E2 Documenting Outdoor Skeletal Scatters Using Close-Range Photogrammetry (CRP): Testing the Number of Individual Coded Targets to Improve 3D Model Accuracy

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Learning Overview: After attending this presentation, attendees will have a better understanding of methods for improving 3D documentation of crime scenes in wooded environments when using CRP. In particular, this presentation will focus on whether incorporating individual coded targets throughout the scene in addition to photogrammetric scale bars with integrated coded targets improves the accuracy of the final 3D models.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by demonstrating methods for increasing the overall accuracy of CRP-generated 3D models when recording skeletal scatters in wooded environments.

CRP is commonly employed by archaeologists to record excavations and artifacts, and guidelines are well developed for archaeological applications. However, archaeological sites recorded using CRP are often different environments from those in outdoor wooded crime scenes. Therefore, the CRP methods employed by archaeologists to generate 3D models need to be tested in simulated forensic settings to better understand how photogrammetric techniques can be adapted for forensic contexts. One method for improving model accuracy that needs to be tested in a forensic setting is the application of individual coded targets. There does not appear to be consistency in archaeology regarding whether incorporating individual coded targets is necessary to generate accurate 3D models. Furthermore, archaeologists are often recording excavations with a cleaned, level, and homogeneously textured bottom surface and typically are not working in a wooded environment with a complex bottom surface. As a result, it is unknown if the addition of extra coded targets will improve accuracy of common forensic scenes with complex ground surfaces that are typical of most wooded environments. Therefore, the purpose of this research was to test the applicability of using extra coded targets in conjunction with scale bars that include integrated coded targets in a wooded simulated scenario.

One simulated forensic scene consisting of a slightly scattered composite human skeleton and clothing was constructed in an oak hammock environment with a ground surface consisting mainly of leaves. Cultural Heritage Imaging-calibrated photogrammetric scale bars were placed around the scene, and photographs were taken freehand using a Nikon® D7200 camera from five view angles while moving around the scene. Additional close-ups were also captured of individual bones and joint surfaces. The scene was photographed a total of four times while varying the number of extra coded targets (12, 8, 4, and 0) placed throughout the scatter. Images were preprocessed using Adobe® Bridge, and Agisoft® MetaShape Professional was then used to generate 3D models and orthomosaic maps of the scene. Accuracy of the 3D models was accessed using Root Mean Square (RMS) reprojection error, scale bar errors, and through visual examination of the 3D models.

Overall, all four models were highly accurate, regardless of the number of individual coded targets used. The RMS reprojection error values for each model did not vary significantly, with all four models achieving an error value close to 0.3 pixels. Additionally, the RMS reprojection error did not exhibit a trend that correlated to the number of extra coded targets. For example, Model 4 (zero extra targets) exhibited the lowest error at 0.335 pixels, while Model 2 (eight extra targets) had the highest at 0.371 pixels. However, there was a consistent trend of lowest total scale bar error for Model 1 (0.053mm) with 12 extra targets to the highest total scale bar error for Model 4 (0.142mm). While all four models achieved scale bar errors of less than 1mm, the level of visual error varied between the four 3D models. Additionally, the visual error does not appear to correspond with the number of extra coded targets because the cranium exhibited the least amount of visual distortion in Models 2 and 4, while it exhibited the most severe distortion in Model 1.

This research has demonstrated that using additional coded targets is not required for documenting forensic scenes with complex bottom surfaces when used in conjunction with scale bars with integrated coded targets. A challenge encountered during the documentation of the skeletal scatters was the varying lighting conditions throughout the day, which resulted in shadows. While this issue would be typical of a wooded scene, major lighting issues such as extreme shadows and highlights can be adjusted when preprocessing the images.

Close-Range Photogrammetry, Scene Documentation, Forensic Archaeology

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