Final Project

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In this project, we will work with faces, just like what you did in your labs. First, you need to take multiple photos of your face. Note that the photos must be in front view and with different expressions. After taking the photos, you must go through the following steps:

1. Registration and The Average Shape

You must first detect the landmarks of the faces using the Dlib library. Now you need to find the average of the faces. But first, you must align faces so they correspond with each other. This step is called registration. You should transfer the photos employing both an affine matrix and a similarity matrix. (for more details watch the last video of the class).
Now that you have found the proper transformation matrices, you should use them to match the photos. Don't forget to subtract the average of the 2D points from their average, so that their average becomes zero.

At the time of presentation, you need to show plots of

1. multiple faces,
2. all faces registered to the first, and
3. the average face.

You must do the above both with two faces and all the facial expressions you have recorded.

2. Face models + Animating principal modes

In this phase, you use all the facial expressions you have created with your face to create a face model. If you work as a team, a faces model must be created for each team member. You must apply the PCA procedure to all the registered faces. Next, choose the first k principal components that best reconstruct the primary face. You need to

1. Normalize all the faces by registering them to the first face. The first face must have a neutral expression.
2. Find the average face after registration.
3. Subtract the average face from the other faces.

4. Apply PCA to compute the principal components, using eigen analysis or SVD.
5. Animate the first k modes (k=16) of variation as explained in the class. That is

$$A = \mu + a\,U_i$$

where *a* ranges from -σ to σ .

3. Transfering gestures

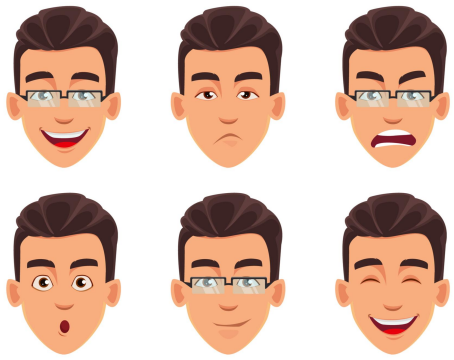
You have found a model of a face so far, call it face A. In this section, you are supposed to transfer the gesture of any given face (call it B) to face A. It is a simple optimization problem. You have calculated the statistical model of face A in the previous section

$$A = \mu + \mathbf{\Sigma} a_i U_i$$

Then, the optimal values of a_i that will transfer the gesture of face B to A could be found by solving the following Least Square problem:

$$a^* = min\left|\left|\mu + \mathbf{\Sigma} a_i U_i - B\right|\right|$$

- Show the result by capturing your face by webcam and transferring the gestures you make to the previous model. Here are some gestures you can make in front of your camera :)



4. Appearance model (bonus)

In the last part, you could not see the results in an appealing way. Faces were a series of points. In this section, you should add colors to the shape model. So, the output will be more familiar. To do this, first run a triangulation algorithm on the neutral face. Use the same triangulation for all faces.

To choose a color for a single face, a simple approach is to transfer the colors from the neutral face. Just iterate over the pixels of the target face. Then for each pixel find the corresponding

location in the neutral face. This can be done by finding the corresponding triangle and using the barycentric coordinates, as explained in the class.

https://docs.scipy.org/doc/scipy/reference/generated/scipy.spatial.Delaunay.html
https://docs.scipy.org/doc/scipy/tutorial/spatial.html