Chapter 42
Virtual Forensic Anthropology: Applications of Advanced Computer Graphics Technology to the Identification of Human Remains

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ABSTRACT

Anthropology is the "study of man" and encompasses a diverse range of topics, including socio-cultural studies, linguistics, archaeology, and physical anthropology. Physical anthropology, or "biological" anthropology, the study of humans both living and deceased, can be further subcategorized into osteology, primatology, human evolution, and forensic anthropology. Forensic anthropology is the application of physical anthropology techniques to medico-legal settings. Virtual Reality (VR) is being applied to forensic anthropology in a multitude of ways to benefit research and teaching. Several large-scale projects have been launched to digitize, reconstruct, and disseminate specimens (for example, http://www.virtual-anthropology.com). This chapter will begin with an overview of the discipline of forensic anthropology and discuss a number of representative applications of VR technology in this field that are changing the way in which case work may be handled in the future.

INTRODUCTION

Forensic anthropology is a very broad discipline, and can therefore be defined in a number of ways. Dirkmaat et al (2008) describe it as "...the scientific discipline that focuses on the life, the death, and the post-life history of a specific individual, as reflected primarily in their skeletal remains and the physical and forensic context in which they are emplaced". Anthropologists are often employed in scenarios involving severely decomposed and/or unidentified human remains. The varied nature of such circumstances dictates that the remit of the anthropologist is

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dynamic and multidisciplinary; one may work alongside pathologists, odontologists, police, archaeologists, and human rights organizations. The anthropologist may be asked to examine trauma, to evaluate skeletal anomalies such as pathological conditions, or to assist in ascertaining the postmortem interval. The anthropologist may also be involved in the exhumation and identification of victims of mass disasters such as aviation crashes or atrocities of warfare and genocide. However, the most common part of the forensic anthropologists' remit is to establish a biological profile of an individual or individuals through osteological (skeletal) analysis.

When establishing a biological profile from human remains, there are numerous questions that must be answered: Are the remains human? Do they belong to a subadult or an adult? What is the sex of the individual? What is the ancestral origin of the individual? What is approximate age range? What was the living stature of the individual? Do the remains exhibit any indication of interpersonal violence or trauma? Is there any evidence of illness, injury, or other unique characteristics that may help to identify the person? Are the remains of forensic significance or are they archaeological/historical in nature? What taphonomic (environmental) factors have acted on the remains since the death of the individual?

In recent decades, there has been a paradigm shift in the field. It has grown from a small group of experienced physical anthropologists primarily tasked with examining bones to a vibrant field of practitioners and researchers working to validate and improve existing techniques or to discover new ones. As forensic science and expert testimony in general has come under scrutiny and new legislation (Office of News and Public Information, 2010; *Daubert vs. Merrell Dow Pharmaceuticals, 1993; Kumho Tire Company, Ltd. v. Carmichael, 1999)*), the discipline has been faced with the challenges of meeting stringent scientific scrutiny where little quantitative data existed previously. Due to the mercurial nature of the casework undertaken by anthropologists, obtaining such data can be very difficult. It is practically impossible to undertake rigorous scientific study of the techniques that rely mainly on observational, experiential and pattern recognition skills. Activities such as estimation of the postmortem interval (time since death) and recognition of bone modification activities can be difficult to quantify, despite being a regular part of an anthropologist's duties (Grivas and Komar, 2008). A Scientific Working Group known as SWGANTH has recently been established to address these types of issues (Christensen and Crowder, 2009).

In the interim, however, moves have been made to standardize the ways in which data is collected. Buikstra and Ubelaker (1994) produced an edited volume outlining standard data collection procedures for dealing with human remains. The United Kingdom followed suit in 2004 with the publication of similar guidelines (Brickley and McKinley, 2004). The University of Tennessee at Knoxville have also developed FORDISC 3.0 (Ousley and Jantz, 2005), a software package which uses discriminant function analysis to classify the sex and ancestry of unknown remains using information of known individuals in the Forensic Data Bank. This software is widely used, and by extension dictates the type of metric measurements that are taken during anthropological assessments of skeletal remains.

The most commonly used techniques for establishing a biological profile utilize observational techniques in which the set of unknown remains is compared to type specimens that fall along a continuum. For example, sex is generally determined based on the morphology of various parts of the pelvis. The characteristics of the ischiopubic ramus, greater sciatic notch, ventral portion of the pubis, and presence/absence of the preauricular sulcus and subpubic concavity all contribute to the classification based on a scoring system (Buikstra and Ubelaker, 1994). Sex of the skull can also be evaluated using a scoring system to evaluate a suite of six traits with an accuracy