Photogrammetric Computer Vision
Assignment 5

Winter Semester 21/22

Submission Deadline: 09.01.22 13:30 pm

VI. Projective and direct Euclidean reconstruction

With knowledge of the relative orientation, *spatial object coordinates* can be triangulated from corresponding image points. If the parameters of the interior orientation are unknown, then only a *projective reconstruction* is possible. Using at least five control points, this intermediate result can be transformed quite simply into a Euclidean reconstruction.

1. **Projective reconstruction:**

   Since the manual matching of image points is quite laborious and boring, a text file `bh.dat` with many homologous image points is made available for the image pair showing the bust of BEETHOVEN.

   a) Read the homologous image coordinates $\mathbf{x}_1 \leftrightarrow \mathbf{x}_2$ in the format (x_1, y_1, x_2, y_2), e.g. with

   ```
   fh = fopen('bh.dat', 'r');
   A = fscanf(fh, '%f%f%f%f', [4 inf]);
   fclose(fh);
   x1 = A(1:2, :); x2 = A(3:4, :);
   ```

   and use your function from exercise 4 in order to determine the relative orientation of the images with the *fundamental matrix* $\mathbf{F}$.

   b) Implement a new function, which defines two corresponding *projection matrices* $\mathbf{P}_N$ and $\mathbf{P}'$ by means of $\mathbf{F}$.

   c) Realize a function for the *linear triangulation* of projective object points $\mathbf{X}_{P1}$ and try to visualize the computed spatial object coordinates, e.g. using

   ```
   figure; scatter3(X(1,:), X(2,:), X(3,:), 10, 'filled');
   axis square; view(32, 75);
   ```

2. **Direct Euclidean reconstruction:**

   a) Read the *control point* information from the provided file `pp.dat` in the format $(x_1, y_1, x_2, y_2, X_E, Y_E, Z_E)$ and triangulate projective object points $\mathbf{X}_{P2}$ from the five homologous image points $\mathbf{x}_1 \leftrightarrow \mathbf{x}_2$ using the already computed projection matrices $\mathbf{P}_N$ and $\mathbf{P}'$.

   b) Extend your algorithm from exercise 2 for the planar 2D homography to a *spatial* 3D *homography* $\mathbf{H}$. Determine the spatial transformation of the five projective object points $\mathbf{X}_{P2}$ to the corresponding Euclidean object points $\mathbf{X}_E$.

   c) Apply this transformation $\mathbf{H}$ to all object points of your projective reconstruction $\mathbf{X}_{P1}$ and visualize the result of the *Euclidean reconstruction* spatially.

Computer Vision in Engineering – Prof. Dr. Rodehorst
M.Sc. Christian Benz
christian.benz@uni-weimar.de