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NEWS

Virtual Archaeology – The NextEngine Desktop Laser Scanner

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Recent advances in 3D technology have led to the increasing use of virtual methods of data collection in archaeology, including the use of computed tomography (CT) and portable laser scanners. One popular piece of equipment is the NextEngine Desktop 3D laser scanner (www.nextengine.com), which was released in 2006 and offers the ability to capture highly accurate 3D images of objects at a very competitive price. The release of this scanner has greatly increased accessibility to virtual surface data, for instance through the creation of virtual museums, and has enabled more researchers to conduct 3D geometric morphometric studies (GMM) of archaeological material. The developing field of geometric morphometrics permits researchers to directly quantify and statistically analyse morphological differences between groups of artifacts, allowing more objective appraisal than that afforded by traditional visual assessment.

The NextEngine uses structured light scanning, which involves the projection of a pattern of laser stripes onto the desired object. A triangulation technique is used to calculate the distance of every point on the lines to the scanner, generating a 3D model. This method is faster than many others, as the four twin laser arrays allow multiple points to be scanned at once (Brown 2010). The NextEngine is well suited to the recording of 3D surface data from archaeological finds. Although objects such as coins have not yet been successfully scanned due to their flat, homogeneous shape, the NextEngine scanner can accurately record many small to medium sized artifacts, with a precision of 0.13–1.66 mm (Polo & Felicísimo 2012).

The NextEngine comes with ScanStudio HD Pro software, which allows highly automated collection of 3D surface models as well as the ability to align multiple scans into a single model. These can be exported in multiple commonly used formats, which can then be easily shared and viewed in free software such as Meshlab (meshlab.sourceforge.net), allowing wide dissemination of data. The scanner is highly portable and requires only a laptop, power source and suitable table space (**Fig. 1**). While this scanner cannot be used in all field conditions, requiring moderately low temperatures and minimal lighting, it can be used in a variety of field-laboratory settings to collect 3D surface data.

The increasing accessibility of laser scanners such as the NextEngine in archaeology is of serious importance to the development of modern analyses of shape, and advances in 3D GMM (Bookstein et al. 2004; Gunz & Mitteroecker 2013). 3D GMM is a collection of methods that use digital data from specimens, normally involving the placement of landmarks onto specimens (a landmark is an element which can be reliably and precisely

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Figure 1: NextEngine laser scanner (model 2020i) in use at the Institute of Archaeology, collecting 3D data for a human skull. Photo: Sandra Bond.

identified between objects and observers, e.g. most lateral point of the right eye). Standard analyses allow quantitative investigation and visualisation of morphological variation which can be related back to the original data. Methods are widespread in comparative biology (Ito, Nishimura & Takai 2014), palaeoanthropology (Nicholson & Harvati 2006) and archaeology (Selden, Perttula & O'Brien 2014), with studies first requiring access to 3D surface data, either from CT scans, laser scanners or photogrammetry.

Many researchers within the Institute of Archaeology are producing interesting results from data collected with the NextEngine scanner in combination with GMM methods. These involve: research into the effects of changes in diet on the morphology of the human mandible (jaw); shape differences between sexes in the head of the human femur (thigh bone); the association between lifestyle, subsequent repeated use of particular muscles, and resulting shape changes in the cross section of the tibia (the larger bone of the lower leg); the ability to quantify the amount of morphological variation in the facial skeleton within and between species, including ourselves and our most recent relatives (hominins and extant primates); and the identification of sharp force trauma injuries to the forearm, comparing images produced by the NextEngine scanner with those produced using other imaging methods (such as scanning electron microscopy).

The specific traits of the NextEngine 3D desktop laser scanner make it extremely useful to archaeological research, being lightweight, affordable, easy to operate and relatively accurate. This has been recognised by a number of researchers, some of whom have used this scanner to collect data for the purpose of 'virtual curation'. One example is the Virtual Curation Laboratory at Virginia Commonwealth University (vcuarchaeology3d.wordpress.com), a project funded by the Department of Defence Legacy Resources Management Program (Means et al 2013). It aims to enhance preservation and increase accessibility to archaeological artifacts, through the combination of 3D data collection using scanning and 3D printing. Data has so far been collected from a number of heritage sites, with great success in imaging objects made from wood, ceramics, metal and bone.

The potential of methods using laser scanners in conservation and archaeology is not just limited to the creation of 'virtual curiosity cabinets' (Simon et al. 2009), and includes applications such as the digital reconstruction of artifacts; creation of virtual typologies for identification of objects in the field; virtual extensions of museum exhibitions; and, when combined with 3D printing, the creation and use of replicas in preservation and teaching (e.g. Kaneda 2009; Simon et al. 2009; Tucci, Cini & Nobile 2011; africanfossils.org).

References

AfricanFossils.org Available at http://africanfossils.org/

Bookstein, F, Dennis, S, Gunz, P and **Mitteroecker, P** 2004 Anthropology takes control of morphometrics. *Collegium anthropologicum*, 28(2): 121–132. DOI: http://dx.doi.org/10.4404/hystrix-24.1-6283

Brown, J 2010 Innovation at home – Inside a 3-D desktop scanner. *Electronic Engineering Times*, 27 September, pp. 48–49. Available at http://www.eetimes.com/document.asp?doc_id=1281318.

Gunz, P and **Mitteroecker, P** 2013 Semilandmarks: a method for quantifying curves and surfaces. *Hystrix*, 24(1): 103–109. DOI: http://dx.doi.org/10.4404/hystrix-24.1-6292

Ito, T, Nishimura, T and **Takai, M** 2014 Ecogeographical and Phylogenetic Effects on Craniofacial Variation in Macaques. *American Journal of Physical Anthropology*, 154: 27–41. DOI: http://dx.doi.org/10.1002/ajpa.22469

Kaneda, A 2009 Application of a Low Cost Laser Scanner for Archaeology in Japan. 22nd CIPA Symposium, Kyoto, Japan, October 11–15, 2009. Available at http://cipa.icomos.org/fileadmin/template/doc/KYOTO/35.pdf.

Means, B K, McCuiston, A and **Bowles, C** 2013 Virtual Artifact Curation of the Historical Past and the NextEngine Desktop 3D Scanner. *Technical Briefs in Historical Archaeology*, 6: 1–12. Available at http://www.sha.org/documents/VirtualArtifacts.pdf.

MeshLab Available at http://meshlab.sourceforge.net/

NextEngine Available at http://www.nextengine.com/

Nicholson, E and **Harvati, K** 2006 Quantitative analysis of human mandibular shape using three-dimensional geometric morphometrics. *American Journal of Physical Anthropology*, 131(3): 368–383. DOI: http://dx.doi.org/10.1002/ajpa.20425

Polo, M E and **Felicísimo, A M** 2012 Analysis of Uncertainty and Repeatability of a Low-Cost 3D Laser Scanner. *Sensors*, 12: 9046–9054. DOI: http://dx.doi.org/10.3390/s120709046

Selden, R Z, Perttula, T K and **O'Brien, M J** 2014 Advances in Documentation, Digital Curation, Virtual Exhibition, and a Test of 3D Geometric Morphometrics: A Case Study of the Vanderpool Vessels from the Ancestral Caddo Territory. *Advances in Archaeological Practice*, 2(2): 64–79. DOI: http://dx.doi.org/10.7183/2326-3768.2.2.64

Simon, K M, Payne, A M, Cole, K, Smallood, C S, Goodmaster, C and **Limp, F** 2009 Close-Range 3D Laser Scanning and Virtual Museums: Beyond Wonder Chambers and Cabinets of Curiosity? Computer Applications and Quantitative Methods in Archaeology (CAA), Williamsburg, Virginia, March 22–26 2009. Available at http://www.caa2009.org/articles/Simon_Contributions368_a%(1).pdf [Last accessed 01/06/2015].

The Virtual Curation Laboratory Available at https://vcuarchaeology3d.wordpress.com/

Tucci, G, Cini, D and **Nobile, A** 2011 Effective 3D Digitization of Archaeological Artifacts for Interactive Virtual Museum. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, Volume XXXVIII-5/W16. ISPRS Trento 2011 Workshop, Trento, Italy, 2–4 March 2011, pp. 413–420. Available at http://www.int-arch-photogramm-remote-sens-spatial-inf-sci.net/XXXVIII-5-W16/413/2011/isprsarchives-XXXVIII-5-W16-413-2011.pdf.

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