H67 Who Is This Person? A Comparison Study of Current 3-Dimensional Facial Approximation Methods

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This presentation will provide insight into the current state of the field of facial approximation by providing the results of a unique three-dimen- sional study conducted on a living individual by an international team of human identification specialists. The results of the clay modeling and advanced computerized facial approximations will be compared both visually and quantitatively. The strengths and weaknesses in each method will be addressed and comparison images will be provided.

This presentation will impact the forensic community by serving to increase scientific knowledge of new technologies and methods available to the forensic community for human cranial identification. It will also attempt to advance current understanding of facial approximation methods which are commonly utilized by law enforcement to identify unknown individuals.

The goal of this project was to test current three-dimensional facial approximation methods currently used by forensic identification researchers and specialists.

Facial approximation is a common tool utilized in forensic human iden- tification. Three-dimensional imaging technologies allow researchers to go beyond traditional clay models to now create virtual computed models of anatomical structures. The goal of this study was to compare the accuracy of available methods of facial approximation ranging from clay modeling to advanced computer facial reconstruction techniques.

Anatomically accurate virtual models of both the skull and of the surface contour of the face were computed from CT image data of the head region of a living individual. The individual was CT scanned and the volu- metric data from the scan was taken into the visualization software *Mimics* (© Materialise). A FloodFill method of seeding the image was done to select only the bone pixels in the data set. This 3-D volumetric pixel grouping was then filtered of artifact holes and closed to create one unsegmented structure. The data set was then rendered into a 3-D Model and exported as a Stere- olithographic file (STL). The virtual facial approximation participants were provided with the STL files and a standard biological profile determined by a forensic anthropologist. Virtual models were created using *3ds Max* © (v.9). An accurate full size prototype of the skull was then produced from the computed virtual skull model using a 3D ZPrinter 310 (© ZCorp) printer which was then submitted to the clay model specialist.

A face was constructed on the skull prototype by an experienced, professional forensic visual identification specialist from the Federal Bureau of Investigation using traditional clay facial approximation techniques.

Virtual facial approximations were also produced using two computer- based techniques. One method, utilized by law enforcement in the United Kingdom and developed by experts at the University of Sheffield, uses the software package, *3ds Max* © (v.8) to create virtual clay models over the skull. The other method in this study tested the FBI's new facial approxi- mation software program, *Reface* ©.

In the University of Sheffield's *FaceIT* method, the skull image obtained from the CT was imported into *3ds Max* © (v.8). A plane was constructed and placed to represent the Frankfurt Horizontal Plane to enable standardization of views. Tissue depth markers, represented by pyramids, were placed at 32 craniometric landmark points on the skull. Based on the anthropologist's biological profile, the depths were taken from previously established data sets for the corresponding individual's profile. A prefabri- cated facial muscle set was then scaled and deformed to match the morphology of the skull. Other anatomical features such as the eyeballs, lips, and ears were also imported from a feature data bank based on estab- lished anthropological characteristics.

A visual information specialist from the Federal Bureau of Investigation was enlisted to test their most current computerized facial approximation method, *Reface* © software. The FBI's software imports the STL files and creates a mask over the virtual skull based on a database of standard cranio- facial features. The software package allows the user to make adjustments to the mask on a sliding scale for age and weight.

The results from all three methods (clay and virtual) were compared visually to each other and collectively to the actual features of the living indi- vidual to determine the level of accuracy and detail that each provided. A quantitative study was also conducted to establish the accuracy of each method. This project demonstrates the wide range of variation between commonly used facial identification methods. The benefit of this study was having a living individual to test the strengths and weaknesses of each method. Resulting images and models will be available for conference participants to review to provide additional input into our evaluation process.

Facial Approximation, 3-D Modeling, Human Identification

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