Tracking the Future: An Augmented Reality Approach to Visualizing and Measuring Biomechanics In Near Real Time

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Context

- My work on this project is a continuation of the work done by Mathew Sielecki.
- Gait analysis and motion tracking equipment can cost thousands of dollars and usually, must be carefully set up inside a dedicated room. [2]
- The majority of physiotherapy patients do not perform their given exercises. [1] A cheap Augmented Reality (AR) application could help.
- An AR device is portable, can be used alone, or by a coach, and in any location.
- Goal to use AR (Augmented Reality) devices to calculate and visualize joint angles (see Fig. 1)

Methods

- One popular method of body tracking is using infrared cameras and reflectors.
- New methods of computer vision tracking have emerged with the help of deep neural learning. [3]
- Openpose is one of these libraries and it uses cameras for 2D and 3D pose estimation.
- This project uses Openpose 2D and the Hololens' depth camera to measure the body and calculate joint angles.(See Fig. 2)
- Using an AR headset allows for 3D models to be placed in world space, giving users an instant visualization of their body's position.

Results

- Targets can be tracked in 2D space at a rate of ~10-12 frames per second, and 3D space at a rate of ~1-2 frames per second.
- TCP is used by the Hololens and computer to communicate together. The speed of this code was improved but could be refined further.
- Extrapolation of previous positional data in between frames is used to create a more fluid visualization.
- In time, the headset could allow for coaches and doctors to see the joint angles of their patients. Currently patients can also look in a mirror to assess themselves.
- As it stands the program can calculate joint angles from the hips down. Future co-op students in the lab will write code for the rest of the body. The system can then be compared against the labs infrared tracker system.

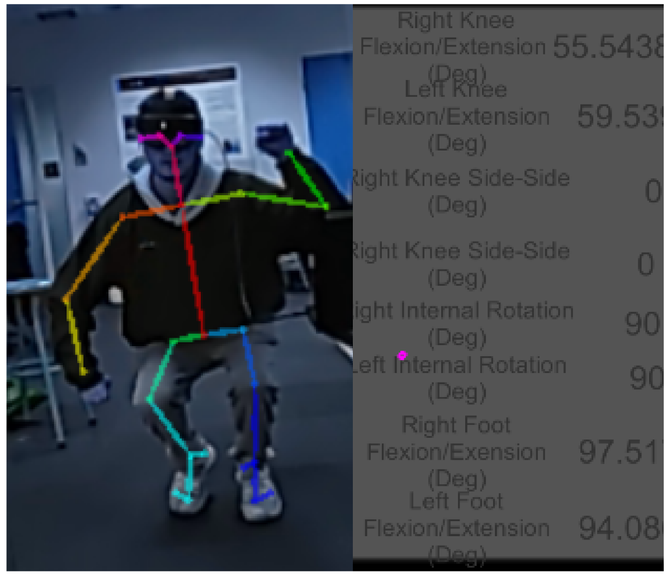

Fig 1. 3D joint information displayed on top of image

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Discussion

- 3D body tracking for biomedical research is a challenging problem that usually requires expensive and stationary systems.
- The field of computer vision is expanding rapidly with advances in machine learning. However, because they have yet to be fully tested they are not in widespread use. [4]
- Computer vision has problems such as clothing and weather conditions. As machine learning improves we may see more body tracking alternatives.
- Systems that lower price and increase portability will increase the accessibility of body tracking for biomedical research, but they should only be considered after their accuracy compared to the currently used, tracker based systems can be tested fully.

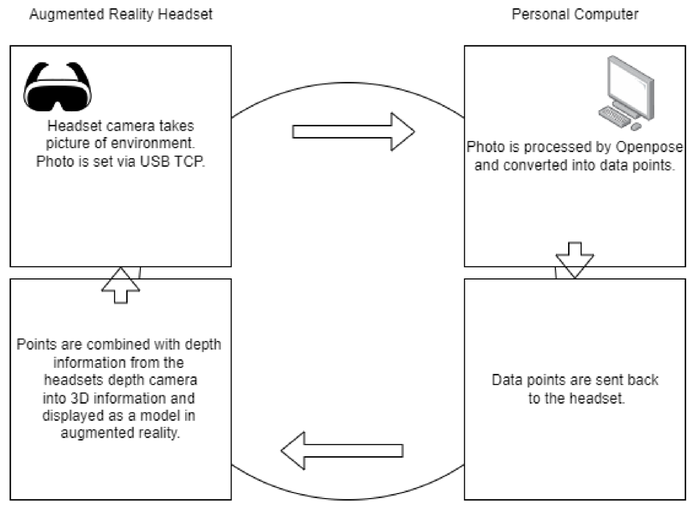

Fig 2. Diagram visualizing the flow of information to and from the AR headset and computer

References

[1] R. Campbell et al. Journal of Epidemiology & Community Health, 2023.
[2] A. Muro-de-la-Herran, B. Garcia-Zapirain, and A. Mendez-Zorrilla, Sensors 2023.
[3] Hanwen Wang et al. Journal of Biomechanics 2023.
[4] S. L. Colyer, M. Evans, D. P. Cosker, and A. I. T. Salo, SpringerOpen, 2023