



Teaching a Robot to Conduct the Band

Alex Gibson, Courtney Pater, Donovan Johnson, Christian Hubicki, Ph.D.

FSU-FAMU College of Engineering



Introduction

- Digit is a bipedal humanoid robot designed by Agility Robotics.
- Digit is fitted with technology that makes it capable of both locomotion and manipulation (legs and arms)
- In this project, we explore Digit's capabilities by using it to emulate the motions of a marching band conductor.
- Our task is to implement conducting patterns on Digit's hardware.
- Conducting patterns are complex and vary with both time signature and tempo.
- Digit should be steady enough to keep a constant beat but should also be flexible enough to change tempos should the need arise.

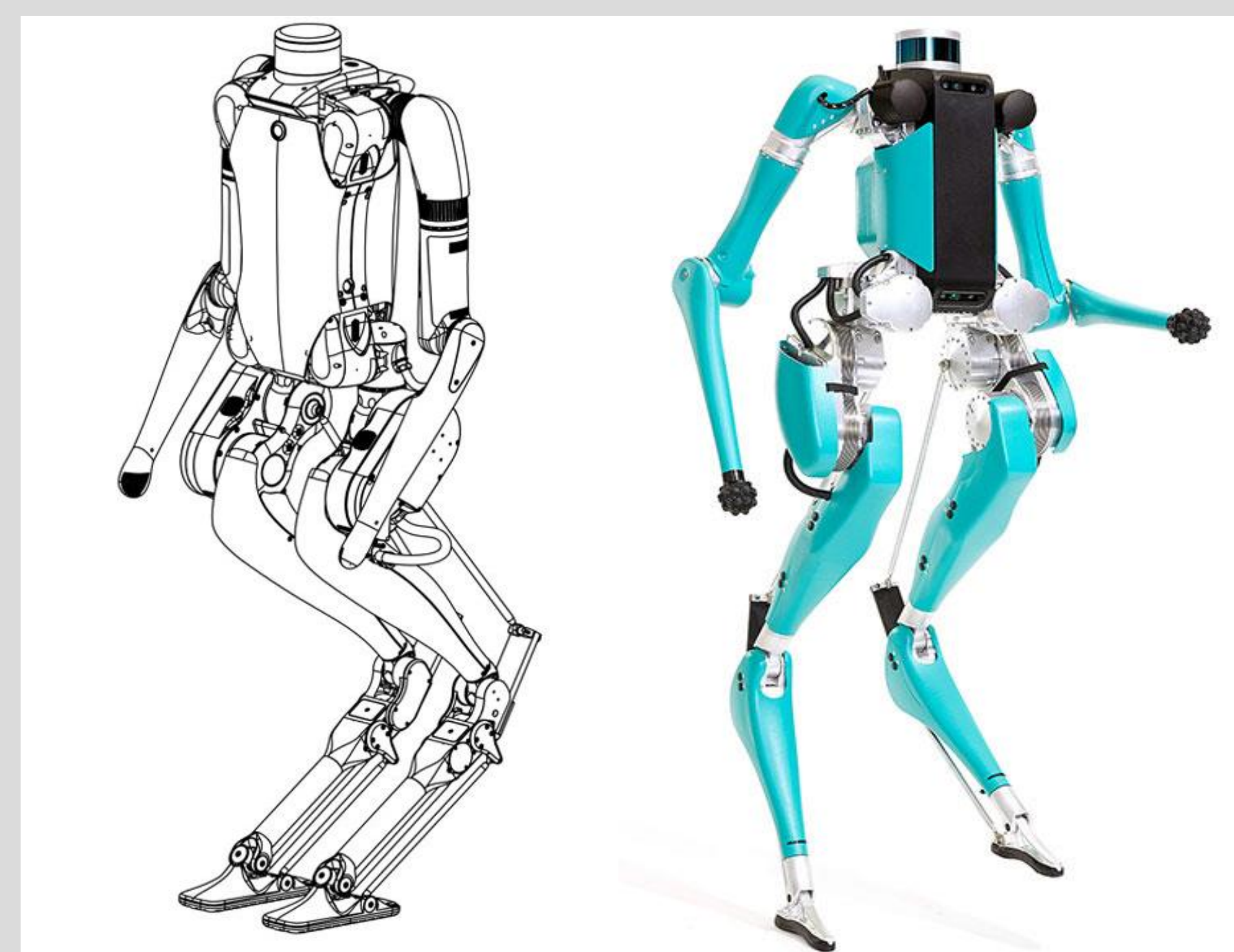


Figure 1: Design sketch and photograph of the DIGIT robot

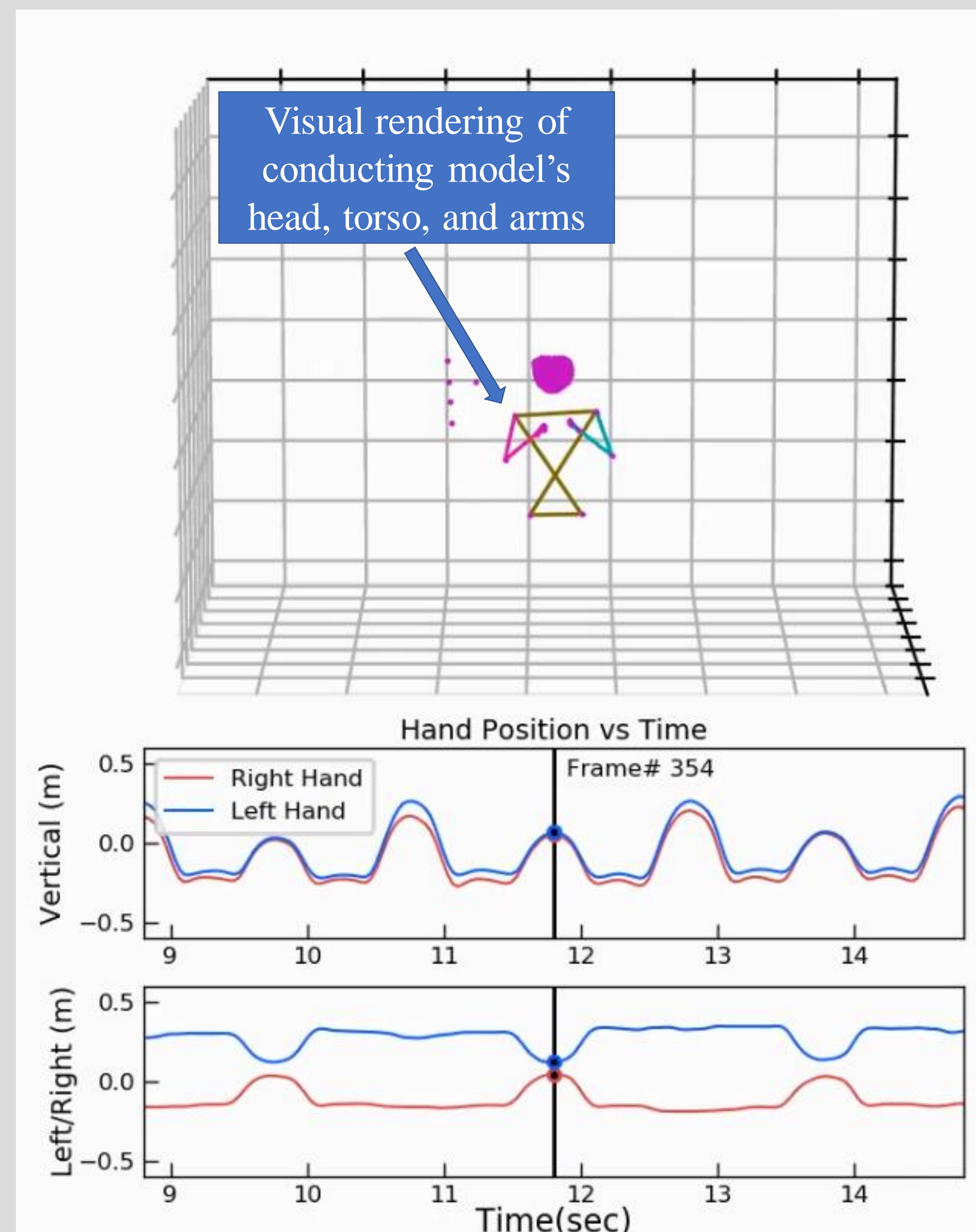


Figure 2: Data collected from a conducting performance using the motion capture software Freemocap. Data is captured in real time in three dimensions and is converted into X, Y, and Z coordinates.

References

Brandon E. Jackson, Dennis J. Evangelista, Dylan D. Ray, Tyson L. Hedrick; 3D for the people: multi-camera motion capture in the field with consumer-grade cameras and open source software. *Biol Open* 15 September 2016; 5 (9): 1334–1342. doi: <https://doi.org/10.1242/bio.018713>

Mistry, M., & Righetti, L. (2012, June). Operational space control of constrained and underactuated systems. In *Robotics: Science and systems* (Vol. 7, pp. 225-232).

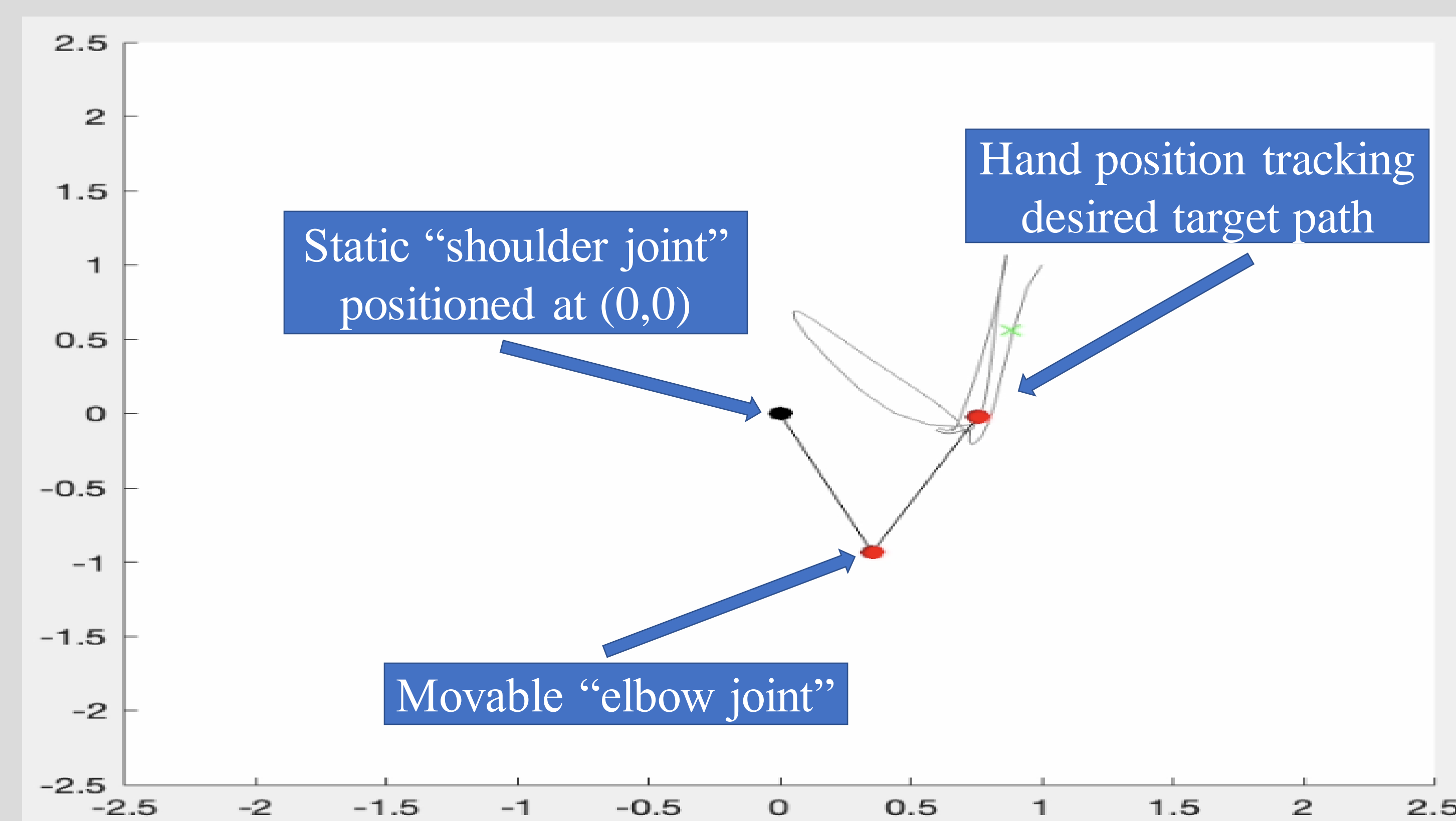


Figure 3: MATLAB simulation of a robotic arm replicating a human conducting motion. Using an operational space controller, the arm tracks data captured from the human performance. This is a proof of concept for future Digit control.



Figure 4: For videos and animations of our work, scan this QR code.

Methods

- Using motion capture software, we translated a simple 4/4, 120 BPM conducting pattern into 3-dimensional coordinate data.
- To improve time resolution, we linearly interpolated to create thousands of additional points in-between each recorded point.
- Imported performance data into MATLAB for simulated proof-of-concept controller.
- Use an operational space controller to track performance data in real time.
- Create a program that allows a user to adjust the speed of the pattern on the fly.

Next Steps

- Now that we have a virtual simulation, we can test our program on the physical hardware of Digit.
- Eventually we hope to implement programmable routines, musical cues, and more styles of conducting patterns.
- The end goal of the project is to arrange for a private rehearsal with a real marching band, followed by a public performance.

Acknowledgements

- We would like to thank Ford Motors as well as the FAMU-FSU College of Engineering for supporting our work.