DeepSketch2Face: A Deep Learning Based Sketching System for 3D Face and Caricature Modeling

(Supplemental Materials)

Xiaoguang Han, Chang Gao, Yizhou Yu

The University of Hong Kong

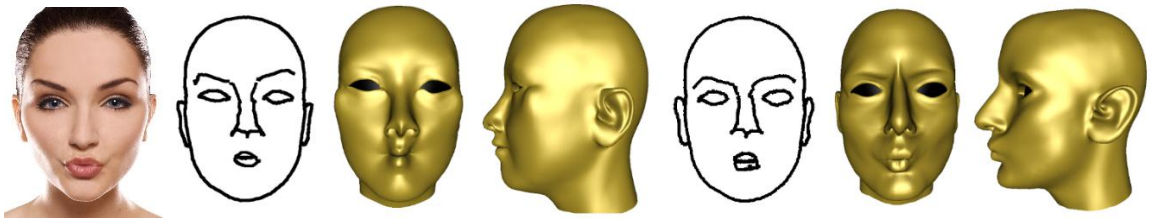
Part I: User Studies on the Interface

Stage I: User experience

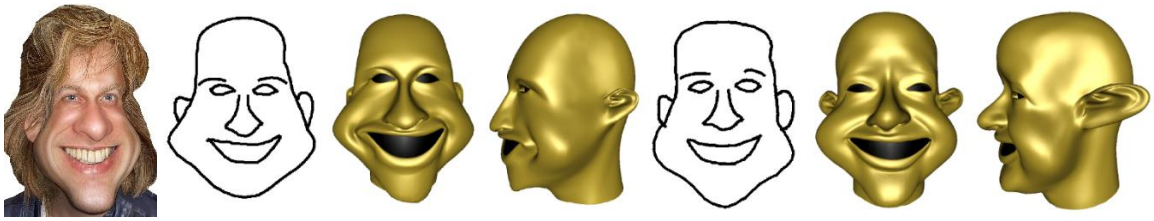
12 amateur users are invited to evaluate our system in this stage. Each participant was given a 2D portrait or caricature face as reference, and asked to create a 3D model with a similar shape and expression using our system. Note that the created 3D model was not required to strictly follow the reference image and differences were allowed. We also created another deformation-only user interface supporting face modeling using handle-based interactive mesh deformation only [1][2][3]. To validate the effectiveness of deep learning based model inference, each participant was asked to repeat the same task twice independently using our system and the deformation-only interface.

All the results are listed below, one row per user. Each row, from left to right, shows the reference image, a hand-drawn sketch and two views of the created 3D face using the deformation-only interface, another hand-drawn sketch and two views of the created face using our system.

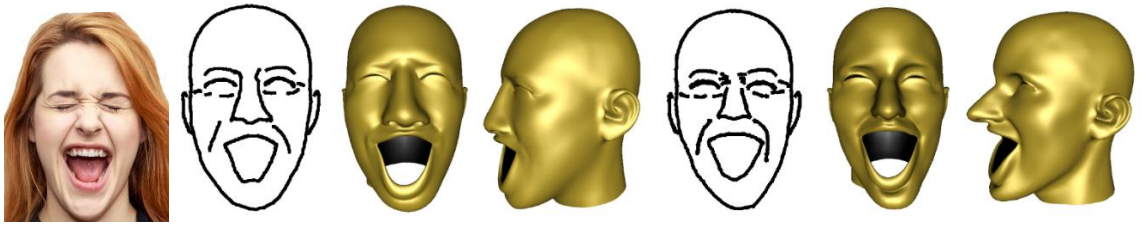
User 1



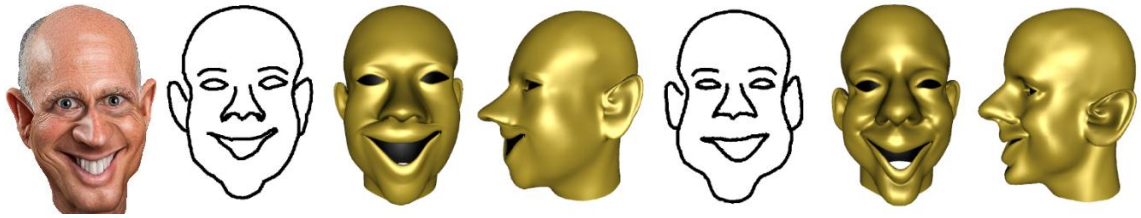
User 2



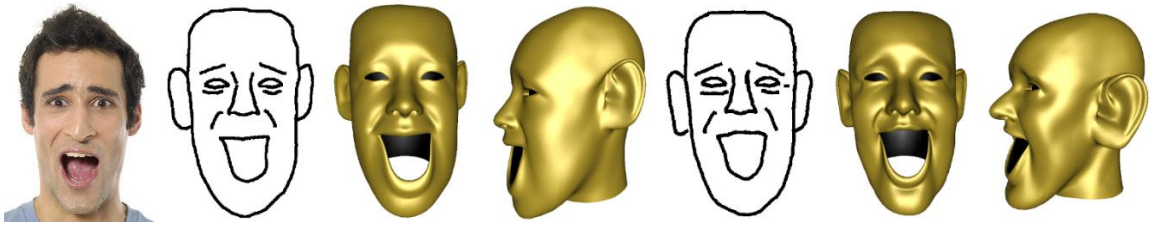
User 3



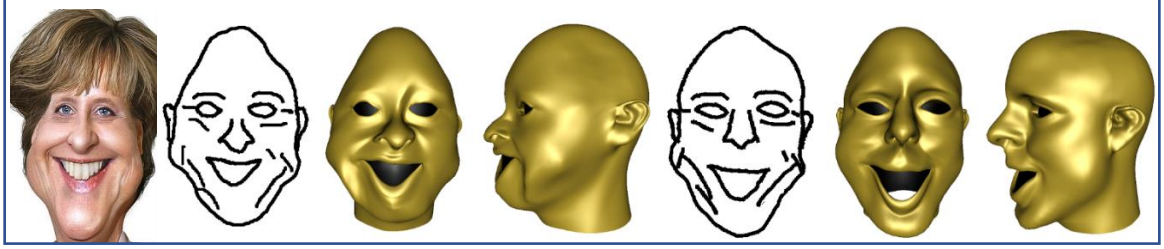
User 4



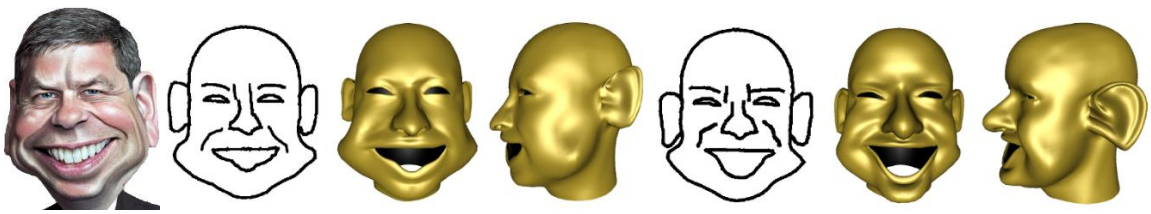
User 5



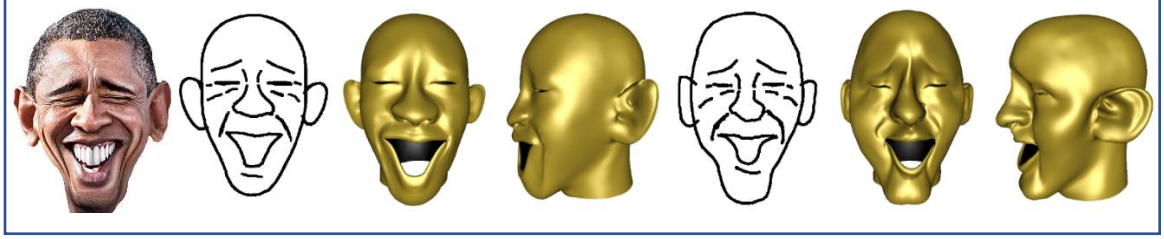
User 6



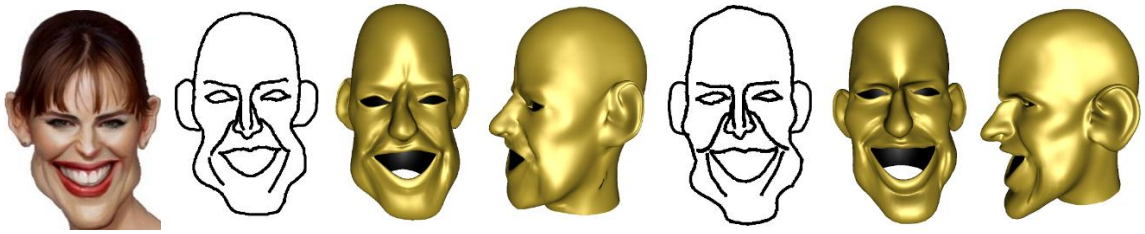
User 7



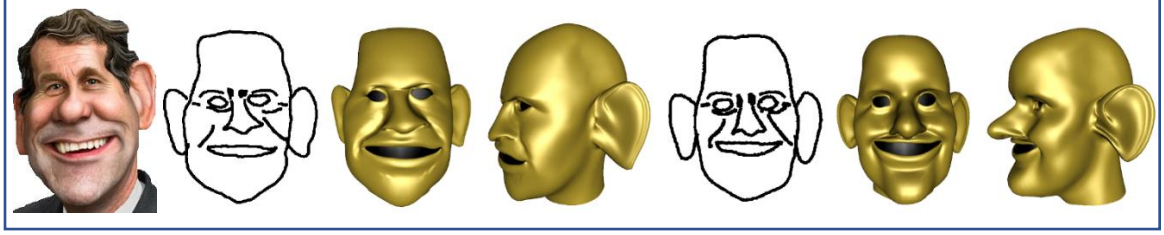
User 8



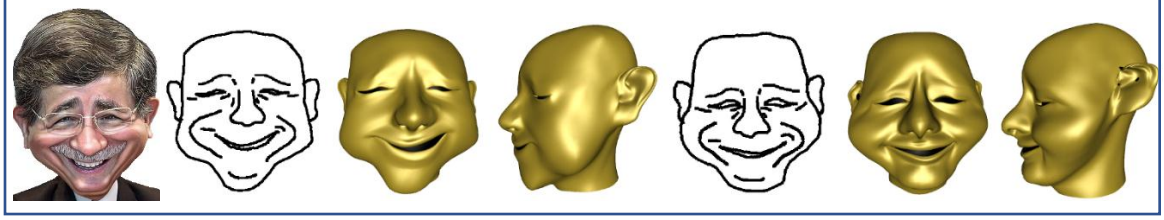
User 9



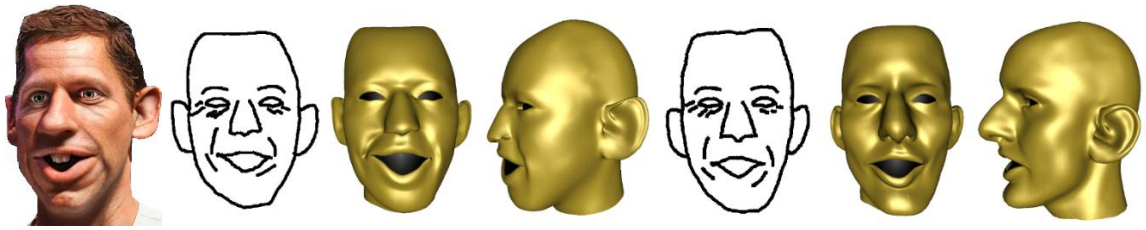
User 10



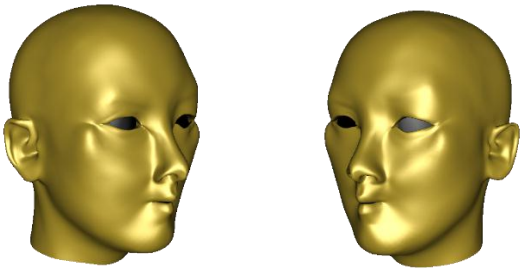
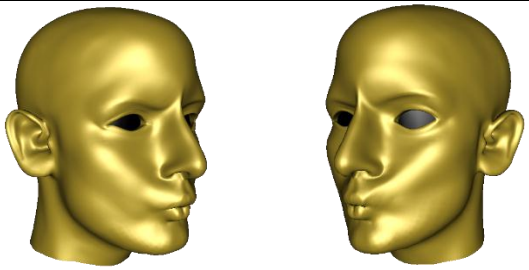
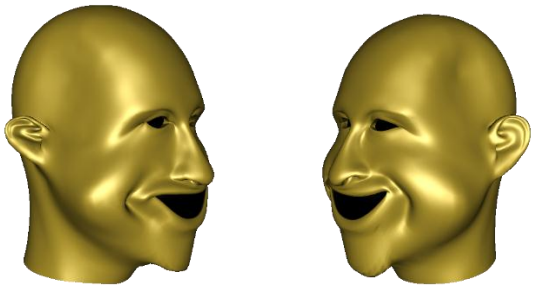
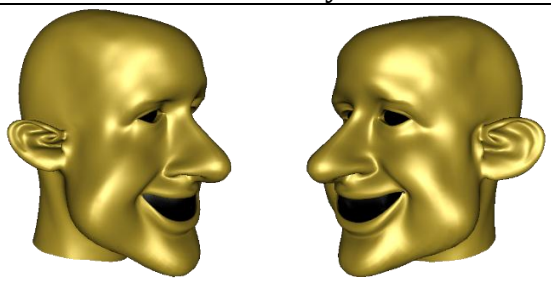
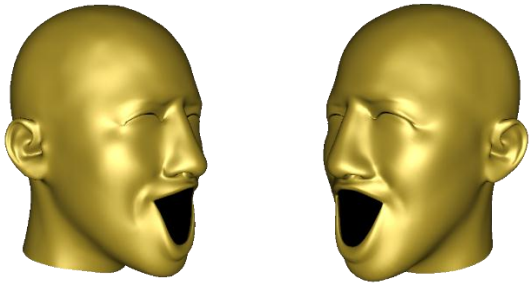
User 11

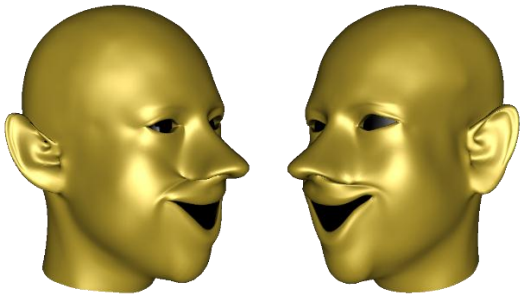
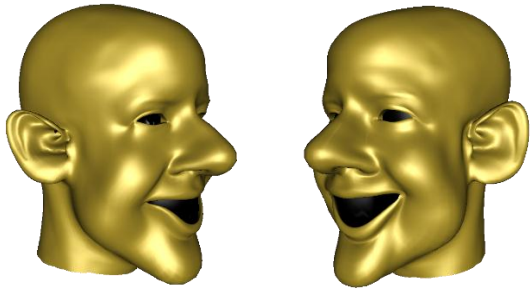
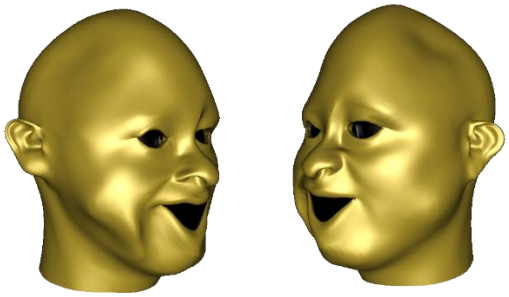
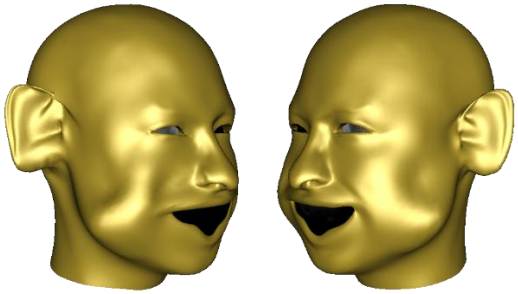
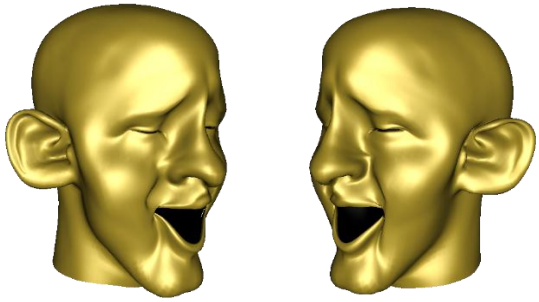


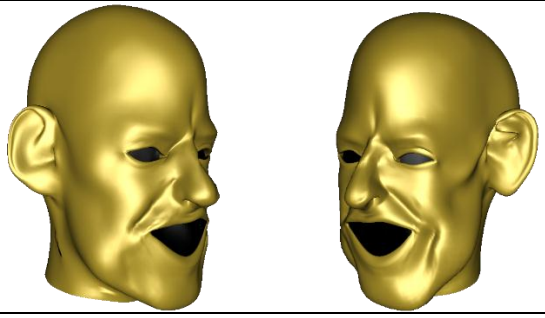
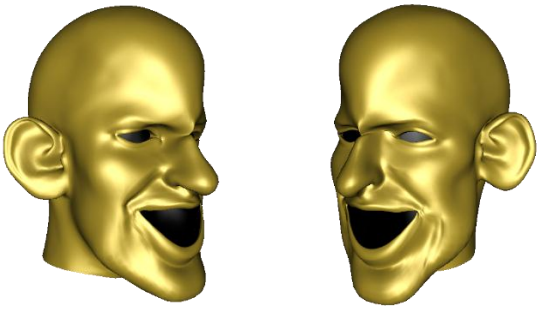
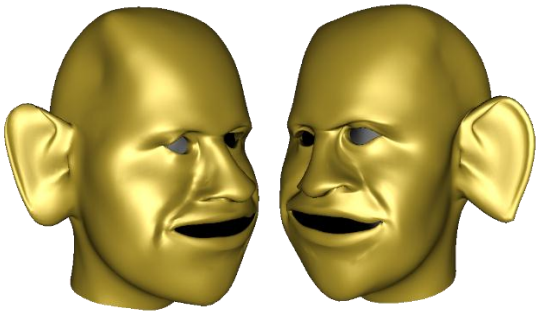
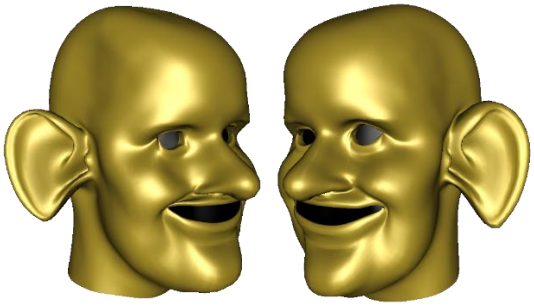
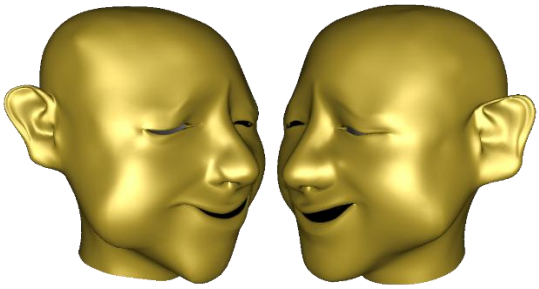
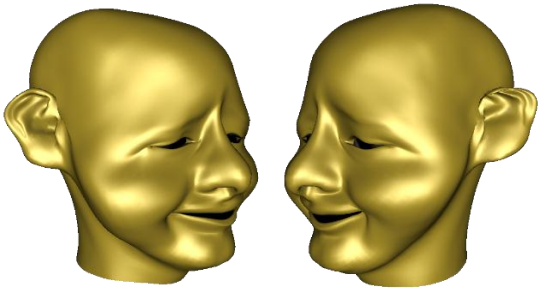
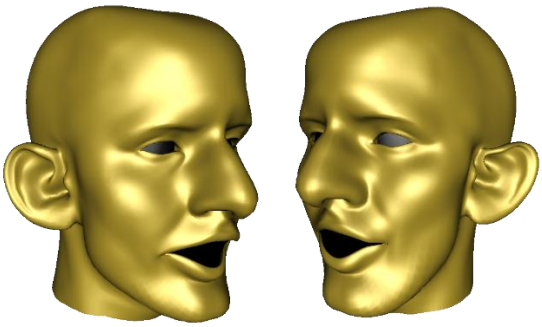
User 12



For careful comparisons, we also show two more views for each 3D model as below.

User 1: deformation-only interface	User 1: our system
	
User 2: deformation-only interface	**User 2: our system**
	
User 3: deformation-only interface	**User 3: our system**
	

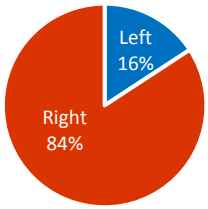
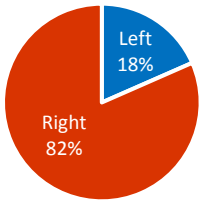
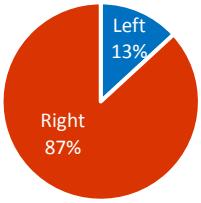
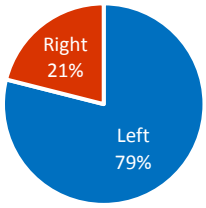
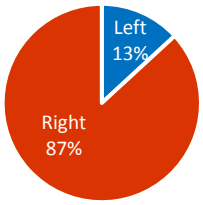
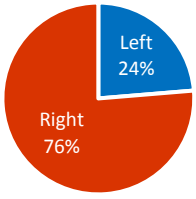
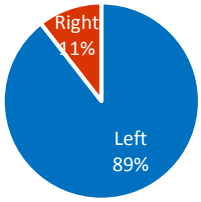
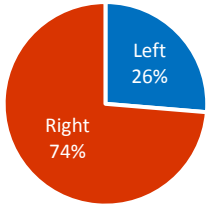
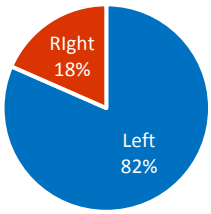
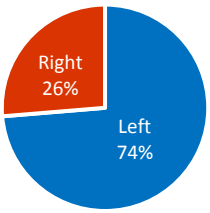
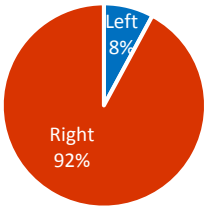
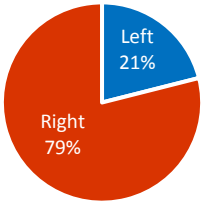
User 4: deformation-only interface	User 4: our system
	
User 5: deformation-only interface	**User 5: our system**
	
User 6: deformation-only interface	**User 6: our system**
	
User 7: deformation-only interface	**User 7: our system**
	
User 8: deformation-only interface	**User 8: our system**
	

User 9: deformation-only interface	User 9: our system
	
User 10: deformation-only interface	**User 10: our system**
	
User 11: deformation-only interface	**User 11: our system**
	
User 12: deformation-only interface	**User 12: our system**
	

Stage II: Evaluation

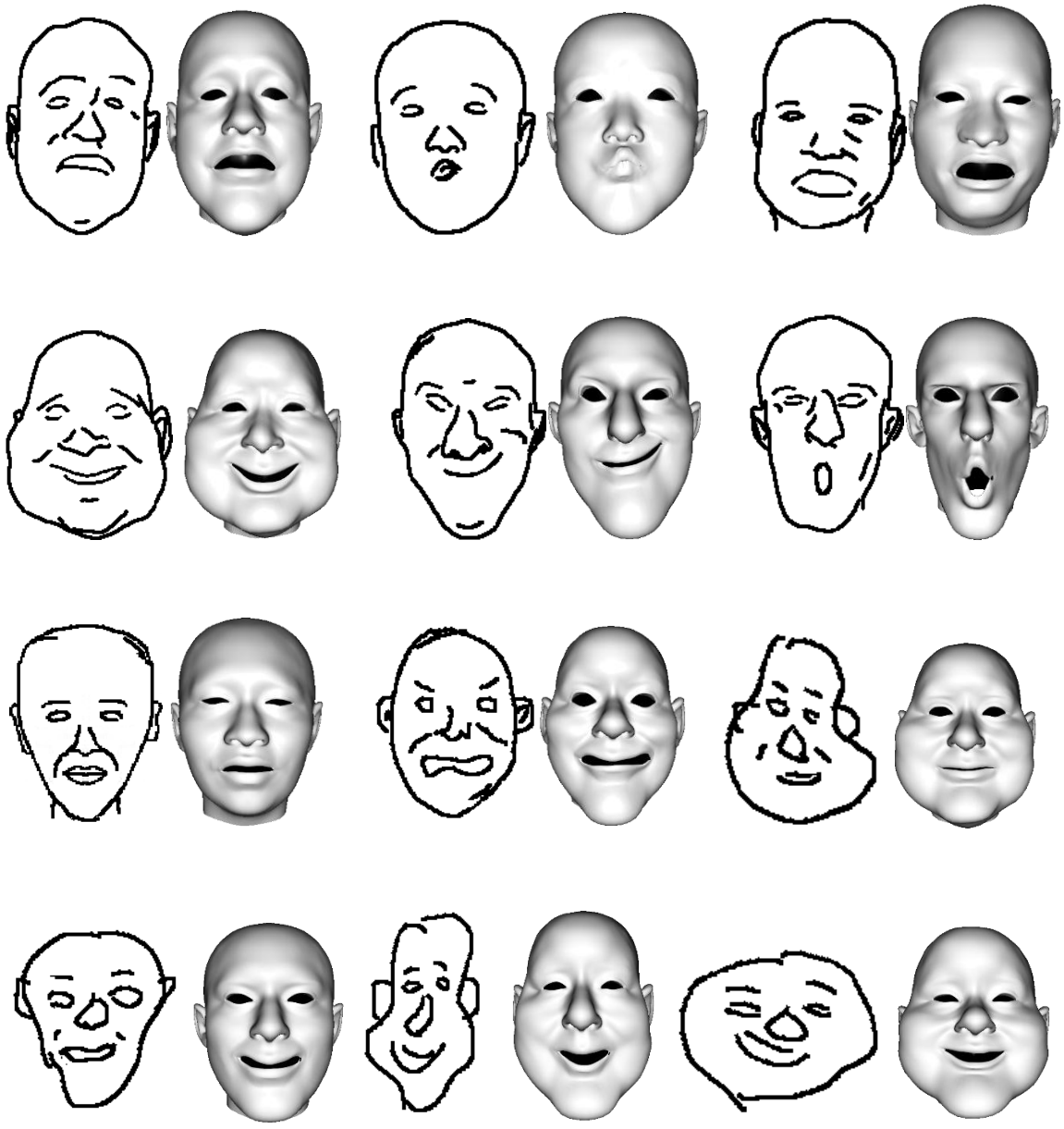
In this stage, we invited 38 additional subjects, who had not participated in the modeling stage, to compare the results created using two different interfaces in Stage I. Every participant needs to look at corresponding models (shown in random order) created in the two interfaces and their associated sketch drawn in Stage I, and was asked to choose the model that looks more natural and better resembles the sketch.

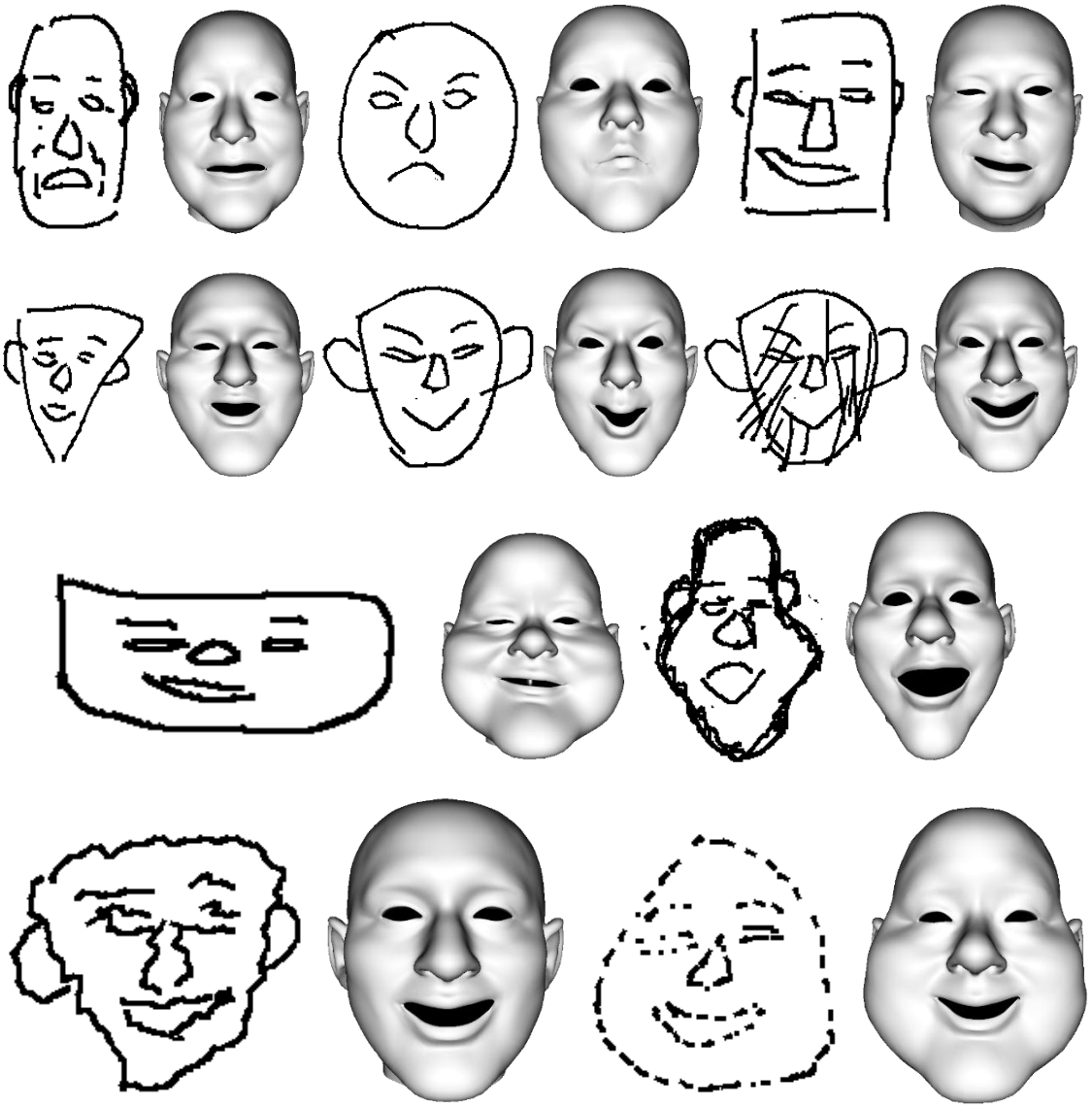
We received 38 valid user responses with 456 votes in total, among which 18% (82 out of 456) support the deformation-only system, 82% (374 out of 456) support our system. The voting results for the models created by each user in Stage I are summarized below.

User 1	**User 2**	**User 3**	**User4**
 Right: Our system	 Right: Our system	 Right: Our system	 Left: Our system
User 5	**User 6**	**User 7**	**User 8**
 Right: Our system	 Right: Our system	 Left: Our system	 Right: Our system
User 9	**User 10**	**User 11**	**User 12**
 Left: Our system	 Left: Our system	 Right: Our system	 Right: Our system

Part II: Results of Our Model Inference Network

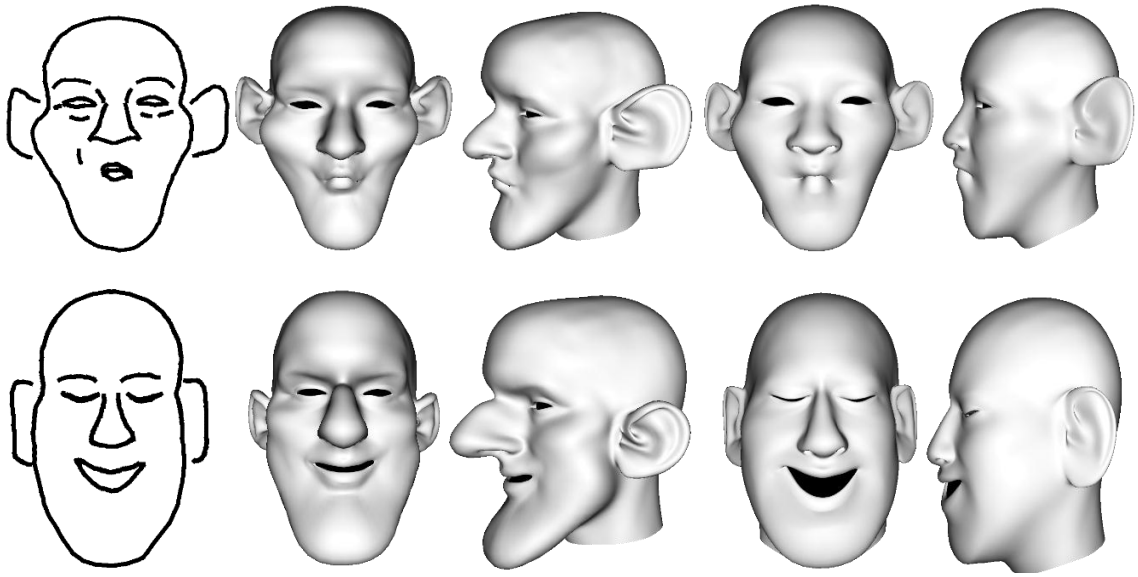
To show the effectiveness and robustness of our deep regression network for model inference, in this part, a set of raw sketches and 3D faces inferred from them are shown side by side. The sketches in the first two rows come from our testing data, which is rendered from 3D models, and all other sketches are freehand drawings.





Part III: With/without Model inference for Deformation

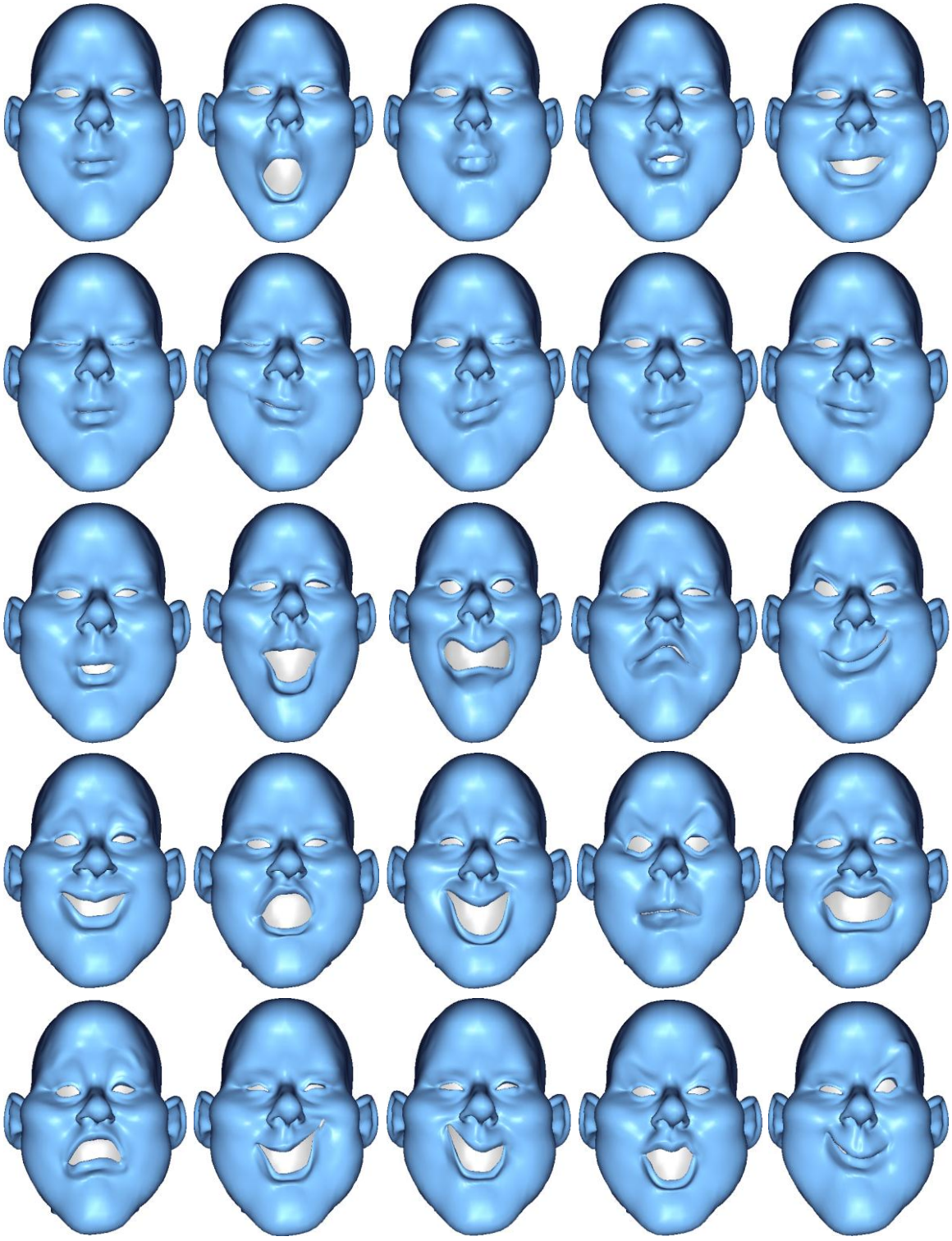
The following two examples show the differences between results obtained with and without performing model inference using our deep network. (a) is an input sketch, (b) shows our deformation result with automatic model inference, and (c) shows the result of Laplacian deformation applied to a template model.



(a) **(b)** **(c)**

Part IV: Expression Set in Our Database

Our face dataset has 25 expressions. 11 of them were selected from *Facewarehouse*[4], a public face database with 150 identities and 20 expressions. We also collected 14 new expressions in caricature style from an artist. All the expressions in two levels of exaggeration are shown below.



References

[1] Sorkine, O., Cohen-Or, D., Lipman, Y., Alexa, M., Rössl, C., & Seidel, H. P. (2004, July). Laplacian surface editing. In *Proceedings of the 2004 Eurographics/ACM SIGGRAPH symposium on Geometry processing* (pp. 175-184). ACM.

[2] Nealen, A., Sorkine, O., Alexa, M., & Cohen-Or, D. (2007, August). A sketch-based interface for detail-preserving mesh editing. In ACM SIGGRAPH 2007 courses (p. 42). ACM.

[3] Nealen, A., Igarashi, T., Sorkine, O., & Alexa, M. (2007). FiberMesh: designing freeform surfaces with 3D curves. ACM transactions on graphics (TOG), 26(3), 41.

[4] Cao, C., Weng, Y., Zhou, S., Tong, Y., & Zhou, K. (2014). Facewarehouse: A 3d facial expression database for visual computing. *IEEE Transactions on Visualization and Computer Graphics*, *20*(3), 413-425.