Exercise for MA-INF 2201 Computer vision WS15/16
07.12.2015
Submission on 13.12.2015

Statistical Shape Models

1. **Procrustes Analysis:** We are given *hands_orig_train.txt* that contains 56 landmark points on hand contours from 39 subjects. Data organization 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:

   1. Compute mean shape and fix its variance to unity (μ_s).
   2. Align each shape to μ_s upto translation, scale and rotation.
   3. Compute rms error between aligned shapes and the new mean shape.
   4. Repeat steps 1:3 until max_iter=10^3 or min_error=10^{-5}.

   Display the final aligned shapes and the mean shape to verify the alignment. *(8 Points)*

2. **Statistical Shape Modeling:** Build a PCA based statistical shape model $\mathcal{M}$ using the data in *hands_align_train.txt*. The data is a set of 56 corresponding landmark points on hand-contours from 39 instances that have already been aligned using Procrustes Analysis. Refer to the *readme* file for details about data organization. The model $\mathcal{M}$ is to be formulated by defining the subspace model as:

$$w_i \approx \mu + \sum_{k=1}^{K} \phi_k h_{ik}$$

$$\mathcal{M} = \{\mu, \phi_1, \phi_2, \ldots, \phi_N\}$$

   where N is the minimum number of principle components preserving 90% of the energy. Visualize μ and the effect of varying positive and negative weights of each ϕ_k. (hint: use opencv eigen(), transpose())
   (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 $\hat{w}_{test}$ and visualize both original and reconstructed shapes.
   (4 Points)