Evaluating reachable workspace and user control over prehensor aperture for a body-powered prosthesis: Data descriptor

This dataset accompanies the paper by Chadwell at el. 'Evaluating reachable workspace and user control over prehensor aperture for a body-powered prosthesis', currently under review.

The data are recorded from 10 anatomically intact participants using a body-powered prosthesis simulator. The aim of this study was to develop an approach to evaluating the restrictions on the reachable workspace caused by the prosthesis harness and to quantify the restrictions on aperture throughout the workspace.

Here we provide 2 Matlab structures (*MarkerPositions.mat* and *GoniometerData.mat*). The sampling rate for both sets of data is 100Hz.

MarkerPositions.mat contains the 3D coordinates of 5 retroreflective markers: 3 placed on the sternum, one on the 'finger' of the prehensor, and one on the right shoulder (Figures 1 and 2). Data is provided for two static trials (undertaken without the prosthesis harness), the data in *StaticArmDown* was recorded with the arm hung down by the side, whilst the data in *StaticArmOut* was recorded with the arm held out horizontally to the side. Data is also provided for the assessment of the reachable workspace both with and without the prosthesis harness connected (*Reachable_Harness* and *Reachable_NoHarness*). Each reachable workspace trial represents a sweep of the arm in an arc around the body. Table 1 describes these arcs, and highlights where a subject may be missing arc data due to being unable to reach the starting position. Finally, *Aperture_Assessment* contains the 3D marker coordinates to accompany the angle data presented in the second Matlab structure *GoniometerData.mat* (Figure 3). Table 2 describes the hand positions assessed with associated images.
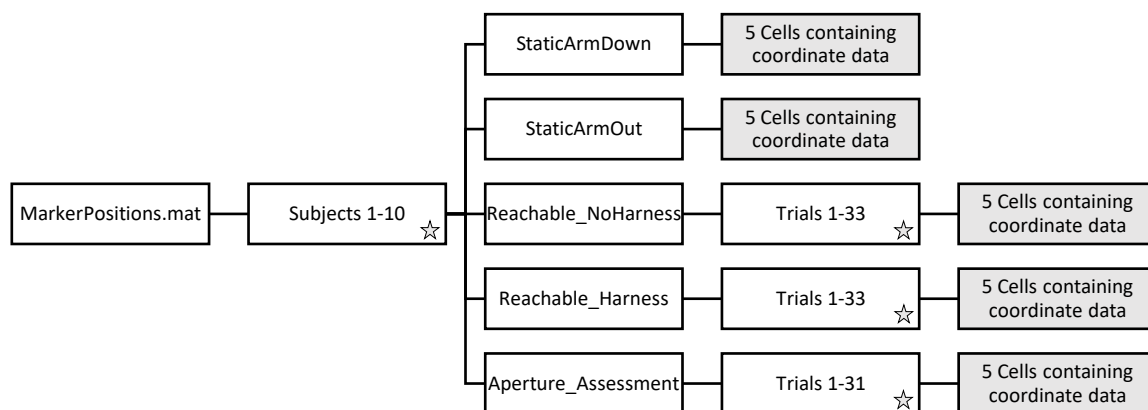
Figure 1. Structure of MarkerPositions.mat. Where a star is shown, the subsequent structure is repeated for each individual Subject/Trial. The structure of the coordinate data cells is detailed in Figure 2.
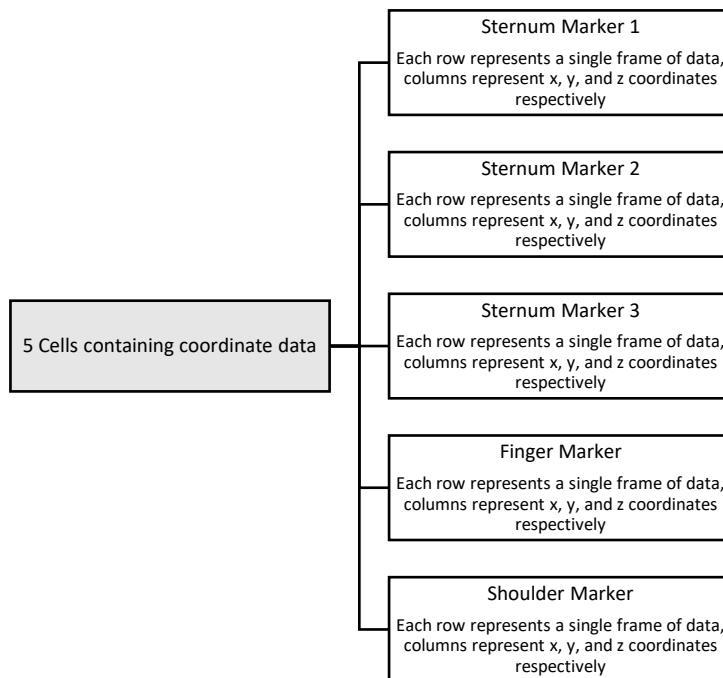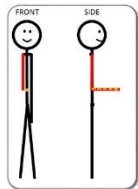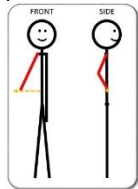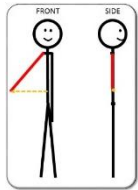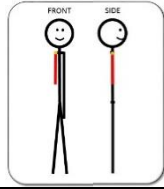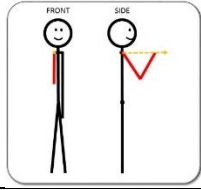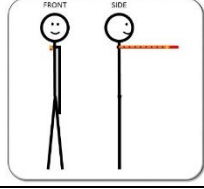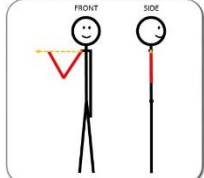
Figure 2. Structure of coordinate data cells. This is the raw data from Qualisys with no filtering or gap filling.

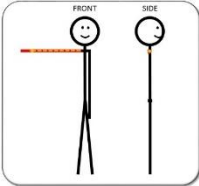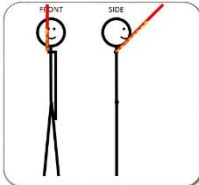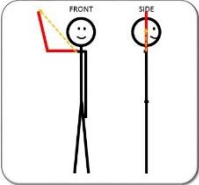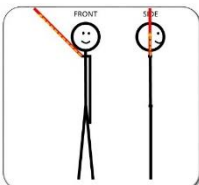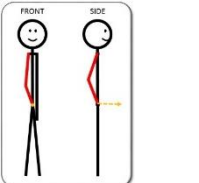**Table 1. Description of reachable workspace trials.** For each trial, a description of the arc the participant was undertaking is provided alongside the orientation of the palm at the start of the trial (participants were instructed to try and keep this orientation the same throughout the movement). Some participants were unable to achieve the starting positions due to the restrictions of anatomy or the harness, in these cases, details of these missing trials are highlighted in the final 2 columns. Each trial was undertaken with and without the harness.
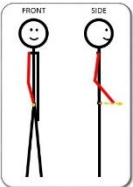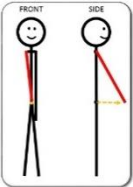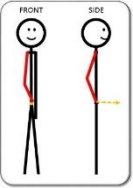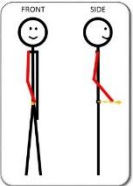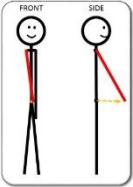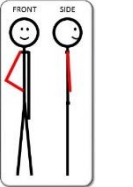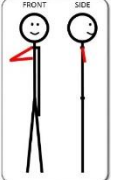
| Trial | Movement | Palm orientation | Missing subjects | |
			No harness	Harness
1	Frontal plane above shoulder height – travelling behind head	Medial		1
2	Frontal plane above shoulder height – travelling behind head	Back		1
3	Frontal plane above shoulder height – travelling behind head	Front		1
4	Frontal plane below shoulder height – travelling behind back	Medial	4,5,7-9	2,4,7,9
5	Frontal plane below shoulder height – travelling behind back	Back	3-9	2-9
6	Frontal plane below shoulder height – travelling behind back	Front		2,7,9
7	Frontal plane above shoulder height – travelling in front of head	Medial		1,10
8	Frontal plane above shoulder height – travelling in front of head	Back		1,10
9	Frontal plane above shoulder height – travelling in front of head	Front		1,10
10	Frontal plane below shoulder height – travelling in front of legs	Medial		
11	Frontal plane below shoulder height – travelling in front of legs	Back		
12	Frontal plane below shoulder height – travelling in front of legs	Front		
13	Latitude – remaining at shoulder height	Medial		1
14	Latitude – remaining at shoulder height	Back		1
15	Latitude – remaining at shoulder height	Front		1
16	Latitude – 45 degrees below horizontal	Medial		
17	Latitude – 45 degrees below horizontal	Back		
18	Latitude – 45 degrees below horizontal	Front		
19	Latitude – down by the pelvis	Medial		

20	Latitude – down by the pelvis	Back		
21	Latitude – down by the pelvis	Front		
22	Latitude – 45 degrees above horizontal	Medial		1,2
23	Latitude – 45 degrees above horizontal	Back	3,4	1-4
24	Latitude – 45 degrees above horizontal	Front		1,2
25	Latitude – vertically up around head	Medial	3	1-3,5,7,9,10
26	Latitude – vertically around head	Back	1-10	1-10
27	Latitude – vertically around head	Front		1-3,7
28	Longitude – 45 degrees away from body	Medial		
29	Longitude – 45 degrees away from body	Back		
30	Longitude – 45 degrees away from body	Front		
31	Longitude – in sagittal plane	Medial		
32	Longitude – in sagittal plane	Back		
33	Longitude – in sagittal plane	Front		

Figure 3. Structure of GoniometerData.mat. Where a star is shown, the subsequent structure is repeated for each individual Subject/Trial. These data have been converted from voltage readings into angles in degrees, however, the data have not been filtered.

Table 2. Description of aperture assessment positions. A description of each hand position is given (this relates to the position of the anatomical hand, not the artificially extended prehensor of the prosthesis simulator). Some participants were unable to achieve the positions due to the restrictions of anatomy or the harness, the trial number associated with each position is therefore given for each subject.

Position	Trial number									
	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6	Subject 7	Subject 8	Subject 9	Subject 10
(1) Hand by right hip	1	1	1	1	1	1	1	1	1	1
(2) Hand mid-way between positions 1 and 3	2	2	2	2	2	2	2	2	2	2

(3) Arm straight down the side of the right leg	3	3	3	3	3	3	3	3	3	3
(4) Hand mid-way between positions 1 and 5	4	4	4	4	4	4	4	4	4	4
(5) Arm extended forwards at hip level	5	5	5	5	5	5	5	5	5	5
(6) Hand mid-way between positions 1 and 7	6	6	6	6	6	6	6	6	6	6
(7) Arm extended sideways (right) at hip level	7	7	7	7	7	7	7	7	7	7
(8) Hand at waist (right)	10	8	8	8	8	8	8	8	8	8
(9) Hand mid-way between positions 8 and 10	8	9	9	9	9	9	9	9	9	9

Position										
(10) Hand directly forward at waist level (elbow bent)	9	10	10	10	10	10	10	10	10	10
(11) Hand mid-way between positions 8 and 12	11	11	11	11	11	11	11	N/A	11	11
(12) Arm extended sideways (right) at waist level	12	12	12	12	12	12	12	N/A	12	12
(13) Hand by right shoulder (as close as anatomically possible)	13	13	13	13	13	13	13	11	13	N/A
(14) Hand mid-way between positions 13 and 15	14	14	14	14	14	14	14	12	14	13
(15) Arm extended forwards at shoulder level (right)	15	15	15	15	15	15	15	13	15	14
(16) Hand mid-way between positions 13 and 17	16	16	16	16	16	16	16	14	16	15

Position										
(17) Arm extended sideways (right) at shoulder level	17	17	17	17	17	17	17	15	17	16
(18) Hand mid-way between positions 13 and 19	18	18	18	18	18	18	18	16	18	17
(19) Arm extended forwards along a path travelling 45 degrees up from the shoulder (as far as the harness allows)	N/A	19	19	N/A	N/A	19	19	17	19	N/A
(20) Hand mid-way between positions 13 and 21	19	20	20	19	19	20	20	18	20	18
(21) Arm extended sideways (right) along a path travelling 45 degrees up from the shoulder (as far as the harness allows)	20	21	21	20	20	21	21	19	21	N/A
(22) Hand by perineum (hip level – central to body)	21	22	22	21	21	22	22	20	22	19

(23) Hand mid-way between positions 22 and 24	22	23	23	22	22	23	23	21	23	20
(24) Arm extended forwards at hip level crossed over the body to align centrally with the perineum	23	24	24	23	23	24	24	22	24	21
(25) Hand by left hip	24	25	25	24	24	25	25	23	25	22
(26) Hand mid-way between positions 25 and 27	25	26	26	25	25	26	26	24	26	23
(27) Arm extended forwards at hip level crossed over the body to align with the left hip	26	27	27	26	26	27	27	25	27	24
(28) Hand by belly button	27	28	28	27	27	28	28	26	28	25
(29) Hand by centre of chest	28	29	29	28	28	29	29	27	29	26

(30) Hand by mouth	29	30	30	29	29	30	30	28	30	27
(31) Hand by left shoulder	30	31	31	30	30	31	31	29	31	28