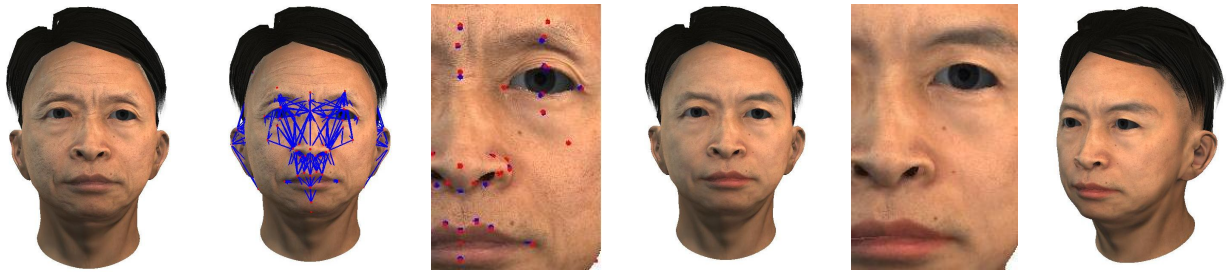
De-aging High-Resolution 3D Facial Models by Example-Driven Mesh Deformation

Hong-Shang Lin, Shih-Yen Hwang, Che-Hua Yeh, and Ming Ouhyoung
National Taiwan University



(a) (b) (c) (d) (e)

Figure 1: *The proposed approach for de-aging: (a) The input high-resolution 3D face model (b) 70 Farkas feature points (red points) and 434 edges (blue lines) generated by Delaunay triangulation (c) New locations (blue points) for the 70 Farkas feature points after optimization (red points for original location) (d) The result after deformation and texture smoothness (e) Final results after applying vertex averaging.*

1 Introduction

Human face conveys significant characteristics of a person such as age traits and facial attractiveness. The absolute aesthetic value for human faces is still unclear; but meanwhile, facial attractiveness has been considered as a cross-culture criteria. By applying de-aging procedure on 3D model geometry can be used to enhance facial attractiveness due to improved shape analysis. We conclude our observation on aging progress into four rules: 1. drooping of eyelids, 2. lack of elasticity cause hollow cheeks, 3. slack on middle face and 4. wrinkles. In this paper we present a framework to beautify (enhance facial attractiveness) realistic facial model by mesh deformation method based on data-driven approach. For an elder input face, we extract the edges connected among feature points on the face mesh. The edge lengths is used as a feature vector, and an age score is associated with it. We search for local minimum to obtain a related young vector and consequently maintain the similarity between the elder and young face. Once the young length vector has been determined, we can embed it to our new feature locations and then deform the model to a younger shape. The effectiveness of our work is to rejuvenate elder face by altering determined the outline of a facial model.

2 Our approach

We extend the framework proposed in [Leyvand et al. 2008] to beautification and de-aging for 3D face models. The first step is to build the de-aging editor. We adopt the Basel Face Model [Paysan et al. 2009] to generate the training dataset, and 200 face models are generated with uniform distribution in the age attribute. Each model is labelled with 70 feature points according to Farkas feature points, and then 434 edges are connected between these feature points through Delaunay triangulation. Figure 1(b) illustrates the labelled Farkas feature points and the edges. The 434 edge lengths are further reduced to 35 by the principal component analysis (PCA), hence each 3D face model can be represented with a 35-dimensional feature vector. To train the regression model, a list of labels or scores are required, and we normalize the age attribute of the 200 models to ranks 1 to 5 in a discrete manner. Finally, the 35-dimensional feature vectors and their corresponding ranks are used as training samples to construct a support vector regression (SVR) model.

Let $\mathbf{v}$ denote the feature vector extracted from an input 3D face model. To de-age the model, we have to generate a new vector $\mathbf{v}^{'}$ where $F_{age}(\mathbf{v}^{'}) > F_{age}(\mathbf{v})$. The function F_{age} is the regression model obtained from the previous step. $\mathbf{v}^{'}$ can be derived by minimizing the function $-F_{age}(\mathbf{v}^{'})$ with standard no-derivatives Direction Set Method. Then Levenberg-Marquardt algorithm is utilized to search the new location of the 70 Farkas feature points based on the derived $\mathbf{v}^{'}$. Figure 1(c) shows the original location (red points) and the new location (blue points). Finally, we apply thin plate spline warping to all vertices in order to warp the 70 Farkas feature points to new locations. As a result, we apply smoothing to the face texture map and apply vertex averaging to the face mesh.

3 Results

Figure 1(a) shows an input example, which is captured through the lightstage system [Ma et al. 2008]. Figure 1(e) is the final results processed by the proposed approach.

References

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