A45 Experimentally Derived Protocols for Generating 3D Cranial Surface Scans for Forensic Anthropological Applications

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After attending this presentation, attendees will be familiar with the utility and limitations of cranial 3D surface scans in forensic anthropological contexts, including the need for further development of standard operating procedures.

This presentation will impact the forensic science community by providing an experimentally derived protocol for the use of the NextEngine® Desktop Scanner in scanning cranial elements for forensic anthropological contexts.

The prevalence of 3D laser technologies employed in contemporary forensic anthropological research introduces the need for assessments of accuracy and systemic standardization of these techniques. The NextEngine® Desktop 3D Scanner is the most widely implemented 3D scanning technology within the discipline due to its user-friendly capabilities, relatively inexpensive cost, and resolution; however, at this time there are no published or implemented standard operating procedures for the collection and utilization of 3D scans for forensic purposes. This can have sizable consequences in forensic examinations, as the application of various settings chosen by the user ultimately affects the accuracy of the scan and 3D model. The purpose of this study was to systematically evaluate the effect of various scanning settings and determine the optimal settings for scanning the cranium. The cranium was selected due to its significance and frequented application in forensic anthropological estimations of the parameters of the biological profile, including age, sex, and ancestry.

Using the NextEngine® Desktop 3D Scanner, cranial scan trials were conducted using 8 divisions, 12 divisions, and 16 divisions for each of the following Points Per Inch (PPI) settings: Quick3, SD1, SD3, HD1, and HD3. In total, 15 scans were conducted. All scan post-processing was performed in the associated ScanStudio™ HDPro software. Following completion, the scans were coded to facilitate an unbiased evaluation and an observer was asked to perform a quality assessment by comparing the scans to the actual specimen and ranking a number of features on a scale of 1 to 10, 1 being terrible and 10 being a perfect representation of those features. Comparative analyses of average scan quality rankings, time requirements, and memory demands in relation to implemented scan settings were performed in order to determine those settings that produce optimal scans for forensic anthropological contexts.

The results of the comparative analyses indicate that the optimal settings for scanning the cranium include 12 divisions at the HD1 PPI setting. Time and memory demands for scan procurement proved to correspond highly, and ultimately determined that the HD3 PPI setting was inoperative, as the memory demands were too high for the scan to be reopened after obtained, even when using a high-end graphics computer. The representative accuracy of trial scans was assessed with regard to unique features, taphonomic qualities, and traits associated with evaluations of the biological profile. In none of the scans, regardless of employed settings, did the observer feel confident in assessing cranial suture closure by means of the Meindl and Lovejoy 1985 age estimation method; however, the observer felt comfortable applying non-metric sex and ancestry estimation methods to the cranial scans.[1] Using the optimal 12 divisions, HD1 settings, the observer felt the scan exhibited a suitable representation of surface coloration and suture representation (score 5). In addition, the observer felt able to discern cranial landmarks (score 5.3), muscle markings (score 5.7), nasal aperture shape (score 6), cranial foramina (score 7), and distinct skeletal markings (score 8).

To further evaluate the accuracy of scans produced using the proposed settings, 24 measurements taken on the cranium were compared to those taken virtually on the 3D scan. The average difference in measurements was 0.62mm (*SD* = 0.51mm), equating to an average percent difference of 1.17%. The highest deviation was found in measurement of the orbital height (1.7mm), which resulted in a 4.5% difference; however, the subjectivity in the definition of this measurement may have factored into this discrepancy. The next highest error was obtained with orbital breadth (2.9%). All other measurements had error rates less than 1.8%.

Once established, a standard operating procedure for the use of the NextEngine Desktop® 3D Scanner would allow further documentation of known error rates in compliance with the *Daubert* ruling and the 2009 National Academy of Sciences (NAS) Report and render them operative practices within forensic anthropological contexts.[2,3]

Reference(s):

1. Meindl R.S., Lovejoy C.O. Ectocranial suture closure: a revised method for the determinations of skeletal age at death based on the lateral-anterior sutures. *Am J Phys Anthropol.* 1985:68(1):57-66.
2. *Daubert v. Merrell Dow Pharmaceuticals*. US Supreme Court 509.U.S.579,113S.Ct.2786, 125L. Ed.2d 469. 1993.
3. National Academy of Sciences. *Strengthening Forensic Sciences in the United States: A Path Forward.* Washington, DC: The National Academies Press, 2009.

3D Laser Scanning, NextEngine Desktop 3D Scanner, Cranial Scans