Multiple View Geometry 4

1 Numerical Exercises

1. In addition to computing the camera pose with 3D-2D correspondences, it is possible to estimate the relative pose transformation based on 3D-3D correspondences. In the following, you will derive the first steps for the "Least-Squares Fitting of Two 3-D Point Sets" Arun et al., PAMI87. Consider two point sets $\{p_i\}$ and $\{p'_i\}$with $i = 1, 2, ..., N$ and relation $p'_i = Rp_i + T$, where R is a rotation matrix, and T a translation vector.

   (a) Write down the least-square cost, which is minimized to find R and T.

   (b) Write down the transformation between the centroids p and p' of the two points sets $\{p_i\}$ and $\{p'_i\}$ and express the translation vector T based on p, p' and R.

   (c) Using the normalized cocordinates $q_i = p_i - p$ and $q'_i = p'_i - p'$, show that the least-square cost can be written only in terms of q_i, q'_i and R.

   (d) Briefly explain in one or two sentences how you would proceed and what are the benefits of the above computations for finding R and T.

2. Consider a stereo camera pair with a relative transformation between the left and right camera $t_{l,r}$. Additionally, we have estimates for the relative motion $t^{ll}_{k,k+1}$ between the left camera from timestep k to $k+1$, the relative motion $t^{lr}_{k+2,k}$ between the left camera at timestep $k+2$ to the right camera at timestep k, the relative motion $t^{rr}_{k+1,k+2}$ between the right camera at time step $k+1$ and $k+2$, and the relative motion $t^{ll}_{k,k+3}$ between the left camera at timestep k and $k+3$.
   Write the optimization problem for optimizing the relative motion estimates.