A174 Shape Measurement Tools in Footwear Evidence: An Investigation to Determine Size Without Scale

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The goal of this presentation is to examine the ability to use shape measurement tools to determine the class characteristic of shoe size without a scale in place on an image.

This presentation will impact the forensic science community by providing a method to allow for sizing of a shoe in circumstances when a scale is not included in the image, aiding the area of footwear impression evidence. This method also has potential applications in impression evidence in cases where key images lack a scale.

When footwear evidence is collected at a crime scene, inclusion of a scale in photographed images is necessary to determine the size of the shoe. If no scale is used, the evidentiary value can be lowered. The goal of this project was to explore the use of shape measurement methods with footwear impression evidence to determine if shape change alone, in element differences in the soles of different brands of shoes, can predict shoe size. These methods provide robust statistical approaches to shape comparison that do not require a scale.

One method that may be used to determine size without scale is geometric morphometic analysis (GM). This technique is used widely in other fields and is often used to describe change in the fossil record in evolutionary biology, in fisheries research and in addressing a range of ecological questions. GM methods involve the placement of a series of landmarks on digital images, positioned on the image as to capture shape information of a structure of interest. These landmarks are then extract and analyzed statistically as a unit. This allows for quantitative evaluation of large datasets.

The landmarks can be plotted in Procrustes superimposition, a method of optimally matching one shape to another. This allows for visualization of shape information and is a measure of the closeness in shape of superimposed specimens. Procrustes distances can be used to express the degree of similarity of individual specimens, means of populations, to summarize variations in populations, or to search for matches between specimens. Procrustes distances provide a general metric of shape distance, and allow for a wide range of statistical and data processing tasks to be readily carried out, including Principal Component Analysis (PCA). This allows for determination of which shape aspect is responsible for the
most variation.

A size series of different brands of shoes were utilized from a local shoe store. The shoes were scanned on a flatbed scanner at 300dpi with an ABFO scale in place. Landmarks were placed on the repeatable locations on elements seen on the soles, specifically at the outer edges. It was noted that there were detectable and predictable shape differences between the sizes in several models of shoes examined, but not all. Results indicated that as the element altered shape and/or position, size could be determined even with no scale in place. Distances from a suspect shoe to each of the shoes in a measured size series of shoes could be used to assign the suspect shoe to a specific size, without use of the scale information. The error level was roughly one half shoe size as could be expected due to variation in manufacturing processes.

The ability to use this method will be brand dependent as not all brands may have repeatable elements relative to size. The method does require a reference set of shoes of varying sizes by which a suspect shoe may be matched. Landmark selection and placement was highly critical in success of this method.

Forensic Science, Footwear Impressions, Geometric Morphometric Analysis

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