B9 Camera-to-Subject Distance and Facial Comparison Examinations

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After attending this presentation, attendees will learn how to calculate the subject-to-camera distance necessary to achieve an orthographic projection for the face over the region extending from the nose to the ears, as well as the implications of this result for individuals and agencies involved in the capture and analysis of facial images, particularly when using measurements of facial features for comparison analysis.

This presentation will impact the forensic science community by informing it of a technical issue relating to forensic facial comparison that could lead to multiple false exclusions of subjects.

Forensic facial comparison examinations often incorporate a combination of morphological and anthropometric analyses.[1] Recent efforts have begun to rigorously assess the utility of anthropological landmarks[2,3] and morphological features[4] as objective, measurable characteristics of faces that can be used for comparison analysis. It is anticipated that forensic facial comparison analyses in the future will incorporate a more explicit determination of the size and shape, relative or otherwise, of specific features of the face and head than has been done in the past. Such features include the eyes, nose, mouth, and ears.

While many key facial features used in forensic comparison (as well as in facial recognition applications) are practically co-planar (e.g., eyes and mouth), the nose and ears are distinctly out of the facial plane. As a result, they are prone to perspective distortion and the relative size of these features will vary with camera position relative to the subject.

The degree to which this effect impacts the accuracy of automated facial recognition (FR) algorithms and systems has not been reported. Since the ears are not considered by most FR algorithms, any distortions to them can be expected to have a negligible effect on the automated portion of the systems. However, practical experience has shown that human reviewers of FR system output frequently focus on the ears and nose to quickly sort through a candidate list. As a result, distortions in ear and nose can negatively impact the overall effectiveness of a

human-computer FR system.

The effect of perspective on facial images is well established in the photographic and forensic communities.[5,6,7] An analysis of anthropological landmarks on several subjects included in the MAGNA database demonstrated the degree of measurement errors that ensue for different camera-to-subject distances.[8] In particular, measurements of features associated with the ears were shown to be especially prone to perspective error. This result was not unexpected, given the fact that the ears are the most remote part of the face and head that is visible in a frontal image.

Under ideal conditions, 2-dimensional images of the face and head (photographs or video images) would be acquired in a way that perspective distortions were removed, and measurements taken from the photograph would accurately reflect the true physical measurements – so long as those measurements were taken in a plane parallel to the plane of the camera sensor. Images which depict three-dimensional objects with no perspective distortion, such as architectural drawings, are referred to as being in orthographic projection[9] and they reflect a situation in which all rays of light reflected off a subject enter the camera lens parallel to one another.

Existing guidance for the acquisition of frontal photographs (e.g., ANSI/NIST-ITL 1-2007)[10] describes a typical camera to subject distance of 1.5- to 2.5-meters. In this paper, it will be demonstrated that this distance is insufficient to generate an orthographic projection of the face and ears when a frontal photograph is acquired to meet resolution requirements for SAP Levels 40 and above. Instead, a distance of approximately 70-meters would be necessary to achieve orthographic projection for a facial image that incorporates the entire region from the nose to the ears at SAP Level 40 (approximately 200-pixels between the pupils**)**, while a distance of approximately 125-meters is necessary for SAP Level 50 (approximately 600-pixels between the pupils). Such distances are impractical in virtually every controlled capture (e.g., enrollment) scenario. As a result, facial comparison practitioners must actively incorporate anticipated perspective effects into their analyses. Likewise, any other forensic or biometric application that incorporates the nose and ear as components must take this effect into account. This particularly applies to anyone who would use photo-anthropometry alone as a basis for inclusion or exclusion of a subject.

It is important to note that human beings are not accustomed to viewing each other in orthographic projection, but in perspective projection. Under such conditions, a photograph depicting a subject in an orthographic projection could lead to an improper exclusion by a screener. As a result, the requirements of manual screening and forensic analysis may be somewhat at odds with one another.

References:

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