Exercise 08 for MA-INF 2201 Computer Vision WS23/24
19.12.2023
Submission on 14.01.2024

1. **Procrustres Analysis:** We are given *hands_orig_train.txt.new* which contains 56 landmark points on hand contours from 39 different subjects. The underlying structure of the given data is further explained in the *readme* file. The goal of this task is to align the data. The rough outline of the analysis is as follows:

   - Compute the mean shape (μ_s).
   - Align each shape to μ_s.
   - Compute the RMS error between aligned shapes and the new mean shape.
   - Repeat above steps until convergence (either small error or max number of steps).

   Display the shapes and the mean shape before and after the alignment to verify your results.

2. **Statistical Shape Modeling:**

   - Build a PPCA based statistical shape model $\mathcal{M}$ using the data in *hands_align_train.txt.new*. The data is a set of 56 corresponding landmark points on hand-contours from 39 instances that have already been aligned using Procrustres Analysis. Refer to the *readme* file for details about data organization. Choose the number of basis functions N to be the minimum number of principal components preserving 90% of the energy. Visualize μ and the effect of varying positive and negative weights of each ϕ_k.
   - When does the computation of the eigenvalue decomposition for matrix WW^T become computationally prohibitive? What can you do in this case?

   Restriction: Implement PPCA by yourself. You can utilize *np.linalg.eig* or *np.lingalg.svd* for this task.

   (8 Points)

3. **Inference:** Express the test shape in *hands_align_test.txt* in terms of the generated model $\mathcal{M}$. Display the values of h_{ik}. Also, reconstruct the test shape as $\hat{w}_{test}$, visualize the original and the reconstructed shapes and calculate the RMS error between both shapes.

   (4 Points)