\boldsymbol{0}} + \boldsymbol{A}\boldsymbol{\Delta}\boldsymbol{p} - \boldsymbol{B}\,\boldsymbol{r})$ and apply both to the linearization point. Make sure to enforce the normalisation constraints. Iterate the procedure and observe the convergence by printing the maximum element of $\boldsymbol{\Delta p}$.

Task 4.

Use the homographies calculated in task 1-3 and replace it in the image panorama stitching procedure you implemented in Lab07. Compare the difference.