Exercise 08 for MA-INF 2201 Computer Vision WS18/19
30.11.2018
Submission on 08.12.2018

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

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

   Restriction: The entire code for task one should not contain more than two loops. Bonus point for using a single loop only.

   Hint: vectorize the data and utilize the broadcasting capabilities of numpy. For the bonus point you might want to read about numpy.einsum

   (8 + 1 Points)

2. **Statistical Shape Modeling:** Build a PCA 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. The model $\mathcal{M}$ is to be formulated by defining the subspace model as:

$$\begin{aligned} w_i &\approx \mu + \sum_{k=1}^{K} \phi_k h_{ik} \\ \mathcal{M} &= \{\mu, \phi_1, \phi_2, \ldots, \phi_N\}, \end{aligned}$$

   where N is 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.

   Restriction: The entire code for task two (excluding the visualization part) should not contain more than a single loop. Implement PCA by yourself. You are allowed to 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.

Restriction: You are not allowed to use a single loop in this task.

(4 Points)

Do not use any library except these given in the template!
Happy Coding :)