Facilitating Practitioner Interaction with 3D Craniofacial Identification Resources

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Introduction

Facial approximation practitioners in the U.S. have not had access to craniofacial reference datasets for study, workshops/training, especially of 3D models derived from computed tomography (CT) scans. In addition, there has been a lack of data translation generated via research projects to general practice. Publication does not necessarily result in incorporation of methods/data by practitioners. The generation of 3D models provides an opportunity to create a standardized reference set to which new data can be continuously added. Products from our dataset will include: 3D models, FTDMs, 2D wireframe plots, 3D printable references, a visual reference containing facial feature dimensions/positions/regressions and qualitative evaluations relative to facial approximation "rules of thumb." We are exploring web-based interactive tools, file-sharing repositories, as well as workshops.

Computed Tomography (CT) Models

- The Cancer Imaging Archives: public, de-identified
- 3D skull and face models rendered via Mimics

Standardized Orientation

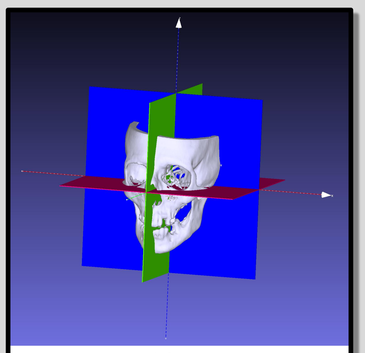

Figure 1. Frankfurt Horizontal (OrL, PoL, PoR at z = 0), Coronal (PoL and PoR at y = 0), Midsagittal (N at x = 0).

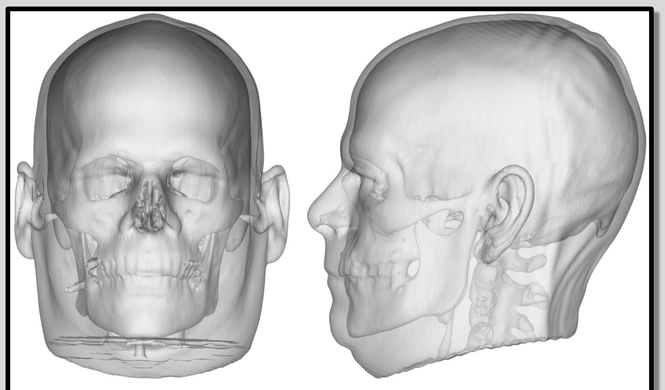

Figure 2. Front and profile views in standardized orientation.

Wireframes (2D)

- Views in any plane:
  - Frontal: x-z
  - Profile: y-z
  - Top: x-y
- Actual distances in each axis
- Translatable to 2D or 3D facial approximation methods
- Applications toward craniofacial superimposition

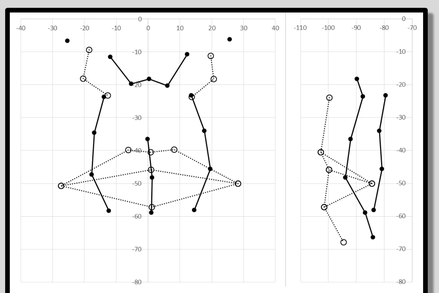

Figure 4. Front and profile views of mouth landmarks (bone = filled solid, skin = not filled, dotted)

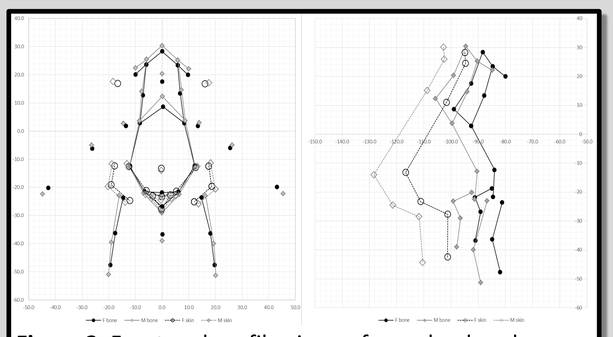

Figure 3. Front and profile views of nose landmarks (bone = filled solid; skin = not filled, dotted; female = black; male = gray)

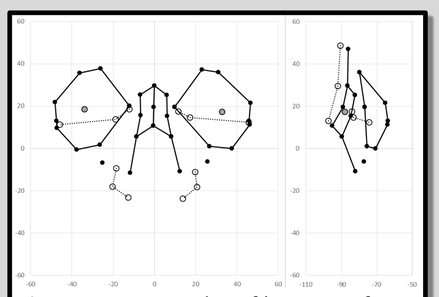

Figure 5. Front and profile views of eye landmarks (bone = filled solid, skin = not filled, dotted; gray fill = oculus anterius)

Meshlab

- Dense facial tissue depth maps (FTDMs): new way for practitioners view tissue depths on the face
  - Face mesh mapped to skull
  - Colorized from 0 to 40.0 mm (red = thinnest, blue = thickest)
  - Point picking (Get Info)
  - Quality Contours/Histograms
  - Incremental (1.0 mm) maps
- Viewing multiple file formats
  - FTDMs (PLY)
  - landmarks (XYZ)
  - original models (STL)
  - one window or multiple windows

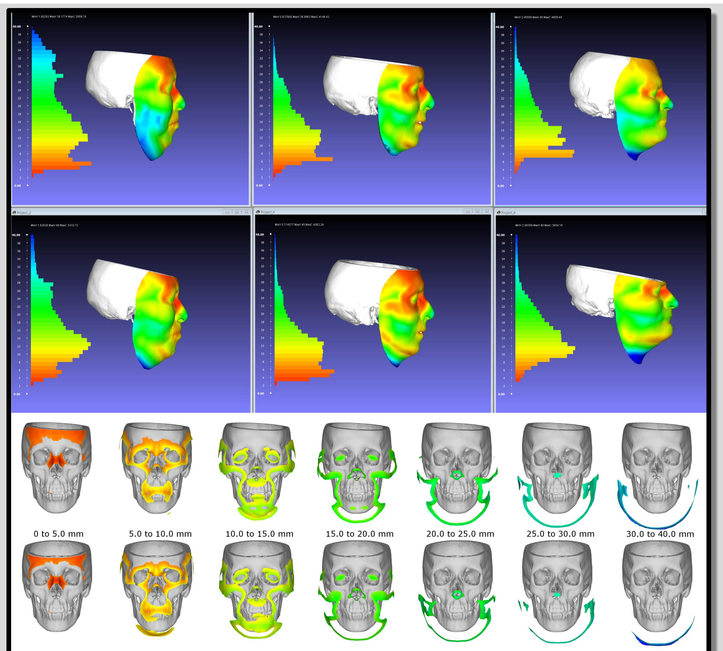

Figure 9. FTDMs of individuals with duplicate scans at different weights. Top row : heavier, 2nd row: thinner, bottom 2 rows: Individual (a) split in to 5.0 mm increment surfaces. Duplicate scans allow assessments of changes due to weight and tooth loss.

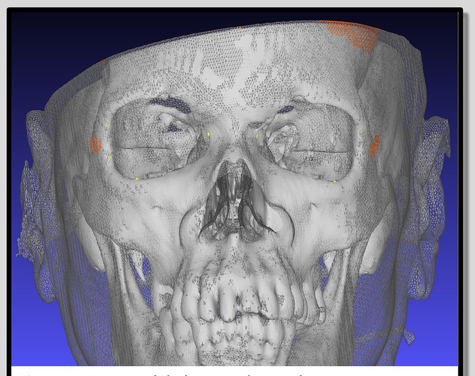

Figure 6. Meshlab window showing multiple file formats and renderings for one head: skull STL, face STL with wireframe rendering, 3.0 mm FTDM vertices (reddish orange, PLY), landmarks around the orbit (yellow, dot decorator, XYZ)

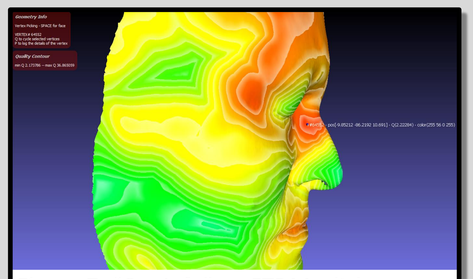

Figure 7. "Get Info" on FTDM: click to get vertex index, 3D coordinate, depth (Q), color. Quality Contour is also shown to illustrate depth transitions.

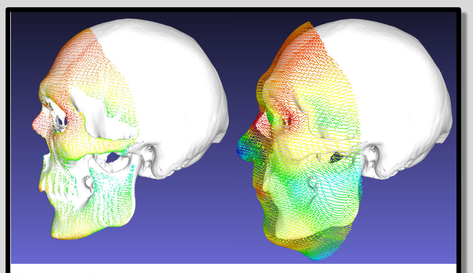

Figure 8. Skull points and face points.

3D Slicer

- View skin over bone/muscles
  - Import STLs, fcsv (landmarks)
  - Volume rendering of .nrrd
- Create 3d printable models: clip at specific landmark coordinates

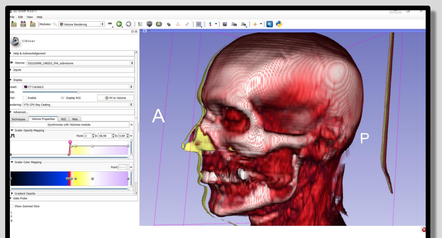

Figure 10. Volume rendering of NRRD CT volume with face STL (yellow).

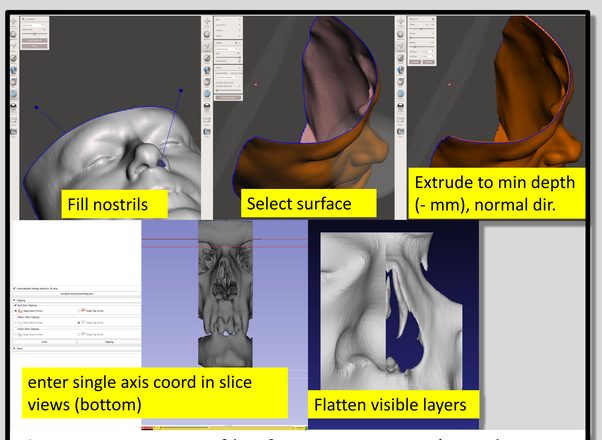

Figure 11. Prepping files for 3D printing: 1) Meshmixer to edit and extrude face shell to minimum tissue depth (from FTDM); 2) new face STL and skull STL to 3D Slicer Easy Clip module and "clip" at specific landmark coordinates; 3) merge clipped STLs in Meshlab.

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