Cosmetic-Vis: Sample-based 3D Facial Editor for Cosmetic Medical Visualization

Mengyuan Ren
Center for Future Media and CCSE,
University of Electronic Science and Technology of China

Ning Xie
Center for Future Media and CCSE,
University of Electronic Science and Technology of China

Yang Yang
Center for Future Media and CCSE,
University of Electronic Science and Technology of China

Heng Tao Shen
Center for Future Media and CCSE,
University of Electronic Science and Technology of China

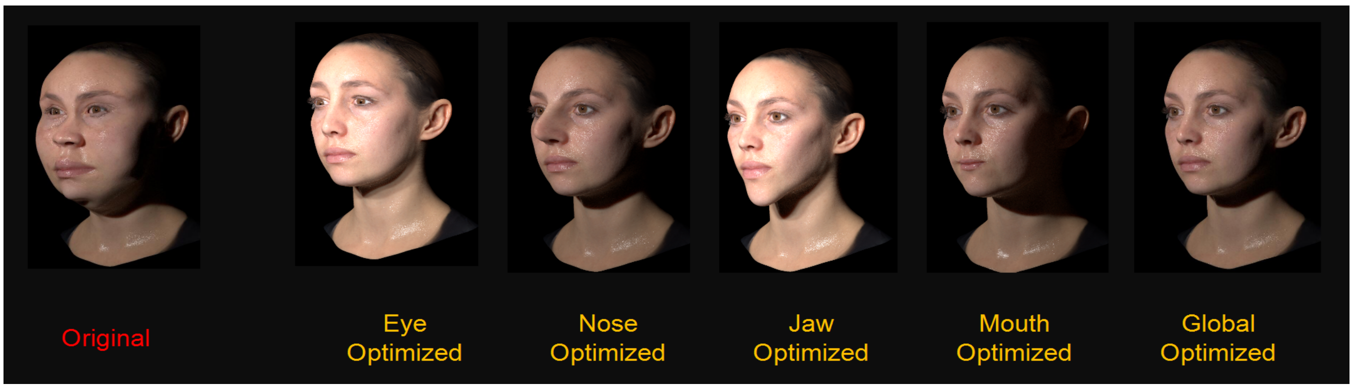

Figure 1: The proposed system *Cosmetic-Vis* allows users to modify the target facial model with samples for cosmetic medical visualization.

CCS CONCEPTS

• **Computing methodologies** → Computer graphics;

KEYWORDS

Blendshapes, Cosmetic Medical Visualization, Facial Organ Partition, Laplacian Matrix

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1 INTRODUCTION

Cosmetic medical visualization has become an important application in computer graphics, especially for facial appearance visualization[Chandawarkar et al. 2013]. Recent approaches have reached very realistic results by blend shape[Ma et al. 2012], which is the most practical tool to make the facial appearance and expression animation in application domains on the entertainment industry (VFXs and games). In many role-playing games (RPGs), players enable to edit the character's facial appearance. However, it is unrealistic since arbitrary discontinuities and position relationship violations (a selected nose might be at a higher position that the bottom of the eyes selected from a different character) caused by players' manual operation. Moreover, the validity on changing facial organs has not be considered well yet.

To fill this gap, we propose a facial composite generator called *Cosmetic-Vis* to investigate the method on facial cosmetic visualization. To ensure the realistic facial structure as illustrated in Figure 2, we propose the facial mesh decomposition based on the organs according to the anatomical structure. In order to blend facial organs partition from samples into target model according to users' input, we analytically convert the problem into setting feature vertices and computing the average on edges by Laplacian method[Ma et al. 2012] so as to guarantee the global smoothness with respect to the second order continuity. Our method preserves the position relationships from the source model with the smooth result. The experimental results have demonstrated that our method based on key vertices enables to achieve great performance for facial regions partition and the great performance of changing the specified organs.

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2 ANATOMICAL FACIAL REGIONS PARTITION

In order to ensure the performance of facial editing, we firstly divide the entire facial mesh into the organ-based partitions (Table 1)

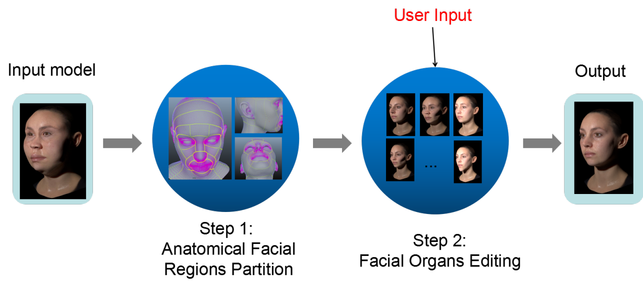

Figure 2: Project pipeline.

Table 1: Anatomical Facial Regions Partition.

Anatomical Facial Regions Partition		
Order	Region	Subregion
1	nose	up, low, wing
2	eye	eyelid, blephar, canthus
3	lip	up, low, edge
4	cheek	- - -
5	temple	- - -
6	jaw	in, out
7	zygoma	- - -
8	frontal	up, low
9	masseter	- - -
10	ear	- - -
11	forehead	geisoma, forehead

according to the anatomical structure. To ensure the efficiency of facial editing in Step 2 of our pipeline, we uniform all facial models with same topology. With the prior knowledge from plastic surgeons, facial models are divided into 20 partitions under 11 regions as illustrated in Table 1. Furthermore, we extract feature vertices from each partition so as to speed up the editing process (Section 3).

3 FACIAL ORGANS EDITING

In order to guarantee continuity and validity of the position relationship of organs, we leverage the method on facial blending with respect to the edges of mesh[Ma et al. 2012]. Once assigning the blending weights ω by users, the edge vectors $\mathbf{e}$ can be computed as

$$\mathbf{e}_t = \sum_{k=1}^{N} \omega_i^k (p_i^k - p_j^k), \tag{1}$$

where $\mathbf{e}_t$ denotes the t-th edge vector that connects the i-th and j-th vertices. N is the number of source face models. The vertex positions $\mathbf{b}$ of the resulting facial mesh can be solved using the linear system

$$\mathbf{M}^{\mathrm{T}}\mathbf{b} = \mathbf{e}, \tag{2}$$

where $\mathbf{M}$ is the oriented incidence matrix based on the undirected graph of our facial model, which is shared by all facial models. $\mathbf{e}$ stores all the edge vectors.

$$\mathbf{M}\mathbf{M}^{\mathrm{T}}\mathbf{b} = \mathbf{M}\mathbf{e} = \mathbf{L}\mathbf{b} \tag{3}$$

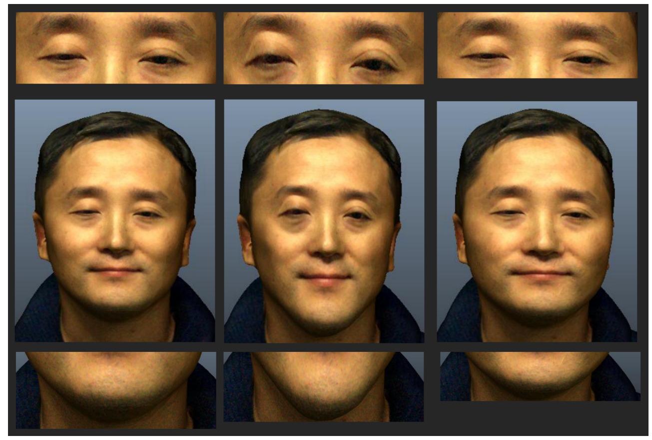

Figure 3: The experimental result.

Equation 2 can be solved by the Equation 3, where $\mathbf{L}$ is the Laplacian matrix. Then, we enable to get the vertex positions $\mathbf{b}$ of the facial model and exhibit the cosmetic medical visualization.

4 RESULTS AND CONCLUSION

We propose an efficient facial composite generator to investigate the method on facial cosmetic visualization. After decomposing the entire facial model into the anatomical regions, we blend the target facial model with samples' models in the organ level respectively.

In the experiment, we firstly test on the facial models named Emily[Fyffe et al. 2014] as illustrated in Figure 1. The series of results show the cosmetic surgery simulation with respect to different organs such as eye, nose, jaw and mouth, etc. We also demonstrated it on the other facial model as illustrated in Figure 3. For practical purpose, we implemented our method as the plugin called *Cosmetic-Vis* for Maya.

In the future work, we would like to make the extension on the realistic face models so as to further model more realistic customers' face models. The skin and muscle simulation[Mukai and Kuriyama 2016] are also the key components when blending the face models.

5 ACKNOWLEDGEMENTS

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