

JNR: Joint-based Neural Rig Representation for Compact 3D Face Modeling

Noranart Vesdapunt, Mitch Rundle, HsiangTao Wu, and Baoyuan Wang

Microsoft Cloud and AI
{noves, mitchr, musclewu, baoyuanw}@microsoft.com
(Supplemental Material)

Our joint-based neural rigging model (JNR) is a 3D face model designed by artist with learned neural skinning weight to increase model capacity while remains compact. We show additional figures and table in this supplementary to provide more visual results on both our retopologized scan and BU-3DFE, and full detail of our joint-based model to allow reproducibility. We also provide videos to demonstrate facial mesh editing and adding accessory.

More Qualitative Results We include more visual results of our retopologized scan in Fig.1 and more visual results of BU-3DFE in Fig.2. Both results are generated by neural skinning weight model. Similar to Fig.4-6 in the main submission.

Joint-based Model Detail We provide full detail of joint-based model in Table 1. Our joints are designed hierarchically to allow intuitive facial mesh editing and we list all the parent of each joint in Table 1. We also list all of our transformation parameters (rotation, translation, scale), transformation range, and a sample visualization of each joint transformation. Note that some joints do not have transformation parameter, but we still keep the joint to make editing more intuitive. For example, ear joint can move both left and right ear together. We list the expression blendshapes we used in Fig.3.

Accessorizing Pipeline To add accessory to our model, artist only need to register the accessory once to template model, and the skinning weight of accessory can be transferred from template model automatically by graphic software (e.g., Blender). Once the accessory is binded, any joint transformation from fitting result of our model can be used to transform accessory to attach to the fitted result. Pipeline diagram can be found in Fig.4.

Demo Video We attach demo videos for both facial mesh editing and adding accessory. Facial mesh editing video show the process of an artist who is changing facial feature by transforming correspondence joint. Accessorize video shows that once the accessory is attached by artist, no matter which identity or pose that our model transform into, the accessory is always attached.

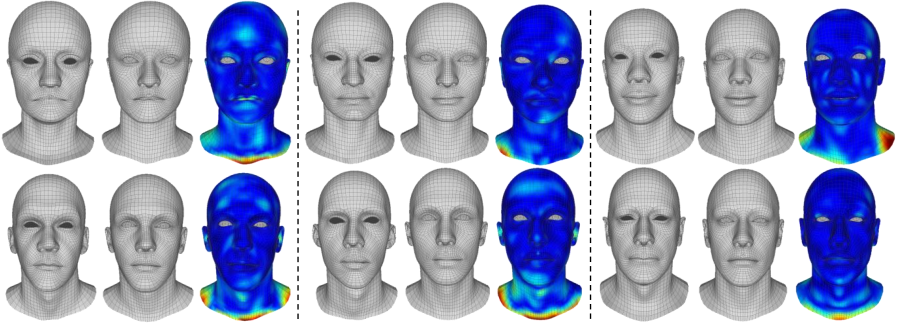


Fig. 1. Visualization of neural skinning weight model fitting result on retopologized scan test set. Images are ground-truth, fitted result, error map.

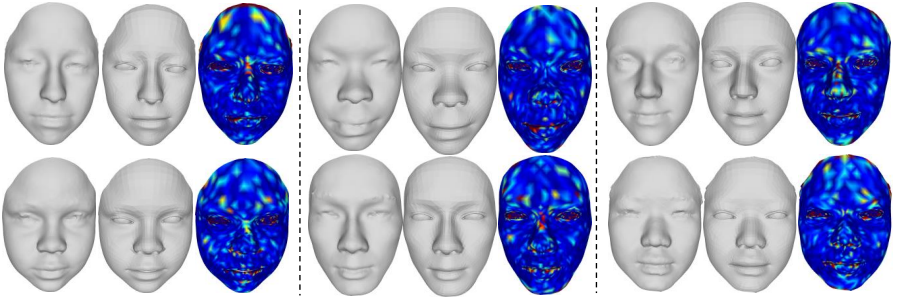


Fig. 2. Visualization of neural skinning weight model fitting result on BU-3DFE. Images are ground-truth, fitted result, error map.

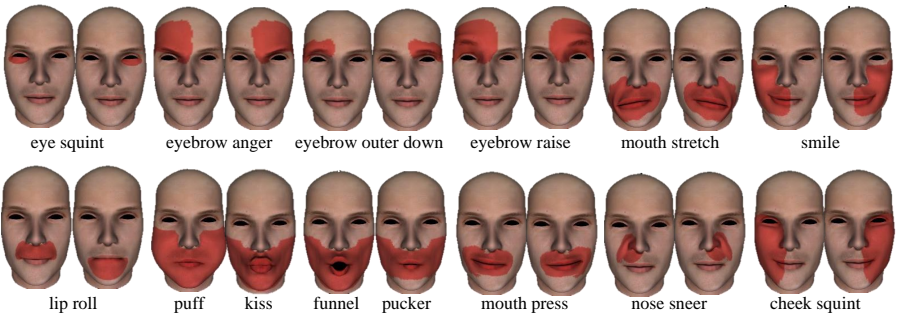


Fig. 3. Visualization of 24 expression blendshapes we used to expand the expression capacity. Red area highlights the vertex movement. Note that texture is only used for visualization purpose.

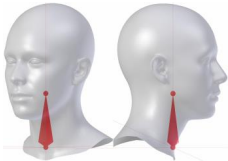

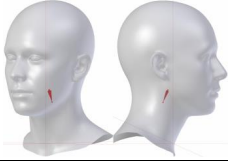

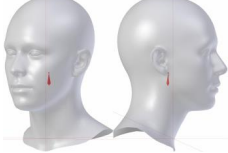

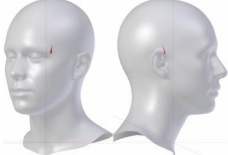

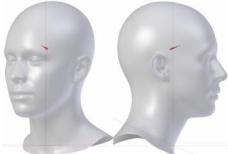

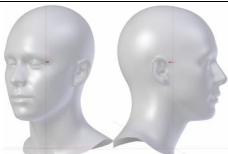

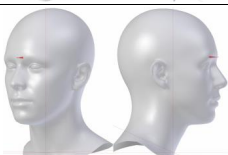

Illustration	Name/Parent	Rotate	Translate	Scale	Sample
	Root /-	-	-	-	
	Neck /Root	x: [-15, 15] y: [-2.4, 1] z: [-15, 15]	-	[0, 1.5]	
	Skull Root /Root	x: [-25, 25] y: [-15, 15] z: [-15, 15]	-	x: [0, 1.1]	
	Cranium /Skull Root	-	-	x: [-1, 1] z: [-1, 1]	
	Crown /Cranium	-	y: [-4, 4]	-	
	Skull Center /Skull Root	-	-	-	
	Brow Center /Skull Center	-	z: [-1, 1]	y: [0, 1.5]	

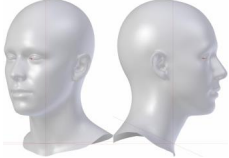

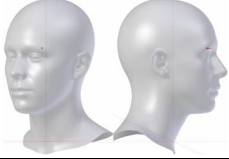

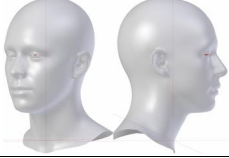

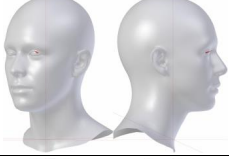

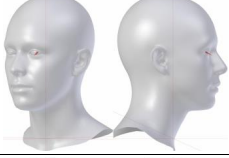

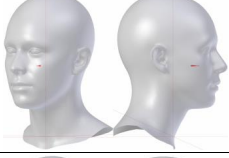

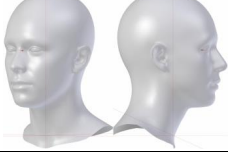

Illustration	Name/Parent	Rotate	Translate	Scale	Sample
	Left Orbital /Skull Center	y: [-2,2]	x: [-1,1] z: [-0.3, 0.3]	-	
	Left Brow Outer /Left orbital	-	z: [-1, 1]	y: [0, 1.5]	
	Left Eye Socket /Left Orbital	y: [-6.5, 9]	x: [-1,1] y: [-1,1]	[0, 1.5]	
	Left Upper Eyelid /Left Eye Socket	x: [-6, 15]	-	-	
	Left Lower Eyelid /Left Eye Socket	x: [-11, 4]	-	-	
	Left Cheek Bone /Left Orbital	-	y: [-1.7, 2]	-	
	Right Orbital /Skull Center	-	x: [-1,1] z: [-0.3, 0.3]	-	

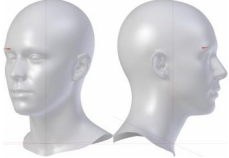

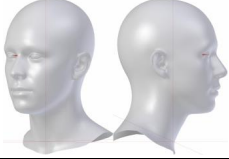

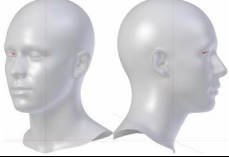

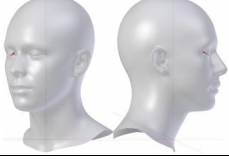

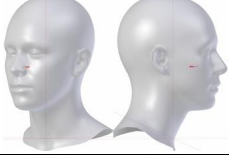

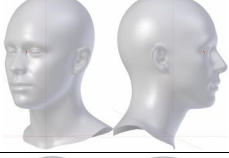

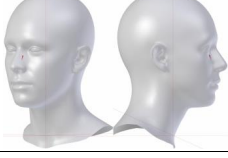

Illustration	Name/Parent	Rotate	Translate	Scale	Sample
	Right Brow Outer /Right orbital	y: [-2,2]	z: [-1, 1]	y: [0, 1.5]	
	Right Eye Socket /Right Orbital	y: [-6.5, 9]	x: [-1,1] y: [-1,1]	[0, 1.5]	
	Right Upper Eyelid /Right Eye Socket	x: [-6, 15]	-	-	
	Right Lower Eyelid /Right Eye Socket	x: [-11, 4]	-	-	
	Right Cheek Bone /Right Orbital	-	y: [-1.7, 2]	-	
	Nose Root A /Skull Center	-	y: [-1, 1] z: [-1, 1]	x: [0, 1.2]	
	Nose Root B /Nose Root A	-	-	-	

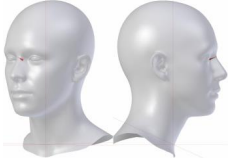

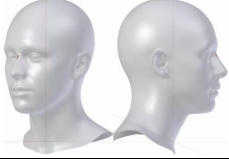

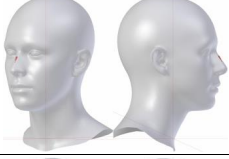

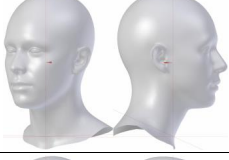

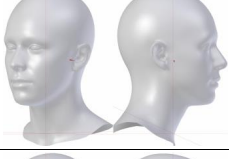

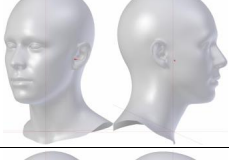

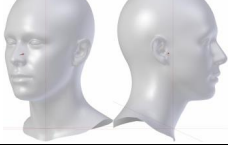

Illustration	Name/Parent	Rotate	Translate	Scale	Sample
	Nose Bridge /Nose Root B	-	y: [-0.5, 0.8]	-	
	Nose Ridge A /Nose Bridge	x: [-10, 8] z: [-2, 2]	-	y: [0, 1.5]	
	Nose Ridge B /Nose Ridge A	x: [-2, 2]	-	y: [0, 1.5]	
	Ears /Skull Root	-	-	-	
	Left Ear Position /Ears	-	x: [-1, 1] z: [-1.4, 1]	-	
	Left Ear Rotate,Scale /Left Ear Position	z: [-30, 15]	-	[0, 1.3]	
	Right Ear Position /Ears	-	x: [-1, 1] z: [-1.4, 1]	-	

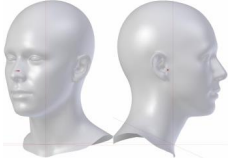

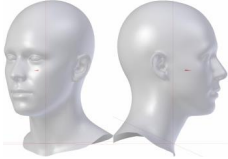

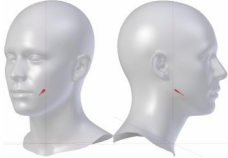

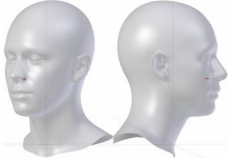

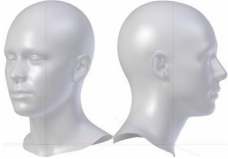

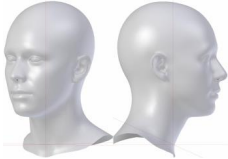

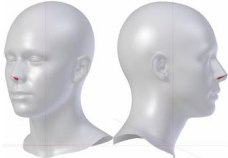

Illustration	Name/Parent	Rotate	Translate	Scale	Sample
	Right Ear Rotate,Scale /Right Ear Position	z: [-30, 15]	-	[0, 1.3]	
	Lower Face Root /Skull Root	-	-	-	
	Jaw Root /Lower Face Root	-	y: [-1.3, 0.6] z: [-1.3, 0.6]	x: [0, 1.1]	
	Maxilla /Lower Face Root	-	y: [-0.5, 0.7] z: [-1, 1]	-	
	Nose Base Position /Maxilla	-	x: [-0.4, 0.4] z: [-0.6, 0.6]	x: [0, 1.2]	
	Nose Base Rotate /Nose Base Position	x: [-8, 8]	-	-	
	Nose Tip /Nose Base Rotate	-	y: [-0.6, 0.6] z: [0.2, 1.1]	[0, 1.2]	

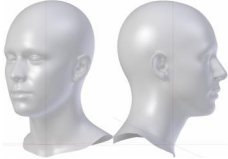

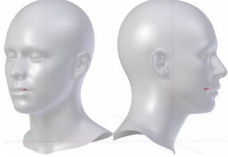

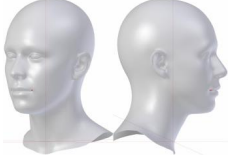

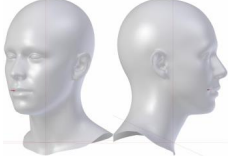

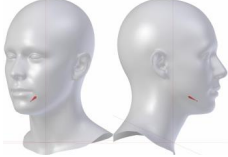

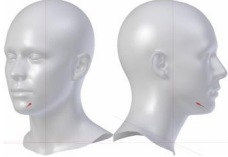

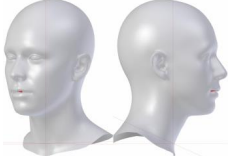

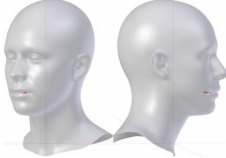

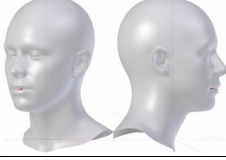

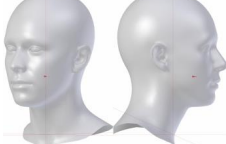

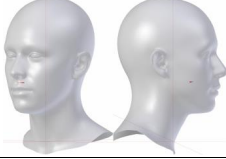

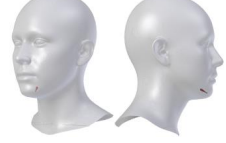

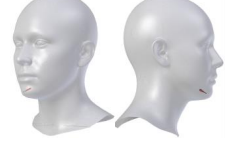

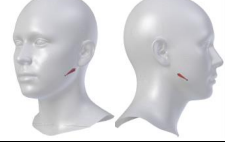

Illustration	Name/Parent	Rotate	Translate	Scale	Sample
	Nose Nostril /Nose Base Rotate	x: [-8, 8]	-	[0, 1.2]	
	Mouth Center Top /Maxilla	-	y: [-1.3, 0.6] z: [-1.3, 0.6]	x: [0, 1.2]	
	Mouth Left Corner /Mouth Center Top	-	x: [-0.2, 0.2] y: [-0.2, 0.2]	-	
	Mouth Right Corner /Mouth Center Top	-	x: [-0.2, 0.2] y: [-0.2, 0.2]	-	
	Jaw Front /Mouth Center Top	z: [-0.9, 0.9]	y: [-0.8, 0.5] z: [-0.5, 0.5]	[0, 1.5]	
	Chin /Jaw Front	-	y: [-0.8, 0.5] z: [-0.5, 0.5]	[0, 1.5]	
	Top Lip /Jaw Front	-	-	y: [0, 1.4] z: [0, 2]	

Illustration	Name/Parent	Rotate	Translate	Scale	Sample
	Mouth Center Bottom /Mouth Center Top	-	y: [-0.3, 0.8]	-	
	Bottom Lip /Mouth Center Bottom	-	-	y: [0, 1.4] z: [0, 1.5]	
	Left Cheek /Maxilla	-	y: [-1.7, 2]	[0, 1.5]	
	Right Cheek /Maxilla	-	y: [-1.7, 2]	[0, 1.5]	
	Left Chin /Chin	-	x: [-0.2, 0.2] y: [-0.6, 0.6]	-	
	Right Chin /Chin	-	x: [-0.2, 0.2] y: [-0.6, 0.6]	-	
	Left Jaw Root /Jaw Front	-	y: [-0.8, 0.8] z: [-0.5, 1.5]	-	

	Right Jaw Root /Jaw Front	-	y: [-0.8, 0.8] z: [-0.5, 1.5]	-	
	Left Crow Outer /Crown	-	x: [-0.1, 0.1] y: [-0.1, 0.1] z: [-0.1, 0.1]	-	
	Right Crown Outer /Crown	-	x: [-0.1, 0.1] y: [-0.1, 0.1] z: [-0.1, 0.1]	-	

Table 1. Full detail of our joint-based model. First column is a visualization of joint (red) on template mesh on 2 views. Second column is the joint name and parent of each joint. Third to fifth column are transformation parameters with limit range. Note that rotation is in degree and scale without x,y,z annotation means all three axes share a single scale parameter. Last column is a visual example of the transformation from each joint.

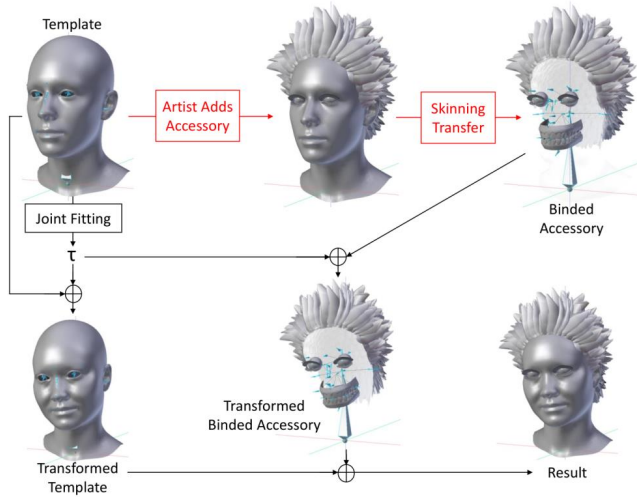


Fig. 4. Illustration of accessorizing. Artist only needs to add accessory to template once and transfers skinning weight to accessory. The binded accessory can be automatically applied by joint transformation (τ) to any identity/pose.