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Video Superimposition of Skulls and Photographic Portraits—A New Aid to Identification

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ABSTRACT: Videosuperimposition of a skull with antemortem photographs of a person suspected to be deceased is a valuable adjunct in the police identification process. In this paper, the technique is described with its flexibility, variations, and limitations discussed.

KEYWORDS: criminalistics, human identification, photography, superimposition

The use of antemortem photographic records of facial features in the identification of human skeletal remains has been well established over the past 40 years [1].

In the identification process, establishing the correct enlargement factor of the photograph to the skull is a critical factor. The enlargement of the photograph to "life size" must be accurate if facial features are to be accurately superimposed. This enlargement factor has been based on the linear measurements of fabric on the victim [2], items within a room in which the photograph portrait was taken [3], or the focal length of the camera lens [4]. When objects surrounding the face were used, they had to be in clear focus and within a similar focal plane.

A more satisfactory method of enlargement has recently been described by McKenna et al. [1] using the dimensions of the anterior teeth in family portraits or passport photographs. With a magnification factor established from the anterior teeth, life-size transparencies of the photograph are superimposed with the skull's dental landmarks, and subsequently, skeletal and facial features. To achieve correct enlargement by this technique, the anterior teeth must be clearly visible in the antemortem photograph. The difficulty in establishing correct enlargements is compounded by the need for establishing a correct angulation of the skull to the photograph. Full facial photographs are not always available and any variations in facial angulation from the frontal view must be carefully estimated before superimposing.

The technique of cranio-facial video superimposition has been developed to overcome the protracted time involved with still photography superimposition. Few reports in the litera-

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ture of the use of this technique exist, but it is apparent that it can be an excellent adjunct to identification when few other means of identification are available. The most common materials used in videosuperimposition are a skull and antemortem photograph [5], although they may be supplemented with a skull radiograph [6].

The aim of this paper is to describe in detail this technique, using video equipment, to enlarge antemortem photographs and then superimpose these on the video picture of the skull of the suspected deceased person.

Method

An unidentified skull requires a thorough visual and radiographic examination to assist in establishing the sex and the age of the victim. All attempts should be made to recover any missing teeth at the site where the body was found. Extraneous soft tissue and foreign matter must be removed from the skull.

The skull is mounted on an adjustable support allowing movement in three planes (Fig. 1). Failure to have apparatus that will allow full three-dimensional movement of the skull will make alignment very difficult. Relatives and friends should have been contacted by the police to obtain photographs (particularly photographic negatives) of the deceased. The most useful photograph is one of a person smiling and showing their teeth. Some hairstyles, headgear, or beards may reduce the value of a photograph.

A Hitachi GP-5 Color Video Camera or its equivalent, firmly mounted on a tripod, is aligned at right angles to the antemortem photograph. The center of the lens should be at the same level as the horizontal center of the photograph. The mounted skull is located in front of a contrasting background and a second video camera, similar to the one above, is aligned to the skull in the same manner as the first camera to the photograph.

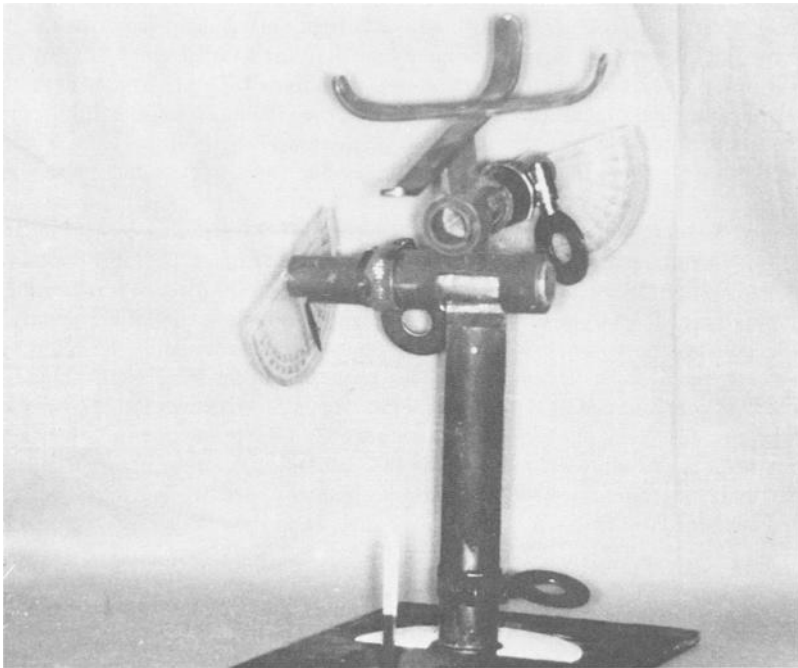


FIG. 1—Adjustable support for a skull—allows controlled movement in three dimensions. The position of the skull can be quantitated by reference to the mounted protractor scales.

Both cameras are then "white" balanced in accordance to the source of the illumination. Illumination can be of any source, but care is taken to ensure that specular reflections and severe highlights are reduced to a minimum on both the photograph and the skull.

Both cameras must be compatible so as to ensure "Gen-Lock"⁴ between the cameras is obtainable. The individual video signals from each camera are fed into a vision mixer so that a variety of functions, for example, horizontal and vertical wiping and superimposition and negative stimulation, can be performed.

Color can be introduced to provide a warmer visual acceptance and create more easily distinguishable highlights. Color will reduce the effect of highlights and provide a warmer visual image. The introduction of gelatin filters (either red yellow or orange spectrum) over the light source illuminating the skull produces a "warmer" visual image than a noncolored illumination.

The skull is orientated, on the adjustable mount, as closely as possible to the angulation of the head of the subject in the antemortem photograph.

The video pictures from both cameras (standard video signal 1 V peak to peak) are relayed into a Viscount 1107 Video Mixer or its equivalent. By adjusting the mixer, the video picture of the antemortem photograph can be enlarged.

If teeth are present in both the skull and the antemortem photograph, enlargement is carried out until the teeth in the antemortem photograph exactly overlap the teeth in the superimposed video picture. If teeth are not present in both specimens, an estimate of the enlargement factor must be made. This estimate is made by adjusting the vertical facial height of the photograph to that of the skull. Allowance for tissue and hair thicknesses [7] must be made. It is vital that the skull is correctly aligned to that of the face as slight variations will cause large discrepancies in superimposing other anatomical features. The video mixer allows great flexibility in making these adjustments and provides an immediate result without having to process photographs or make tracings.

With correct enlargements and skull orientation the anatomical features of both the skull and antemortem photographs can be superimposed. The main anatomical landmarks matched are the external auditory meatus, orbits, anterior nasal spin, chin point, angles of the mandible, and zygomatic processes. If a video tape is being made of the superimposition, the anatomical landmarks can be highlighted on the skull by placing a white pointer in or around each area. By taking the antemortem photograph in and out of the mixer video screen, each anatomical landmark can be accurately viewed.

Successful superimposition should have all anatomical features matching. The video mixer allows for the fading in and out of view of either the skull or the antemortem photograph or sweeping either the skull or photograph over each other in the vertical or horizontal plane. This latter procedure permits a quarter, half, or three quarters of either the skull or the antemortem photographs to be superimposed in either the vertical or horizontal plane on the video screen.

Case Report

On 5 Jan. 1980, three amateur prospectors discovered a human skeleton underneath logs at the bottom of a sink hole near Inglewood Victoria, Australia. Subsequent examination of the remains revealed that the deceased was a nonaboriginal female between 20 to 25 years of age. Apparent cause of death was a fractured skull.

Extensive enquiries were conducted throughout Australia and New Zealand without result. Events around May 1982 made police suspect this skeleton could be the remains of a

⁴Gen-Lock—the ability of two video cameras to synchronize together in order to use the facility of video or vision mixing.

Lynette Frances Jones who had not been seen since August 1975. Two of the authors (Dalitz and Woodward) were requested by the police to reconstruct the skull and perform craniofacial video superimposition on photographs of Jones (Figs. 2, 3, and 4).

The results were sufficiently convincing to allow police to approach suspects with confidence. The suspects confirmed the identification and murder charges based on this were made. The video superimposition evidence was presented in court and accepted as positive identification of the Inglewood skeleton as Jones.

Discussion

The two most important factors to control in superimposition work are the enlargement of the antemortem photograph and the alignment of the skull to the photograph. Video superimposition will provide quicker and greater flexibility in both these areas than other techniques if no dental or other landmarks are available in the antemortem photograph. If the anterior teeth are present in both specimens then the technique of McKenna et al. [1] is suggested as more quantitatively accurate in establishing correct enlargement than the video superimposition technique.

With teeth present, initial skull alignment could be greatly facilitated by using the video technique and then the final superimposition could be achieved by using the technique of McKenna et al. [1].

Inherent in all superimposition procedures are assumptions and estimations that have to be made of the bony anatomical features on the antemortem photograph. The average thicknesses of tissue over bone have been recorded [7], and therefore, a calculation can be made of the soft tissue outlines on the skull.

With some skulls, anatomical landmarks may not always be clearly discernible on the video screen. Such landmarks are best located or outlined by a white pointer, in particular,

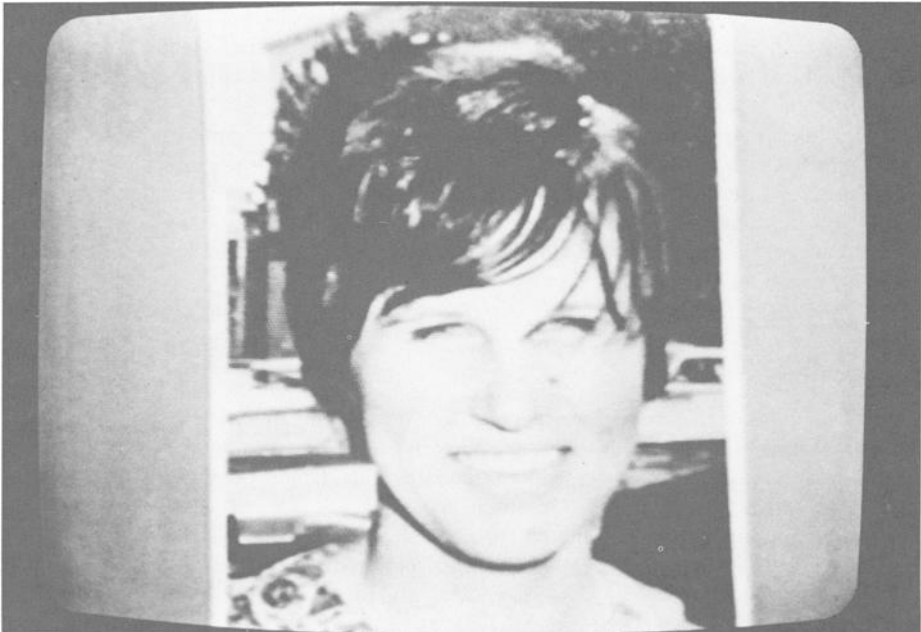


FIG. 2.—*Photograph of Jones (as actually seen on television monitor screen).*

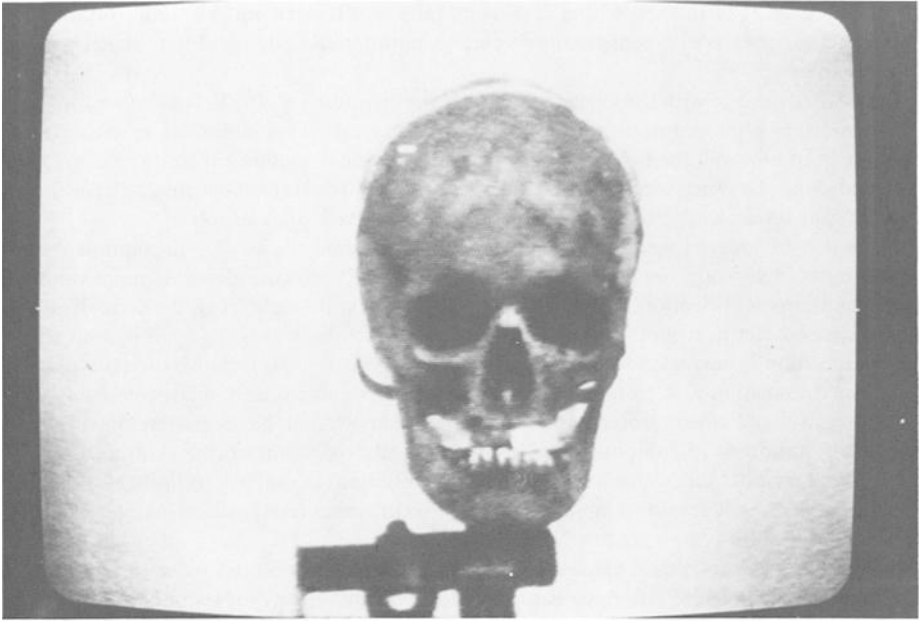


FIG. 3—*Inglewood skull on adjustable apparatus.*



FIG. 4—*Video superimposition of Inglewood skull on photograph of Jones.*

the external auditory meatus. Highlighting bony contours on the skull may also be achieved by outlining areas of interest with a fine white tape or a fluorescent dye under fluorescent light. Profile views are of confirmatory value as additional anatomical landmarks can be superimposed.

Of great advantage with the video technique is the operator's ability to fade either the skull or antemortem photograph in and out of the video screen. This allows for careful overall assessment of how well the two specimens match. Individual anatomical landmarks are best matched using the sweep technique in either the horizontal or vertical quarter, half, or three-quarter split screen image of either the skull or antemortem photograph.

The value of superimposition has been challenged [8] on the basis that alignment and enlargement factors are too variable. The technique has been considered as more value in exclusion than identification. The possibility that other skulls could fit all the facial features of a suspected victim's photograph could occur [6], and therefore, the technique of video superimposition is best used to supply corroborative evidence. To improve the reliability of videosuperimposition and to reduce the problems of alignment and enlargement, a computer program and video camera (with a specialized lens) system has been developed [9]. By comparing hundreds of computer-read angles at similar positions on the skull and photograph, a quantitative measure between the two is obtainable. Such a technique, although not fully refined, will provide a more reliable and accurate superimposition matching than is currently available.

In Australian courts of law, video superimposition has been accepted as a means of identifying skeletal remains [5]. Its value is highlighted when other methods of identification are not possible or reliable.

To avoid false findings, careful interpretation of results is essential, especially if anterior teeth are absent. All anatomical landmarks must match, and ideally, other photographs showing different facial views should be used. If all anatomical features match on the skull and antemortem photograph, then a clear similarity can be established.

In the overall process of identification of human remains, cranio-facial video superimposition can play an important part and supplement the more established methods currently used.

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