Theia3D Version Compare

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Last compiled on 2022-01-14

Contents

1 Introduction

Objective

Compare version iterations of Theia3D on a dataset of 109 subjects during walking gait with an average of 16 strides per side.

Data Collection

The dataset was collected outdoors using 8 Sony RX0II at 60 fps.

Thiea3D Processing

Data were processed using two versions of Theia3D using default preferences. Versions v2021.2.0.1675 and v2021.3.0.2047.

Visual3D Processing

Data were processed in Visual3D using identical pipelines. All events were determined kinematically and matched exactly, i.e., events were calculated for one dataset and then imported to the second dataset. Joint angles, global segment angles, and joint positions were exported for the lower extremities.

Data Analysis

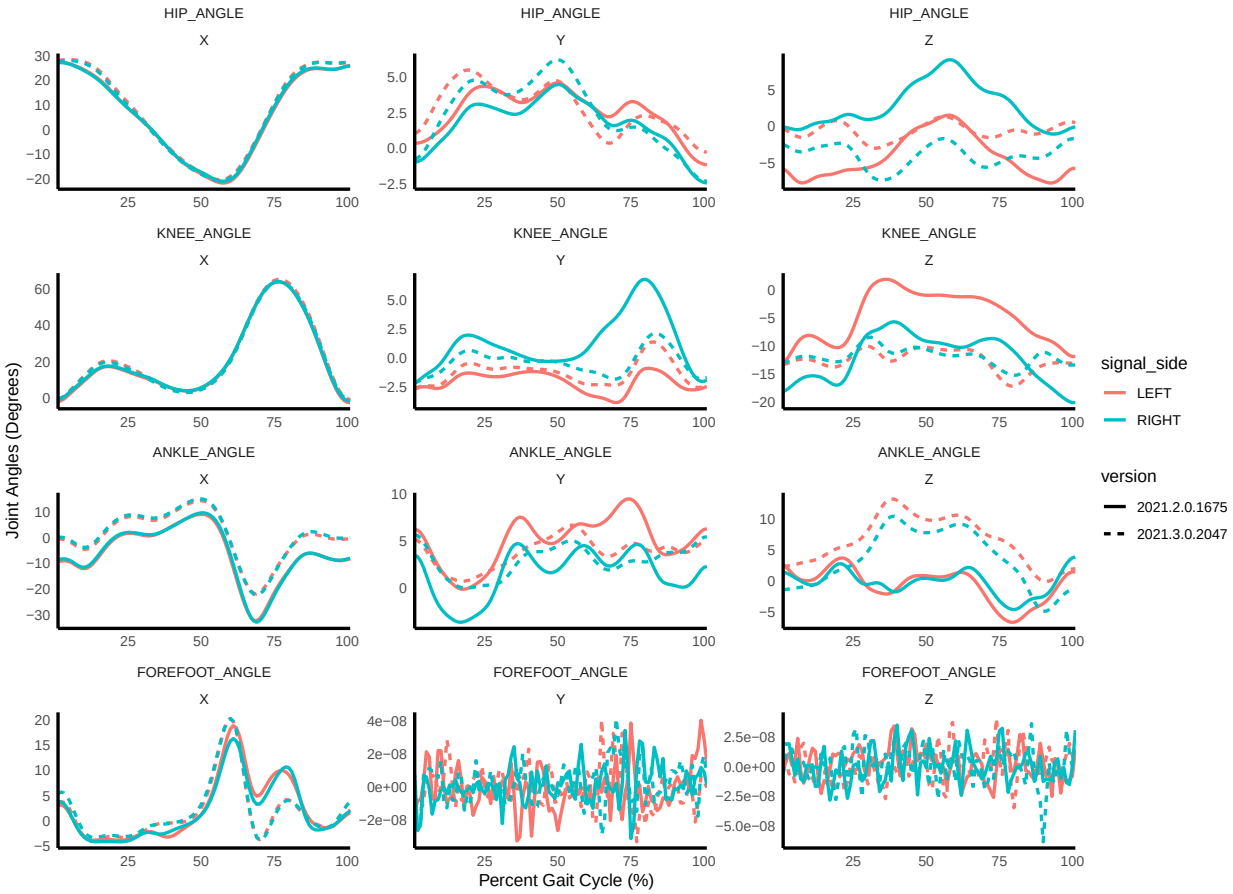
- The differences between versions for each signal, side, and component were calculated for matching strides.
- The 3D Euclidean distance was also calculated for joint positions.
- The RMS difference was then calculated for each individual stride.
- Data are presented by side to discern any side-to-side differences, expect for RMSD.
- **UNDER CONSTRUCTION** Within subject stride-to-stride waveform variabilty was also explored. This was done by simply averaging each stride waveform (results in one number per stride) and then taking the standard deviation (SD) of these averages for a subject. This was done for each signal, side and component for both versions to assess spread.

Summary

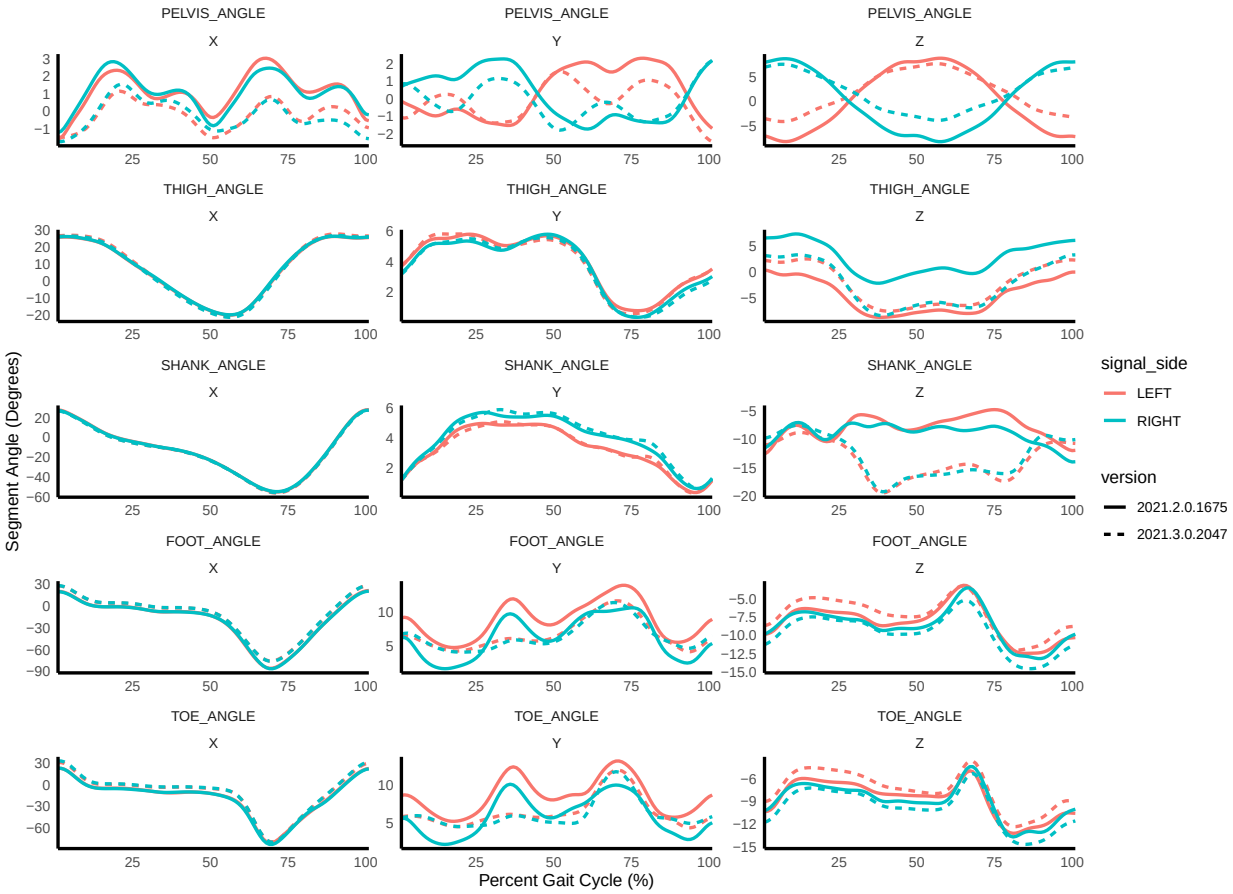
- In general Version v2021.3.0.2047 looks to have improved the side-to-side artefacts that were observed in v2021.2.0.1675, with the overall means being much tighter between sides and don't exhibit waveform patterns that have discernable differences.
- The Z-axis joint angles (internal/external rotation) of the Hip, Knee, and Ankle, along with the Y-axis of the Knee Joint (ab/adduction), particularly in late stance, look to have changed the most.
- Other notable changes were seen in the Ankle Joint dorsiflexion angle that exhibits systematically less plantarflexion (~7 degrees, i.e., more flatfoot at heel strike) throughout the gait cycle. The forefoot flexion angle also exhibits a higher range of motion during push off.
- The Shank Segment Angle in the Z-axis (rotation along its long axis) exhibits a large pattern change and is more externally rotated. This likely results in the larger ankle joint adduction (Z-axis) angle.
- Joint Positions exhibit minimal changes between versions. The Z-position of the Pelvis Joint (pelvis segment origin), however, looks to be systemically shifted upwards by ~1 cm.
- Joint Positions RMSD values are about half of what Kanko et al. showed in the markerbased vs marker less comparison. This is expected.
- Interestingly, Joint Angle and Segment Angle RMSD values either match Kanko et al. or are 2 to 4 degrees less. Meaning these changes are mostly equivalent to the changes shown between two systems (markerless and markerbased) or are little less.
- Initial observations on waveform variability show minimal differences between versions as scatter clusters look similar between versions and sides.

2 Results

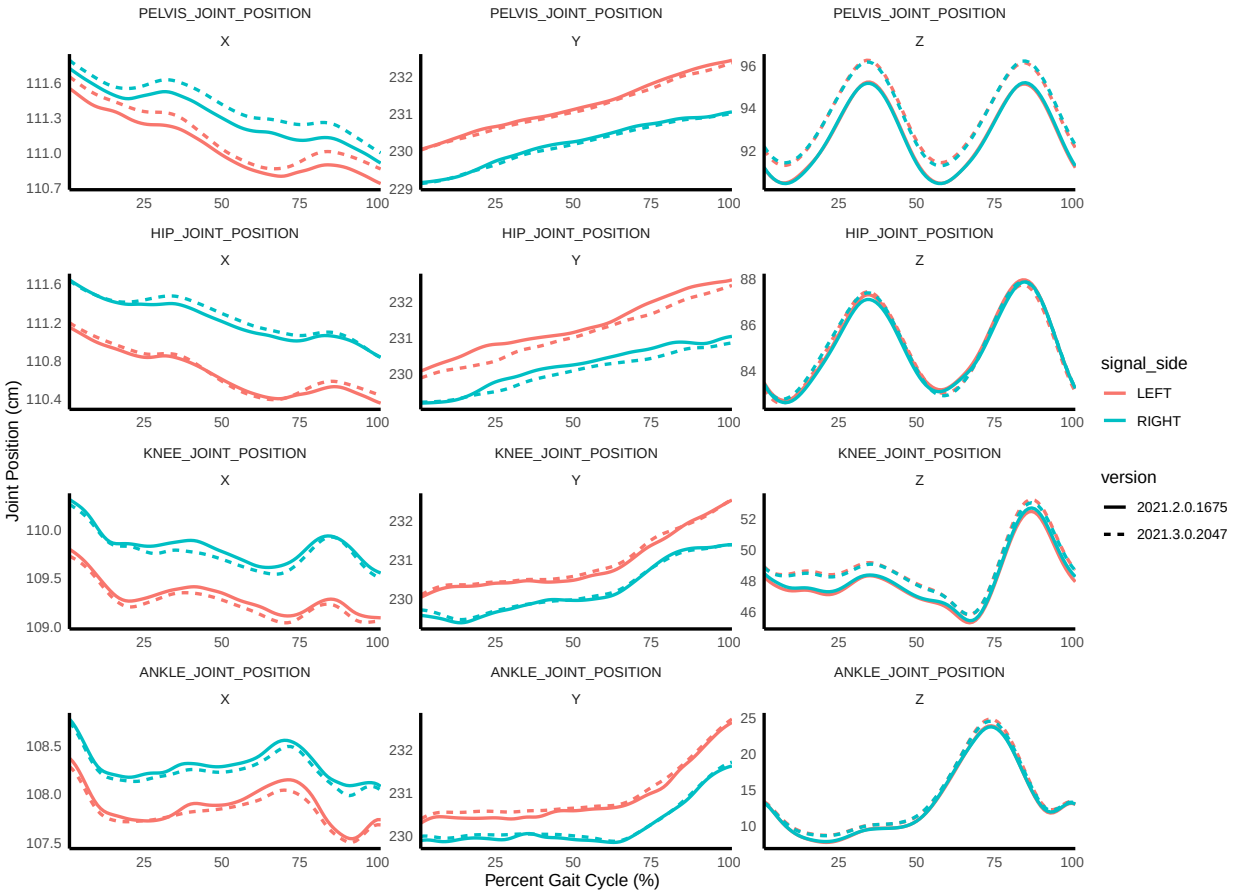
2.1 Mean Joint Angles



2.2 Mean Segment Angles

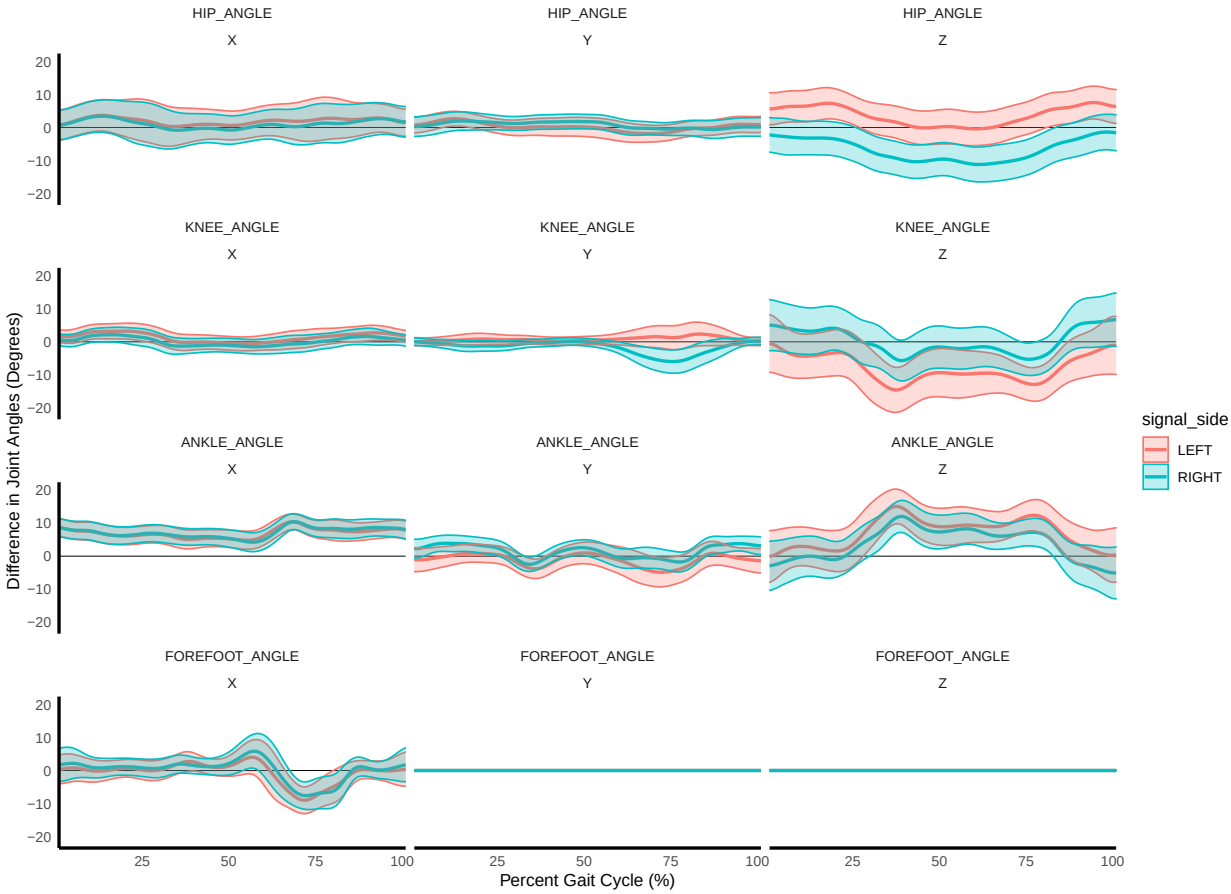


2.3 Mean Joint Positions



3 Mean Difference Plots and RMSD Tables

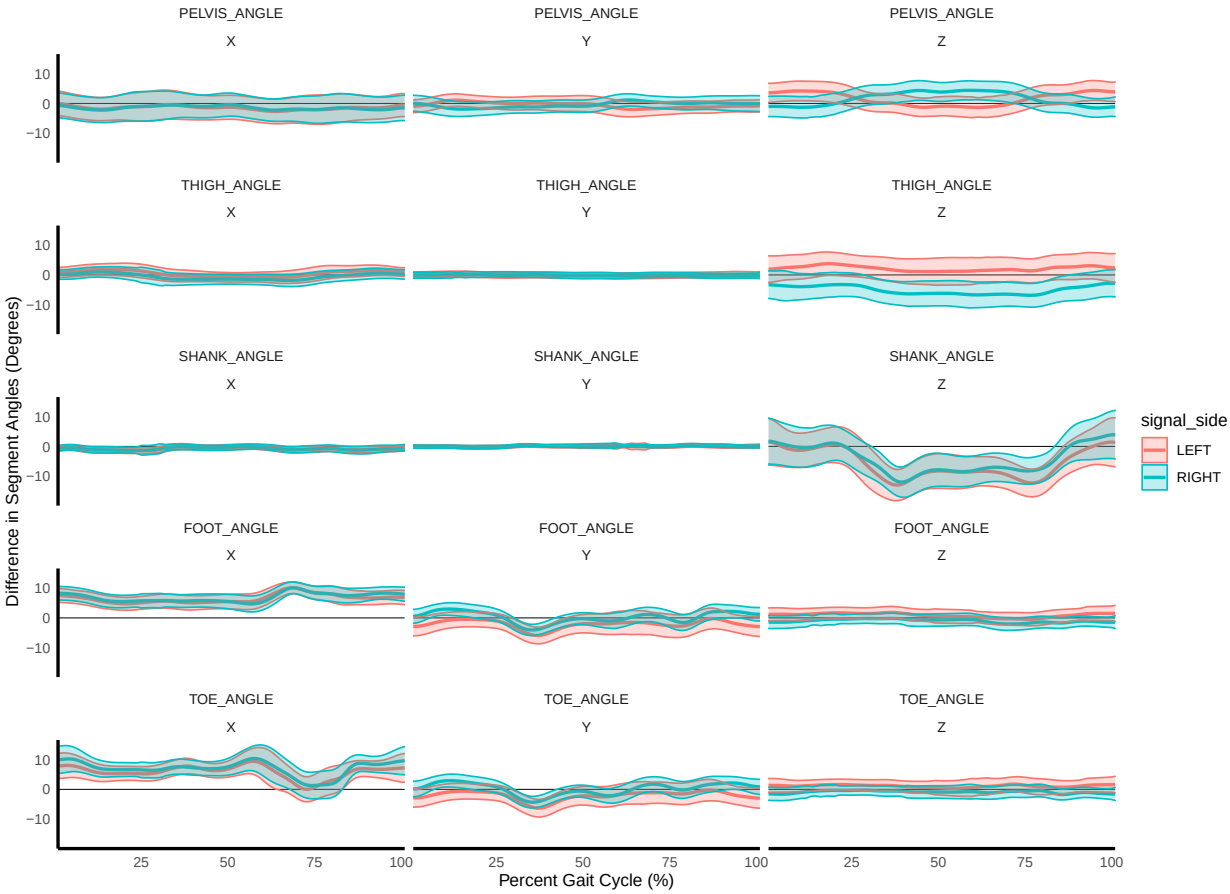
3.1 Joint Angle Mean Differences



3.2 Joint Angle RMSD

signal_names	signal_side	X	Y	Z
HIP_ANGLE	LEFT	5.12	2.59	6.33
HIP_ANGLE	RIGHT	4.91	2.52	8.48
KNEE_ANGLE	LEFT	2.79	2.13	10.54
KNEE_ANGLE	RIGHT	2.41	2.95	7.19
ANKLE_ANGLE	LEFT	7.40	3.86	9.82
ANKLE_ANGLE	RIGHT	7.59	3.49	7.90
FOREFOOT_ANGLE	LEFT	4.92	0.00	0.00
FOREFOOT_ANGLE	RIGHT	4.91	0.00	0.00

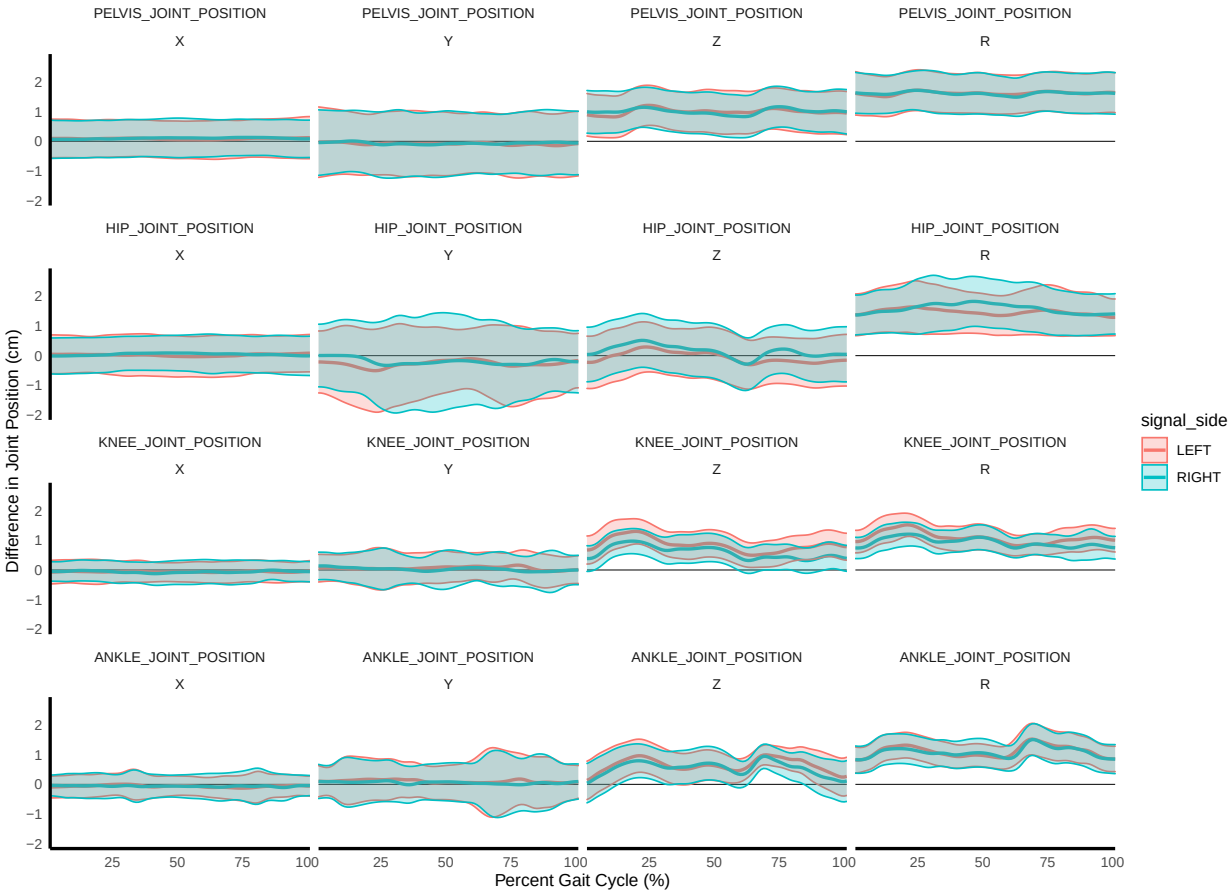
3.3 Segment Angle Mean Differences



3.4 Segment Angle RMSD

signal_names	signal_side	X	Y	Z
PELVIS_ANGLE	LEFT	4.16	2.29	4.02
PELVIS_ANGLE	RIGHT	4.13	2.27	4.06
THIGH_ANGLE	LEFT	2.06	0.89	4.32
THIGH_ANGLE	RIGHT	1.99	0.84	6.17
SHANK_ANGLE	LEFT	1.18	0.51	9.24
SHANK_ANGLE	RIGHT	1.18	0.53	8.25
FOOT_ANGLE	LEFT	6.93	3.84	2.16
FOOT_ANGLE	RIGHT	7.27	2.85	1.97
TOE_ANGLE	LEFT	7.04	3.85	2.31
TOE_ANGLE	RIGHT	8.08	2.96	1.93

3.5 Joint Position Mean Differences

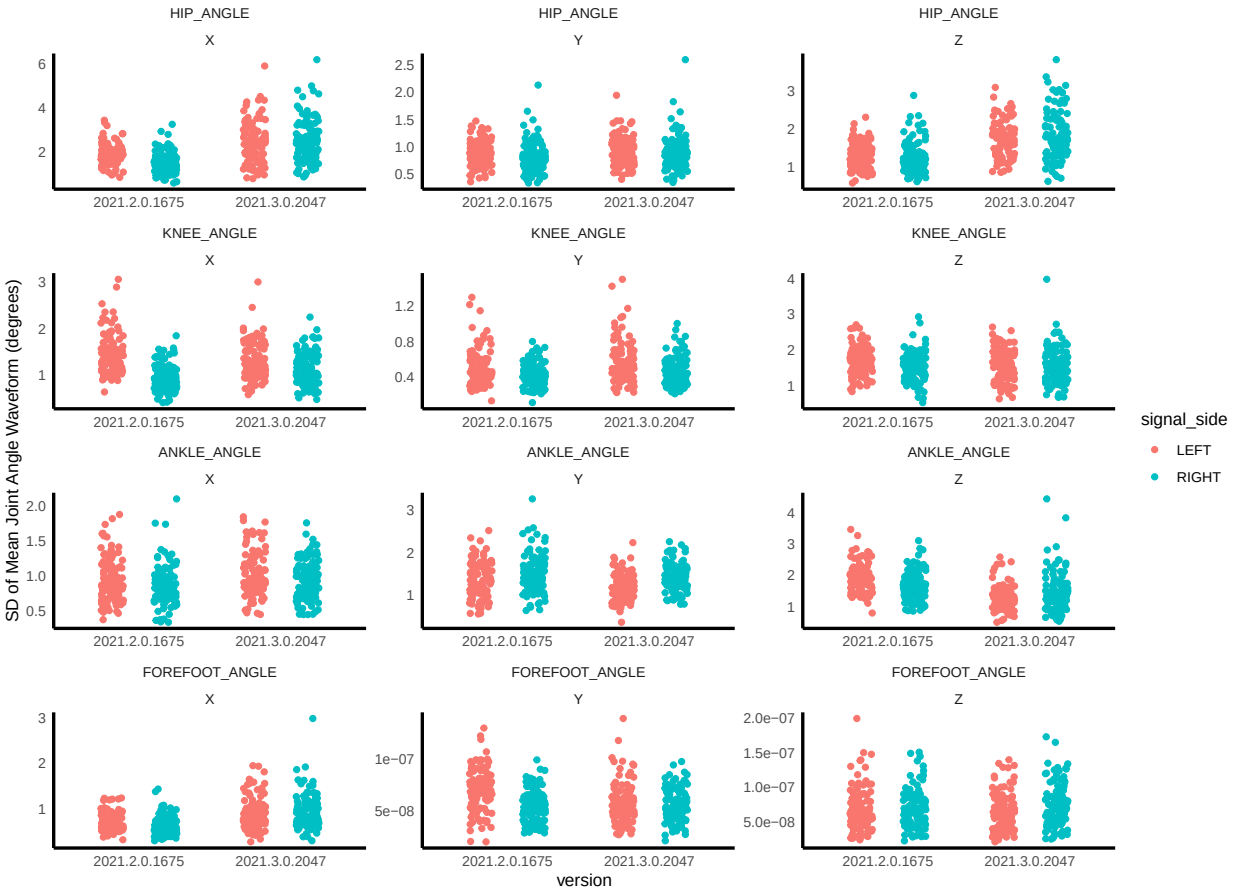


3.6 Joint Position RMSD

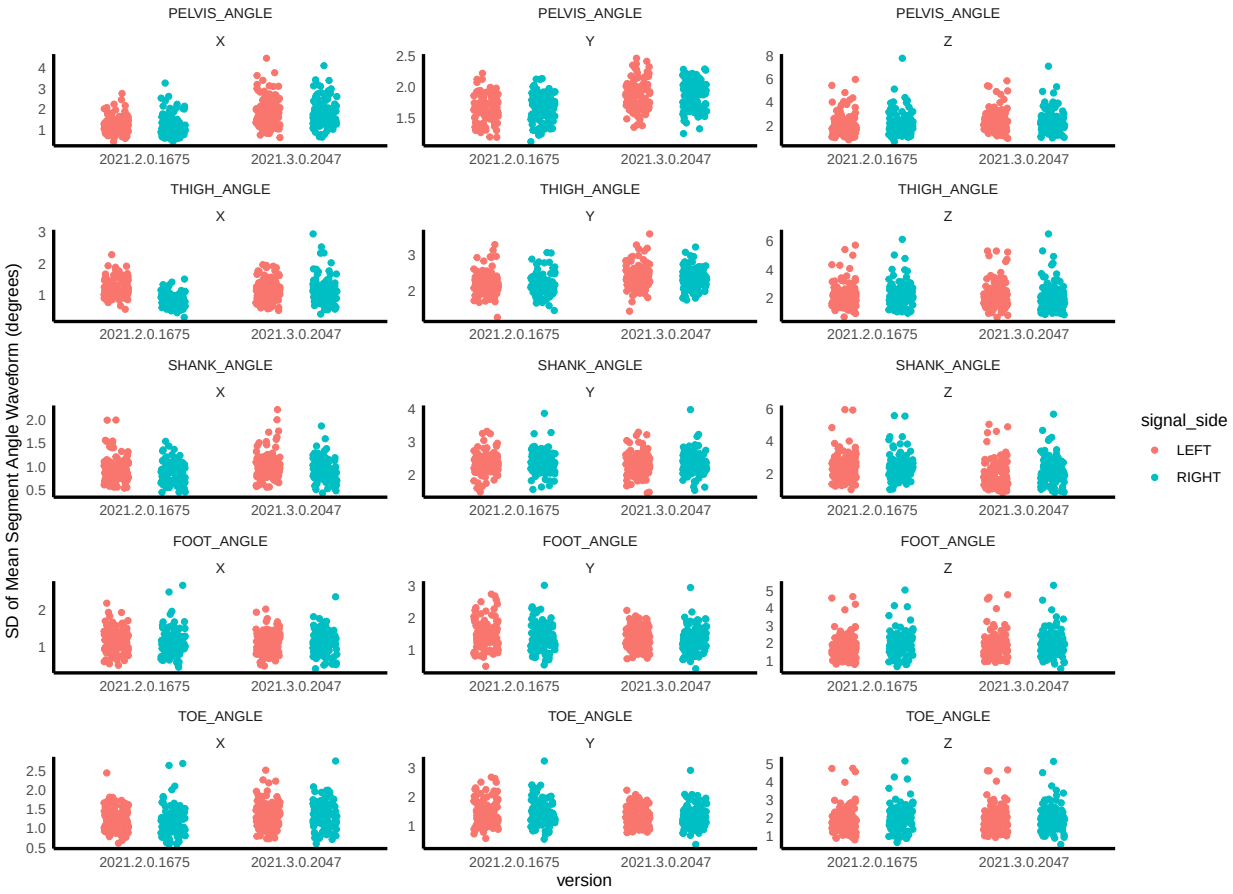
signal_names	signal_side	X	Y	Z	R
PELVIS_JOINT_POSITION	LEFT	0.58	0.92	1.11	1.66
PELVIS_JOINT_POSITION	RIGHT	0.57	0.92	1.11	1.65
HIP_JOINT_POSITION	LEFT	0.59	1.13	0.74	1.56
HIP_JOINT_POSITION	RIGHT	0.56	1.25	0.81	1.67
KNEE_JOINT_POSITION	LEFT	0.35	0.50	0.94	1.15
KNEE_JOINT_POSITION	RIGHT	0.36	0.53	0.72	0.99
ANKLE_JOINT_POSITION	LEFT	0.37	0.69	0.81	1.17
ANKLE_JOINT_POSITION	RIGHT	0.42	0.69	0.75	1.15

4 Waveform Variability

4.1 Joint Angle Variation



4.2 Segment Angle Variation



4.3 Joint Position Variation