## H124 Morphometric Comparison of Clavicle Outlines From 3D Bone Scans and 2D Chest Radiographs Using Elliptic Fourier Analysis: A Short-Listing Tool for the Radiographic Identification of Human Skeletons

*Carl N. Stephan, PhD, and Pierre Guyomarc'h, PhD*, JPAC-CIL, 310 Worchester Ave, Bldg 45, Joint Base Pearl Harbor-Hickam, HI 96853; Brett G. Amidan, MSc, James Chung, MSc, and Harold E. Trease, MSc, Pacific Northwest National Laboratory, 902 Battelle Blvd, Richland, WA 99352; and John E. Byrd, PhD, 95-033 Hokuiwa St, #51, Mililani, HI 96853-5530*

The goal of this presentation is to report the performance of a semi-automated computer capability that enables fast large-scale searches of 2D antemortem chest radiograph libraries for potential matches to 3D bone scans. The radiographs of the short-listed candidates can then be compared against postmortem radiographs of the skeleton to confirm, or deny, their "match" status.

This presentation will impact the forensic science community by delivering a method that enables large databanks of 2D antemortem chest radiographs to be quickly searched in reference to 3D bone scans. This holds vital importance for the identification of individuals represented in large assemblages of antemortem chest radiographs, e.g., c.8,100 unaccounted-for U.S. soldiers from the Korean War who were subject to chest radiography at induction into the military.

The visual comparison of postmortem radiographs to thousands of images/individuals in large antemortem chest radiograph libraries, for identification, is impractical in terms of time and cost. Instead, these circumstances demand a computer-automated short-listing tool, whereby individuals of high match potential can be quickly and reliably isolated for finer and more time-intensive analysis using manual methods. This presentation describes such a method, which uses quantified clavicle shape as the filtering mechanism. The clavicles are useful in this regard because: they are morphologically variable between individuals; are visible on the chest radiographs; and possess high field-survivability in comparison to other osseous elements of the thorax (such as ribs). This study uses 414 postero-anterior chest radiographs (many of which are 1940s 4"x5" photoflurographs) as its antemortem reference sample (note: the clavicle outlines were manually traced on Wacom touch-screens), and uses clavicles from 17 field-recovered skeletons as its test group.

The first procedure necessary for the above-outlined computer-automated comparison is 3D scanning of the clavicles and generation of a surface mesh of the bones (.stl file). The computer then rotates the 3D model and captures regularly spaced 2D images at different orientations. This serves two purposes. First, precise position of the clavicle on any antemortem radiograph cannot be reliably predicted *a priori* so a range of positions is examined; and second, it produces 2D images of the 3D model comparable to the 2D radiographs. From the array of snapshot images, four that cover common antemortem clavicle positions are selected to provide good coverage (the small number reduces the chance for false positive matching). The medial and lateral ends of the clavicles on these four 2D snapshots are then trimmed off as they cannot often be seen on the antemortem radiographs (e.g., shoulders fall beyond the image receptor of the X-ray machine). Both the 2D tracings of the clavicles on the antemortem radiographs and the trimmed 2D outlines of the scanned osseous elements are then subject to elliptical Fourier analysis using 40 harmonics (=160 Fourier descriptors for each clavicle). The shape distance between each of the trimmed 2D outlines and the tracings of the antemortem radiographs is computed by the sum of the squared differences across the 320 Fourier descriptors (left and right clavicle sides combined). The computer then ranks the individuals represented by the antemortem radiographs in order of their shape distances.

Using 17 skeletons of known identity, and tracings of 414 antemortem radiographs, short-lists of the top 5% of the antemortem sample (20 individuals) to include the correct match to the skeleton 74% of the time were found. Short-lists of 104 individuals (25% of the antemortem sample) included the correct match 91% of the time. It took less than 1.5 seconds for each search against the 414 person database. It is concluded that elliptical Fourier analysis of clavicle outline shape provides fast and efficient short-listing of potentially matching candidates from postero-anterior chest radiograph libraries. These short-lists can then be subject to closer inspection using more detailed visual inspection methods, sparing their blanket and time-intensive application to all individuals in the reference library. In the future, this computer search capability will likely facilitate identification of several hundred unaccounted-for U.S. soldiers from the Korean War buried at the National Memorial Cemetery of the Pacific.

**Radiography, Morphometrics, Fourier Analysis**

 ** Presenting Author*