3D Face Hallucination from a Single Depth Frame

Shu Liang, Ira Kemelmacher-Shlizerman, Linda G. Shapiro
Department of Computer Science& Engineering
University of Washington

Goal

- Given:
  - A single RGBD frame
- Produce:
  - High-res and personalized 3D mesh of the input


3dMD

A Single frame from Kinect

Related Work

OURS:

- Single depth frame
- Personalized result
- Metrically correct

RELATED:

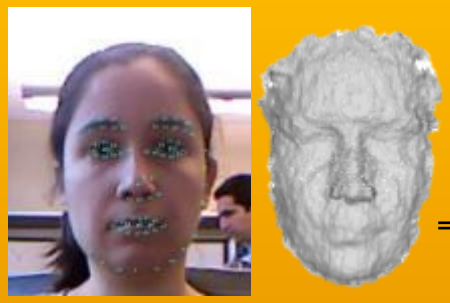
- KinectFusion [Newcombe et al. 2011]
  - Requires several frames
  - Non-moving
- Morphable model [Blanz et al. 1999][Weise et al. 2011][Cao et al. 2013]
  - Limited by a linear span of faces
- Shape from Shading [Kemelmacher-Shlizerman et al. 2011]
  - prone to gauge and bas-relief ambiguities

Method

A single Kinect Frame


1204

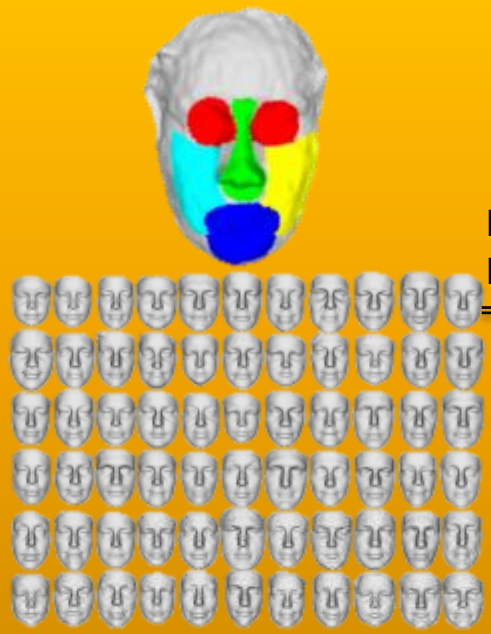
Pipeline



Raw Kinect Input
Single RGBD + 83 fiducials

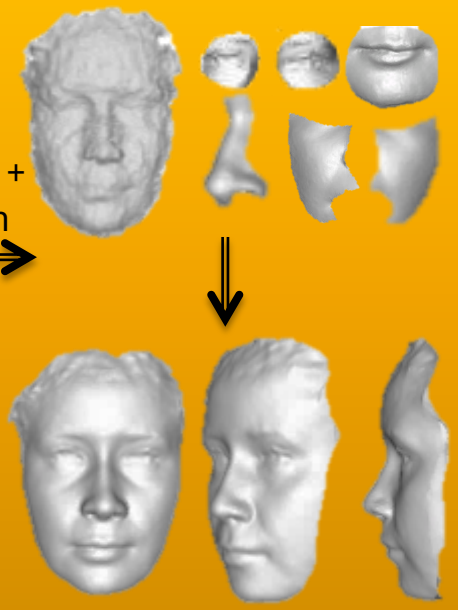
Aligning a Single Depth Frame

Nonrigid registration



Part-based Matching

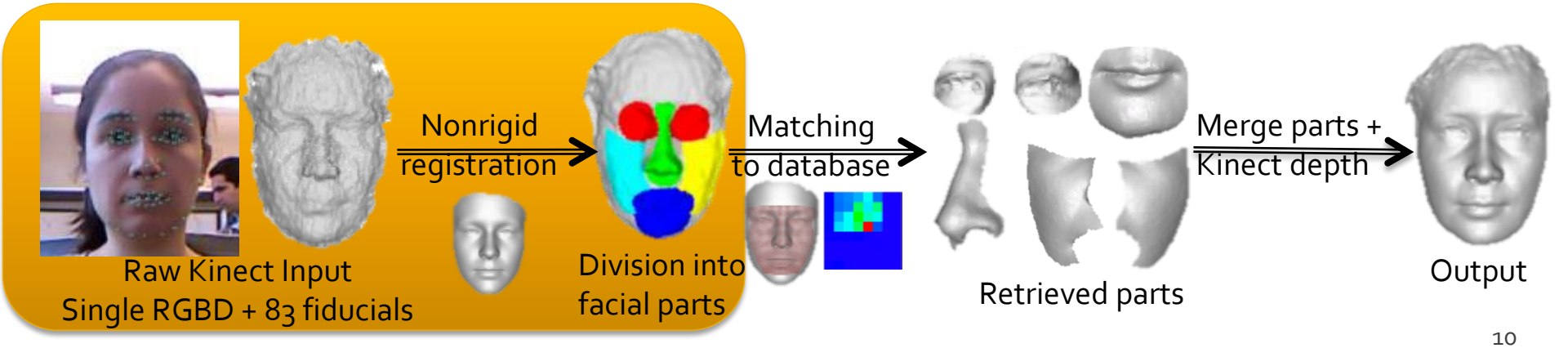
Merge parts + Kinect depth



Merging

Aligning the input to the database

- 83 fiducial points on RGB using Face++
- Rigid pose alignment via Procrustes analysis
- Non-rigid registration [Allen et al. 2003]
- Define five facial parts



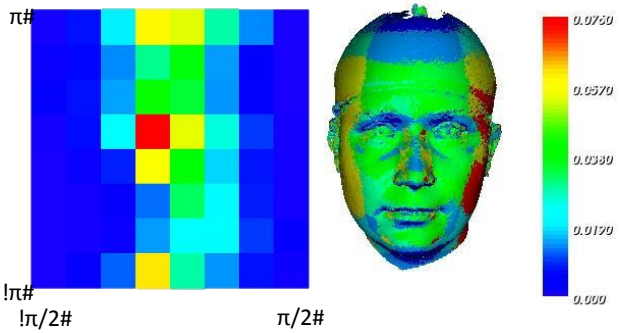
Part-based matching

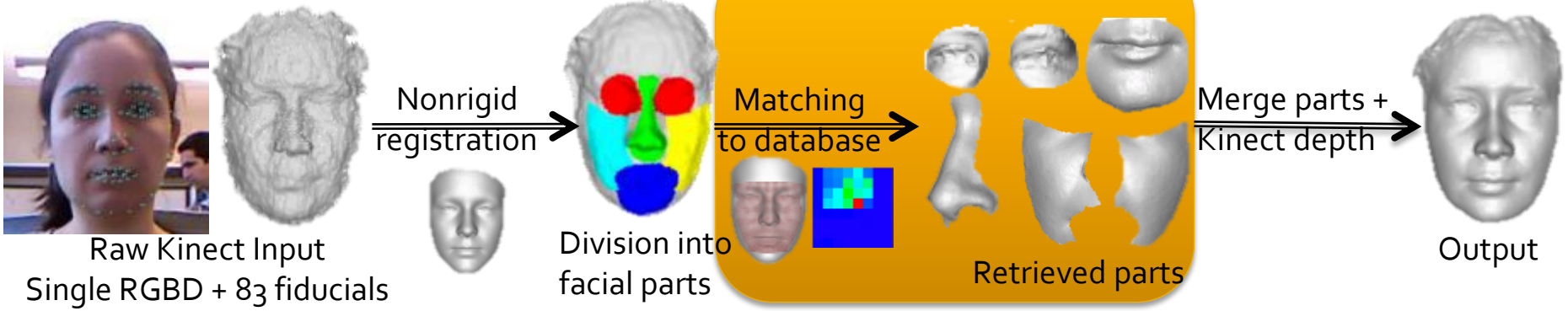
- Distance function: a combination of pseudo-landmarks and a histogram of azimuth-elevation angles of normals

$$D_{pts}^{j} = \sum_{i=1}^{(m+2)n} \left\| P_i^j - P_i^{input} \right\|^2$$

$$D_{normals} = \chi^2(H^j, H^{input})$$

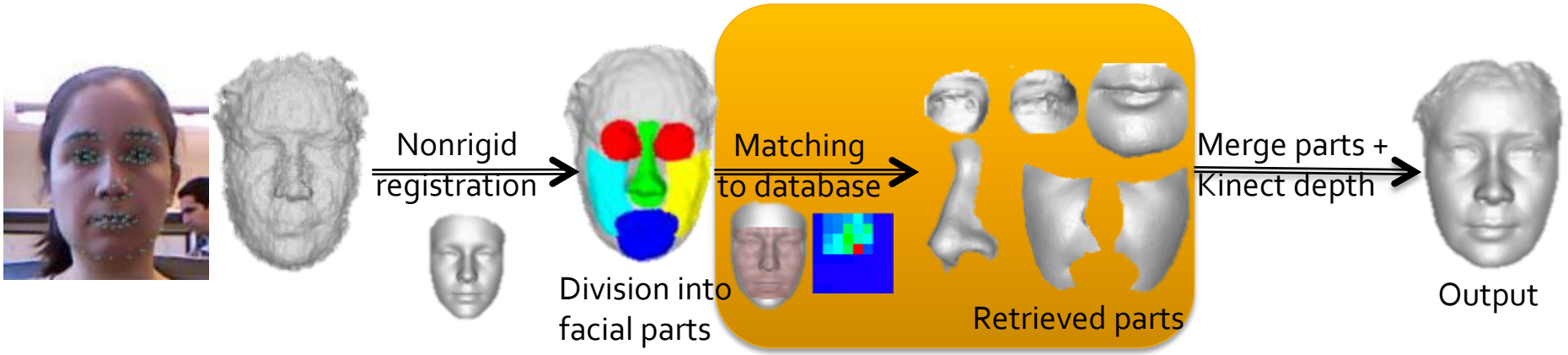
$$D = D_{pts} + \alpha D_{normals}$$





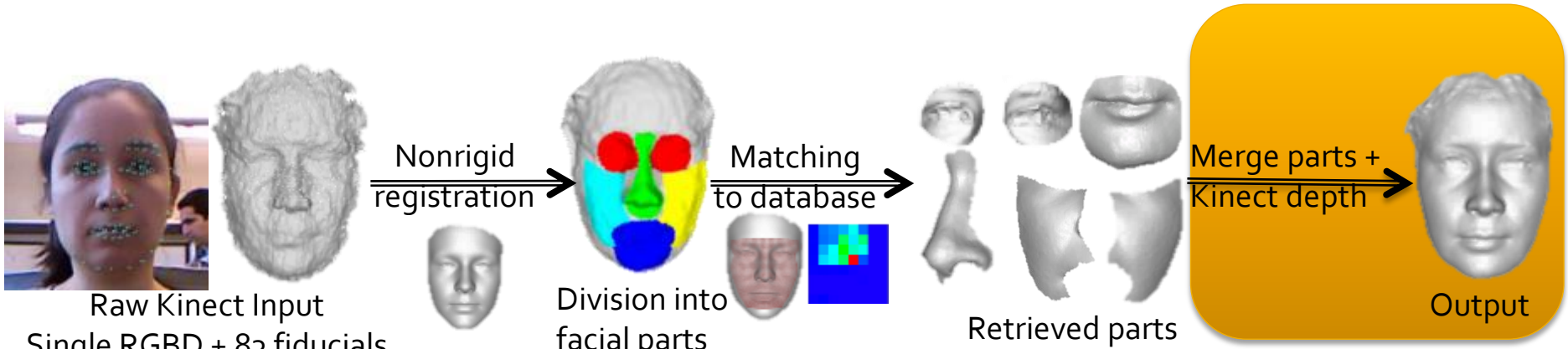
Part-based matching

- Distance function: a combination of pseudo-landmarks and a histogram of azimuth-elevation angles of normals
- Weights chosen according to our similarity evaluation of 7 subjects



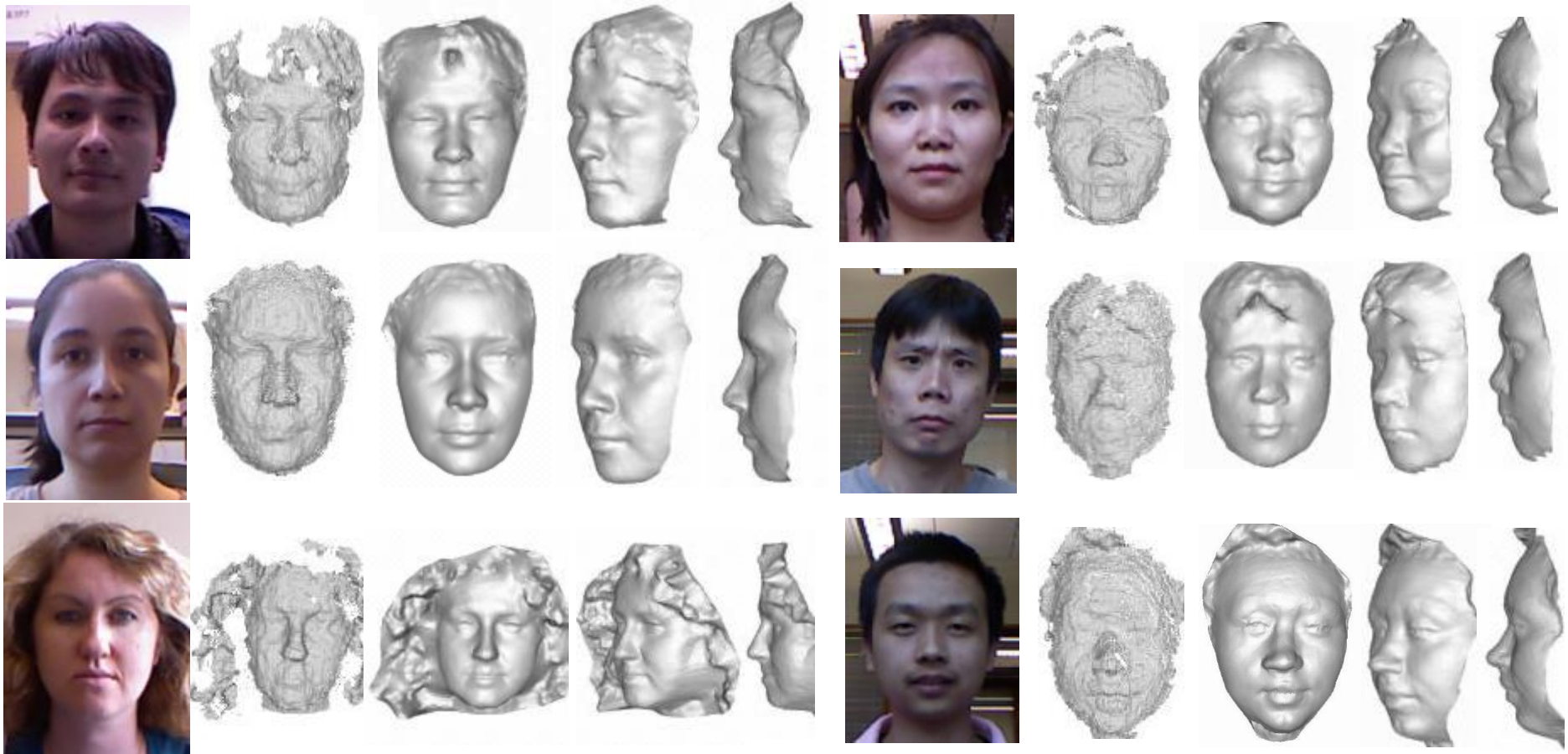
Merging the matches

- Skin region: vertex normal transferred from matched shapes. Hair region: original normal kept
- Combining depth and normal [Nehab et al. 2005]
- Faces with expression: one neutral frame for retrieval, one expression frame for merging



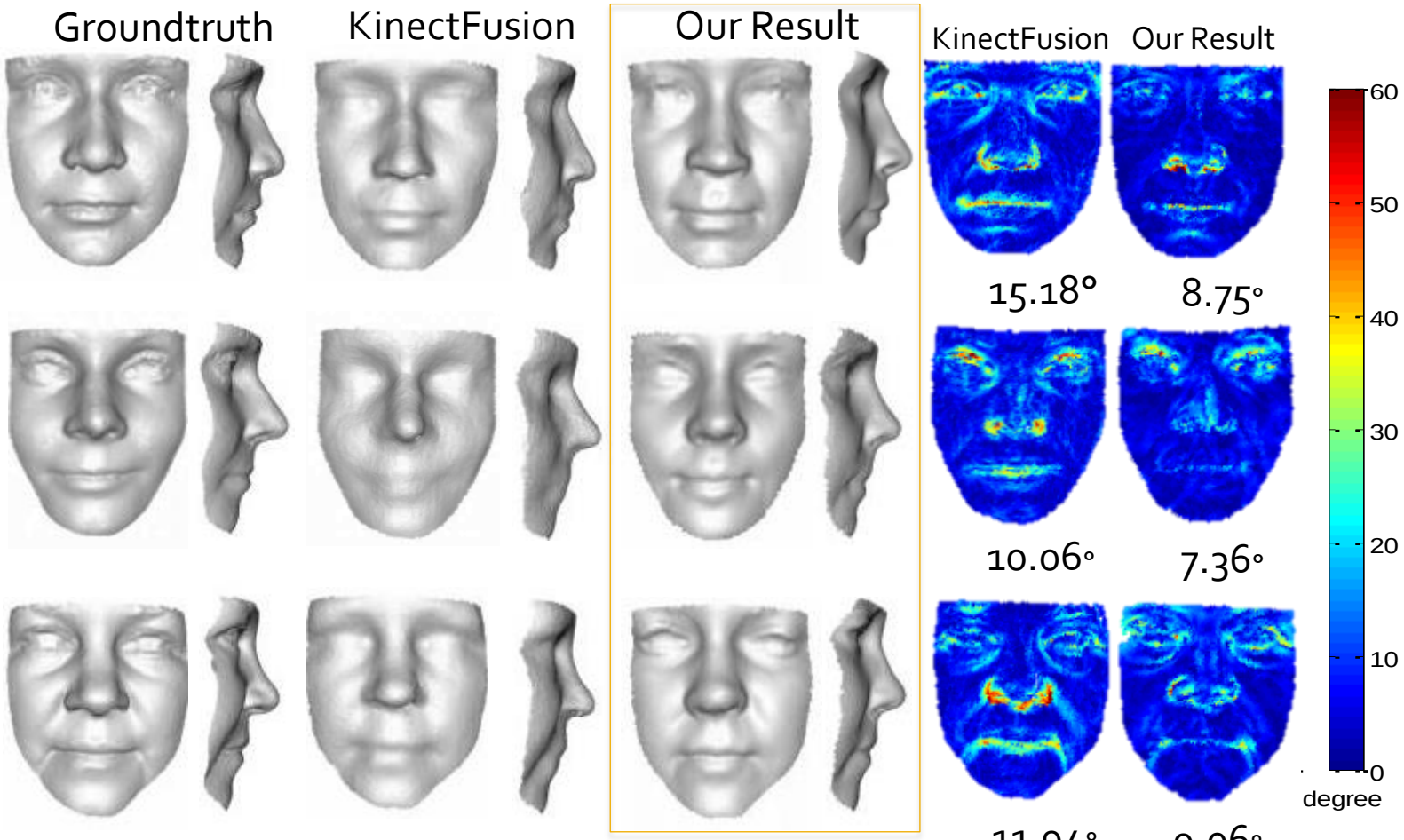
Results for neutral faces

Color Image | Raw Input | Our Result | Color Image | Raw Input | Our Result



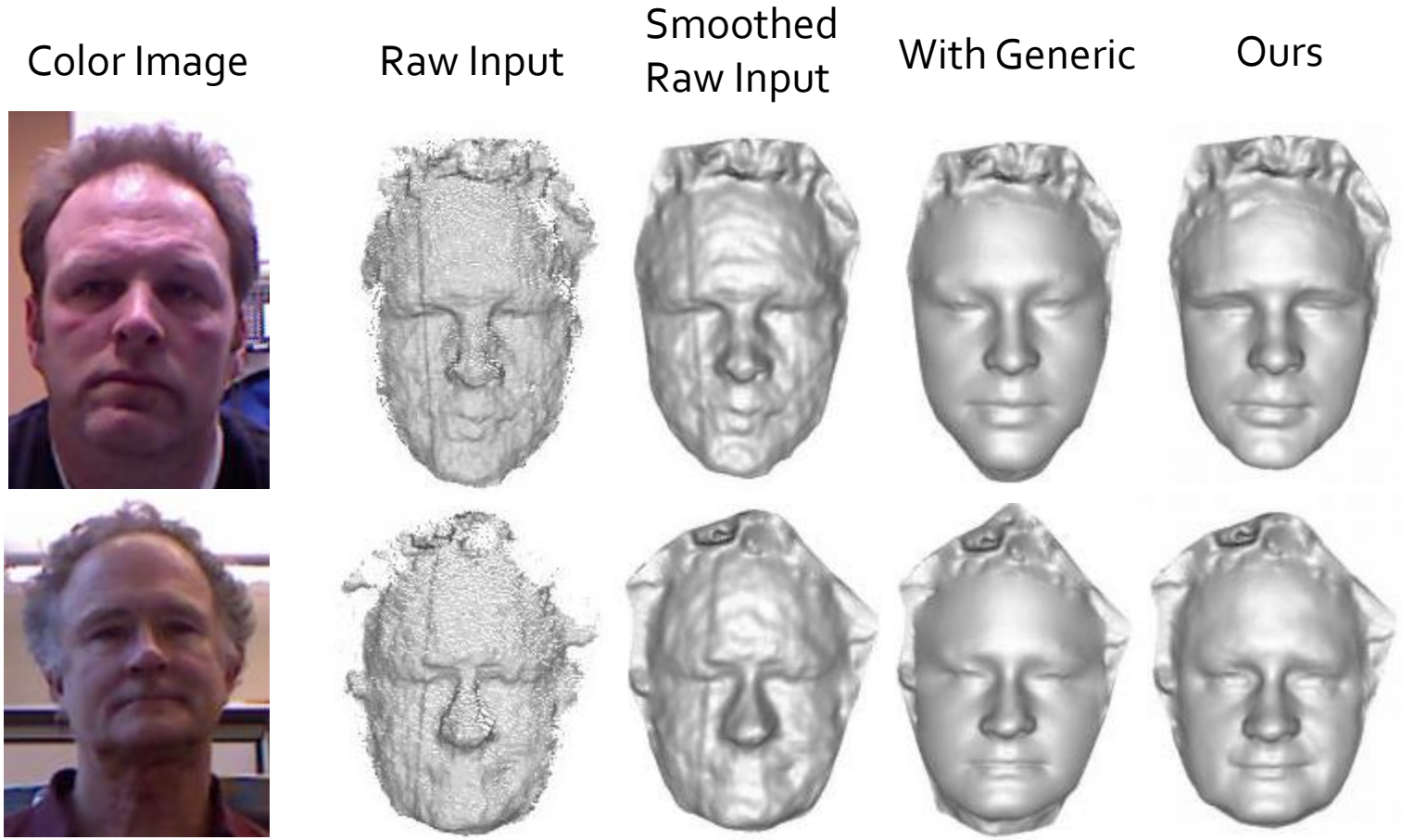
Comparison

- With KinectFusion(Kinect for Windows SDK 1.8)



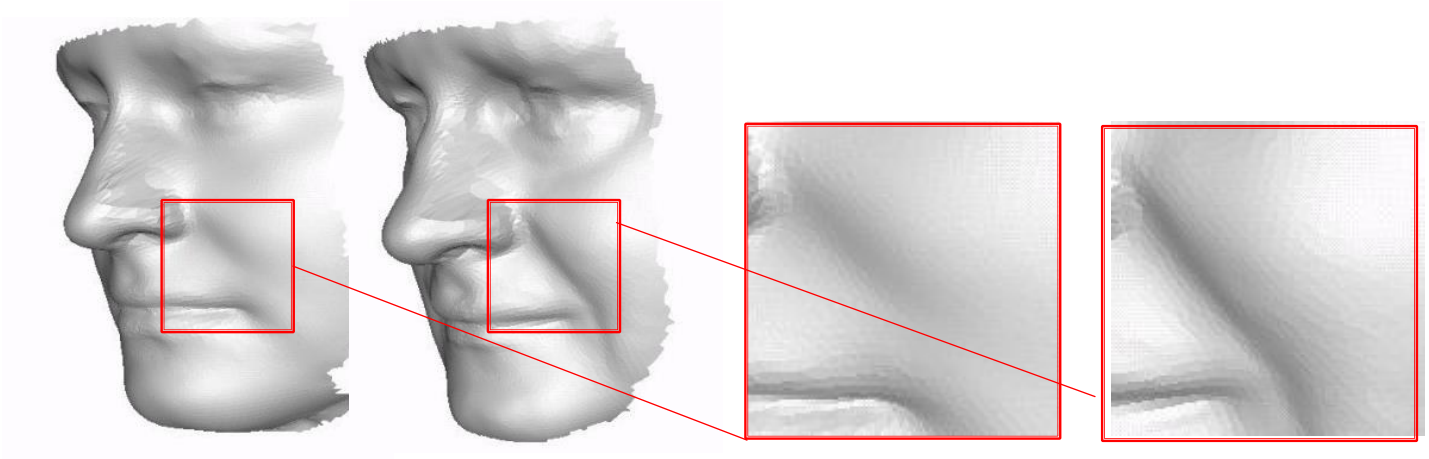
Comparison

- With details from a generic shape



Comparison

- With details from a generic shape



a) Details from the generic shape

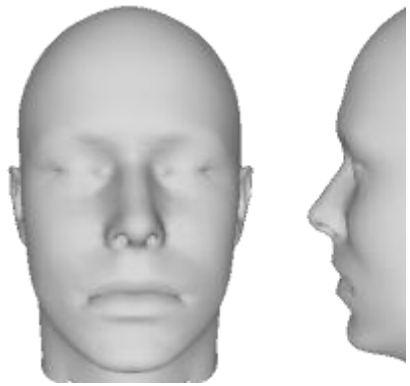
b) Details from similar facial components

Comparison

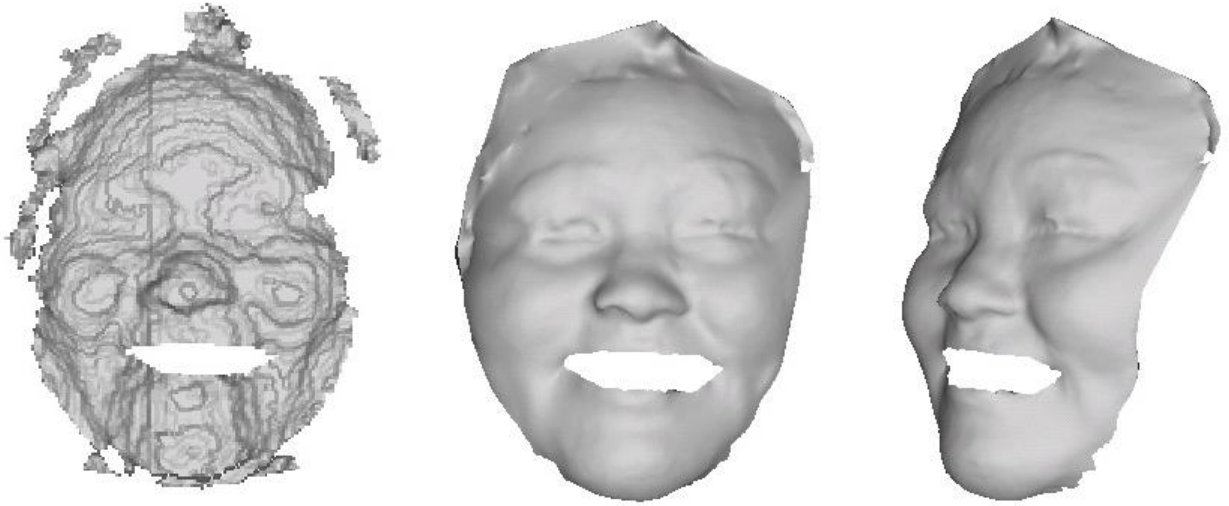
- With Morphable Model method(Vizago)

Color Image | Morphable Model | Our Result

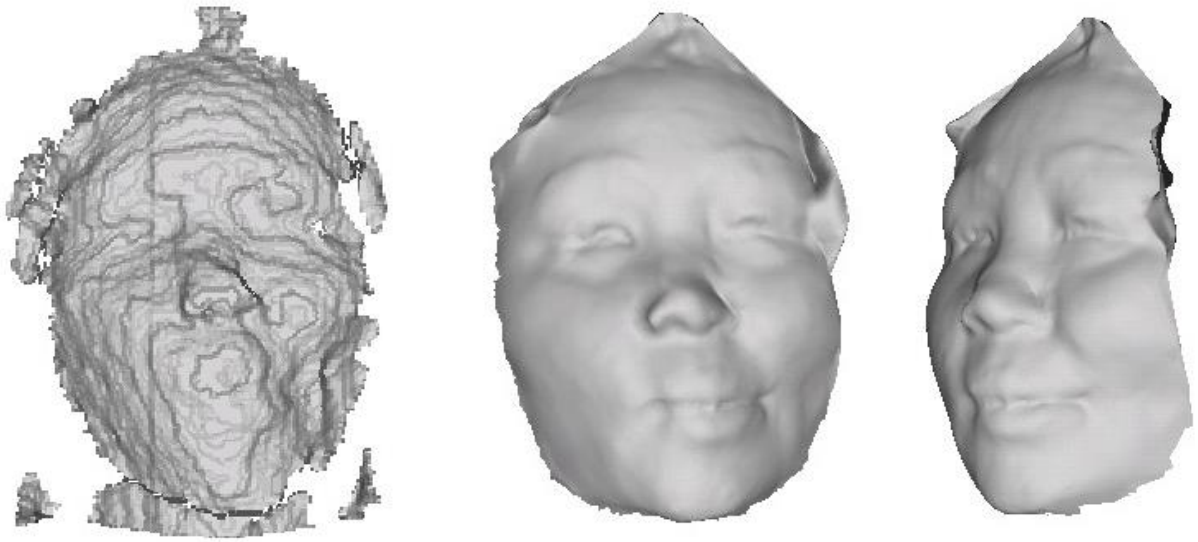




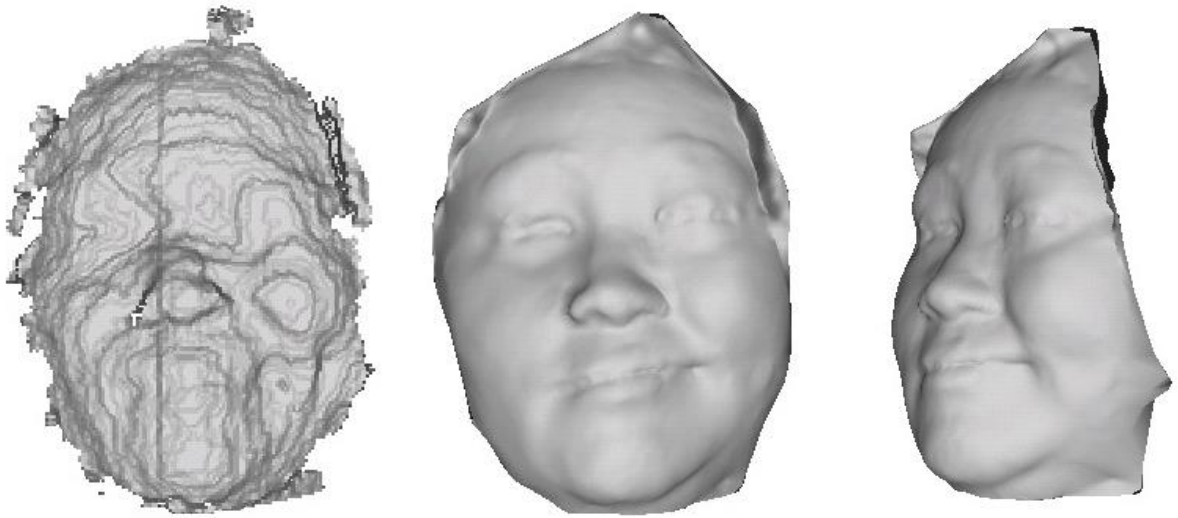

Expression results



Expression results



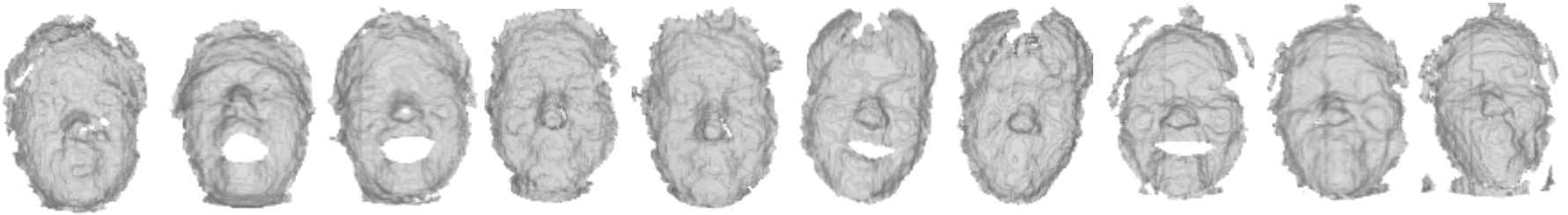
Expression results



Expression results

Color Image

Raw Input



Our Result