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A PRELIMINARY STUDY OF A MOTION CAPTURE SYSTEM USING SMARTPHONES FOR THE ANKLE ANALYSIS

Undergraduate Aggie Challenge Project

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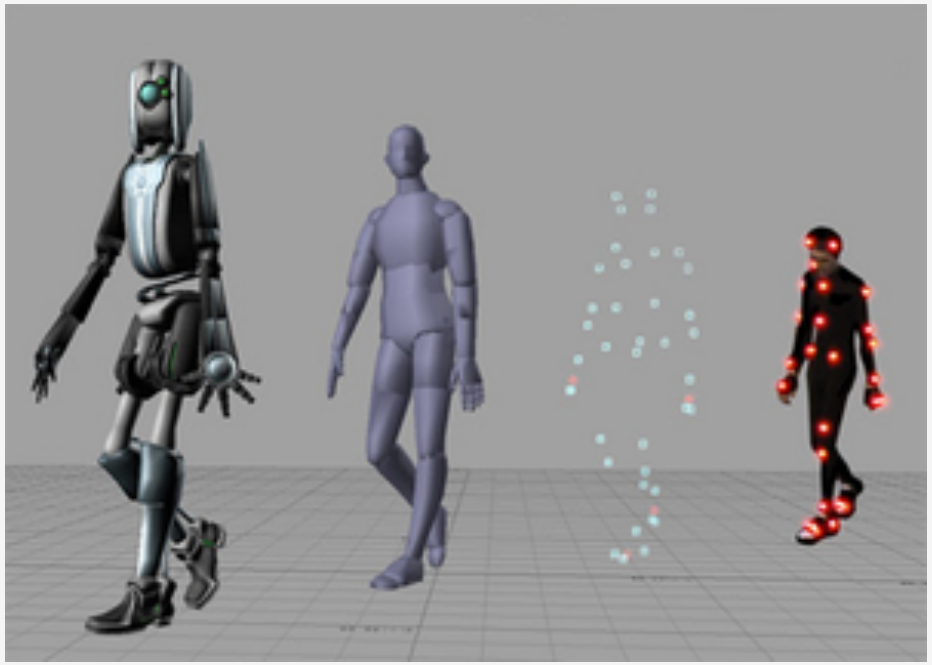
Introduction

- Motion capture (MoCap) systems are widely used to analyze human movement in the field of robotics or biomechanics
- Conventional MoCap technology (e.g., Vicon) requires an expensive setup and a well-controlled space



Research Objective

- We want to propose a smartphone-based motion capture system that will be more portable and accessible than currently available MoCap systems

Research Focus

- Show the feasibility of using smartphones for motion capture purposes
- Analyze the ankle kinematics using the proposed method

Proposed Method

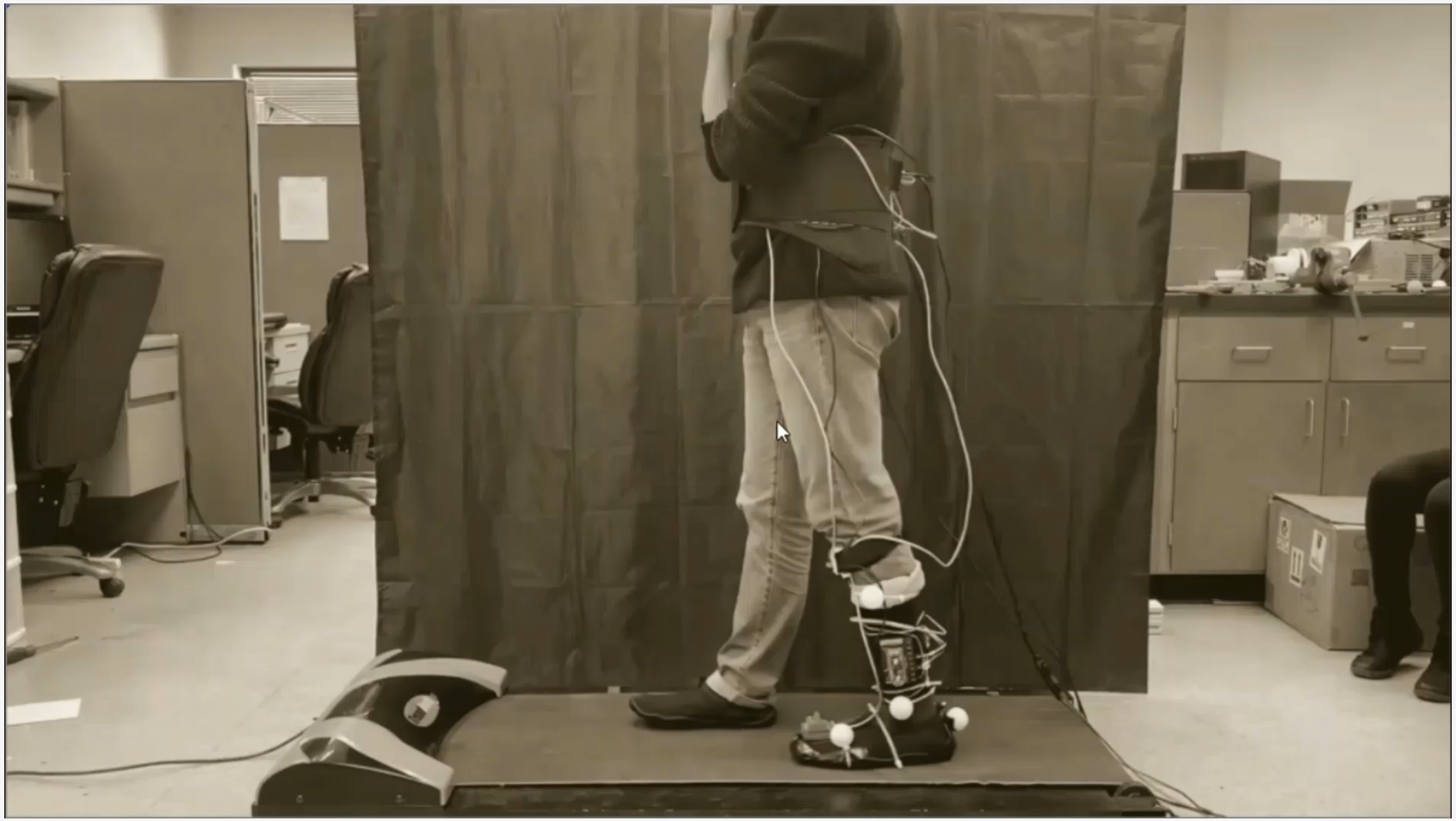
1. Capture motion tracking data with a minimum of two smartphone cameras and a reference frame for calibration purposes
2. Find the relation between coordinates by the Direct Linear Transformation (DLT) Method[1]
3. Validate the data

[1] Y. Kwon, 1998

1. Motion Tracking

- Use at least two cameras and a reference frame
- Each of the two cameras provides 2D position data
- 3D position is obtained by combining two 2D position data sets
- Reference frame allows for cameras to be positioned anywhere space allows, as long as their location remains constant after calibration

1. Motion Tracking Video



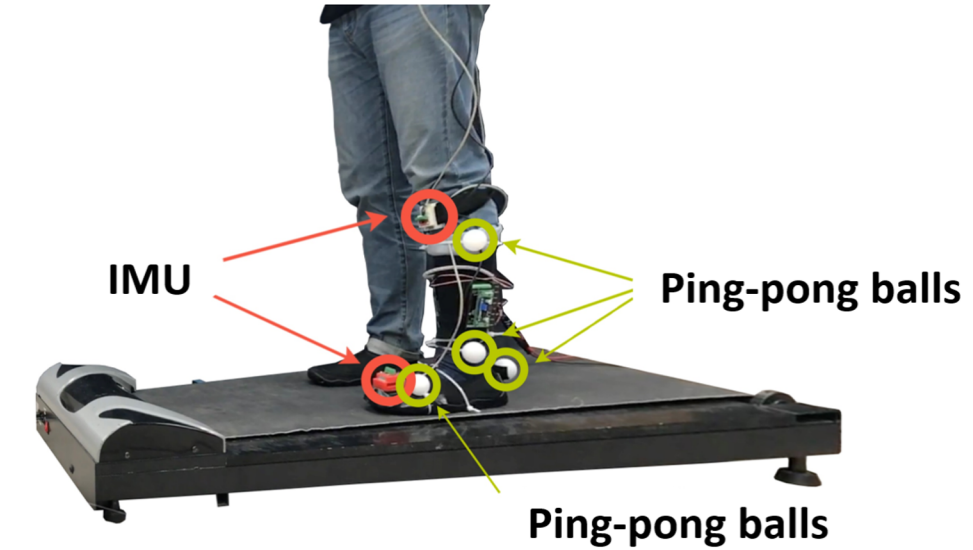
2. Direct Linear Transformation (DLT)[1]

- Method for determining the 3D location of objects using two or more views
- Requires known points for calibration
- Utilizes sets of similar relations derived from known points to solve for variables

[1] Y. Kwon, 1998

3. Data Validation

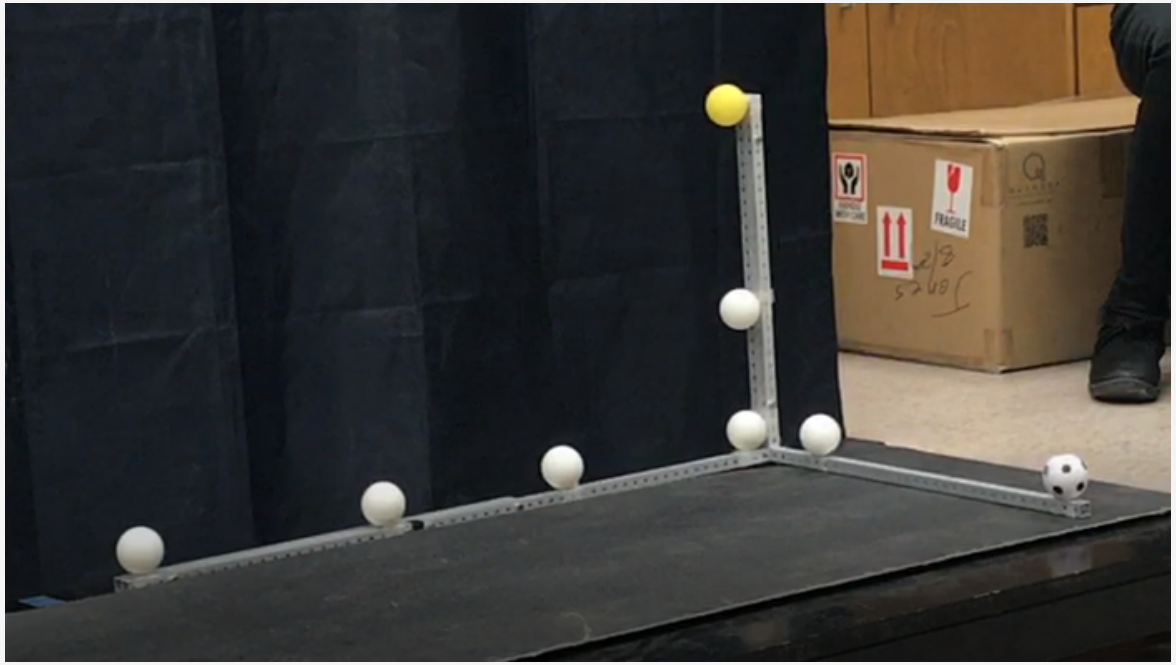
- Uses motion tracking software to track motion data of each data point
- Calculates joint angles with motion data obtained
- Compares our MoCap system result with the result from IMU system[2]

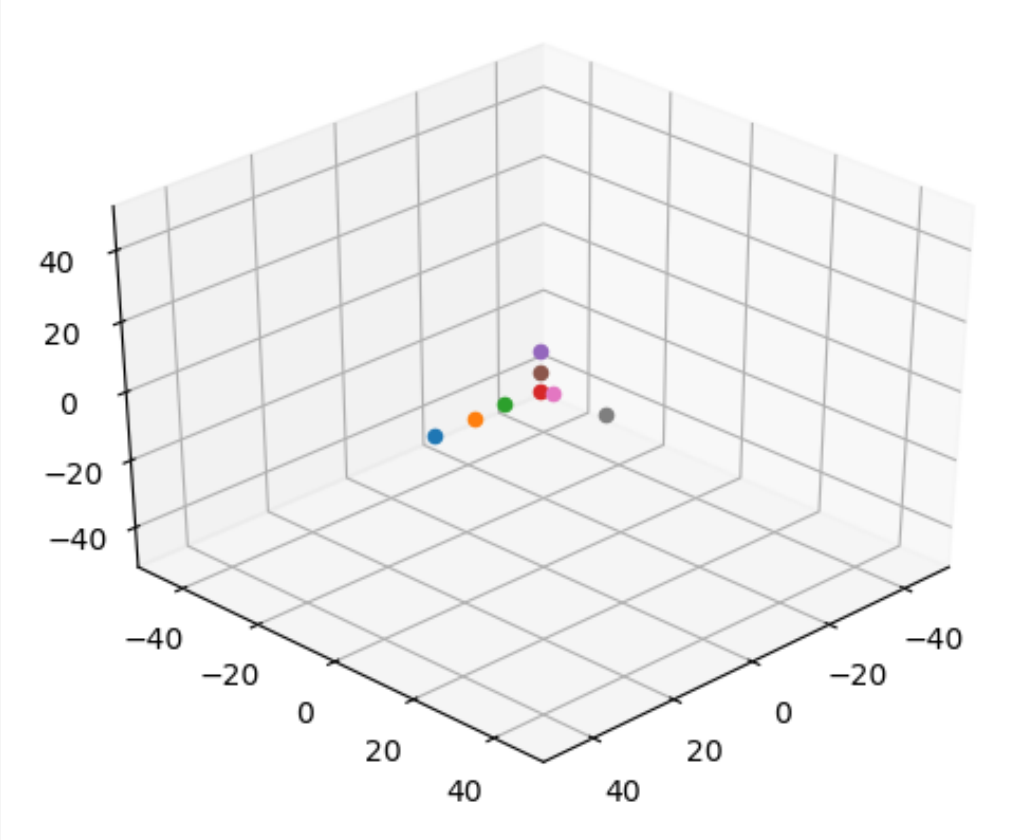


[2] W. Hong, et al., 2019

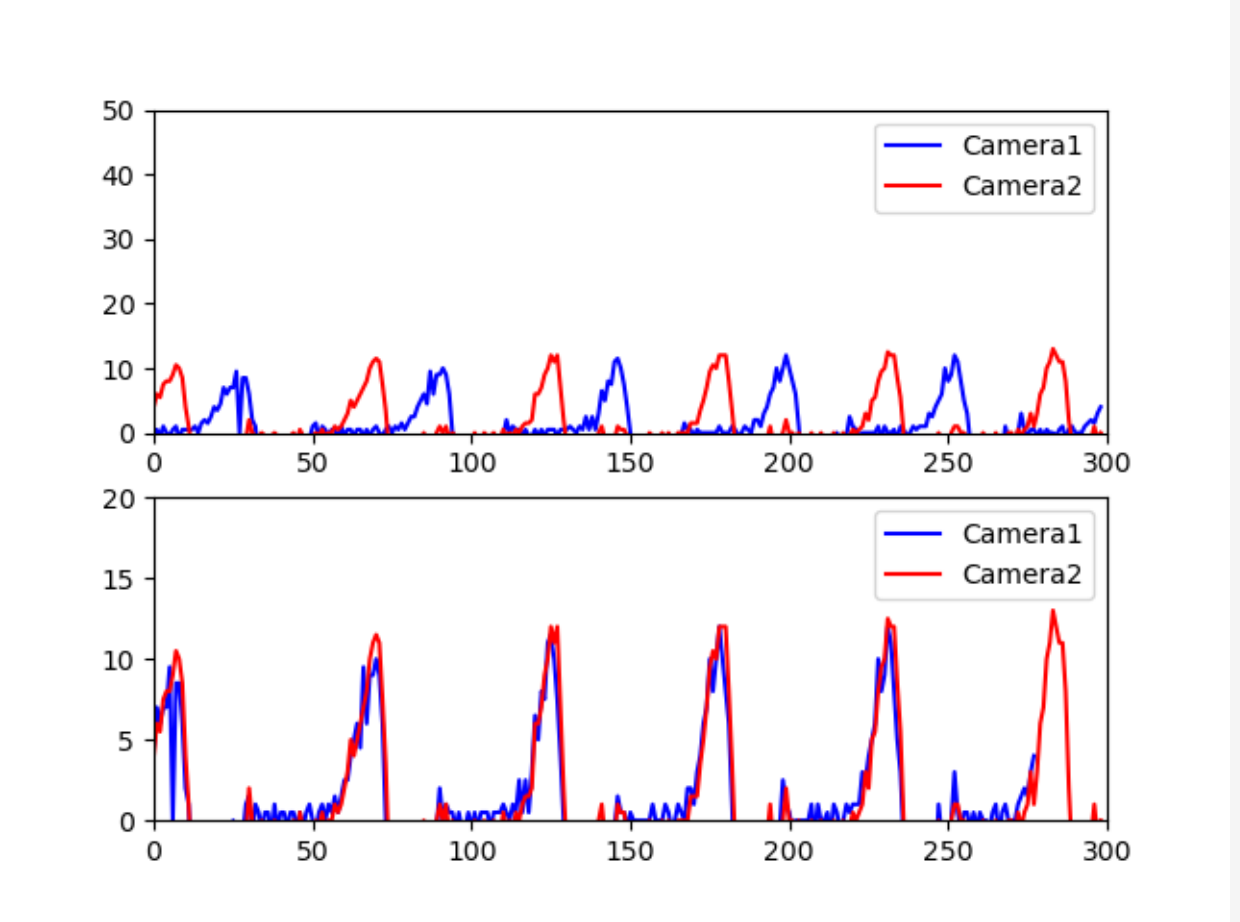
EXPERIMENT RESULTS

Calibration: Stationary Points

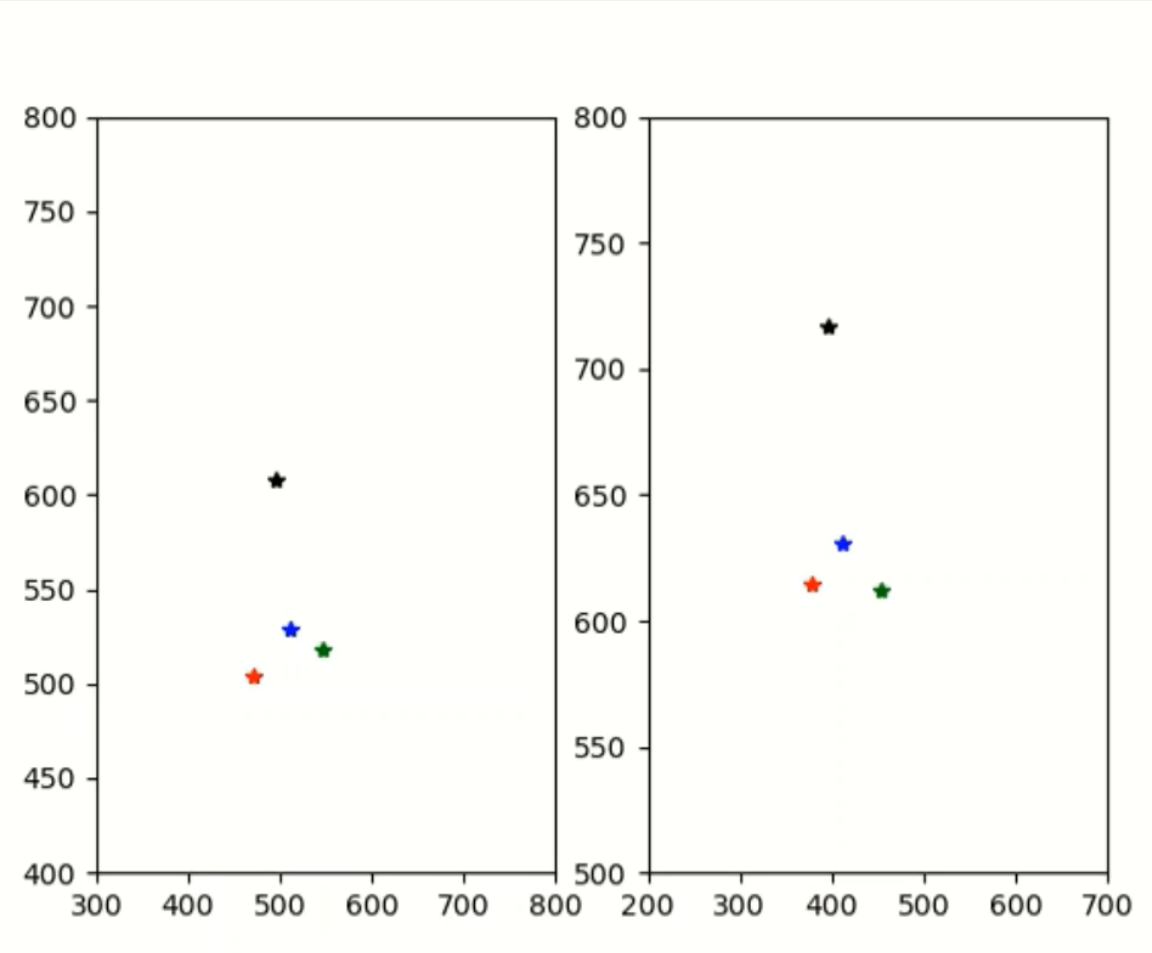




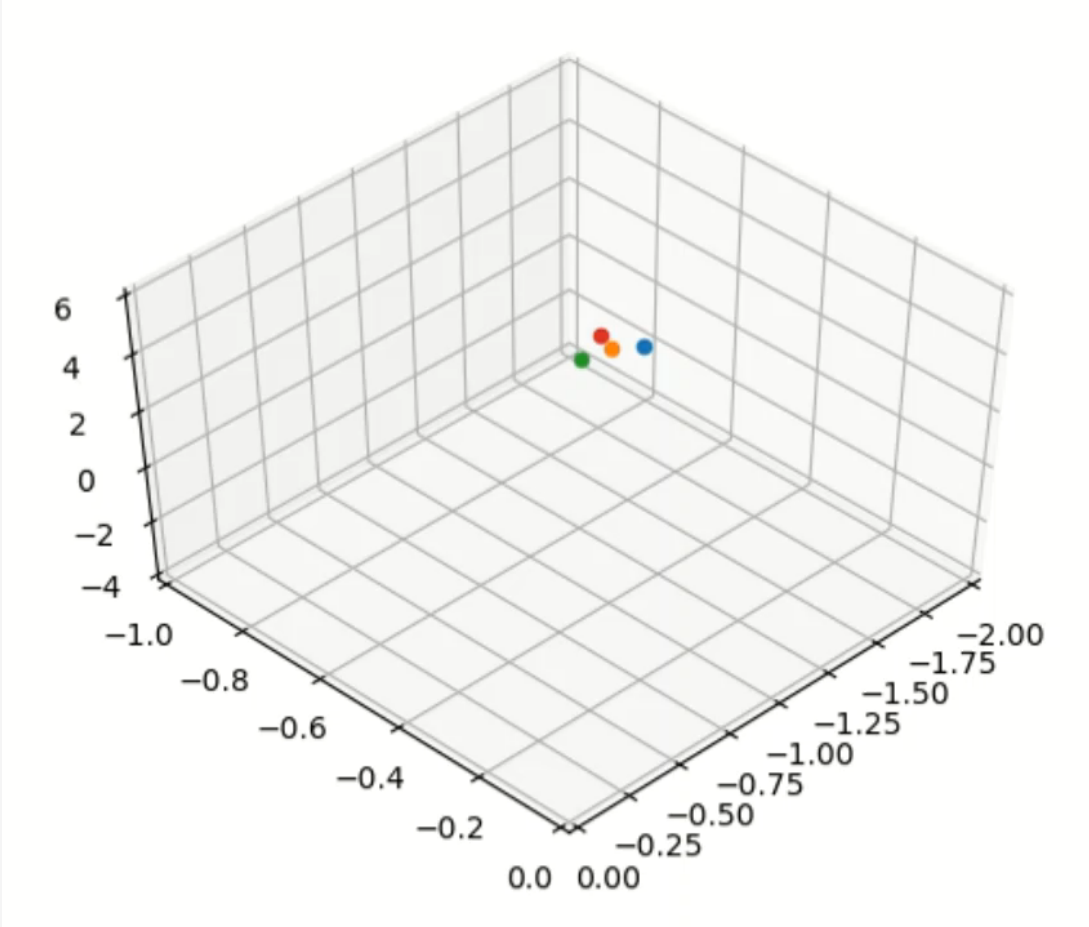
Data Synchronization



Synchronized Motion (2D)

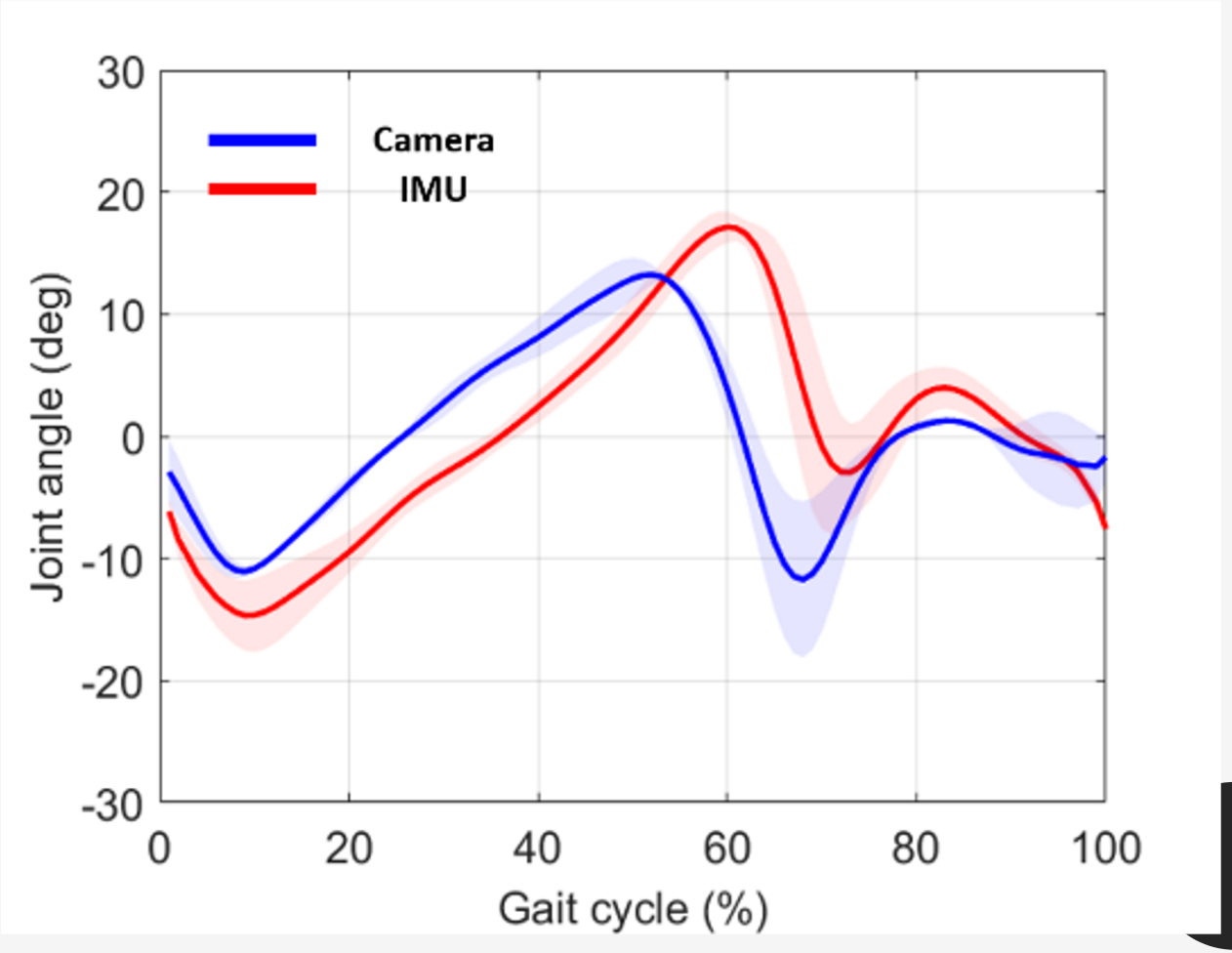


3D Reconstructed Motion



Ankle Joint Kinematics Comparison

- Comparison of ankle joint angles with the IMU-based system[2]
- Confirms preliminary feasibility
- Qualitatively similar trend for the entire gait cycle



[2] W. Hong, et al., 2019

Conclusion

- Comparison of ankle joint angles with the other MoCap system[2] confirms preliminary feasibility of our system
- Comparison shows qualitatively similar trends for the entire gait cycle
- Proposed system is concluded to be practical and warrants further investigation

[2] W. Hong, et al., 2019

Future Plans

- Increase the number of tracking points(data points) to analyze whole-body motion
- Improve the tracking algorithm(tracking speed and accuracy) of the proposed system and compare to the industry standard
- Share this work to the public (GitHub)

References

[1] *Y. Kwon, DLT Method, 1998,* http://kwon3d.com/theory/dlt/dlt.html

[2] W. Hong, V. Paredes, K. Chao, S. Patrick, and P. Hur, “Consolidated control framework to control a powered transfemoral prosthesis over inclined terrain conditions”, *IEEE International Conference on Robotics and Automation (ICRA)*, 2019

THANK YOU FOR WATCHING