

Tether Conclusions

The following MATLAB Live Script details the conclusions of the tether experiments, including the resulting plots for a total of 49 experiments performed on the orange 4-limbed robot on the black mat. The data suggest that the influence of the tether is most pronounced with the original heavy tether, followed by the light sheath tether. Artefacts due to the movement / placement of the tether are present in the motion / twist plots which correlate with the videos. When the tether protocol is set to "not following", dependence on the tether movement is seen in twist plots by plotting w.r.t. the global orientation of the robot. The comparative plots show that the tether influence is minimized when using the "no sheath" tether to the point that the tether protocol (following / not following) and placement do not have much impact on the resulting motion.

The fourth tether type tested was the AWG 32 wire with and without a slip ring. However, all of these trials include interference of the tether with the limbs. Therefore, resulting stability / tether influence reduction is poor. While it is assumed that proper designing and management of these thinner and lighter wires will result in better performance, no definite conclusions can be drawn until the current design/protocol issues are fixed and new data analyzed.

Extract and define parameters for GaitTest() objects.

From 20220707 Experiments:

Gait B-120 [heavy - not following (restting) - left/up]

Gait E-120 [heavy - not following - left/up]

Gait E-60 [heavy - not following - left/up]

Gait E-60* [heavy - not following - right/up] Caution! Not real E gait! Limb A not actuating

From 20220819 Experiments:

Gait B-120 [light sheath - not following (restting) - right/up]

From 20220829 Experiments:

Gait B Follow (Left)* [light sheath - following - left] Caution! Not real B gait! Limb A not actuating

Gait B Follow (Right)* [light sheath - following - right] Caution! Not real B gait! Limb A not actuating

Gait E Left (sheath on) [light sheath - not following - left]

Gait E Right (sheath on) [no sheath - not following - right]

Gait E Left (sheath off) [no sheath - not following - left]

Gait E Right (sheath off)* [no sheath - not following - right] Caution! Not real E gait! Limb B not actuating

From 20220901 Experiments:

Gait E Left (sheath off) [no sheath - not following - left (flipped)]

Gait B Follow (Left) Trial 1 [light sheath - following - left]

Gait B Follow (Left) Trial 2 [light sheath - following - left (flipped)]

Gait B Left (Sheath on) Trial 1 [light sheath - not following - left]

Gait B Left (Sheath on) Trial 2 [light sheath - not following - left (flipped)]

From 20220908 Experiments:

Gait B Right (sheath on) [sheath - not following - right] (not consistent / semi-following)

Gait B Right Follow (sheath off) Trial 1 [no sheath - following - right]

Gait B Right Follow (sheath off) Trial 2 [no sheath - following - right]

Gait B Left Follow (sheath off) Trial 1 [no sheath - following - left]

Gait B Left Follow (sheath off) Trial 2 [no sheath - following - left]

Gait B Right (sheath off) Trial 1 [no sheath - not following - right] (not consistent / semi-following)

Gait B Right (sheath off) Trial 2 [no sheath - not following - right] (not consistent / semi-following)

Gait B Left (sheath off) Trial 1 [no sheath - not following - left] (not consistent / semi-following)

Gait B Left (sheath off) Trial 2 [no sheath - not following - left] (not consistent / semi-following)

Gait B Right Follow (sheath on) [sheath - following - right]

Gait E Right (sheath off) Trial 1 [no sheath - not following - right] (not consistent / semi-following)

Gait E Right (sheath off) Trial 2 [no sheath - not following - right] (not consistent / semi-following)

Gait E Left (sheath off) Trial 1 [no sheath - not following - left] (not consistent / semi-following)

Gait E Left (sheath off) Trial 2 [no sheath - not following - left] (not consistent / semi-following)

From 20220928 Experiments:

Gait B Left AWG 32 Trial 1 [AWG 32 sheath - not following - left]

Gait B Left AWG 32 Trial 2 [AWG 32 sheath - not following - left]

Gait B Right AWG 32 Trial 1 [AWG 32 sheath - not following - right]

Gait B Right AWG 32 Trial 2 [AWG 32 sheath - not following - right]

Gait B Right AWG 32 Trial 1 [AWG 32 slip ring - not following - right]

Gait B Right AWG 32 Trial 2 [AWG 32 slip ring - not following - right]

From 20221018 Experiments:

Gait F Left AWG 32 Slip ring Trial 1 [AWG 32 slip ring - not following - left]

Gait F Left AWG 32 Slip ring Trial 2 [AWG 32 slip ring - not following - left]

Gait G Left AWG 32 Slip ring Trial 1 [AWG 32 slip ring - not following - left]

Gait G Left AWG 32 Slip ring Trial 2 [AWG 32 slip ring - not following - left]

From 20221102 Experiments:

Gait G Right AWG 32 Slip ring Trial 1 [AWG 32 slip ring - not following - right]

Gait G Right AWG 32 Slip ring Trial 2 [AWG 32 slip ring - not following - right]

Gait B Left AWG 32 Slip ring Trial 1 [AWG 32 slip ring - not following - left]

Gait B Right AWG 32 Slip ring Trial 1 [AWG 32 slip ring - not following - right]

Gait H Left AWG 32 Slip ring Trial 1 [AWG 32 slip ring - not following - left]

Gait H Left AWG 32 Slip ring Trial 2 [AWG 32 slip ring - not following - left]

Gait H Right AWG 32 Slip ring Trial 1 [AWG 32 slip ring - not following - right]

Gait H Right AWG 32 Slip ring Trial 2 [AWG 32 slip ring - not following - right]

Gait F Right AWG 32 Slip ring Trial 1 [AWG 32 slip ring - not following - right]

Gait F Right AWG 32 Slip ring Trial 2 [AWG 32 slip ring - not following - right]

Build Experiment Matrix

`sorted_exps = 49x7 table`

	Experiment	Gait	#Cycles	Tether	Protocol	Placement	Trial
1	31	'B'	'60'	'32'	'NF'	'L'	1
2	32	'B'	'60'	'32'	'NF'	'L'	2
3	33	'B'	'60'	'32'	'NF'	'R'	1
4	34	'B'	'60'	'32'	'NF'	'R'	2
5	42	'B'	'60'	'32SR'	'NF'	'L'	1
6	43	'B'	'60'	'32SR'	'NF'	'R'	1
7	35	'B'	'60'	'32SR1'	'NF'	'R'	2
8	1	'B'	'120'	'H'	'NF'	'L'	
9	20	'B'	'60'	'NS'	'F'	'L'	
10	21	'B'	'60'	'NS'	'F'	'L'	2
11	18	'B'	'60'	'NS'	'F'	'R'	
12	19	'B'	'60'	'NS'	'F'	'R'	2
13	24	'B'	'60'	'NS'	'NF'	'L'	
14	25	'B'	'60'	'NS'	'NF'	'L'	2

	Experiment	Gait	#Cycles	Tether	Protocol	Placement	Trial
15	22	'B'	'60'	'NS'	'NF'	'R'	
16	23	'B'	'60'	'NS'	'NF'	'R'	2
17	13	'B'	'60'	'S'	'F'	'L'	
18	14	'B'	'60'	'S'	'F'	'Lf'	
19	26	'B'	'60'	'S'	'F'	'R'	
20	15	'B'	'60'	'S'	'NF'	'L'	
21	16	'B'	'60'	'S'	'NF'	'Lf'	
22	5	'B'	'120'	'S'	'NF'	'R'	
23	17	'B'	'60'	'S'	'NF'	'R'	
24	6	'Bs'	'60'	'S'	'F'	'L'	
25	7	'Bs'	'60'	'S'	'F'	'R'	
26	2	'E'	'120'	'H'	'NF'	'L'	
27	3	'E'	'60'	'H'	'NF'	'L'	
28	10	'E'	'60'	'NS'	'NF'	'L'	
29	29	'E'	'60'	'NS'	'NF'	'L'	2
30	30	'E'	'60'	'NS'	'NF'	'L'	3
31	12	'E'	'60'	'NS'	'NF'	'Lf'	
32	27	'E'	'60'	'NS'	'NF'	'R'	
33	28	'E'	'60'	'NS'	'NF'	'R'	2
34	8	'E'	'60'	'S'	'NF'	'L'	
35	9	'E'	'60'	'S'	'NF'	'R'	
36	4	'Es'	'60'	'H'	'NF'	'R'	
37	11	'Es'	'60'	'NS'	'NF'	'R'	
38	36	'F'	'60'	'32SR'	'NF'	'L'	1
39	37	'F'	'60'	'32SR'	'NF'	'L'	2
40	48	'F'	'60'	'32SR'	'NF'	'R'	1
41	49	'F'	'60'	'32SR'	'NF'	'R'	2
42	38	'G'	'60'	'32SR'	'NF'	'L'	1
43	39	'G'	'60'	'32SR'	'NF'	'L'	2
44	40	'G'	'60'	'32SR'	'NF'	'R'	1
45	41	'G'	'60'	'32SR'	'NF'	'R'	2
46	44	'H'	'60'	'32SR'	'NF'	'L'	1
47	45	'H'	'60'	'32SR'	'NF'	'L'	2

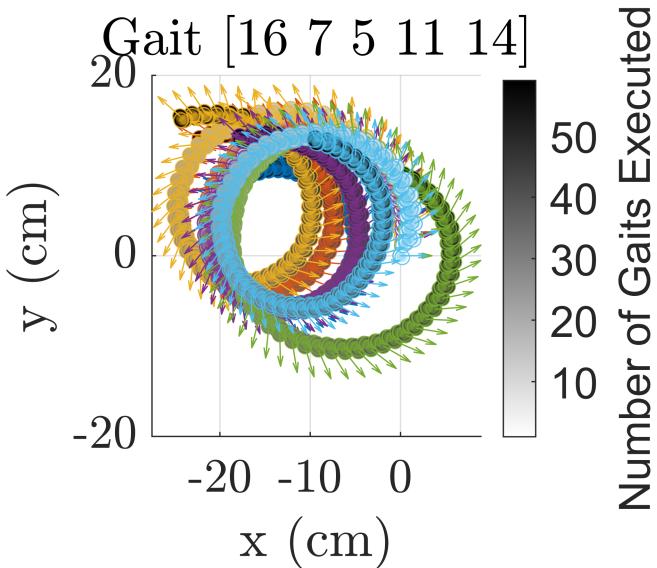
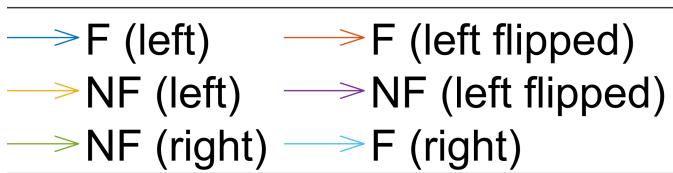
	Experiment	Gait	#Cycles	Tether	Protocol	Placement	Trial
48	46	'H'	'60'	'32SR'	'NF'	'R'	1
49	47	'H'	'60'	'32SR'	'NF'	'R'	2

Analyze the experiment data:

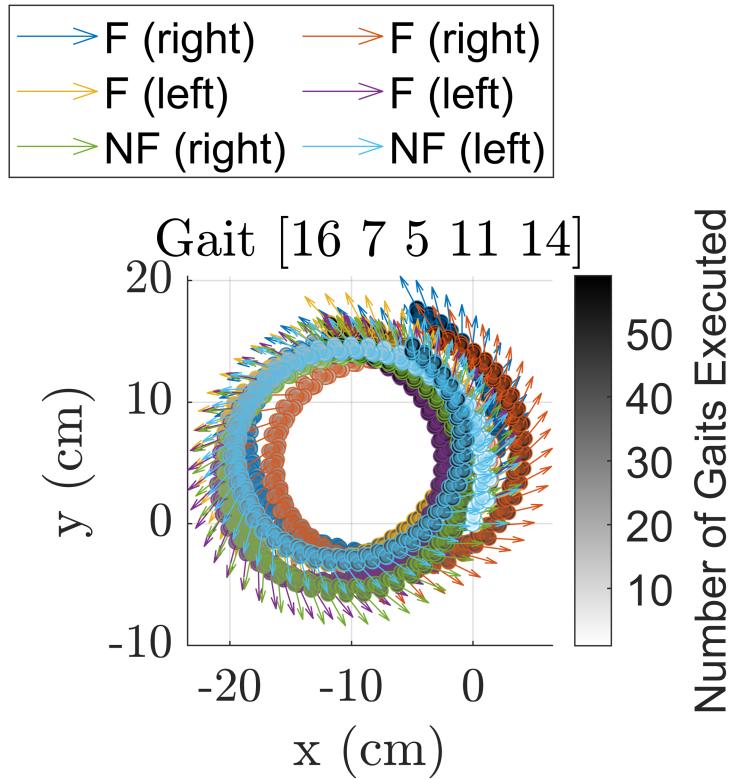
1. Rotate the data w.r.t. the initial global orientation.
2. Instantiate GaitTest() objects for each experimental trial.
3. Calculate twists for each gait experiment.

Construct comparative motion plots.

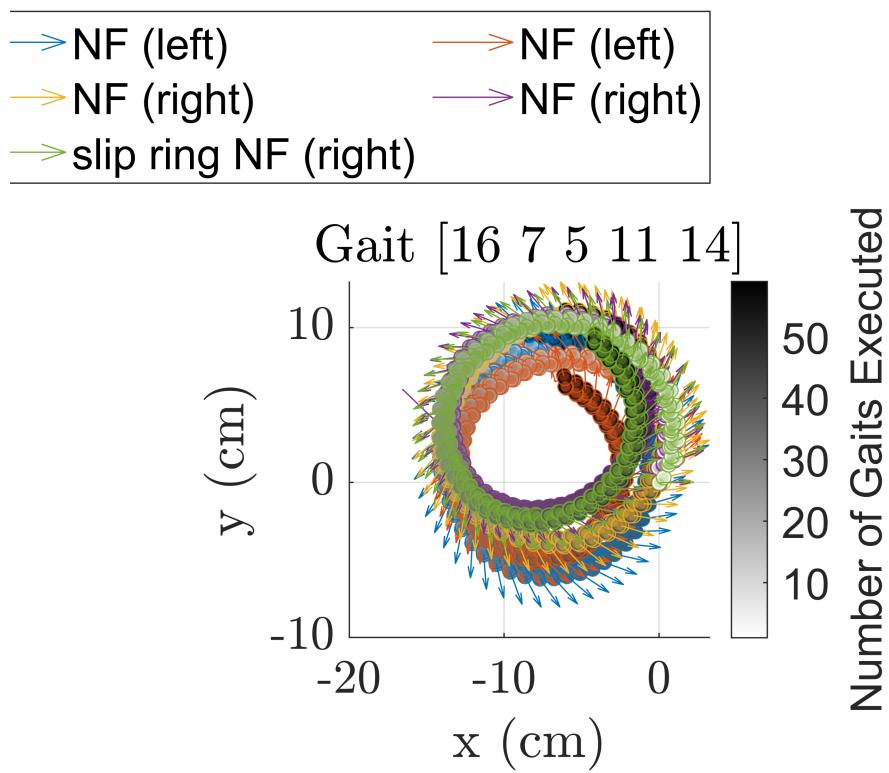
Comparison (overlay) of 6 trials of gait B (light sheath):



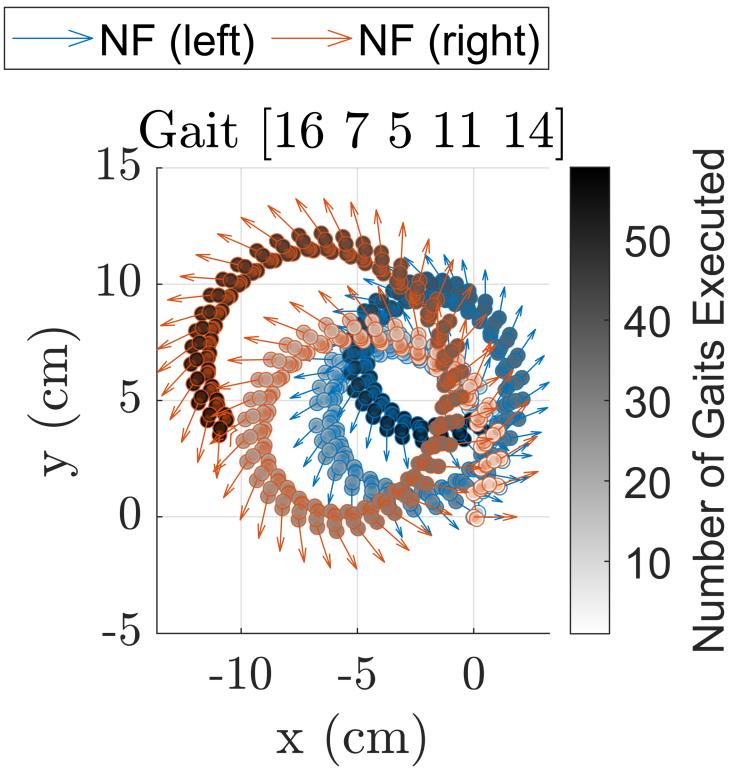
Comparison (overlay) of 6 trials of gait B (no sheath):



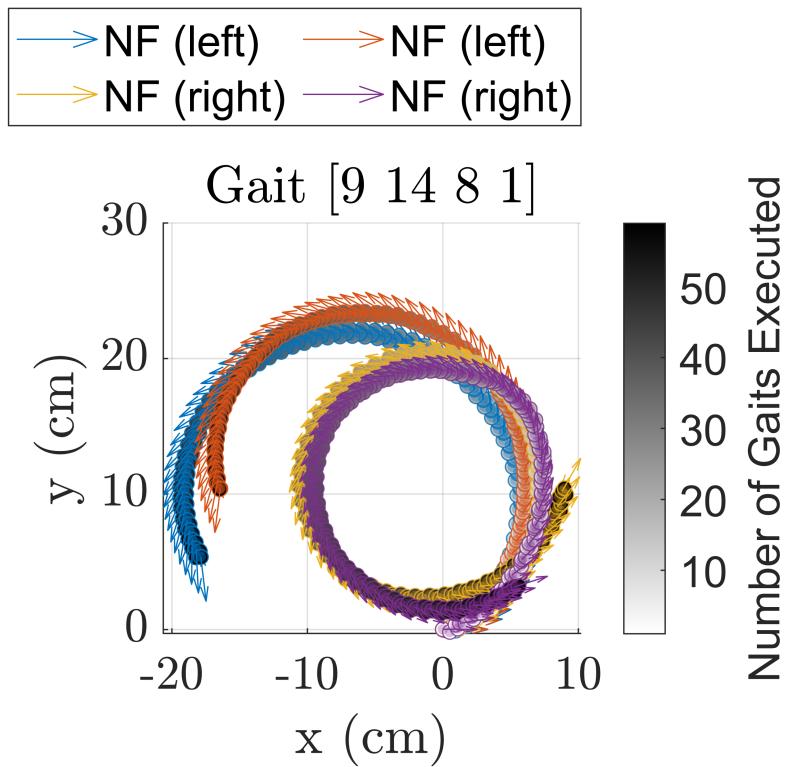
Comparison (overlay) of 5 trials of gait B (32 AWG sheath) with accidental interference from the tether:



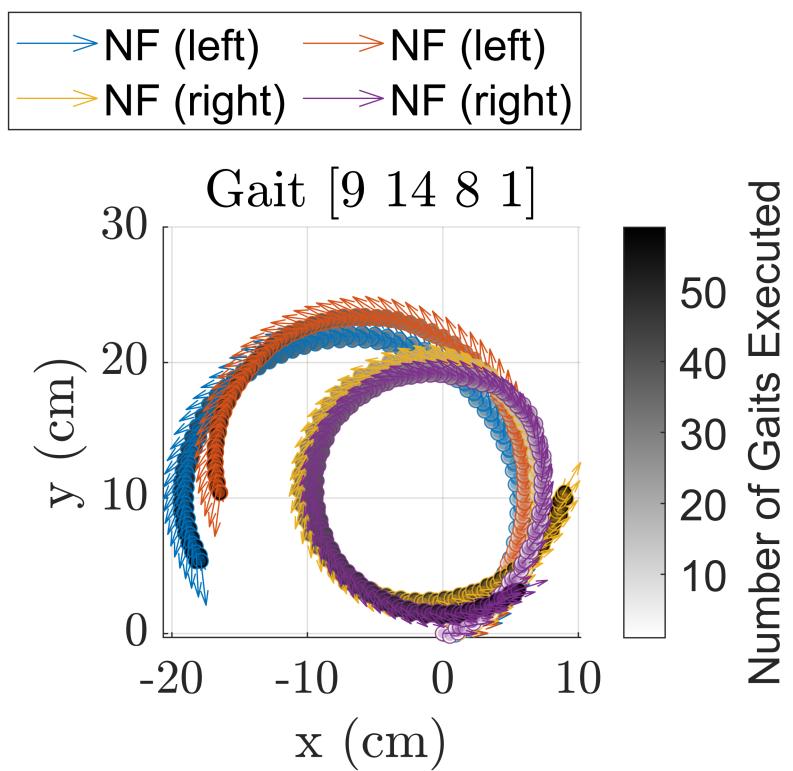
Comparison (overlay) of 2 trials of gait B (AWG 32 with slip ring):



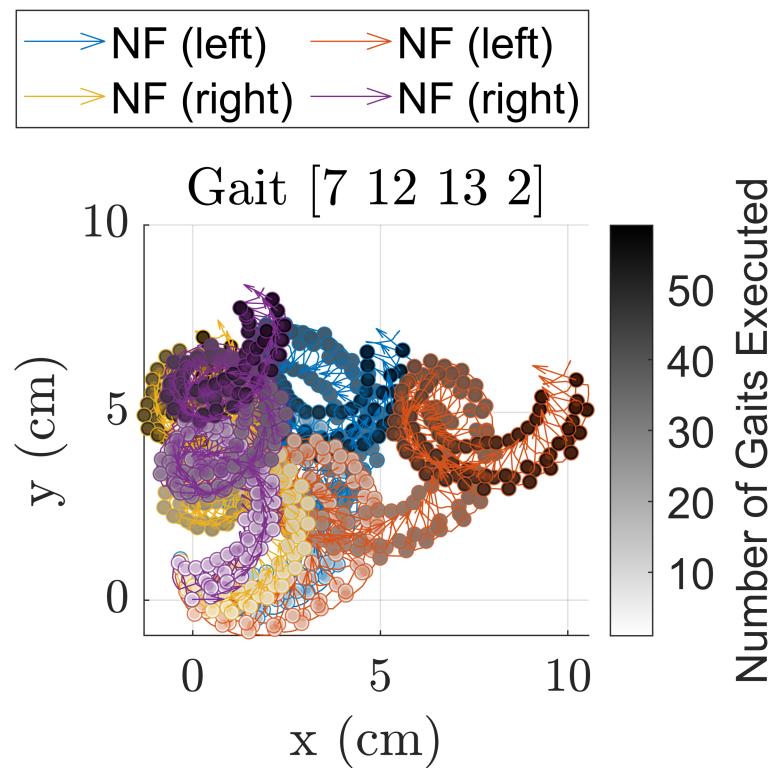
Comparison (overlay) of 4 trials of gait F (AWG 32 with slip ring):



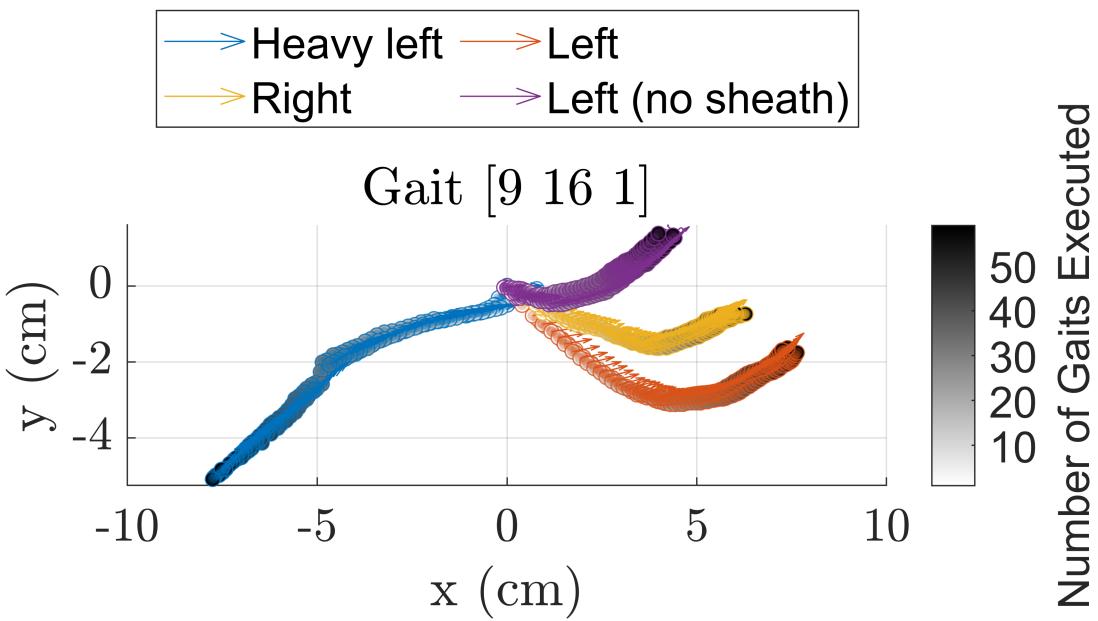
Comparison (overlay) of 4 trials of gait G (AWG 32 with slip ring):



Comparison (overlay) of 4 trials of gait H (AWG 32 with slip ring) with accidental interference with tether:

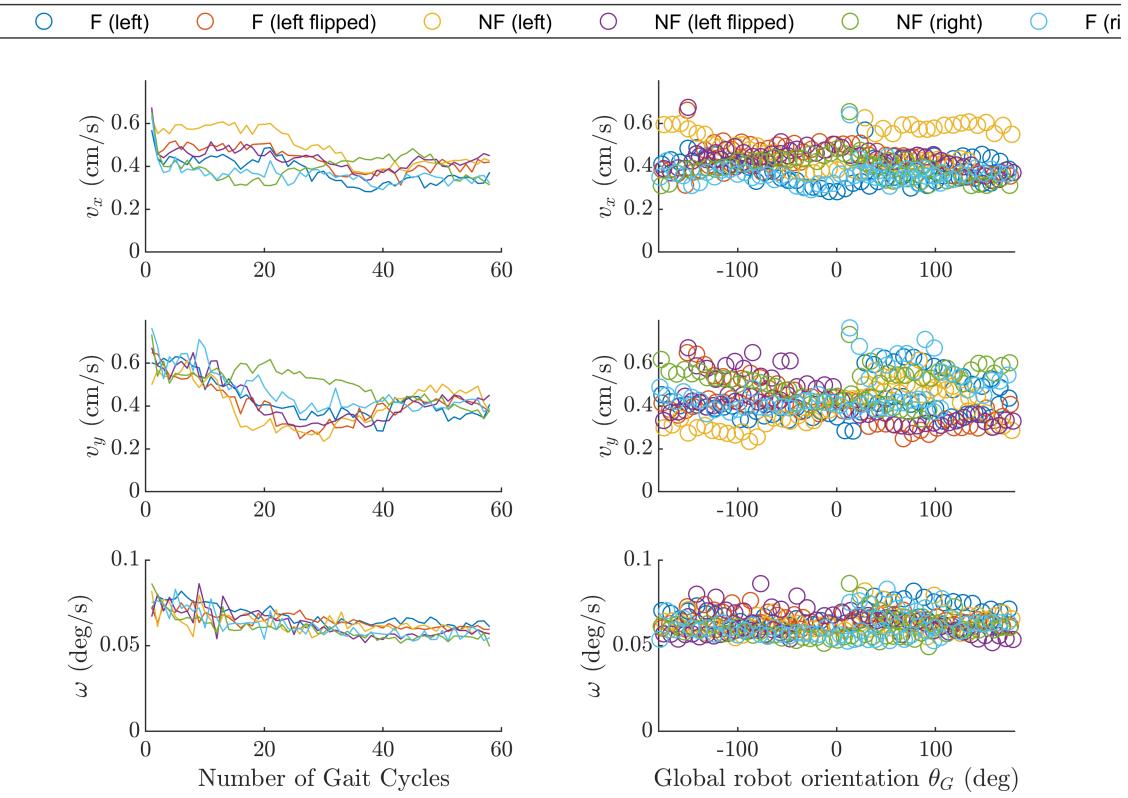


Comparison (overlay) of 4 trials of gait E (not following):

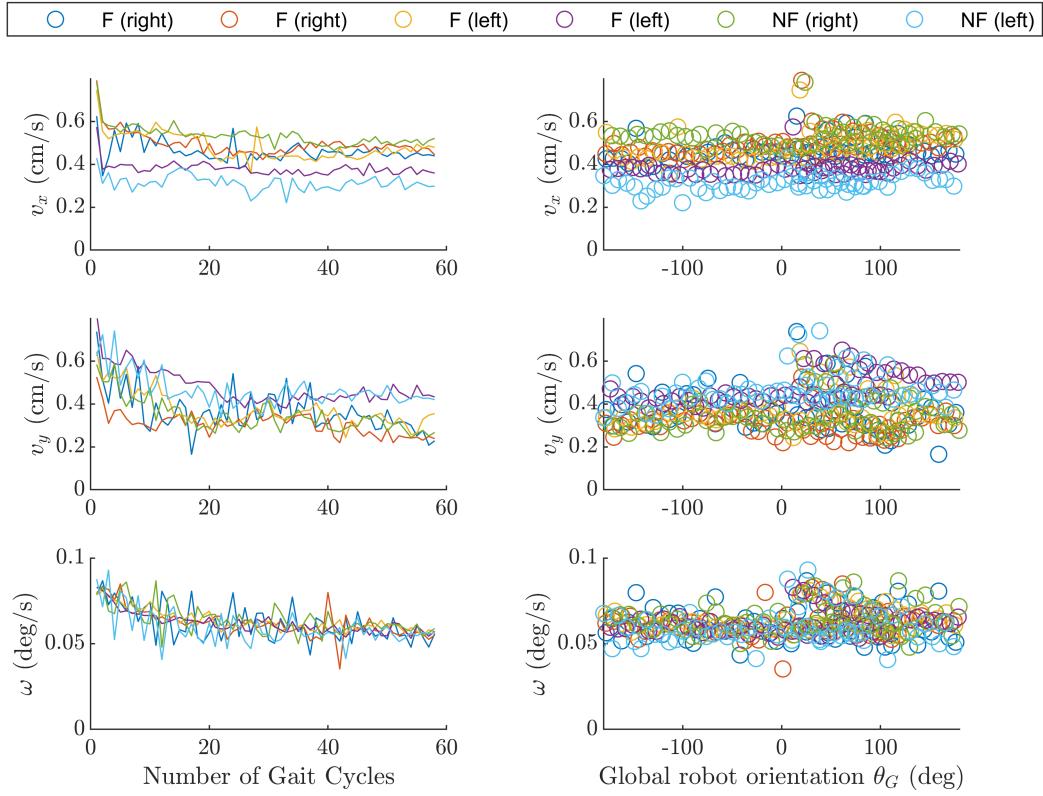


Construct comparative twist plots.

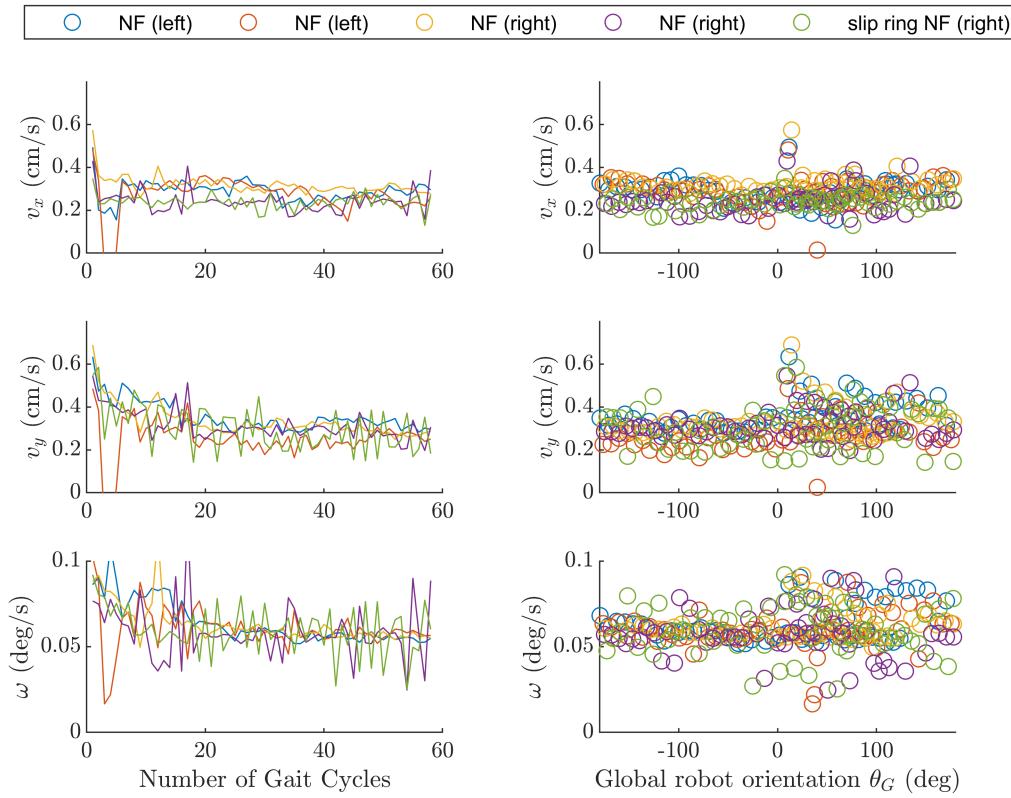
Twist comparison for 6 trials of gait B (light sheath):



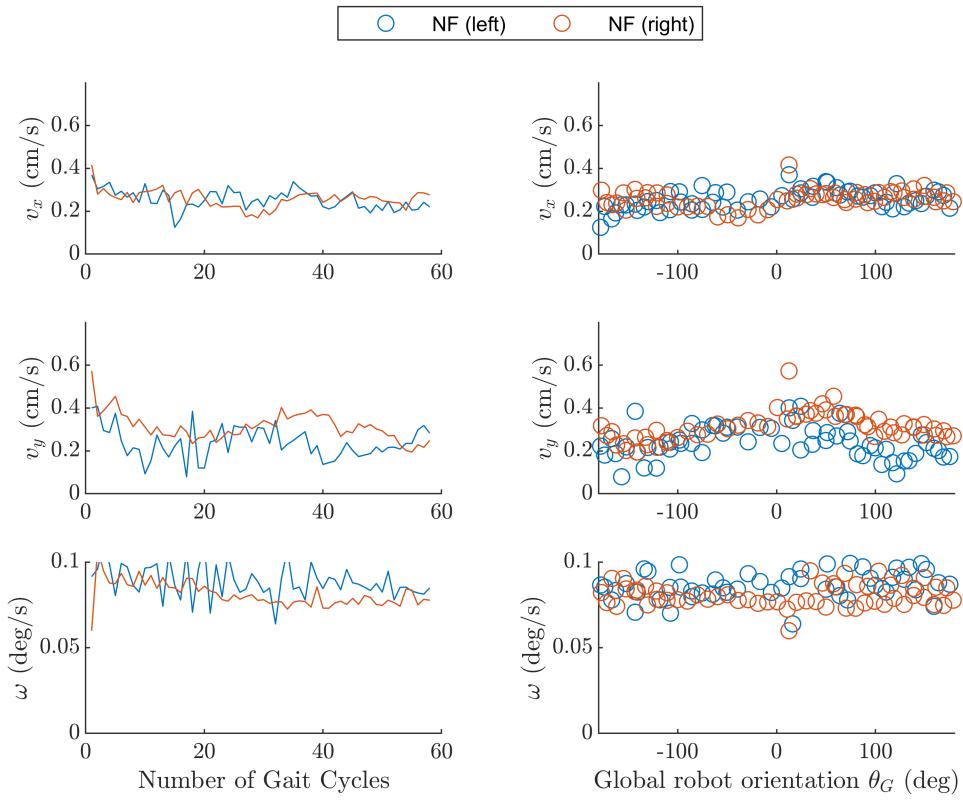
Twist comparison for 6 trials of gait B (no sheath):



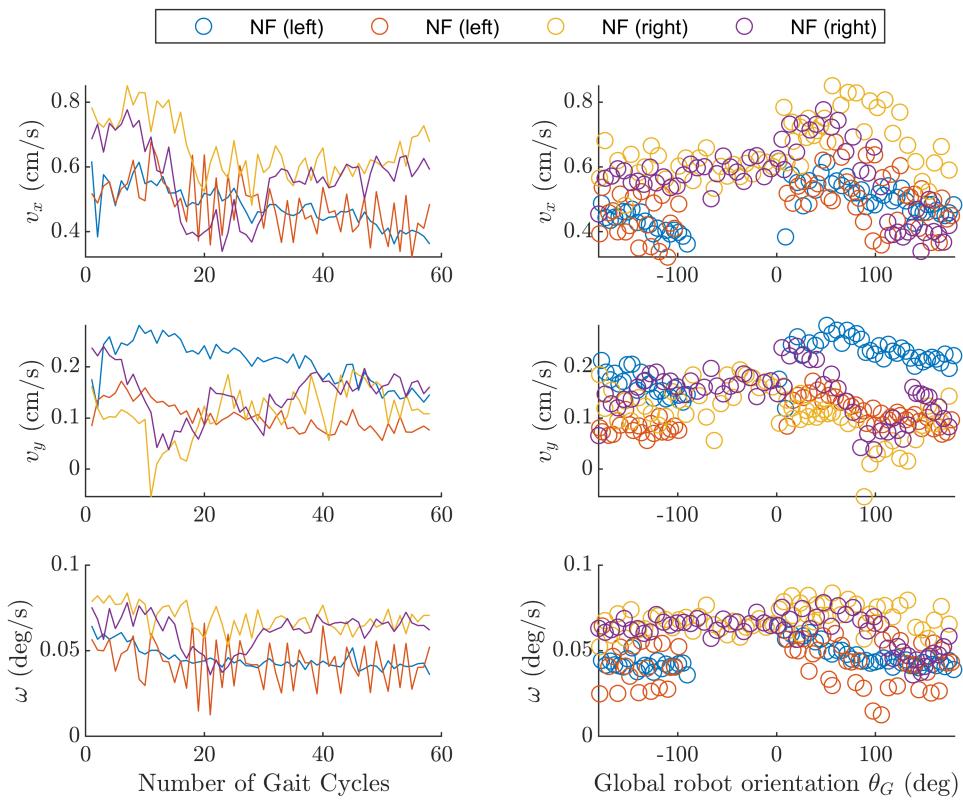
Twist comparison for 5 trials of gait B (32 AWG sheath) with accidental interference with tether:



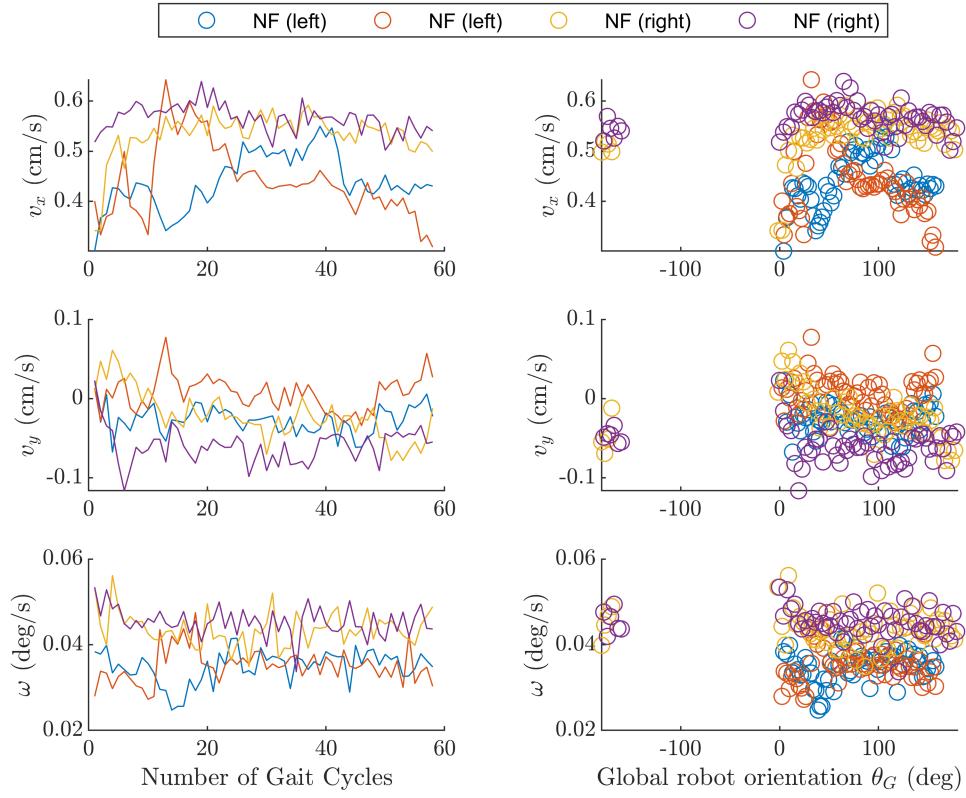
Twist comparison for 2 trials of gait B (AWG 32 with slip ring):



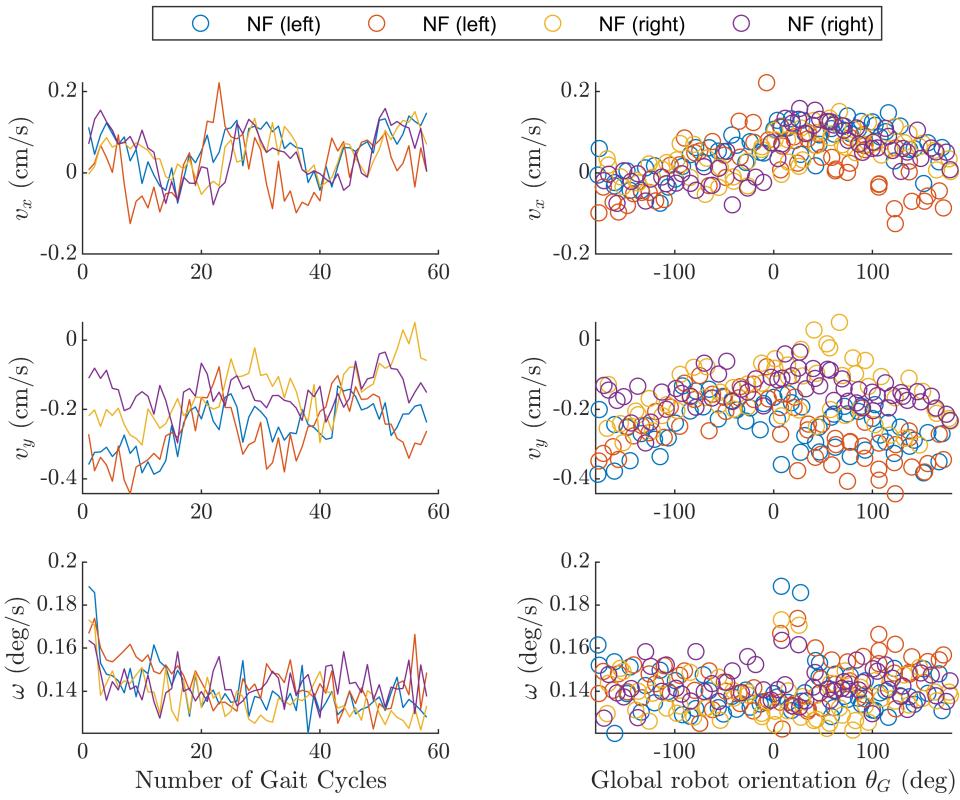
Twist comparison for 4 trials of gait F (32 AWG sheath):



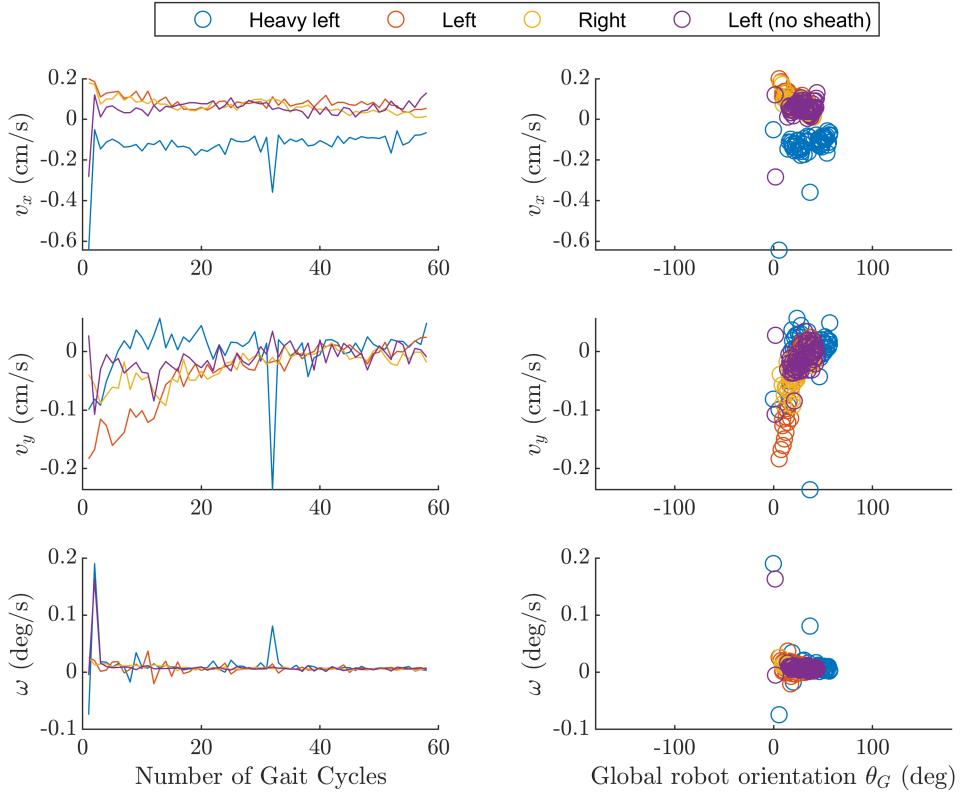
Twist comparison for 4 trials of gait G (32 AWG sheath):



Twist comparison for 4 trials of gait H (32 AWG sheath) with accidental interference with tether:

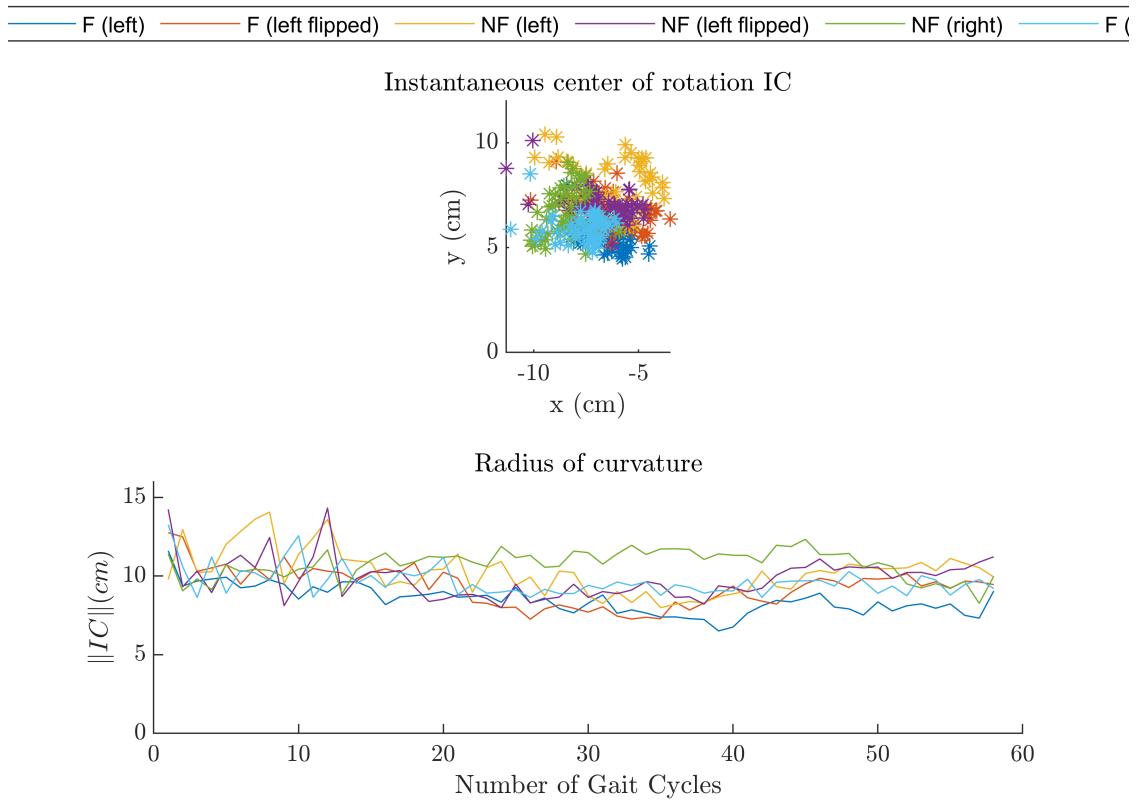


Twist comparison for 4 trials of gait E (not following):



Construct comparative ICR / ROC plots.

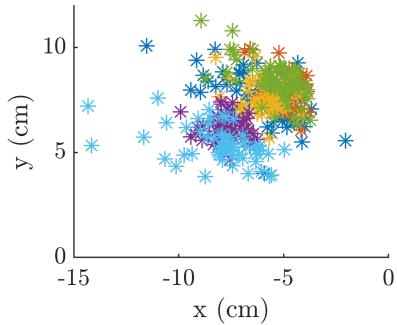
ICR / ROC comparison for 6 trials of gait B (light sheath):



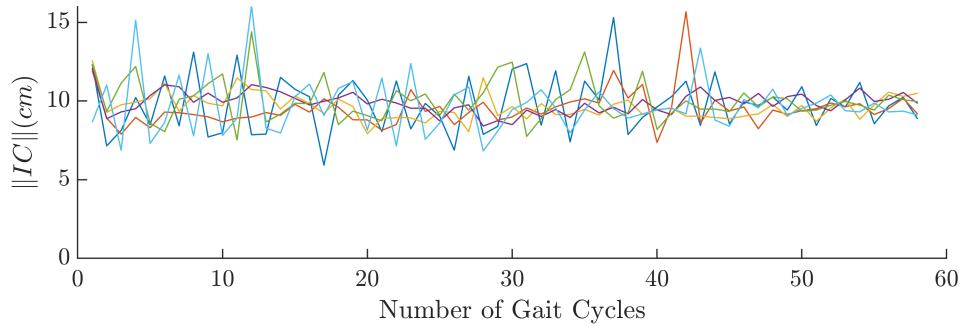
ICR / ROC comparison for 6 trials of gait B (no sheath):



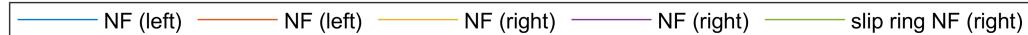
Instantaneous center of rotation IC



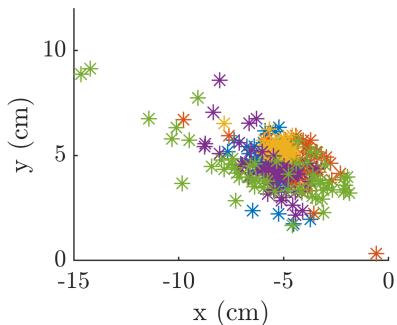
Radius of curvature



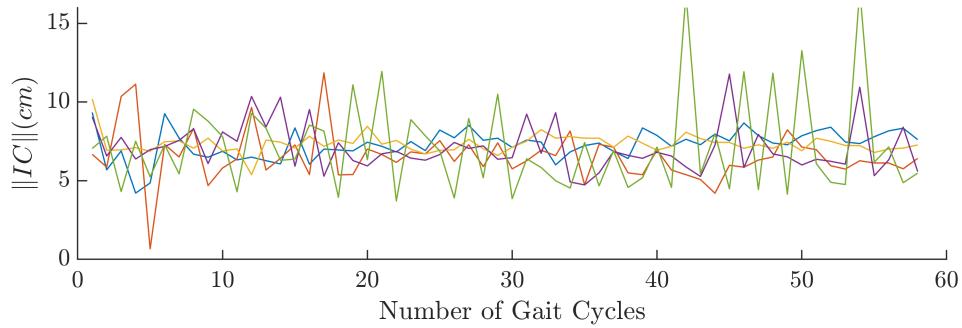
ICR / ROC comparison for 6 trials of gait B (32 AWG sheath) with accidental interference with tether:



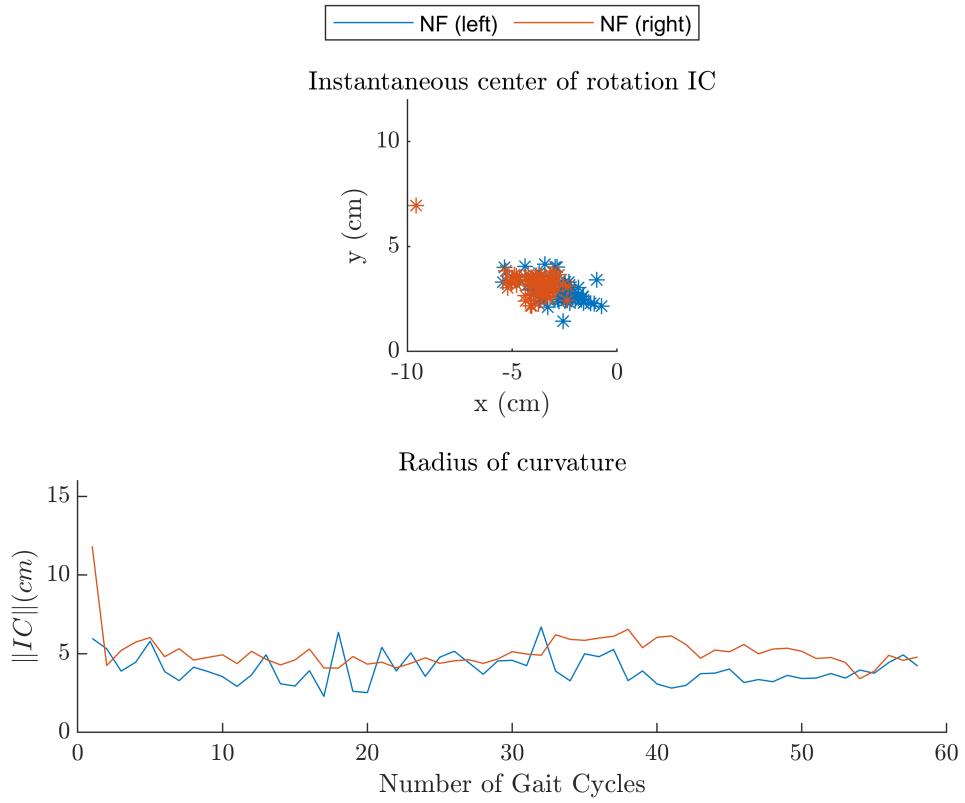
Instantaneous center of rotation IC



Radius of curvature



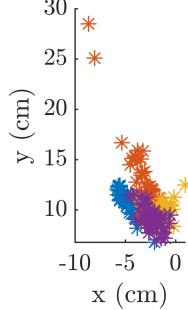
ICR / ROC comparison for 2 trials of gait B (AWG 32 with slip ring)



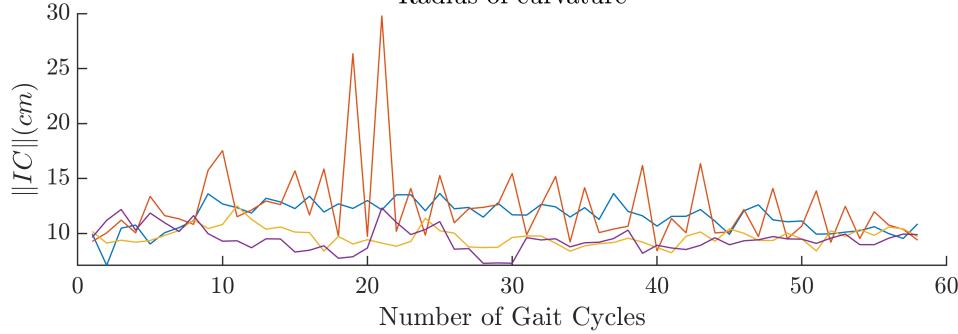
ICR / ROC comparison for 4 trials of gait F (AWG 32 with slip ring)



Instantaneous center of rotation IC



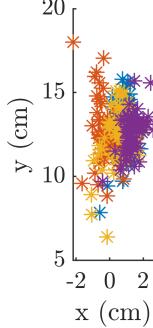
Radius of curvature



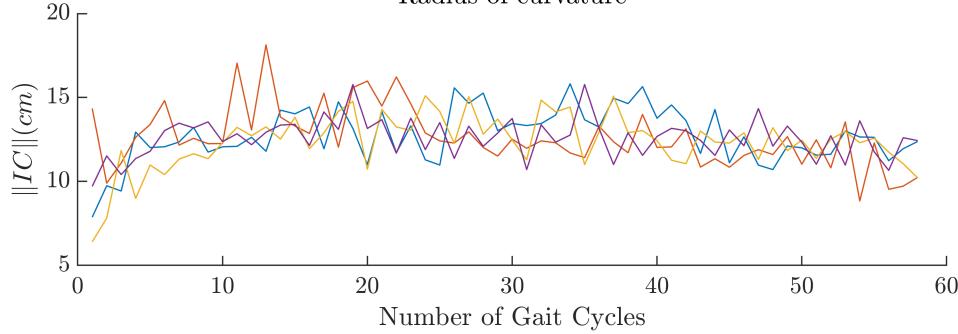
ICR / ROC comparison for 4 trials of gait G (AWG 32 with slip ring)



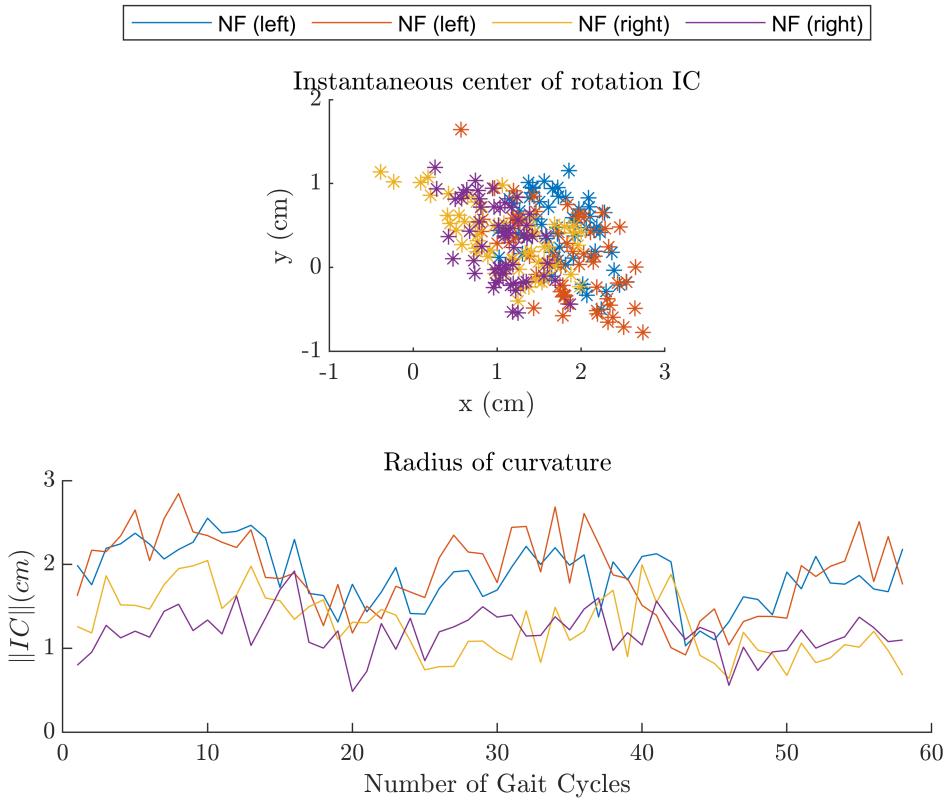
Instantaneous center of rotation IC



Radius of curvature



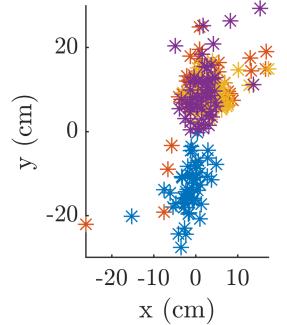
ICR / ROC comparison for 4 trials of gait H (AWG 32 with slip ring) with accidental interference with tether:



ICR / ROC comparison for 4 trials of gait E (not following):



Instantaneous center of rotation IC



Radius of curvature

