Review Article

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Changing Face of History: Virtual Anthropology

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Abstract

Cadavers speak their own language. Moving back in history human identification was one of the most challenging subjects that man had confronted. The concept of identity, with few significant variations, is the same as the assertion of Alves[1] that identity is a set of physical characteristics, functional or psychic, normal or pathological, that define an individual. The determination of race, sex, age, and stature of the bone gives valuable information in establishing the identity of a person.

Another skill that is receiving increasing attention is the virtual anthropology.

Key words: Anthropology; Identity; Forensic; Imaging.

Virtual anthropology is becoming a fundamental tool for anthropological analysis, it allows researchers to deal with problems that could not be resolved using traditional anthropological approaches without compromising the integrity of the physical remains (i.e., analysis of mummies, reconstruction of deformed fossils, etc.). Models of the physical object allow for virtual manipulation, simulation, and bone sectioning, etc., in a virtual space, therefore preserving the original object from invasive procedures.

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Early methods used were

- Anthropometry; 'measurement of mankind'
- Osteometrics; measurements of skeleton
- Craniometrics; measurements of skull
- Anthroposcopy: visual differences

Facial imaging technologies for virtual antropology

Imaging modalities for clinical evaluation of the face, such as photographs and two-dimensional radiographic films (used since 1931) were developed decades ago and are still in mainstream clinical use. However, the information they provide is limited in perspective, accuracy, and contains information voids. For these reasons, in the last decades, three dimensional techniques such as 3D CT, laser surface scanning, photogrammetry (conversion of photographs taken from different views into 3D models), Moire' stripes18, and Computer Assisted Design (CAD) manipulation of these models have been explored.[5]

CT Scans

Computed tomography (CT scan) has much of its history in general medicine while its use in craniofacial assessment is more recent. In this area, the bulk of the research work is focused upon bony cranial landmarks. Previous work reported the use of 3D CT for craniofacial surgical planning and comprehensive assessment. Richtsmeier and her research group[6] developed mathematical tools such as EDMA (Euclidean Distance Matrix Analysis) to assess asymmetry in human skulls, detection of influential landmarks[7] and confidence intervals.[8]

Laser Facial Scanning

Technologies for generating a 3-dimensional model of a human face with registered texture include laser scanning and visible light techniques. The laser scanners produce a detailed model. Researchers have explored the use of laser surface scanning for assessment of facial asymmetry.[9] The authors divided the face in different regions and then classified the pre-surgical and post-surgical areas according to different surface type primitives: valley, ridge, saddle surface, etc. The quantitative changes per region are expressed in terms of area size changes and their movement on the face.[9]

Stereo-Photogrammetry

In 1960 dot stereograms and the idea that stereoscopic vision is a cooperative process were introduced.[10] An algorithm for stereo reconstruction followed. Stereo-photogrammetry has also been used to find the optimal plane of reference for assessment of craniofacial anomalies.

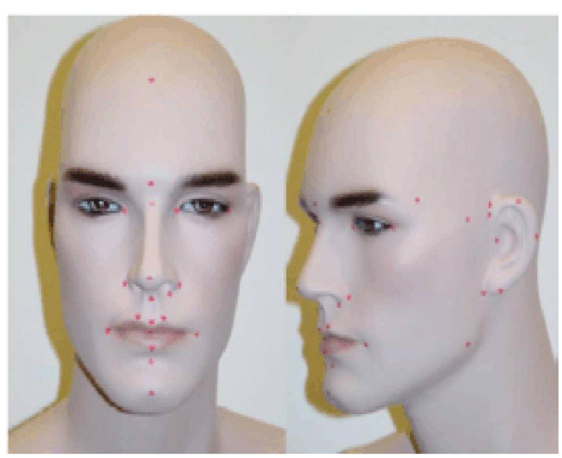
Commercial Visible-light Imaging Systems

Fixed viewpoint depth maps are created from stereo-photogrammetry systems (Geometrix's Face 200 and 800) and structured-light camera systems (such as Eyetronics, 3DMD and Inspeck requiring a slide projector and one or more cameras). To produce a full face model (from ear to ear) with these systems, two or three depth maps are obtained for a subject from varying view points (e.g., left-side, right-side, and frontal) and stitched together with manual assistance. The only commercially available system that acquires an ear-to-ear model is Face 1200 from Geometrix with 12 cameras. Given the current state, a fast, efficient, reliable, non-invasive solution to 3-D facial image acquisition would be a very significant step forward. A system such as this would eliminate many of the barriers for clinicians to obtain and use such as system. Today, no 3-D systems are in common clinical use, while traditional photography is the standard.

Cranial form analysis

Landmarks have been used for over a century by anthropometrists interested in

Figure 1: Subset of Farkas's anthropometric landmarks (frontal and side picture of the mannequin)



quantifying cranial variation. A new field, morphometrics, has grown around the statistical analysis of shape and size for comparison of biological shapes.[11] A great body of work in craniofacial anthropometry is that of Farkas[12] who established a database of anthropometric norms by measuring and comparing more than 100 dimensions (linear, angular and surface contour's) and proportions in hundreds of people over a period of many years. These measurements include 47 landmark points to describe the face (Figure 1 shows some of the Farkas' landmarks)

Farkas's inventory of facial measurements has been used in computer graphics to automatically create new "plausible" computer graphic faces.[12]

Steps for reconstruction

1. Click photograph and digitize it using digital camera
2. Place digitized markers on anthropometric landmarks
   - *Head:* g – glabella, tr – trichion, ft – frontotemporale.
   - *Face:* zy – zygion, go – gonion, sl – sublabiale, pg– pogonion, gn – gnathion (or menton, not visible), cdl –condylion laterale.
   - *Orbits:* en – endocanthion, ex – exocanthion.
   - *Nose:* n – nasion, prn – pronasale, sn – subnasale, sbal – sub-alare (sbal'), ac – alar curvature (ac').
   - *Lips and mouth:* cph – crista philtri (cph'), ch – cheilion (ch'), sto – stomion, ls – labiale superius, li– labialeinferius.
   - *Ears:* obi – otobasion inferius, obs – otobasion superius, sa – superaurale, sba – subaurale, pa – postaurale,pra – preaurale.[12]
3. Depth of skin that overlays the skull is estimated.
4. Small pegs are used as facial depth indicators and are fixed into the skull.
5. The mimic muscles are made of plastilin or clay, eyes are of marble and the nose is formed from paraffin or wax.
6. Started with 20-35 tissue layers usually, scattered all over the face. Main heavily concentrated depths are situated around the mouth and in between the eyes
7. Work on the eyes, mouth, ears, nose, chin, jaws and cheeks is now started.
8. Next a mould from clay head is made using plaster of paris
9. Muscles are approximated by noting the shape and size of certain facial bones. Shaping and fixing of each muscle onto the skull in it's place is important criteria.
10. The final step is to cover the clay muscles with a layer of clay skin, which is smoothened over such that it resembles the real skin.
11. Color: Hair, skin and eye color are added by borrowing the physical features of a living person of similar age, racial qualities and built by a process called "3-D mapping." F.A.C.E.S and C.A.R.E Softwares.

Conclusion

Forensic arts has to deal with many ambiguous variables (such as the shape of the eyes, the lips and the nose), cranio-facial reconstruction cannot claim to provide with absolute certainty the look of the personage. On the other hand, we can assume that facial reconstruction based on forensic procedures is the most scientific approach to obtain an approximated aspect of the face, at least regarding the overall shape.

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