Exercise 07 for MA-INF 2201 Computer Vision WS19/20
02.12.2019
Submission on 08.12.2019

Notice. In this exercise you **must** provide the source code with a report explaining functionality of the codes, describing the outputs, and explaining the solution for each task. If you are using *Jupyter Notebook* you can provide the report in the notebook. Otherwise, the report should be provided in a *PDF* file. Missing reports will result in 0 **points** for the corresponding task. You are only allowed to use *OpenCV, Numpy, and matplotlib* libraries.

1. **Iterative Closest Points:** The goal of this task is to estimate the template model. Using the given image *hand.jpg* and set of landmark points *hand_landmarks.txt*:

   - Estimate the transformation Ψ
   - Visualize the transformed landmark points using the estimated transformation Ψ

   (7 Points)

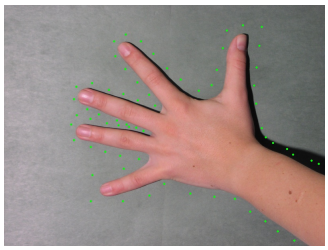

Figure 1: Visualization of the given landmark points on the image

2. **Statistical Shape Modeling:** Build a PCA based statistical shape model $\mathcal{M}$ using the data in *hands_align_train.txt.new*. The data in a set of 56 corresponding landmark points on hand-contours from 39 instances that have already been aligned using Procrusters 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:

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

$$\mathcal{M} = \{\mu, \phi_1, \phi_2, \ldots, \phi_N\}, \tag{2}$$

   where N is the minimum number of principal components preserving 90% of the energy. Visualize μ and the effect of weights $W = (-0.4, -0.2, 0.0, 0.2, 0.4)$ of each ϕ_k. **Restriction:** The entire code for this task (excluding the visualization part) should not contain more than a single loop. The PCA must be implemented by yourself. You are allowed to utilize *np.linalg.eig* or *np.linalg.svd* for this task.
   (8 Points)

3. **Inference:** Given the test shape in *hand_align_test.txt* and the generated model $\mathcal{M}$ estimate the values of h_{ik} using the ICP approach. Also, visualize the reconstructed

shapes and calculate the RMS error between the reconstructed shape and the original shape for all of the iterations.
(5 Points)