

Construction of New Gait Library (no symmetry assumption)

The following MATLAB Live Script builds a new gait library (gait_library_4) based on gaits B, G, I, J, K. The last three gaits (I,J,K) are based on symmetric permutations of gait G (i.e., gait G actuation sequence has been successively rotated by 90 degrees). If the robot is symmetric, this should produce gaits that are identical but with trajectories at four distinct angles offset by 90 degrees (NW, SW, SE, NE).

The results show that the robot is not symmetric. While the symmetric permutations do roughly produce trajectories in these four directions, they have different velocities and radii of curvature. Therefore, we can construct a new gait library to encode these unique twists and incorporate them into the path planning algorithm.

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]

From 20221201 Experiments:

- Gait G Left AWG 32 Slip ring Trial 3* [AWG 32 slip ring - not following - left]
Gait G Left AWG 32 Slip ring Trial 4 [AWG 32 slip ring - not following - left]
Gait I Left AWG 32 Slip ring Trial 1 [AWG 32 slip ring - not following - left]
Gait I Left AWG 32 Slip ring Trial 2 [AWG 32 slip ring - not following - left]
Gait J Left AWG 32 Slip ring Trial 1 [AWG 32 slip ring - not following - left]
Gait J Left AWG 32 Slip ring Trial 2 [AWG 32 slip ring - not following - left]
Gait K Left AWG 32 Slip ring Trial 1 [AWG 32 slip ring - not following - left]
Gait K Left AWG 32 Slip ring Trial 2 [AWG 32 slip ring - not following - left]

From 20221213 Experiments:

- Gait G Right AWG 32 Slip ring Trial 3* [AWG 32 slip ring - not following - left]
Gait G Right AWG 32 Slip ring Trial 4 [AWG 32 slip ring - not following - left]
Gait I Right AWG 32 Slip ring Trial 1 [AWG 32 slip ring - not following - left]
Gait I Right AWG 32 Slip ring Trial 2 [AWG 32 slip ring - not following - left]
Gait J Right AWG 32 Slip ring Trial 1 [AWG 32 slip ring - not following - left]
Gait J Right AWG 32 Slip ring Trial 2 [AWG 32 slip ring - not following - left]
Gait K Right AWG 32 Slip ring Trial 1 [AWG 32 slip ring - not following - left]
Gait K Right AWG 32 Slip ring Trial 2 [AWG 32 slip ring - not following - left]

From 20221220 Experiments:

Gait G Left AWG 32 Slip ring Trial 5 [AWG 32 slip ring - not following - left]

Gait I Left AWG 32 Slip ring Trial 3 [AWG 32 slip ring - not following - left]

Gait J Left AWG 32 Slip ring Trial 3 [AWG 32 slip ring - not following - left]

Gait K Left AWG 32 Slip ring Trial 3 [AWG 32 slip ring - not following - left]

Build Experiment Matrix

`sorted_exps = 69x7 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
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'	

	Experiment	Gait	#Cycles	Tether	Protocol	Placement	Trial
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	66	'G'	'30'	'32SR'	'NF'	'L'	1
44	39	'G'	'60'	'32SR'	'NF'	'L'	2
45	50	'G'	'60'	'32SR'	'NF'	'L'	3
46	51	'G'	'60'	'32SR'	'NF'	'L'	4
47	40	'G'	'60'	'32SR'	'NF'	'R'	1
48	41	'G'	'60'	'32SR'	'NF'	'R'	2
49	58	'G'	'60'	'32SR'	'NF'	'R'	3
50	59	'G'	'60'	'32SR'	'NF'	'R'	4
51	44	'H'	'60'	'32SR'	'NF'	'L'	1
52	45	'H'	'60'	'32SR'	'NF'	'L'	2
53	46	'H'	'60'	'32SR'	'NF'	'R'	1
54	47	'H'	'60'	'32SR'	'NF'	'R'	2
55	52	'I'	'60'	'32SR'	'NF'	'L'	1
56	67	'I'	'30'	'32SR'	'NF'	'L'	1
57	53	'I'	'60'	'32SR'	'NF'	'L'	2
58	60	'I'	'60'	'32SR'	'NF'	'R'	1
59	61	'I'	'60'	'32SR'	'NF'	'R'	2

	Experiment	Gait	#Cycles	Tether	Protocol	Placement	Trial
60	54	'J'	'60'	'32SR'	'NF'	'L'	1
61	68	'J'	'30'	'32SR'	'NF'	'L'	1
62	55	'J'	'60'	'32SR'	'NF'	'L'	2
63	62	'J'	'60'	'32SR'	'NF'	'R'	1
64	63	'J'	'60'	'32SR'	'NF'	'R'	2
65	56	'K'	'60'	'32SR'	'NF'	'L'	1
66	69	'K'	'30'	'32SR'	'NF'	'L'	1
67	57	'K'	'60'	'32SR'	'NF'	'L'	2
68	64	'K'	'60'	'32SR'	'NF'	'R'	1
69	65	'K'	'60'	'32SR'	'NF'	'R'	2

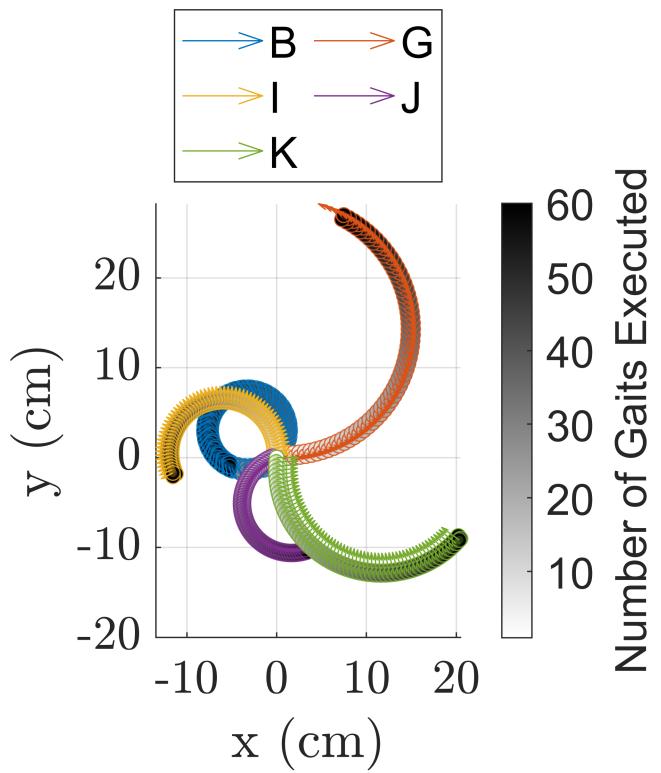
Analyze the experiment data:

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 ICR / ROC plots.

Make gait libraries.

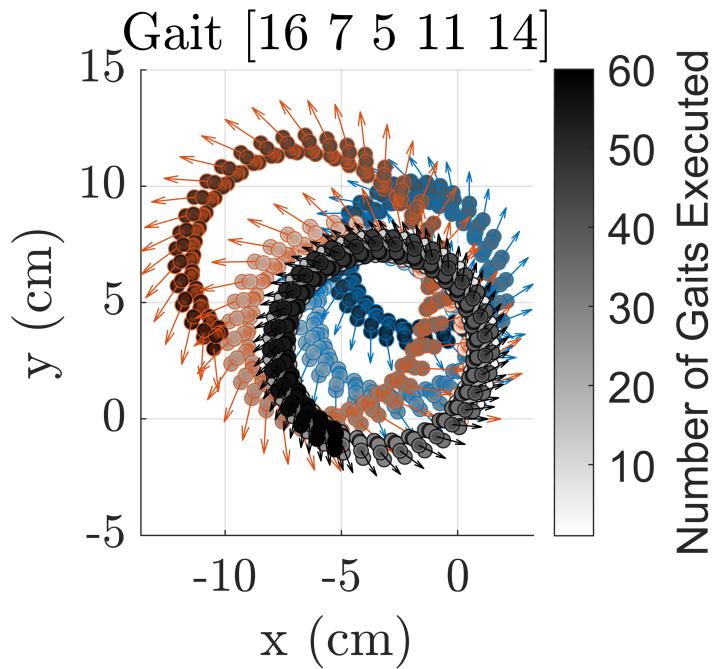
Plot gait libraries.



Construct comparative motion plots.

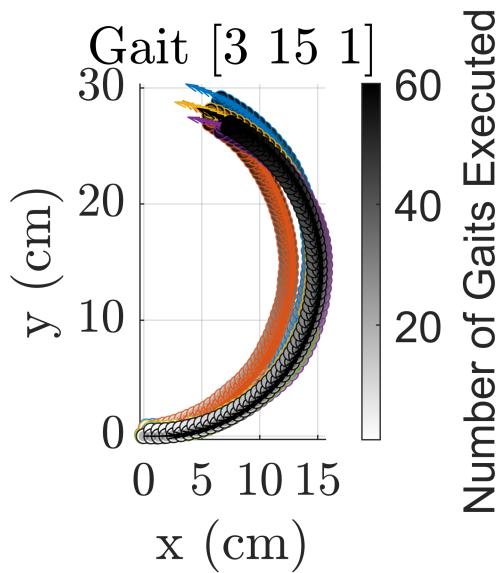
Comparison (overlay) of 2 trials of gait B (AWG 32 with new slip ring):

NF (left) → NF (right) → Average

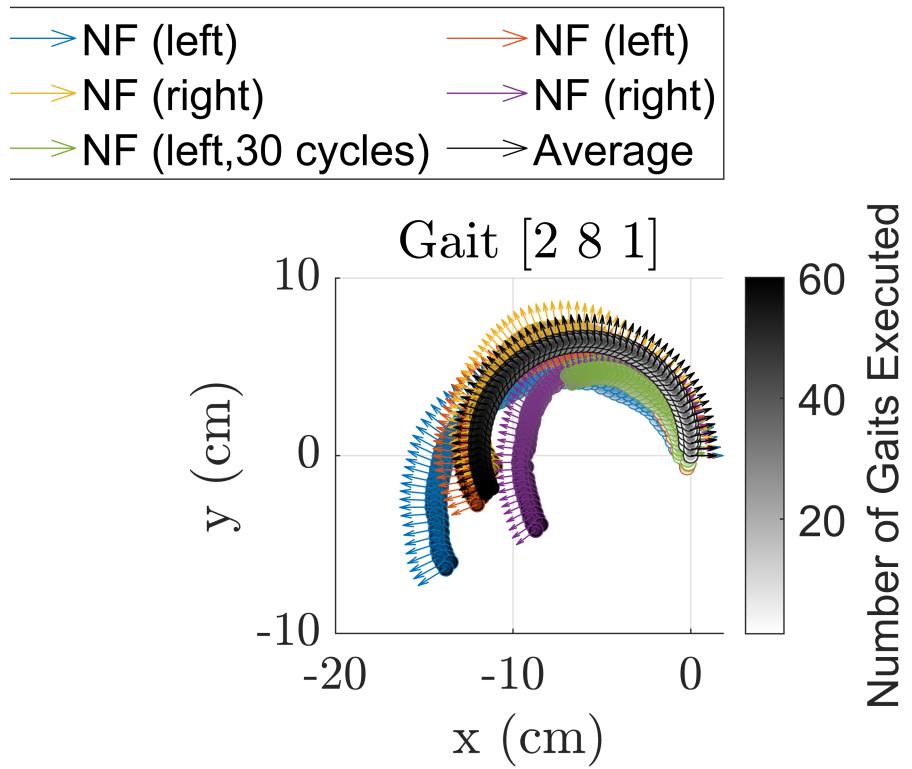


Comparison (overlay) of 5 trials of gait G (AWG 32 with slip ring):

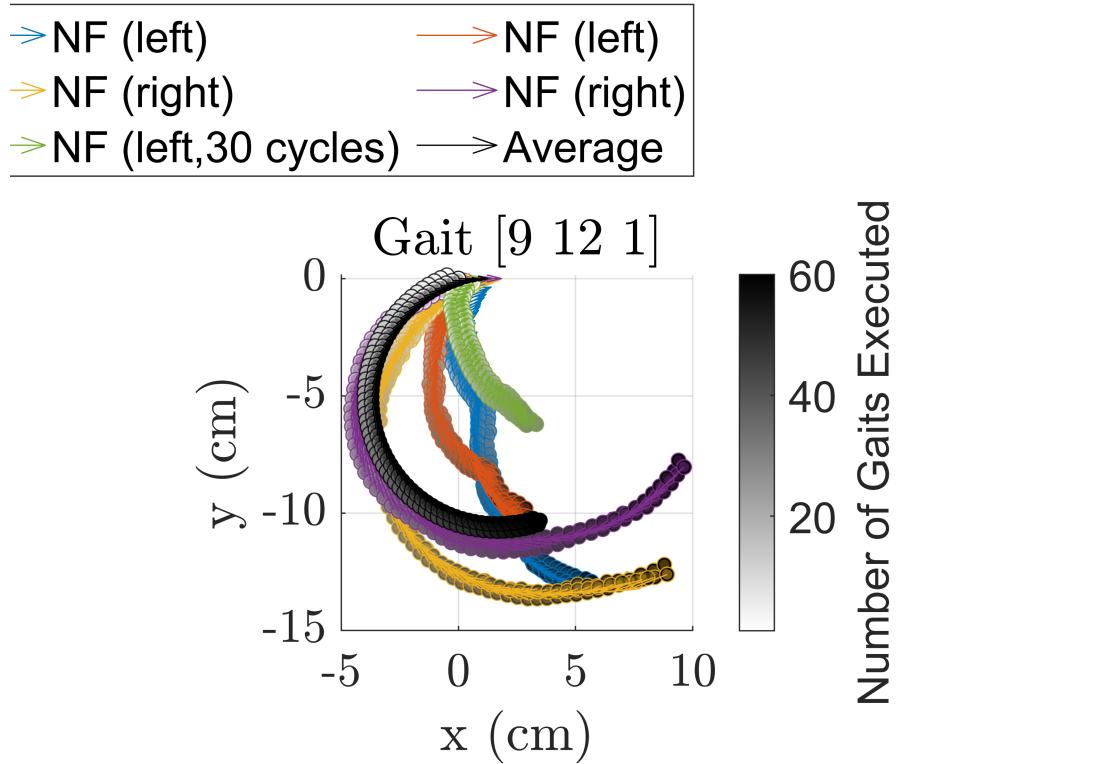
F (left) → NF (left)
 F (right) → NF (right)
 F (left,30 cycles) → Average



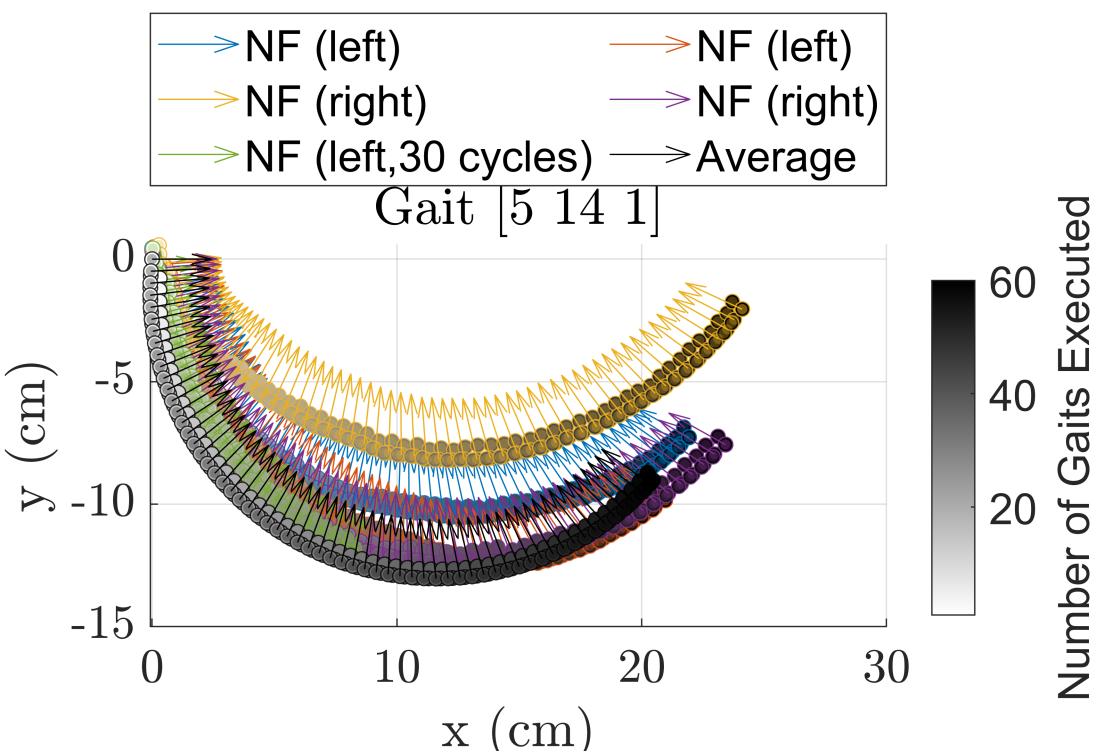
Comparison (overlay) of 5 trials of gait I (AWG 32 with new slip ring):



Comparison (overlay) of 5 trials of gait J (AWG 32 with new slip ring):

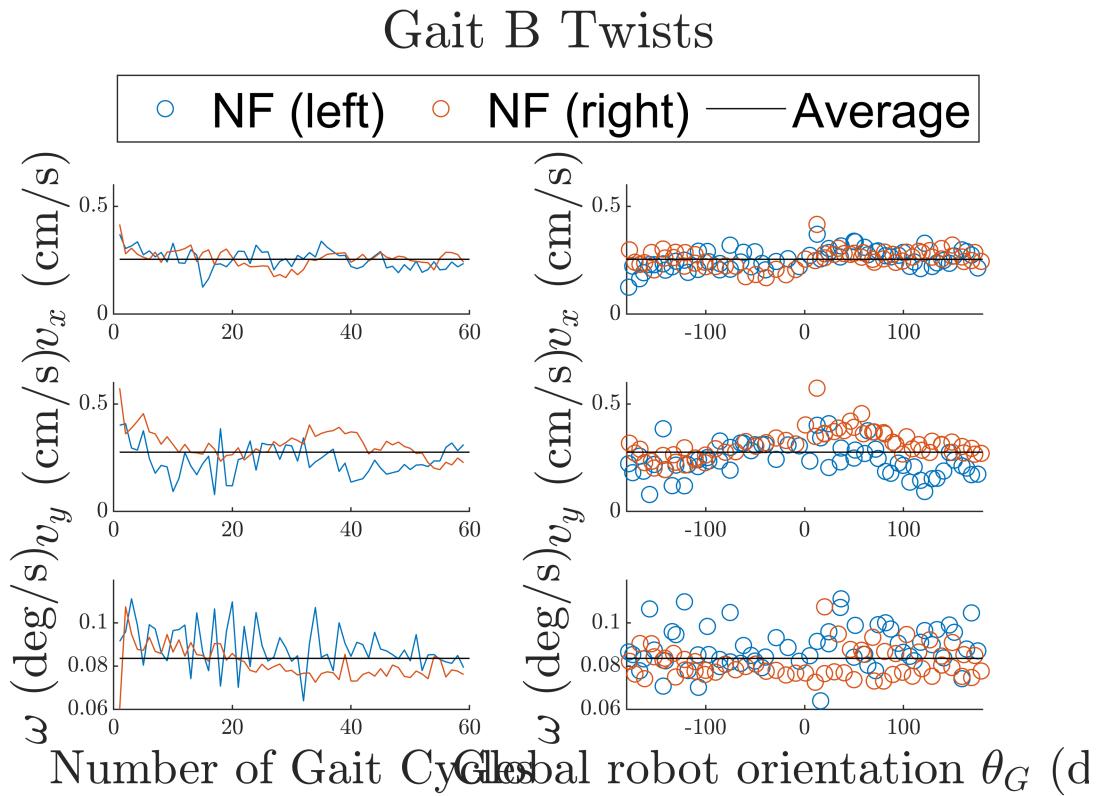


Comparison (overlay) of 5 trials of gait K (AWG 32 with new slip ring):



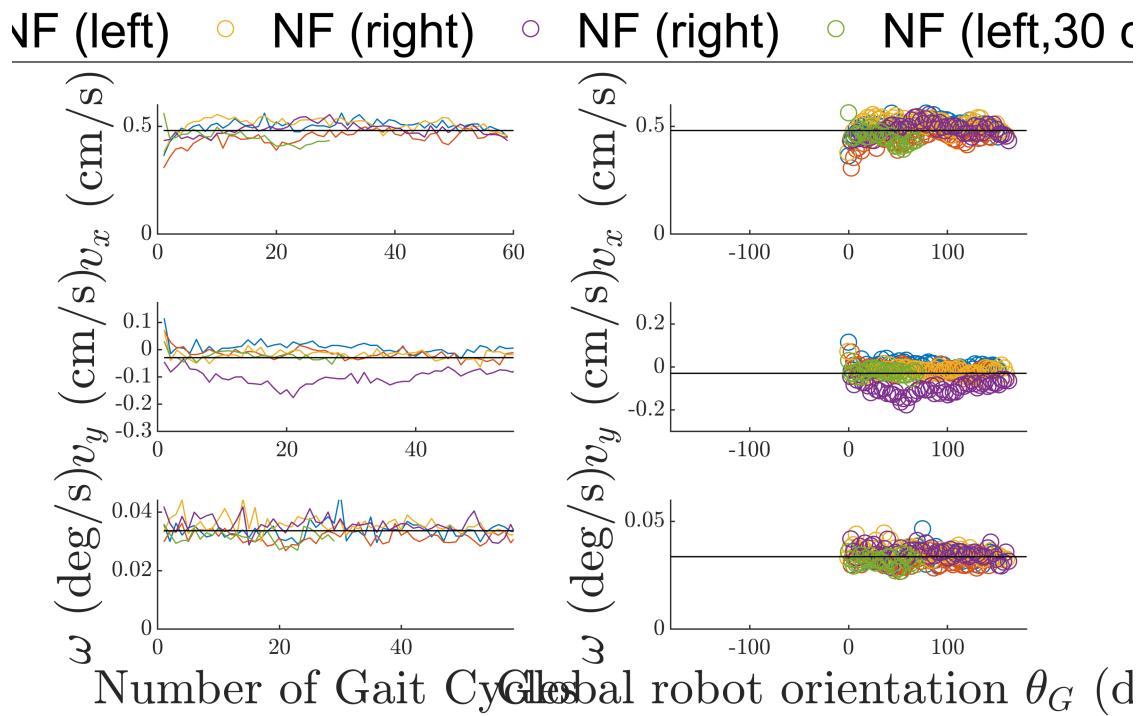
Construct comparative twist plots.

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



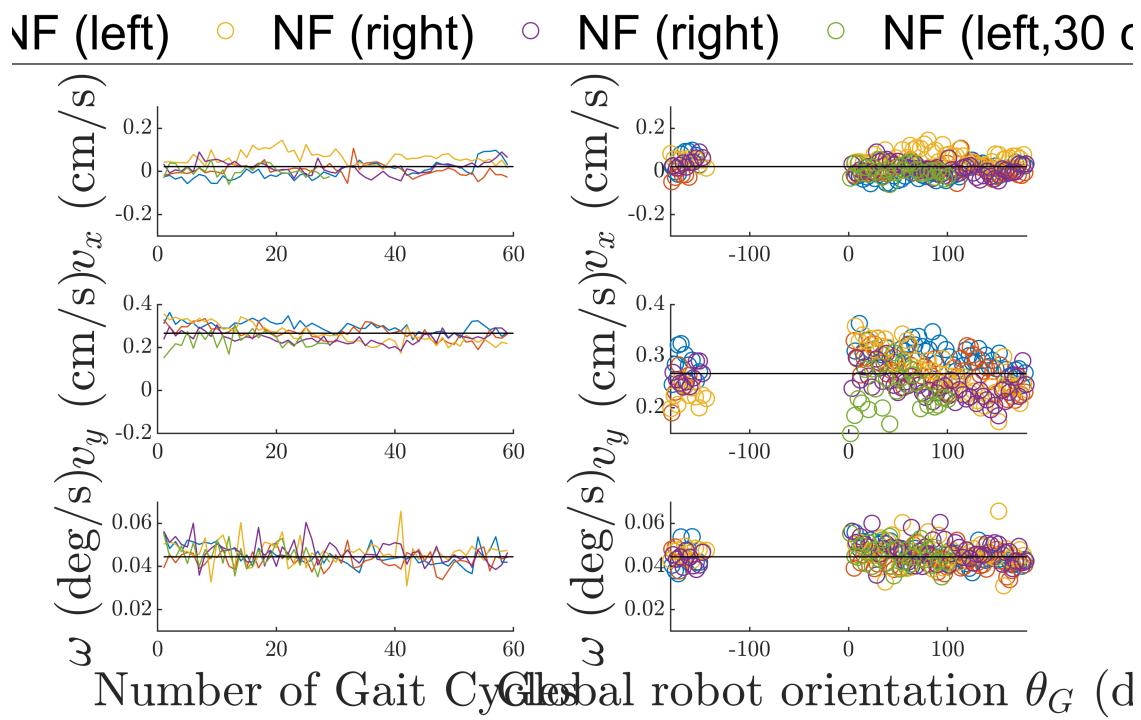
Twist comparison for 5 trials of gait G (AWG 32 with new slip ring):

Gait G Twists

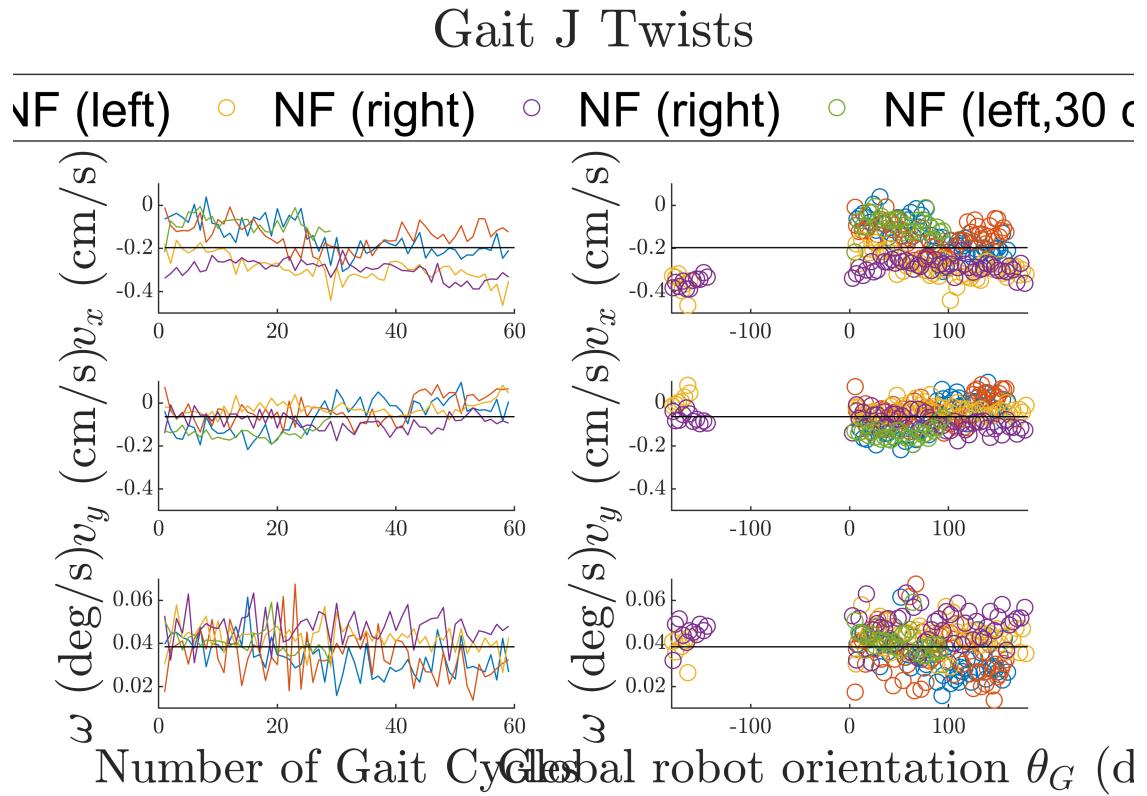


Twist comparison for 5 trials of gait I (AWG 32 with new slip ring):

Gait I Twists



Twist comparison for 5 trials of gait J (AWG 32 with new slip ring):



Twist comparison for 5 trials of gait K (AWG 32 with new slip ring):

Gait K Twists

