Making a Mark With Markerless Motion Capture for Spine Kinematics

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INTRODUCTION

- Most lab-based motion capture systems are expensive, highly technical, and require instrumentation affixed to the body.
- DeepLabCut (DLC) is a markerless motion capture solution utilizing deep learning and artificial intelligence algorithms.
- DLC has been developed to track animal kinematics [1] and may be utilized to track the movement of the spine.

PURPOSE

To assess precision and accuracy of DLC relative to a gold standard motion capture system with dynamic elbow and spine flexion.

METHODS

- 14 participants (6 male, 8 female) were recruited to attend 1 experimental visit.
- An 8-camera infrared Vicon-system [2] with synchronized video was used to track the 3D locations of a markers placed on T12, S1 and arm.
- Video data were used as inputs to DLC [3]. Participants were partitioned into training and testing groups
- Training is facilitated through the use of a neural network Figure 1.
- Training videos were labelled manually and used evaluate specific anatomical landmarks across all videos (Figure 2).
- The model developed from the training group was evaluated on the testing group, including new data.
- Data from both approaches was evaluated to estimate relative lumbar and elbow flexion/extension movements (Figure 2). Precision and accuracy of data obtained from DLC was compared to data obtained from Vicon

RESULTS

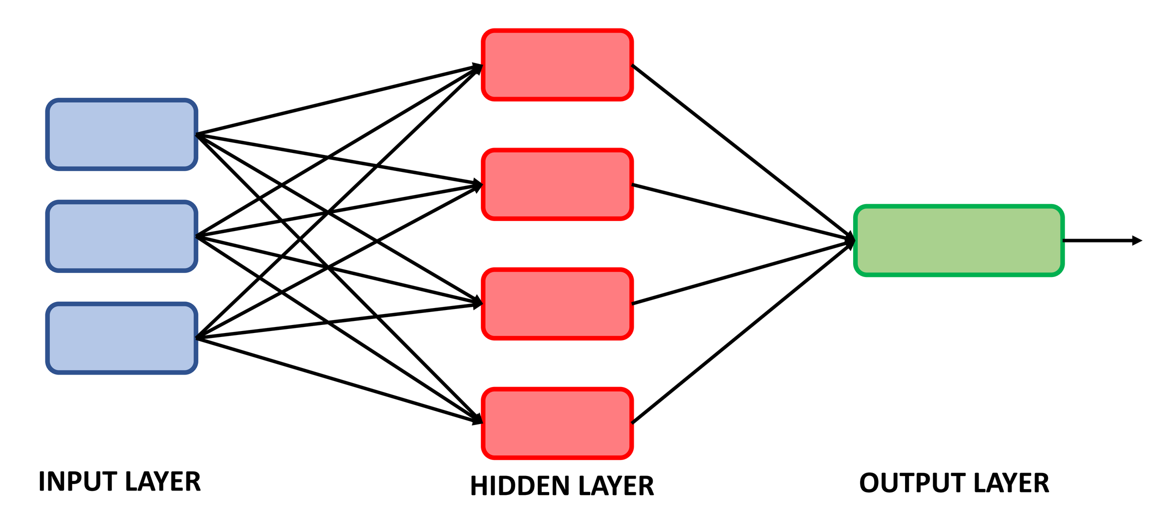

Figure 1: Basic neural network architecture.

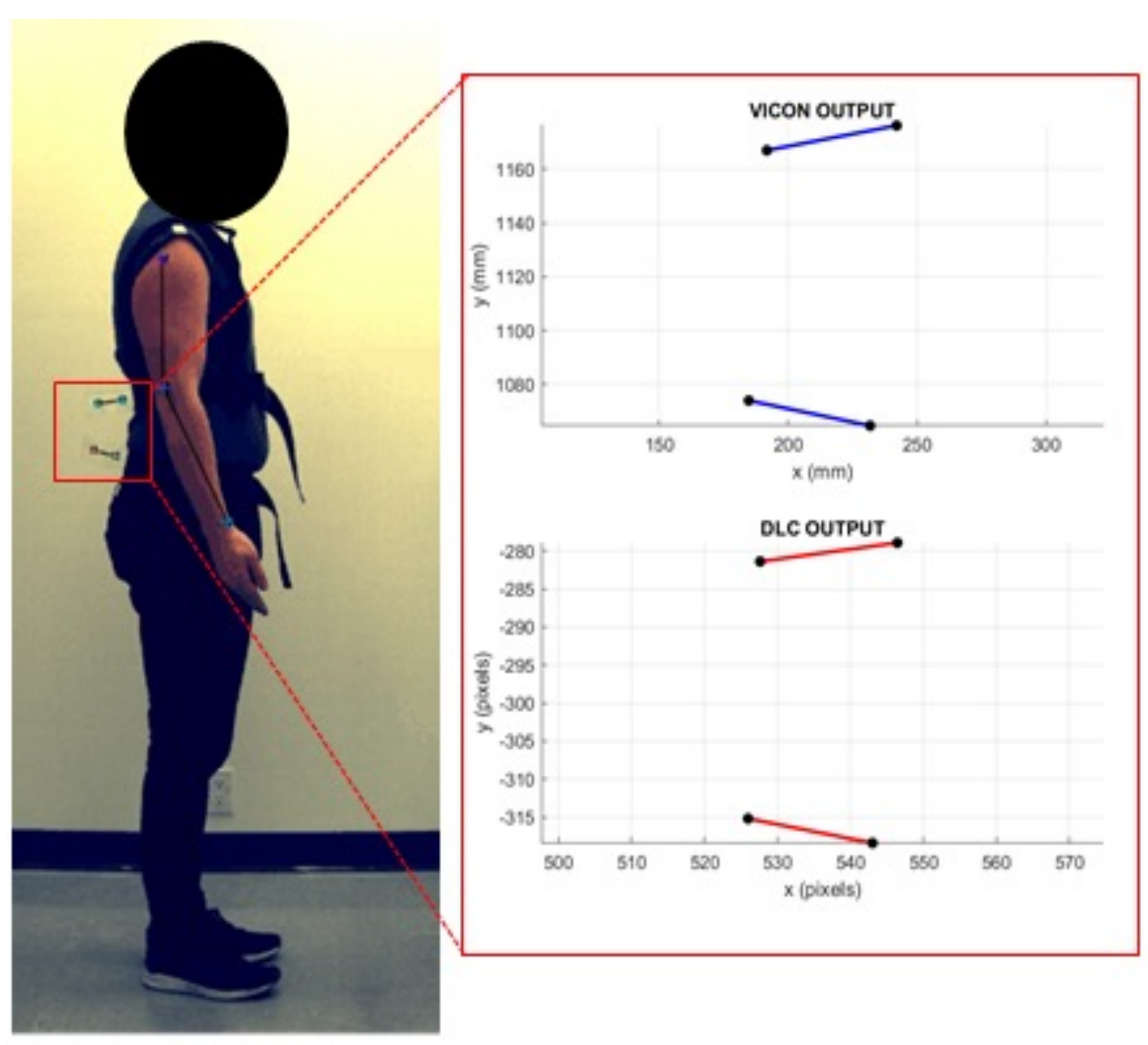

Figure 2: Example of Labelling Procedure in DLC.

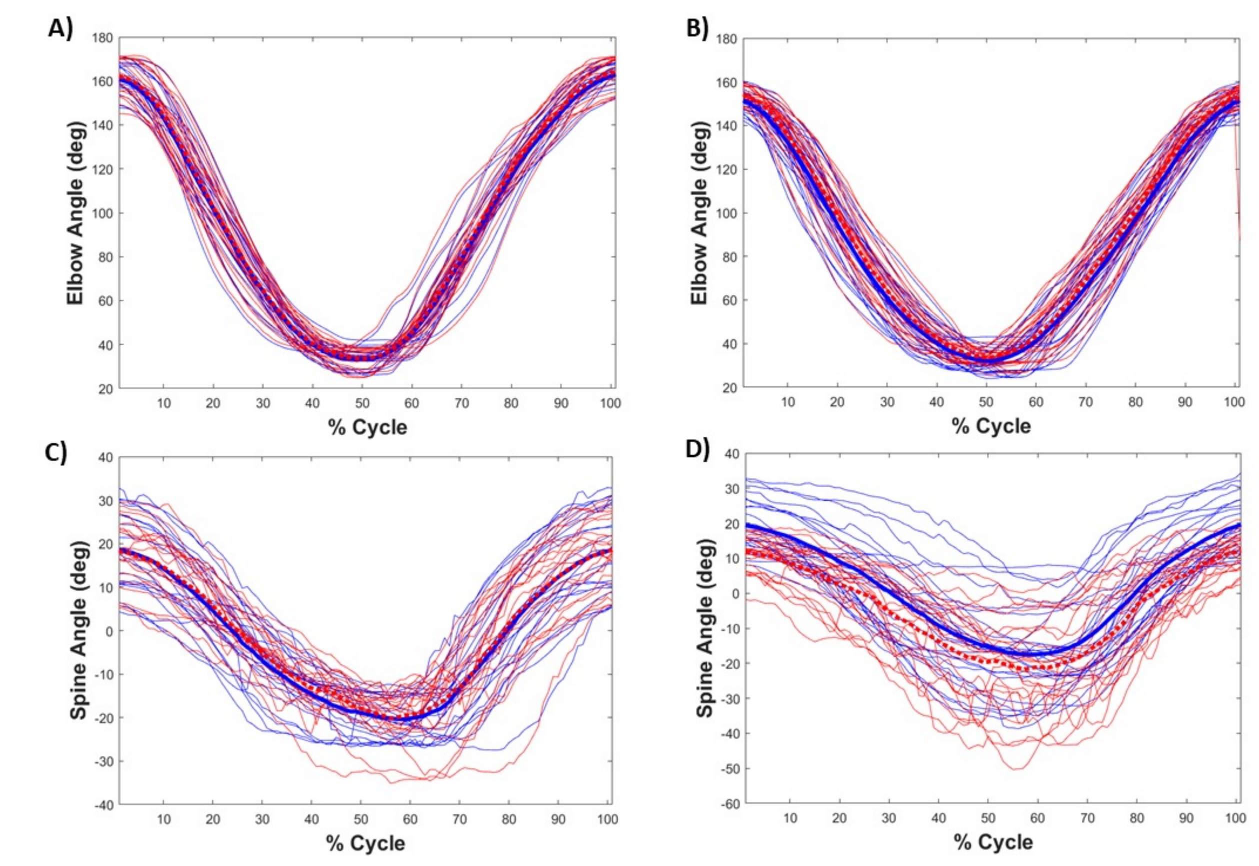

Figure 3: Comparison of Accuracy of DLC vs. Vicon.

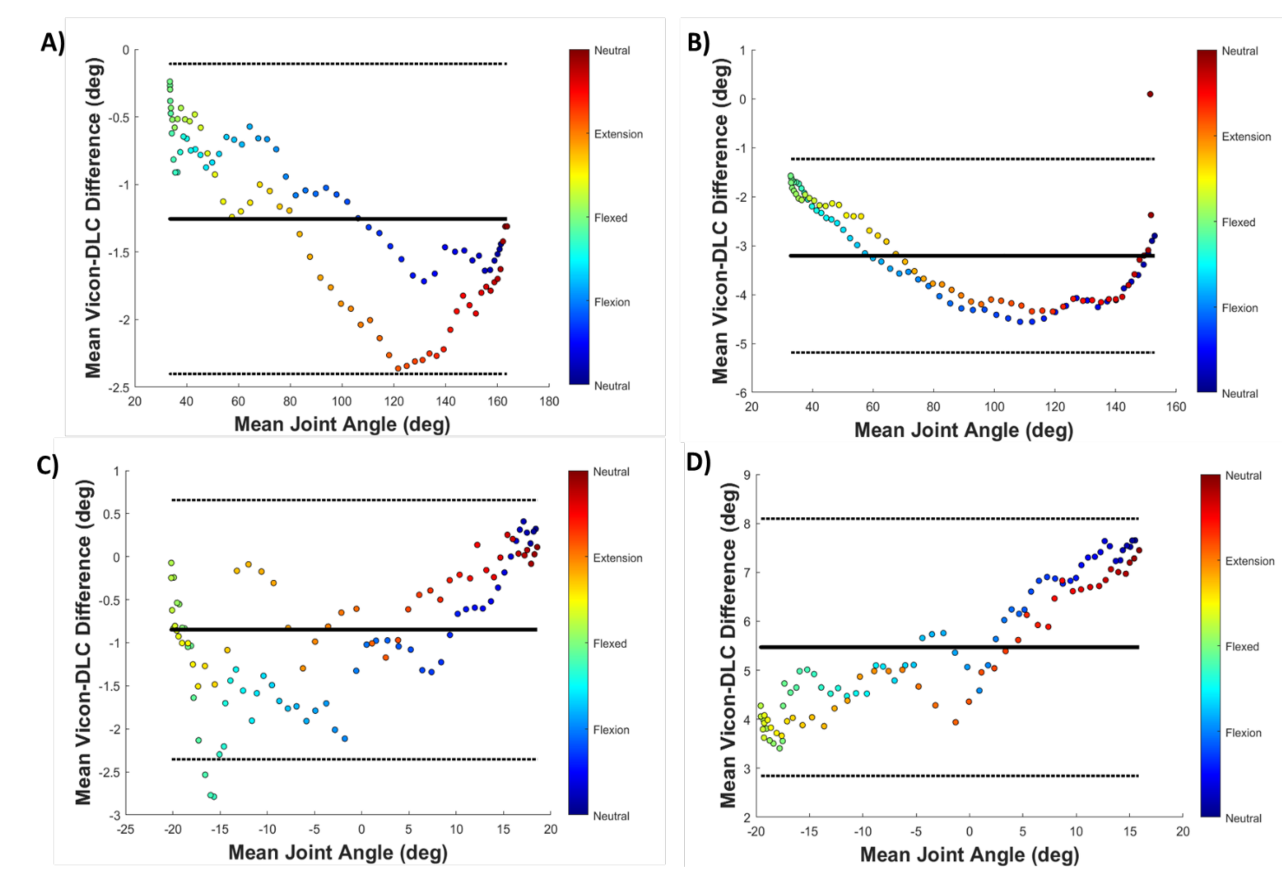

Figure 4: Bland Altman Plots Depicting Bias & LoA.

- No significant differences were detected between DLC and Vicon, nor were any higher order interactions detected between the motion capture modality and the training vs. testing sets (Figure 3).
- For the analysis of time-varying elbow flexion-extension angles the mean bias was -1.25° for the training set and -3.21° for the testing set (Figure 4).
- For the analysis of time0varying spine flexion-extension angles the mean bias was -0.85° for the training set and 5.47° for the testing set.

CONCLUSIONS

- DLC-derived planar flexion-extension angles of both the elbow and spine are of acceptable accuracy when compared to laboratory gold standards.
- This novel, non-invasive method of motion capture does not require video from expensive equipment, encouraging the use of the technology in field-based environments [4].
- Further work is needed to evaluate the performance of these methods under different movement scenarios, including movements in different anatomical planes.

REFERENCES

[1] Nath et al.(2018). *bioRxiv*, 476531.
[2] Perrott et al. (2017). *Gait & Posture*, 52, 57-61.
[3] Zwambag et al. (2019). *Journal of Biomechanics*, 86, 89-95.
[4] van der Kruk et al. (2018). *European Journal of Sport Science*, 18(6), 806-819.

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