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Magic Mirror with RGB-D Camera

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Abstract

Current methods of medical and anatomical education experienced a shift during the COVID-19 pandemic with a decrease in hands-on experiences, resulting in many missing experiences for medical trainees.[1] 21st century technologies have introduced a rapidly changing education landscape that provide a wealth of opportunities to enhance traditional learning methods. There is evidence that interactive education experiences like the AR Magic Mirror significantly enhance educational experiences for medical students, especially in the case of students with low mental rotation scores.[2] This project demonstrates an extension of the methods and concepts in the AR Magic Mirror technology to a Unity 3D application with support for RGBD cameras. It reveals successful implementation of joint mapping and model overlay for a human muscle model, thus showing promise for being a useful educational tool for anatomical visualization.

Method

- Joint coordinates were tracked using the a deep learning model MoveNet integrated in DepthAI plugin[3] for Unity3D, as the plugin has support for OAK-D Lite and integration with Unity.
- 2D joint coordinates were then extracted from the plugin's JSON output and smoothed using a low pass filter, and overlay of the .fbx models was done using point mappings of the 2D coordinates to positional values of the models' "Armature" joint systems. Rotational movements of different sections within the models were found to be best controlled by calculated angles between the 2D coordinates.
- Initial proof of concept for joint mapping and model overlay was done with a unit skeleton model consisting solely of lines between joints in the "Armature" system.
- Overlay of the muscle model was attempted by directly corresponding its "Armature" system to that of the unit skeleton. However, adjustments to coordinate mapping and model part scalings were necessary due to differences within the "Armature" systems and disproportionate stretching of the anatomy by the joint mappings.
- Visualization of the muscle model was further enhanced with Unity materials and the option to toggle the transparency and active states of various subregions within the anatomy.

Results

The created Unity application successfully extracts and maps joint coordinates tracked from the OAK-D Lite camera input to the human muscle model in Unity 3D. The model follows limb movements and bends in the elbow (Fig. b), and the subject's orientation (leaning side to side and forward or backward) is successfully visualized by the position of the model. Alterations to the visualization such as transparency (Fig. b), tissue patterned materials, and a menu for toggling active states for subsections of the model were successfully implemented.

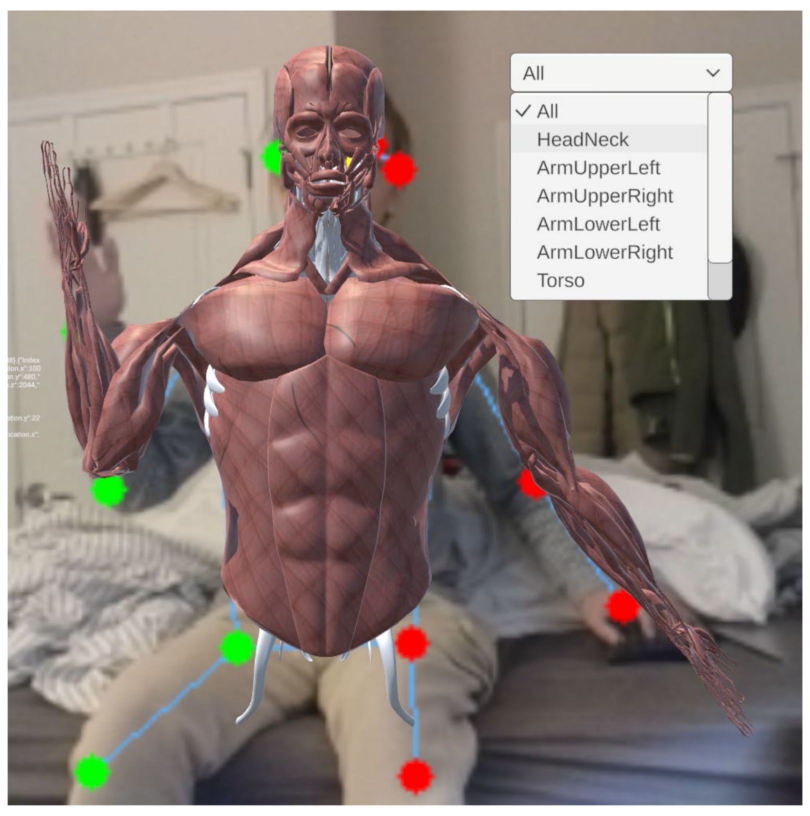

Fig. a (above): opaque muscle model overlay with the right arm bent at the elbow

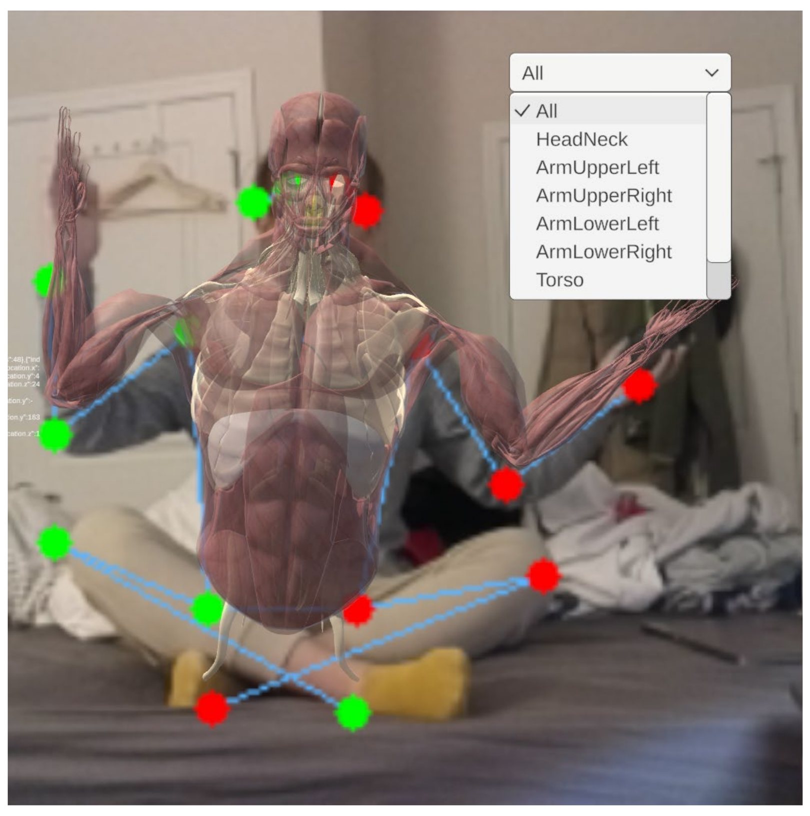

Fig. b (above): partially transparent muscle model overlay with both elbows bent

Conclusions

This project demonstrates integration of Unity3D models with joint tracking data to create a tool for visualizing anatomical models in augmented reality. It shows promise for RGBD camera based augmented reality as a worthwhile addition to anatomy and radiology education, as it reinforces the feasibility of overlaying models on a human body to visualize where various anatomical locations are. This augmented reality application can provide a higher level of interactive experience than traditional textbook viewing for anatomical learning. Further extensions of this project would include the activation of the leg portions of the muscle model, visualizations of other anatomical systems (e.g. skeletal or vascular system models), visualizations of cross sectional images in relation to the 3D anatomical model

[1] O. Oyeniran, "Sourcing and Availability of Cadavers for Anatomical Dissection Amid Covid-19 Pandemic: Safety Challenges and Possible Solutions," THE ULUTAS MEDICAL JOURNAL, vol. 6, p. 188, Jan. 2020, doi: 10.5455/umj.20201103113120.
[2] F. Bork et al., "The Benefits of an Augmented Reality Magic Mirror System for Integrated Radiology Teaching in Gross Anatomy," Anatomical Sciences Education, vol. 12, no. 6, pp. 585–598, 2019, doi: 10.1002/ase.1864.
[3] G. Espona, "depthai-unity-plugin." Oct. 11, 2022. Accessed: Dec. 09, 2022. [Online]. Available: https://github.com/gespona/depthai-unity-plugin