Markerless Motion Analysis: Evaluation of OpenPose software for clinical gait analysis

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Introduction

- Motion analysis plays a crucial role in clinical, research, and rehabilitation settings [1].
- Markerless motion capture (MMC) could offer a cheaper, quicker and more accessible alternative to movement analysis than marker-based approaches [2].
- OpenPose is an open-source human pose estimation software which could potentially be used as part of a markerless approach.

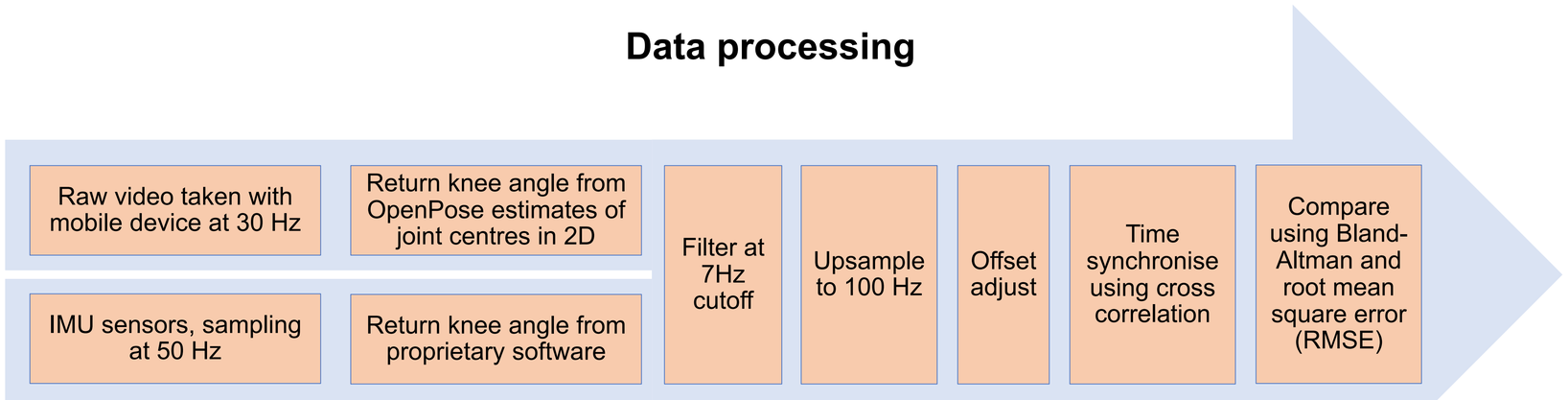
Aim

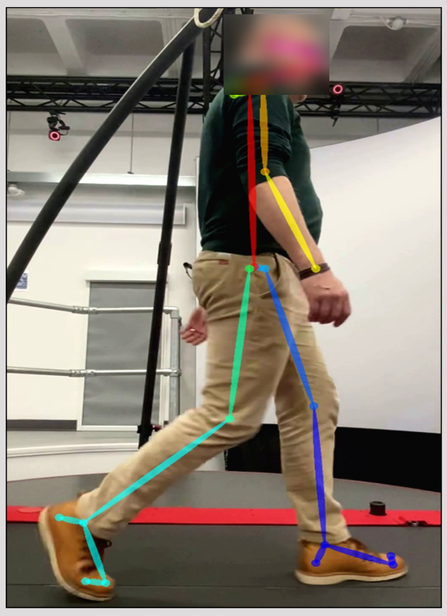
- To determine the performance of OpenPose as an alternative movement analysis approach for knee flexion.

Experimental Methods

- 14 able-bodied people volunteered (M = 10, F = 4)
- Sagittal plane video was acquired of ~2 minutes of walking
- IMU (MotionSense, Stryker) provided ground truth knee angles

Data processing





Results

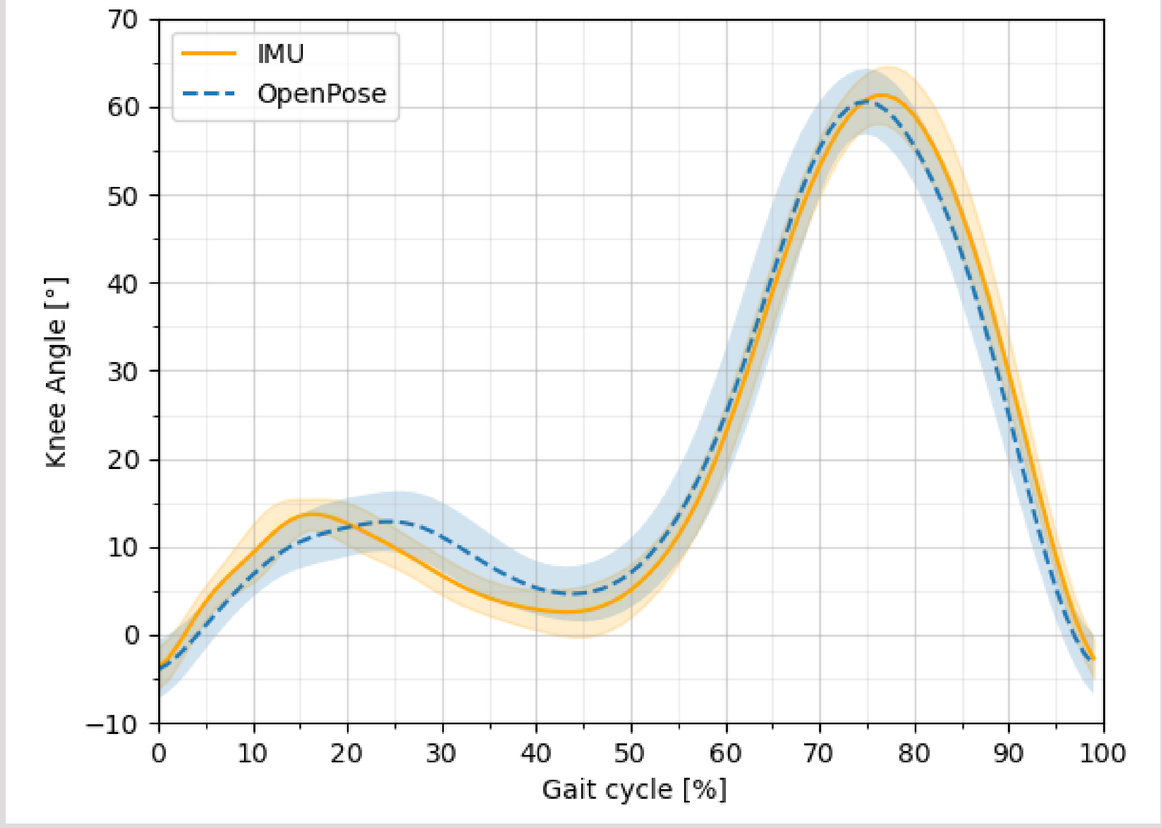


Figure 1. Mean knee flexion (+/- 1 standard deviation, n = 15)

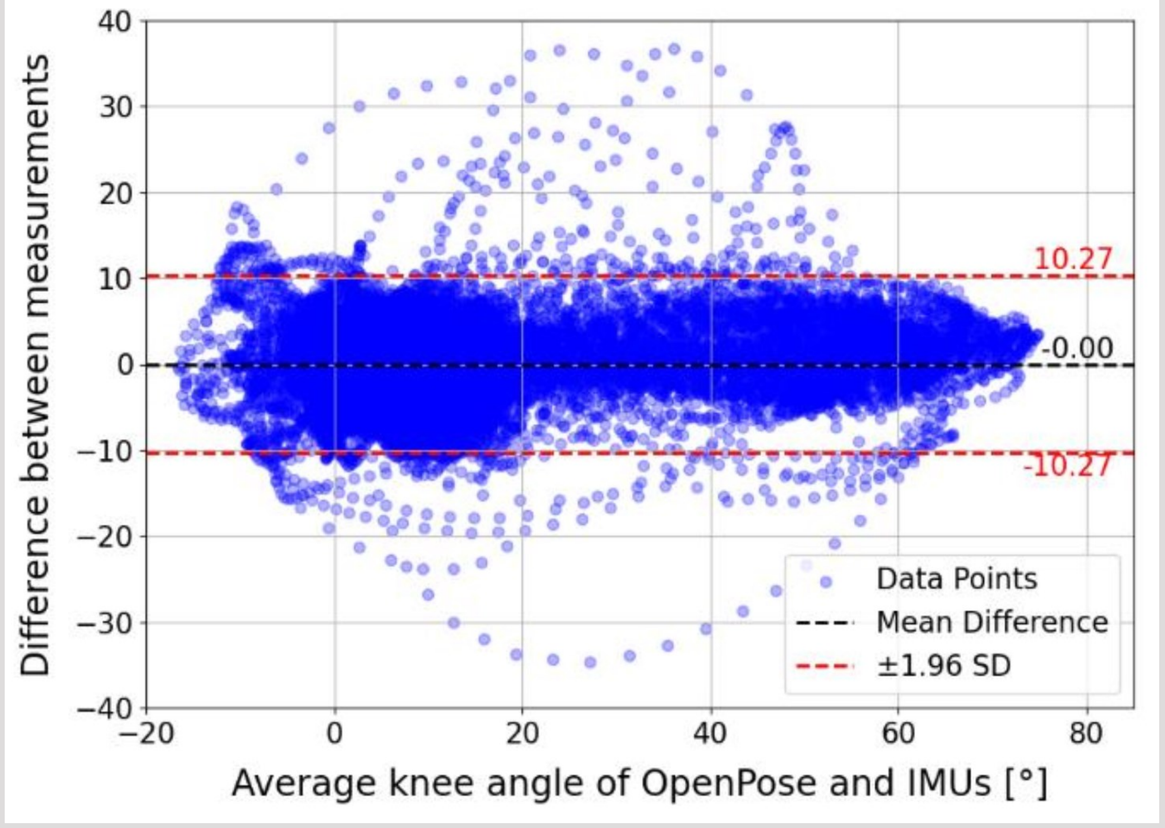


Figure 2. Bland-Altman comparison of the technologies

- Knee angle estimates from MMC demonstrated high correlation to the IMU-based approach in all cases ($r > 0.97$, $p < 0.01$) with a mean RMSE of 3.98° (Figure 1).
- The Bland-Altman analysis (Figure 2) showed homogeneity of the difference with knee angle with a 95% confidence interval of 10.3°.
- Infrequent mismatches were evident and, anecdotally, it was noticed that OpenPose performed better when the participant's face was visible in the video.

Conclusion

- MMC pose estimation algorithms show potential to be used in clinical settings for sagittal plane knee flexion measurements.

References

[1] Khera, P. and Kumar, N. (2020). J. Med. Eng. & Tech., 44(8), pp.441–467.
[2] Wade, L. et al. (2022). PeerJ, 10 (e12995), p.e12995.