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Validation of Rotoscoping Method for Two-Marker Bones in the Alligator Forearm

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Introduction

XROMM methods "re-animate" 3D skeletal motion of living animals by aligning digital bone models to X-ray videos. Surgically implanted markers permit automatic alignment of bone models if three or more markers are used. However, one of our specimens only had two markers implanted. These bones could be automatically positioned and partially oriented using the two markers but require manual alignment to the X-ray images to orient about the axis passing between the two markers. Here, we validated the method by digitally removing a marker from a 3-marker bone and comparing 2-marker to 3-marker reconstructions of elbow motion for 145 x-ray images.

Anatomical and Axis Models

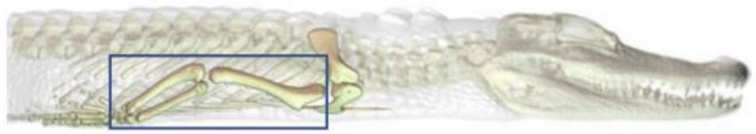

Figure 1. Alligator elbow joint. The elbow consists of articulations between three bones forming the humero-ulnar joint, humeroradial joint, and radio-ulnar joint. In this study, we limit our focus to radius.

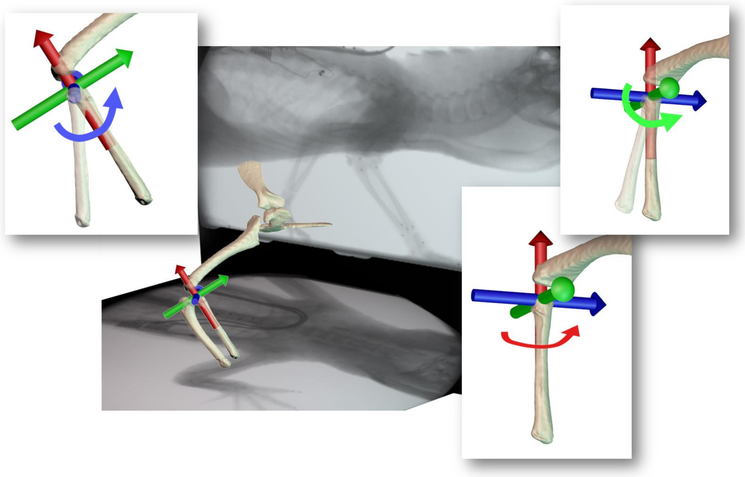

Figure 2. Alligator bone model aligned with 2 cameras X-ray imaging. In the bone models, the red arrow is showing the x-axis of rotation (long axis). The green arrow is showing the y-axis rotation (abduction/adduction). The blue arrow is showing the x-axis of rotation (flexion/extension).

3-Markers vs. 2-Markers on Radius

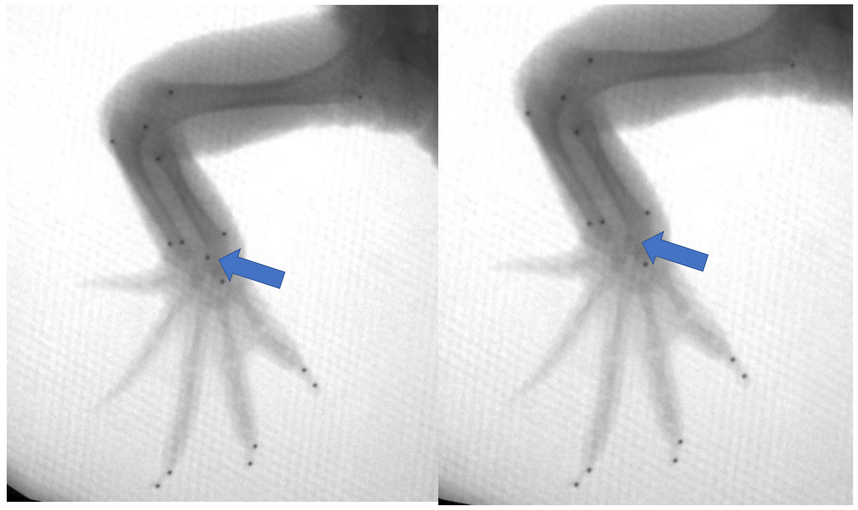

Figure 3. Example of the marker being removed from the radius of the 3-marker alligator from image on the left to the image on the right. The blue arrow points to the marker that was removed using Photoshop.

Motion Graph Frame by Frame

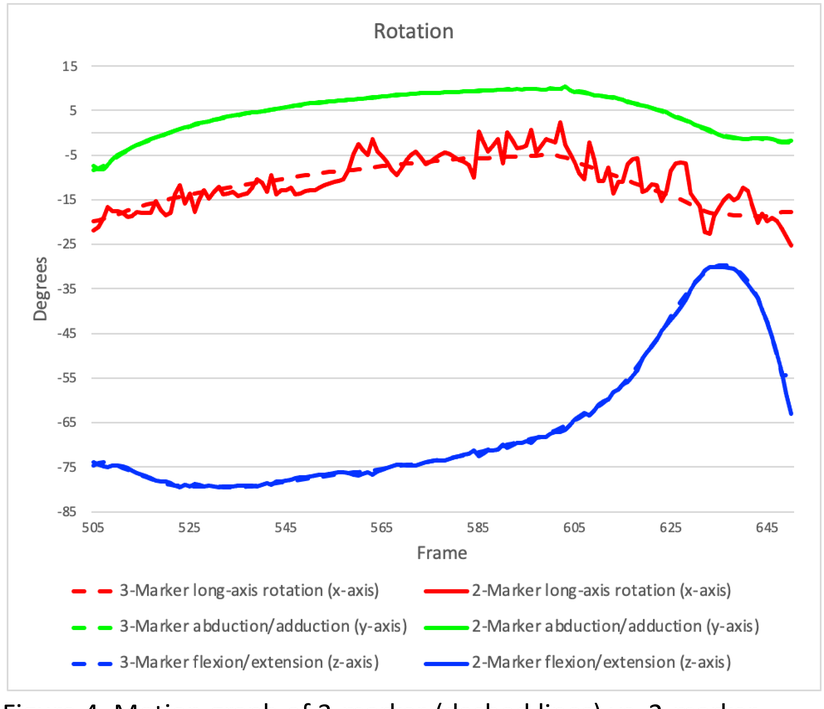

Figure 4. Motion graph of 3-marker (dashed lines) vs. 2-marker (solid lines) alligator after rotoscoping. The x, y, and z-axis were plotted and compared per frame. We manually adjusted the long-axis (red line) in the 2-marker images while rotoscoping.

Standard Deviation per Axis

3-Marker/2-Marker Differences	Standard Deviation
Rotation X-Axis (Degrees)	±3.08
Rotation Y-Axis (Degrees)	±0.16
Rotation Z-Axis (Degrees)	±0.89

Table 1. The difference was taken from each frame of each axis of rotation. The average of each difference was then taken. The standard deviation was then found of each axis and is presented above.

Conclusions

We found that two-marker rotoscoping produced similar results to three-marker rotoscoping. Although three-markers are the preferred method, the two-marker alligator provides us with useful and adequate data. Manually rotoscoping and adjusting the x-axis (long-axis rotation) has very similar results to three-marker validation.

Future Research

In the future, we should check the accuracy of the bone models and correct them to make them as realistic as possible. Correcting the models will allow for more precise matching to the shadows and realism.

References

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