HELLO!

I am HR Mokhtarinia

I am here because I love to give presentations.

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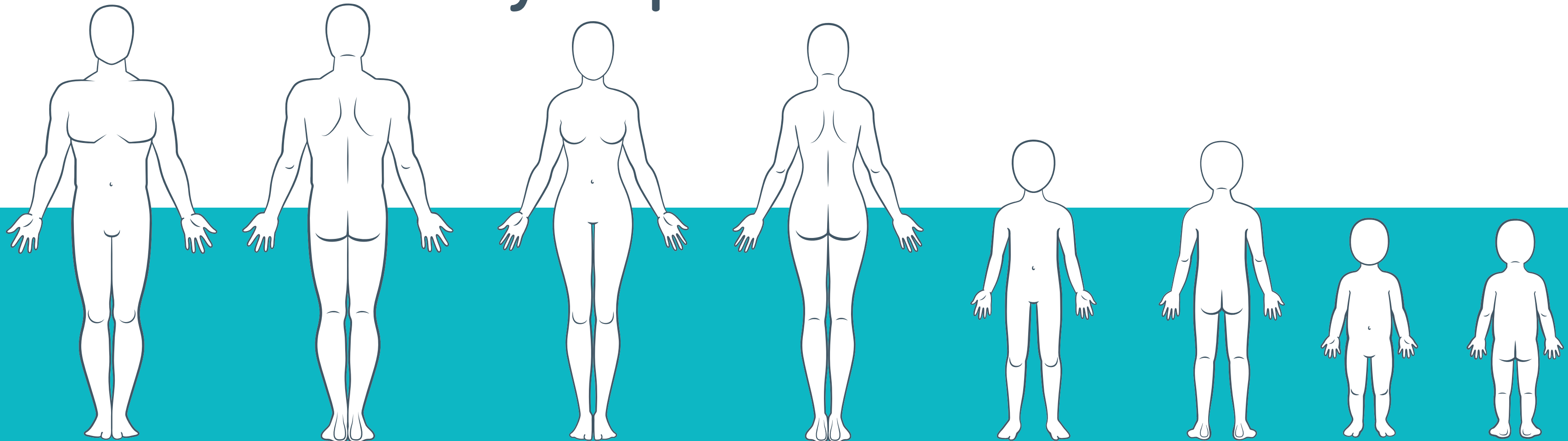
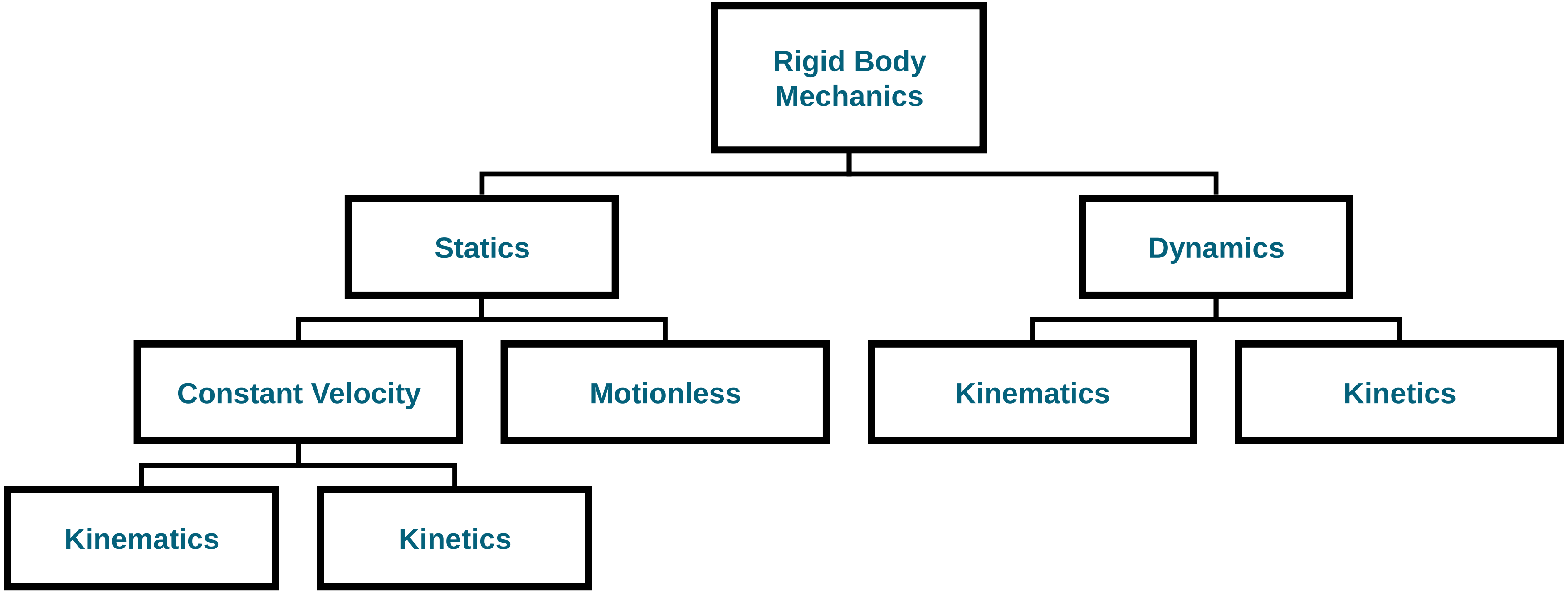
Motion Analysis Indications in Ergonomics

- **Basic concepts of Kinematics**
- **Variables**
- **Bioinstrumentation**
- **Data gathering**
- **Data analysis**
- **Provide study samples**



Rigid Body Mechanic



Basic Kinematic Concepts

- Variables for Describing Motion
- Reference Systems for Describing Motion of the Human Body and Its Segments
- Spatial and temporal characteristics
  - Spatial (where, how far, what direction)
  - Temporal (how long, how fast,)
- Qualitative or quantitative
- Linear & angular motion

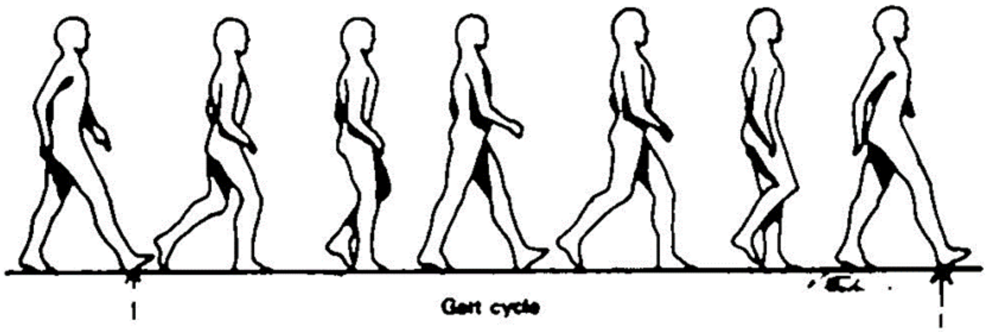
Kinematic Variables

- Time
- Position
- Displacement & distance
- Velocity & speed
- Acceleration

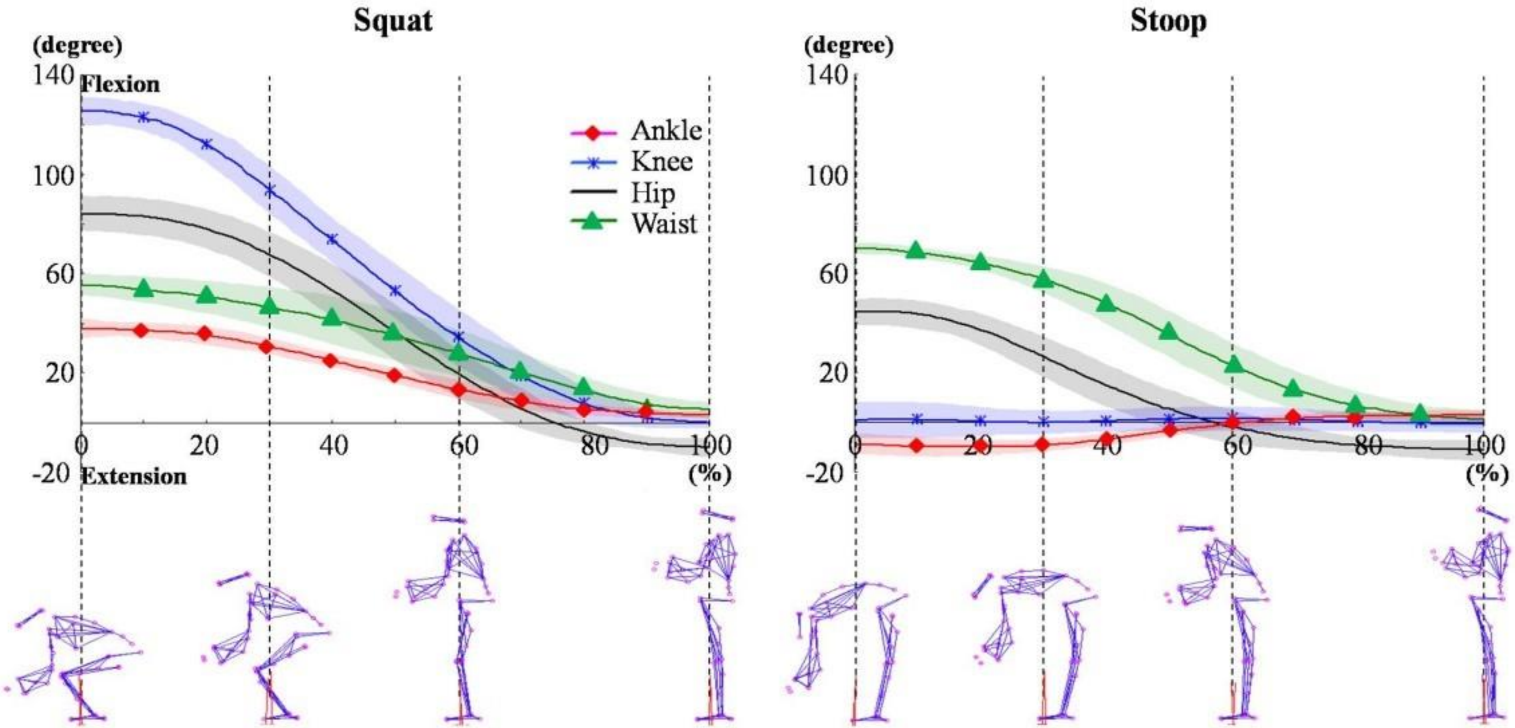
Time – Temporal Analysis

- WHEN?
- HOW OFTEN?
- IN WHAT ORDER?
- HOW LONG?

- **Most basic analysis**
- **Examples:**
  - **Cadence**
  - **Stride time**
  - **Temporal patterning**



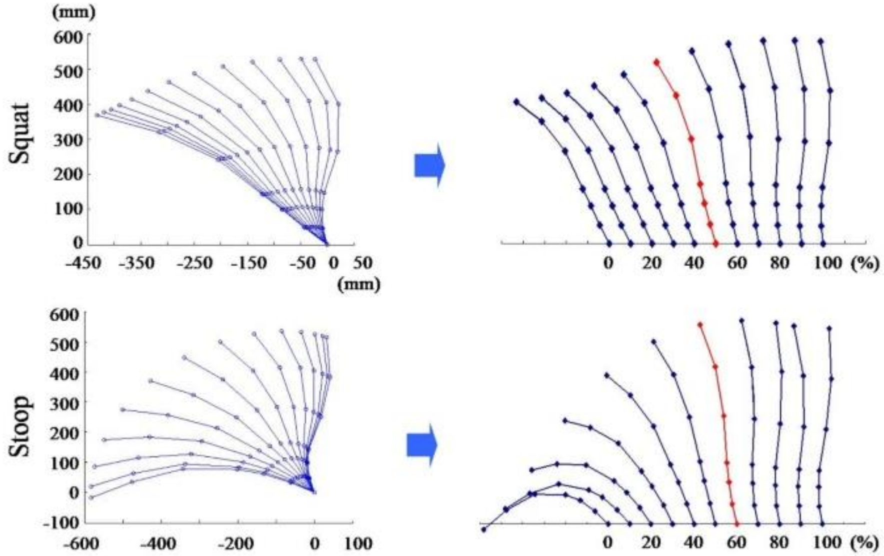
Time – Temporal Analysis



Position Analysis

- Where?
- position - location in space relative to some reference point
- Linear position (s)
  - x,y,z coordinates
- Angular position (▯)
  - Angle relative to the zero degree
- Units (meter or degree)

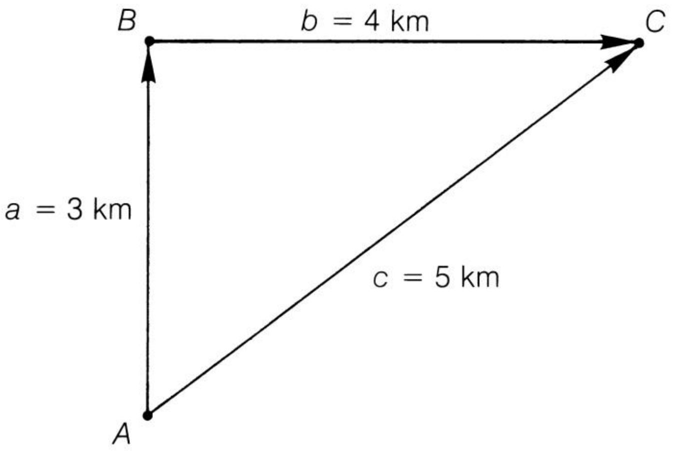
Lumbar spine curvatures during squat and stoop lifting. Lumbar curvature was changed from the kyphosis to the lordosis about 50% in the squat lifting, and 60% in the stoop lifting regardless of weights.



Displacement & Distance

- Displacement (Δs, $\Delta\theta$)
  - Final change in position
  - Vector quantity
  - Angular or transitional
- Distance (Δp, ϕ)
  - Sum of all changes in position
  - Scalar quantity
- units (m, °)

Displacement (motion): 5 km to the northeast
Distance: 7 km



Velocity & Acceleration

HOW FAST?

- Velocity (v, ω)
  - Vector quantity
  - Δposition ÷ time
  - Units ($m{\cdot}s^{-1}$, $°{\cdot}s^{-1}$)

HOW QUICKLY IS VELOCITY CHANGING?

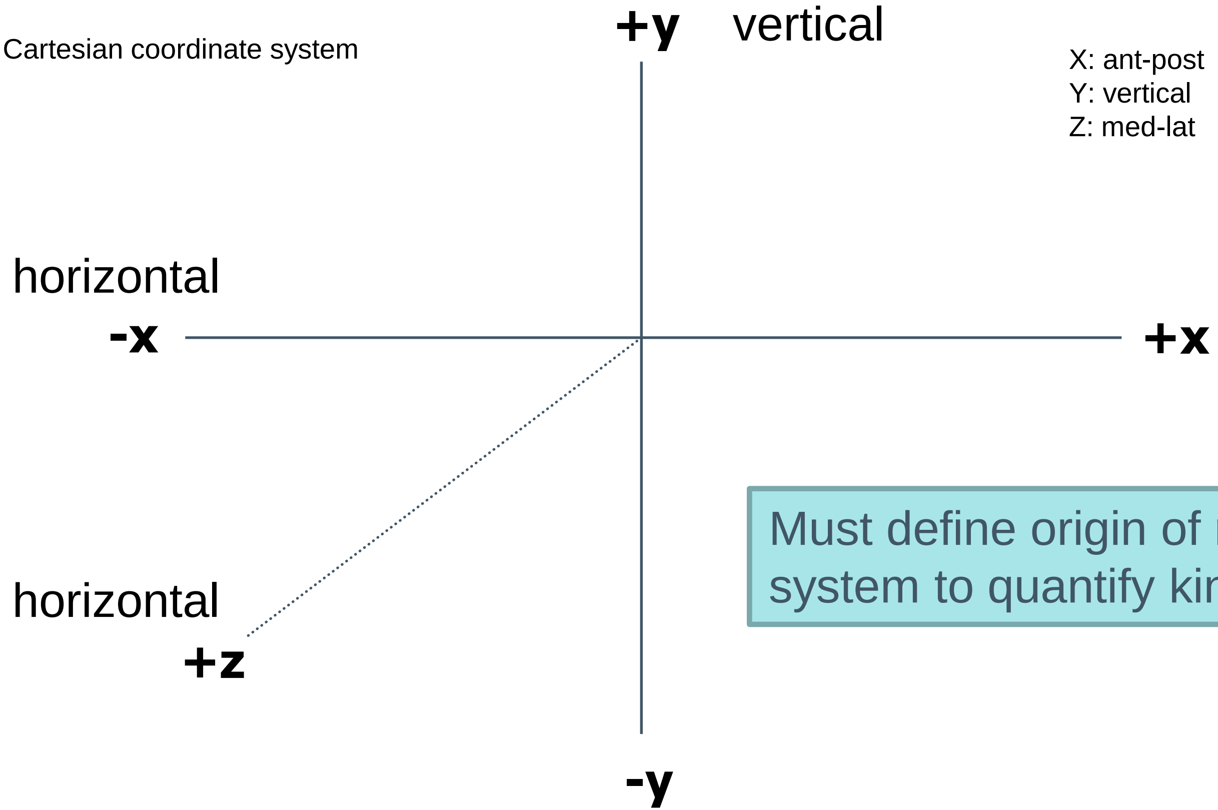
- Acceleration (a, α)
  - Vector quantity
  - Δvelocity ÷ time
  - Units ($m{\cdot}s^{-2}$, $°{\cdot}s^{-2}$)
  - Insight into forces/torques

Reference systems

- Linear
- Angular
- **Relative and Aboulute**

Reference Systems: Linear

3D Cartesian coordinate system

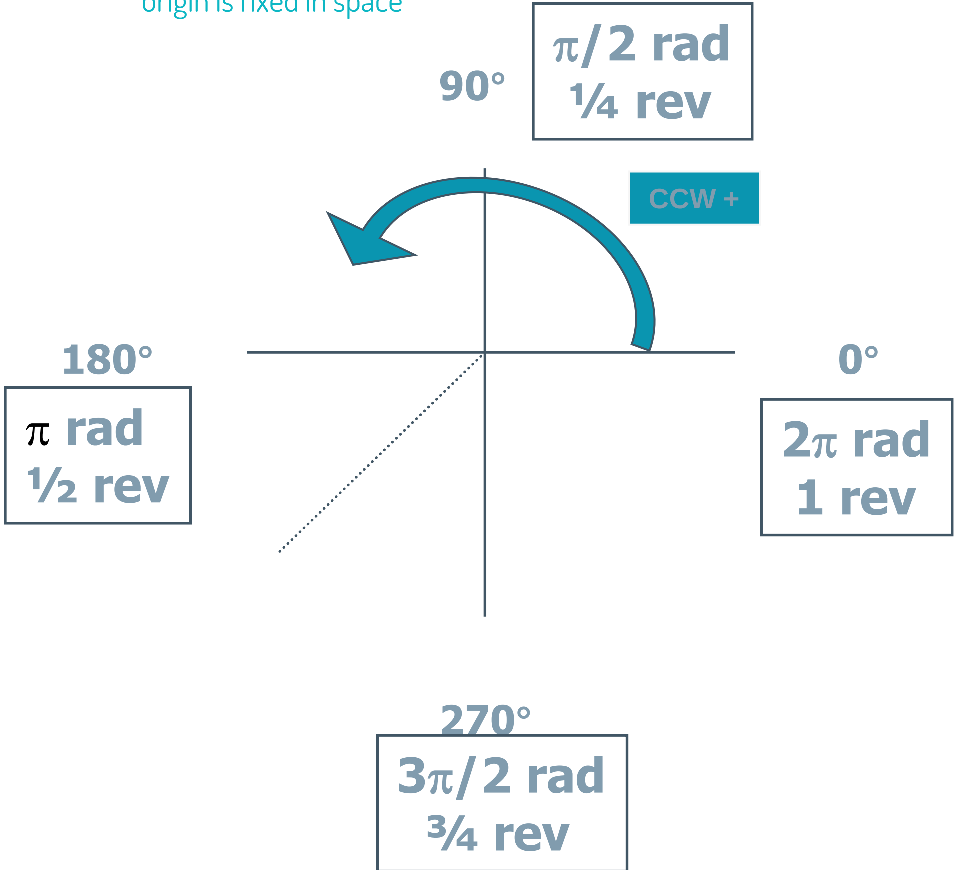


X: ant-post
Y: vertical
Z: med-lat

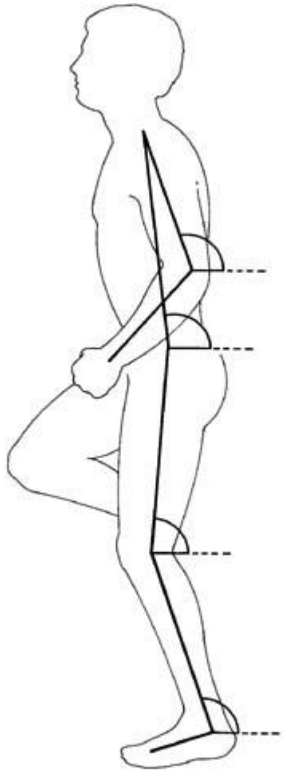
Must define origin of reference system to quantify kinematics.

Angular: Absolute Reference Systems

origin is fixed in space

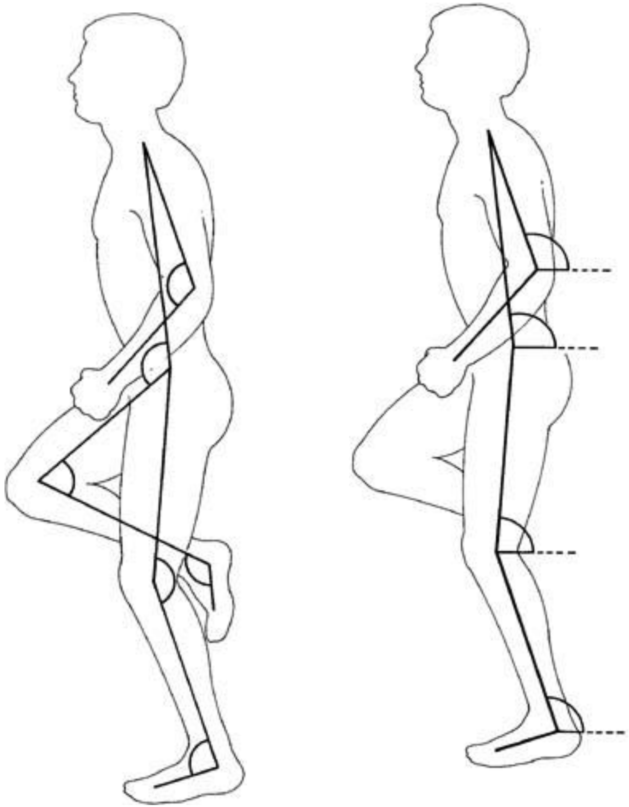


According to segment

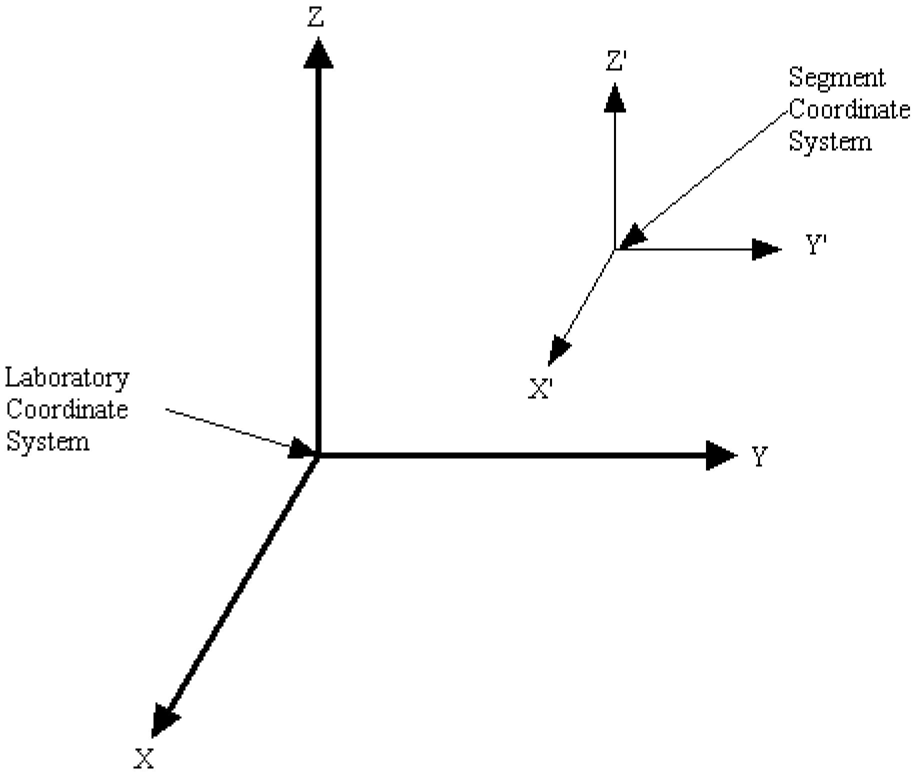


Angular: Relative Reference Systems

- Relative segment to adjacent segment
- Angle between two segment
- In ab.ref zero point is fixed but in rel.ref may be not



What we see in the LAB



Bio-instruments for Motion analysis

Instruments History

- Motion tracking or motion capture started as a **photogrammetric** analysis in the 1970s
- Since the 20th century the performer has to wear **markers** near each joint to identify the motion by the positions or angles between the markers.
- Acoustic, inertial, LED, magnetic or reflective markers, or combinations
- Optical systems

Instruments History

- Photography
- Motion trackers
- Motion analysis systems or Tracking or motion capture
- Optical systems
- Goniometers
- Electrogoniometers
- Accelerometres

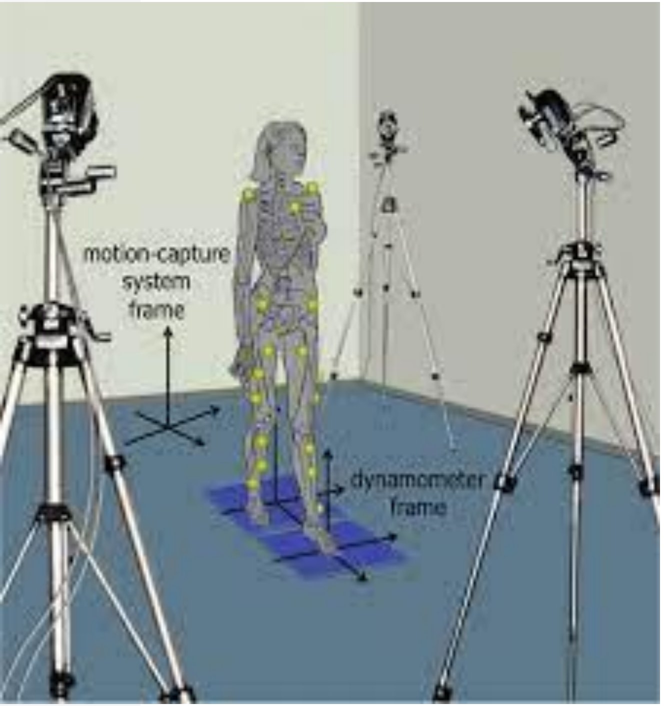
Optical Motion Analysis systems

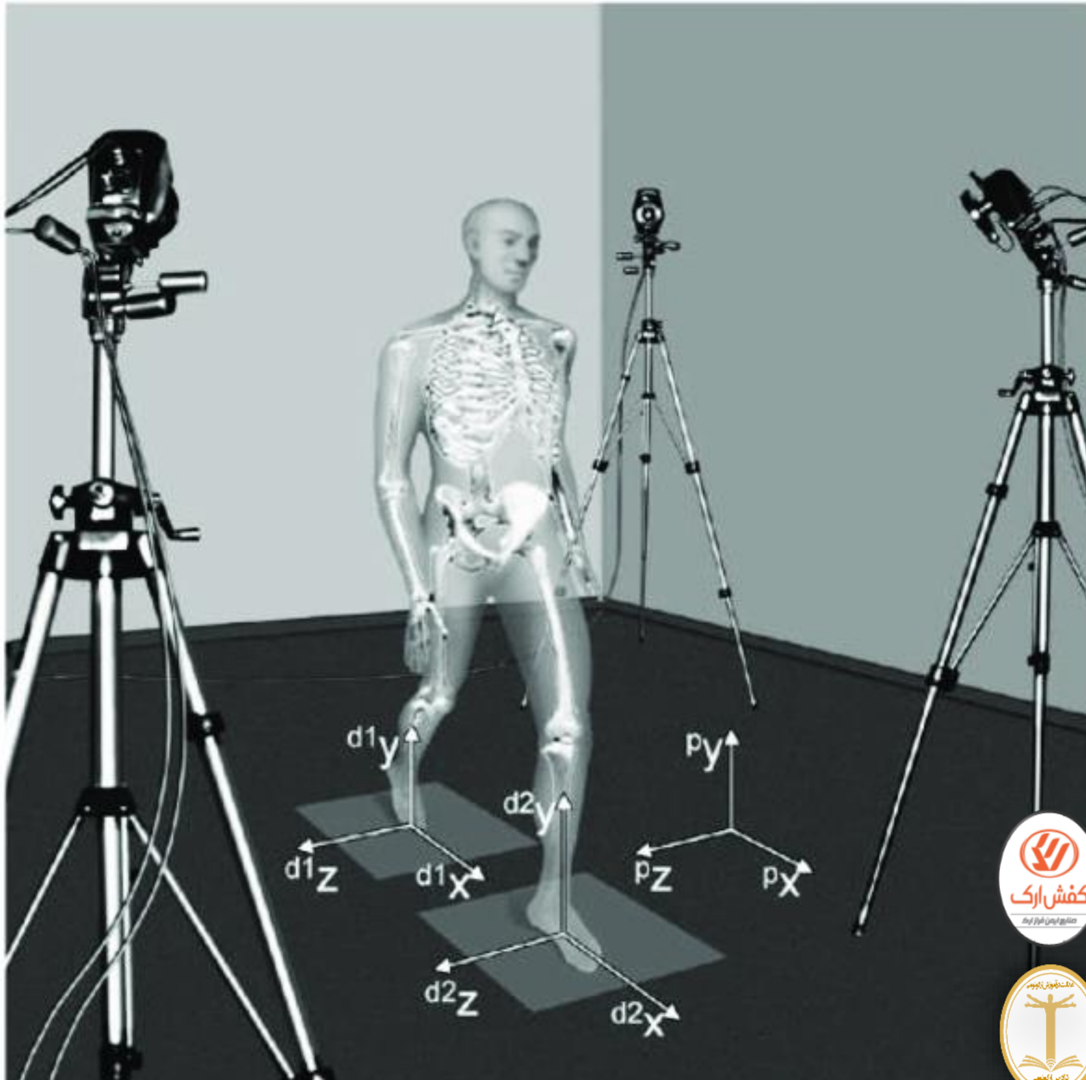
- Data captured from sensors to triangulate the 3D position of a subject between two or more cameras
- These systems produce data with three degrees of freedom for each marker,
- Typically a system will consist of around 2 to 48 cameras.
- Markers
  - **Active**: one LED at a time very quickly or multiple LEDs
  - **Passive**: markers coated with a retroreflective material

Data gathering procedures with Motion Analysis systems

”

Motion Analysis LAB





Data Gathering Procedures

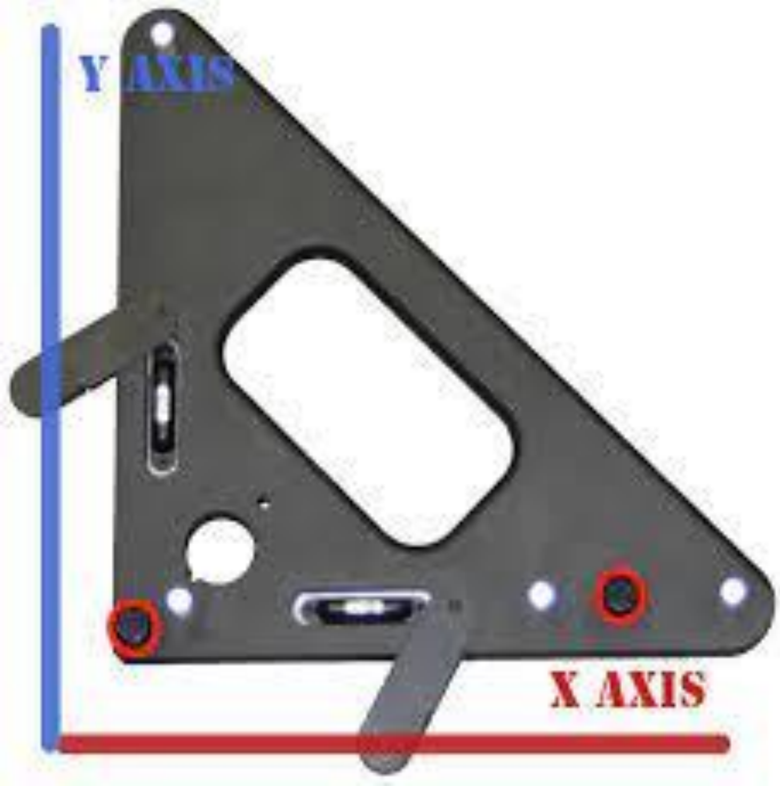
- Calibrations
- Landmark Placement
- Data gathering
- Data reduction and Clear
- Modeling
- Calculating the angles

Calibration

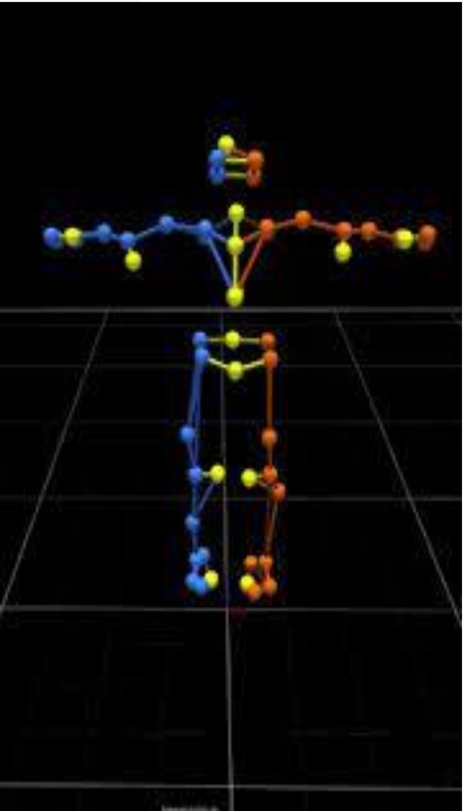
- Statics calibration
- Dynamic Calibration
-

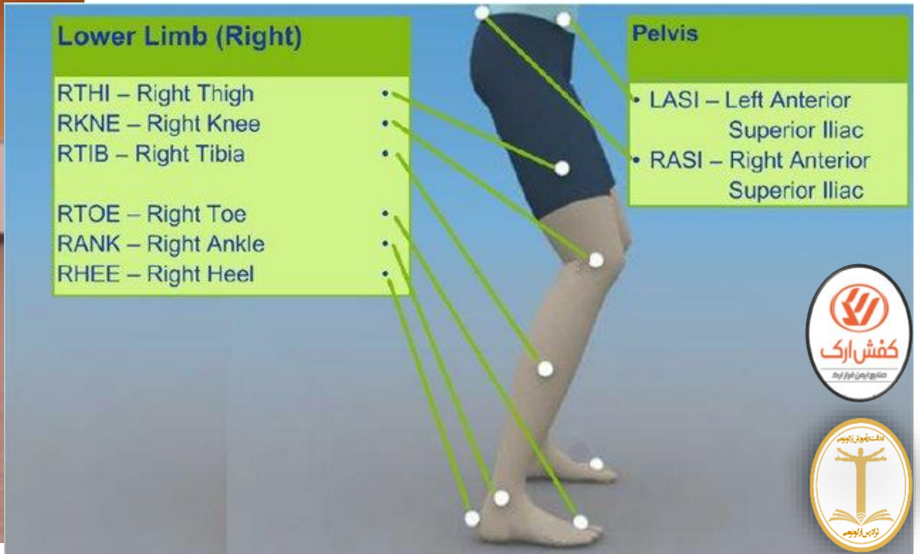
https://www.youtube.com/watch?v=nZsxehVlz9E

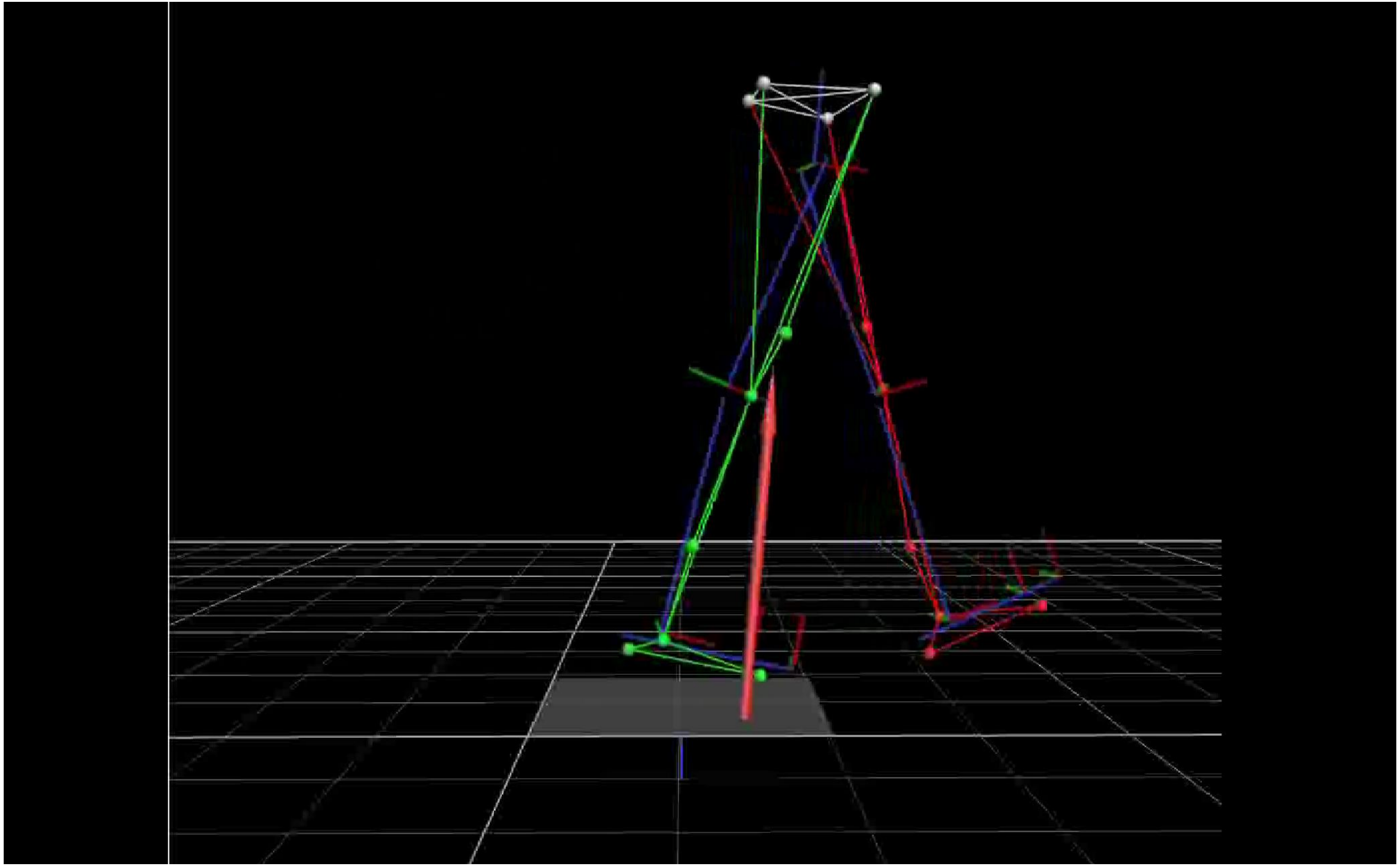
Calibration Devices: Wand



Landmark Placement







SLL - Excel

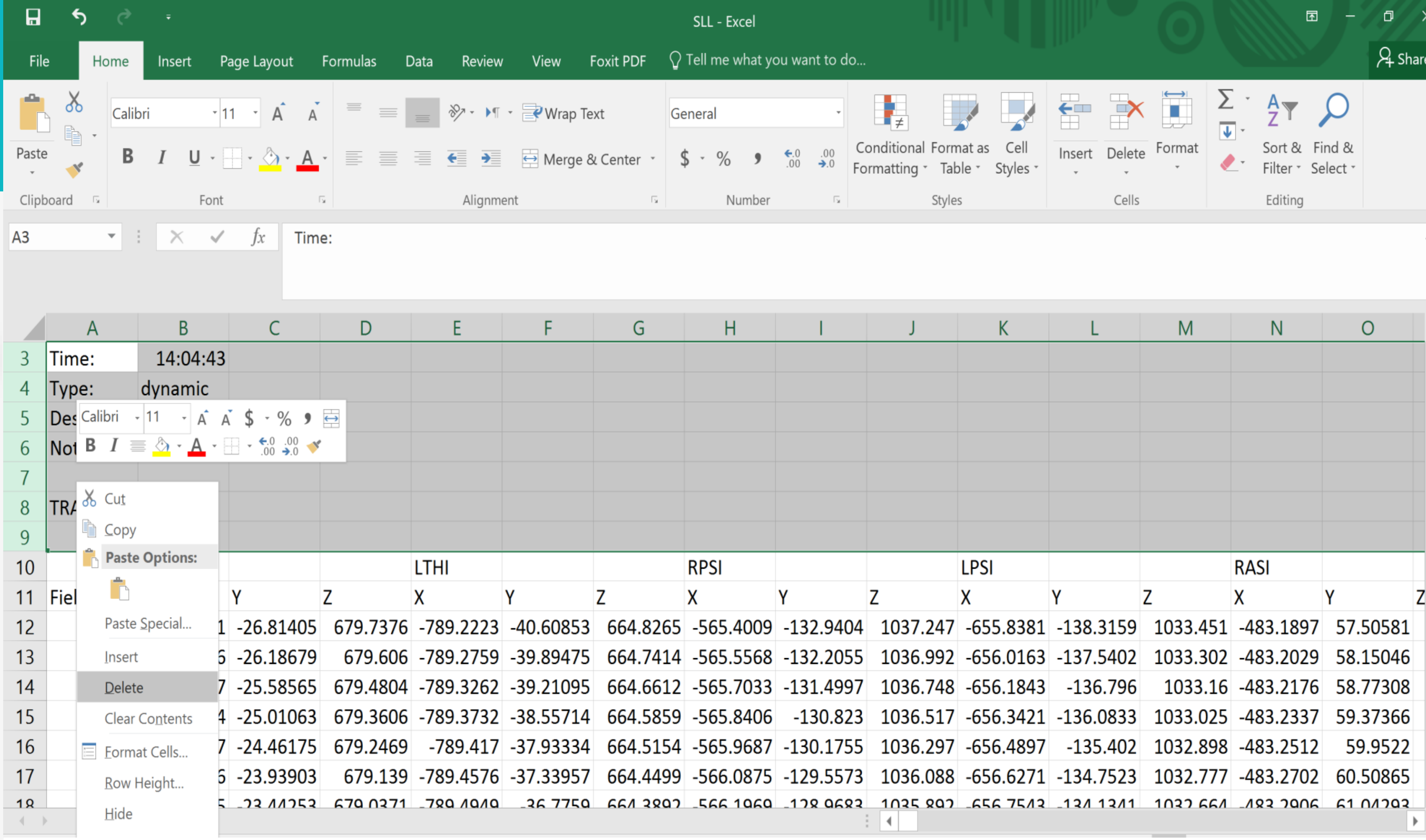
Time:

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Time:	14:04:43													
Type:	dynamic													
Description:														
Notes:														
TRAJECTORIES														
100	Hz													
	RTHI			LTHI			RPSI			LPSI			RASI	
Field #	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	X	Y
1	-447.6081	-26.81405	679.7376	-789.2223	-40.60853	664.8265	-565.4009	-132.9404	1037.247	-655.8381	-138.3159	1033.451	-483.1897	57.50581
2	-447.6786	-26.18679	679.606	-789.2759	-39.89475	664.7414	-565.5568	-132.2055	1036.992	-656.0163	-137.5402	1033.302	-483.2029	58.15046
3	-447.7467	-25.58565	679.4804	-789.3262	-39.21095	664.6612	-565.7033	-131.4997	1036.748	-656.1843	-136.796	1033.16	-483.2176	58.77308
4	-447.8124	-25.01063	679.3606	-789.3732	-38.55714	664.5859	-565.8406	-130.823	1036.517	-656.3421	-136.0833	1033.025	-483.2337	59.37366
5	-447.8757	-24.46175	679.2469	-789.417	-37.93334	664.5154	-565.9687	-130.1755	1036.297	-656.4897	-135.402	1032.898	-483.2512	59.9522
6	-447.9366	-23.93903	679.139	-789.4576	-37.33957	664.4499	-566.0875	-129.5573	1036.088	-656.6271	-134.7523	1032.777	-483.2702	60.50865
7	-447.995	-23.44253	679.0371	-789.4949	-36.7759	664.3892	-566.1969	-128.9683	1035.892	-656.7543	-134.1341	1032.664	-483.2906	61.04293

SLL

Check the Data

- Repetition Trials
- Missing values
- Interpolation for miss data if possible
- Data reduction and clear data


SLL - Excel
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Wrap Text
Merge & Center
Alignment
General
Number
Conditional Formatting
Format as Table
Cell Styles
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Sort & Filter
Find & Select
Editing
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Time: 14:04:43
Type: dynamic
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LTHI
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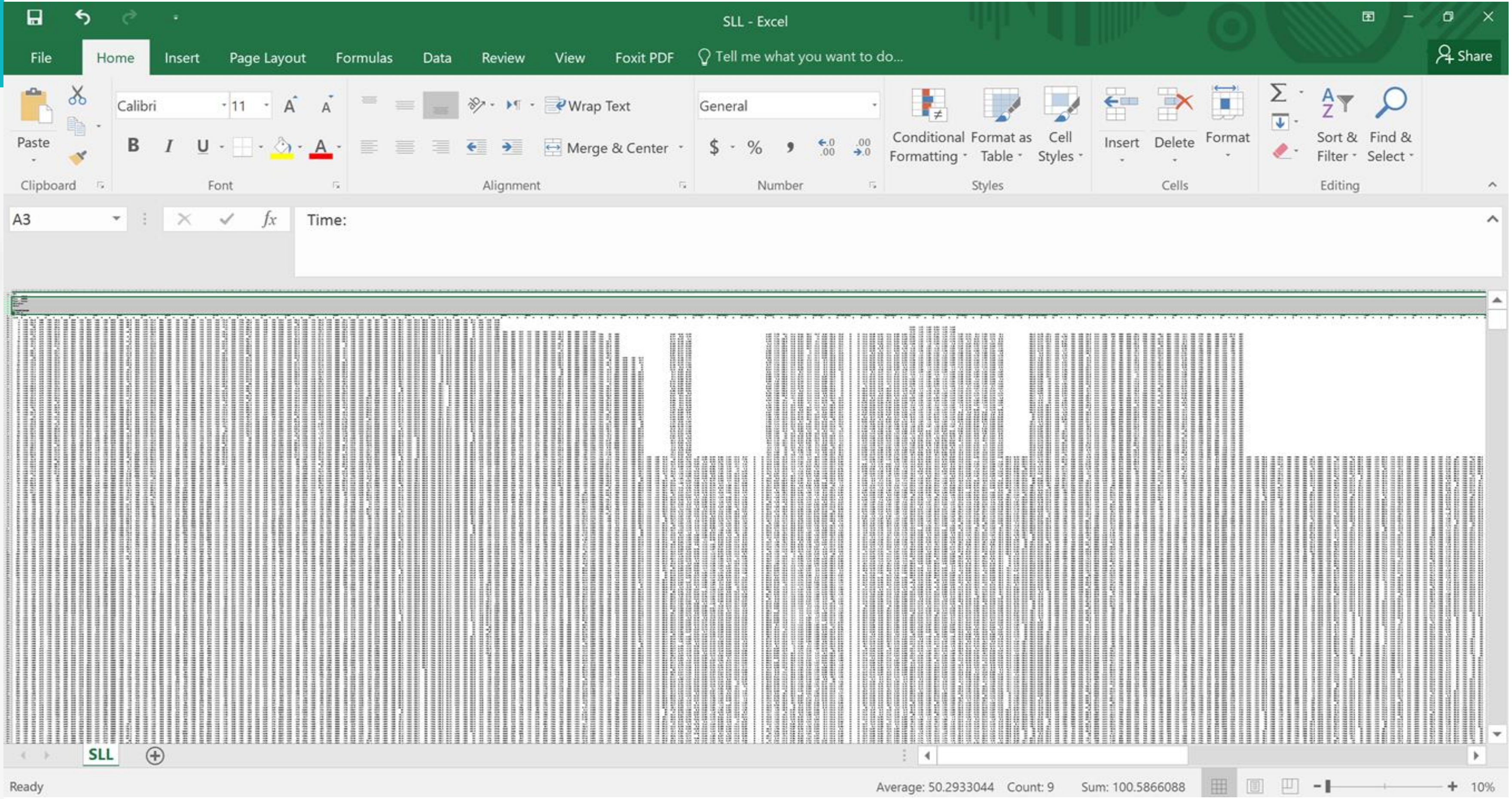
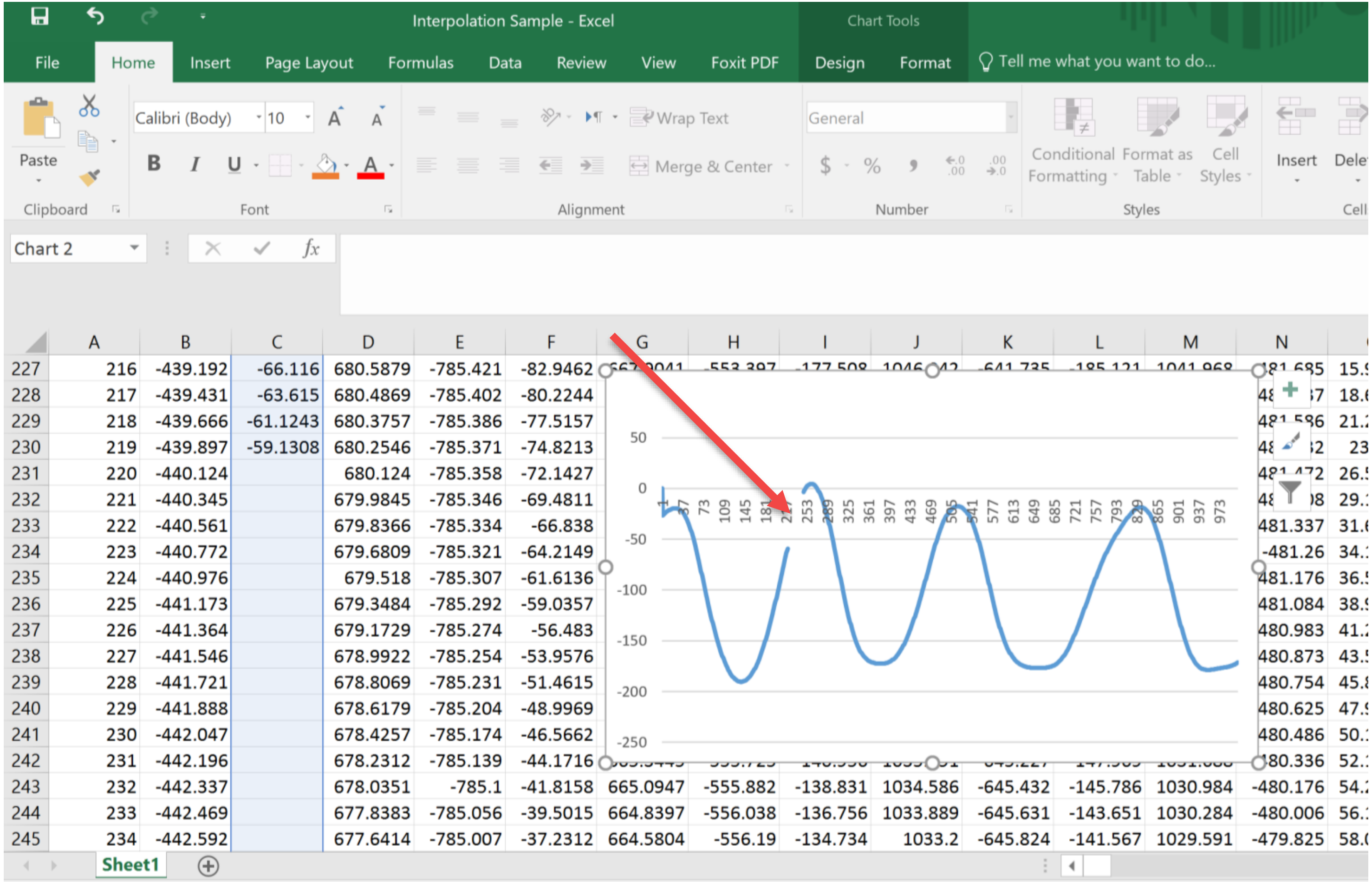
Y Z X Y Z X Y Z X Y Z X Y
-26.81405 679.7376 -789.2223 -40.60853 664.8265 -565.4009 -132.9404 1037.247 -655.8381 -138.3159 1033.451 -483.1897 57.50581
-26.18679 679.606 -789.2759 -39.89475 664.7414 -565.5568 -132.2055 1036.992 -656.0163 -137.5402 1033.302 -483.2029 58.15046
-25.58565 679.4804 -789.3262 -39.21095 664.6612 -565.7033 -131.4997 1036.748 -656.1843 -136.796 1033.16 -483.2176 58.77308
-25.01063 679.3606 -789.3732 -38.55714 664.5859 -565.8406 -130.823 1036.517 -656.3421 -136.0833 1033.025 -483.2337 59.37366
-24.46175 679.2469 -789.417 -37.93334 664.5154 -565.9687 -130.1755 1036.297 -656.4897 -135.402 1032.898 -483.2512 59.9522
-23.93903 679.139 -789.4576 -37.33957 664.4499 -566.0875 -129.5573 1036.088 -656.6271 -134.7523 1032.777 -483.2702 60.50865

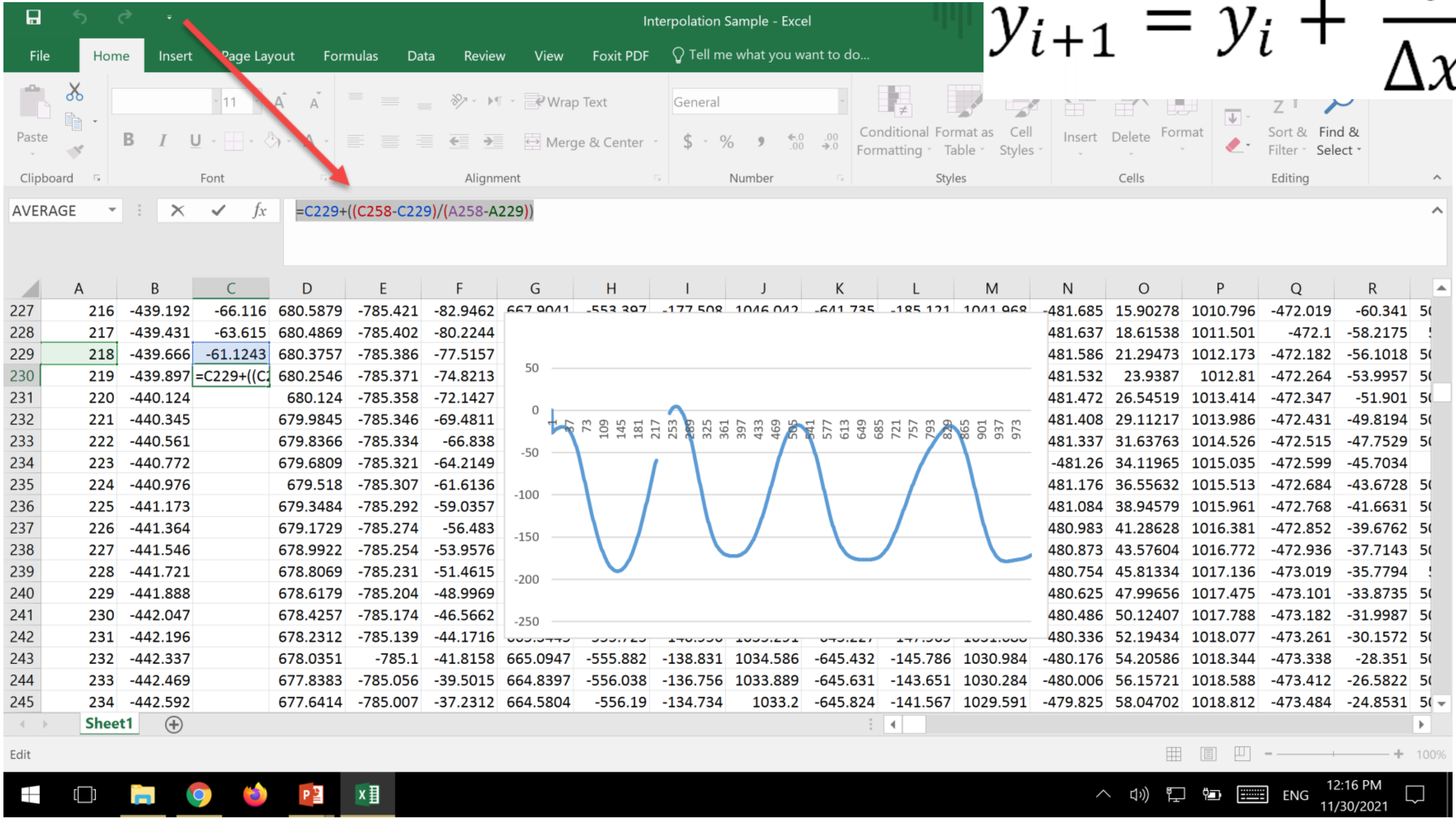
Interpolation (Linear)





	A	B	C	D	E	F	G	H	I	J	K	L	M	N
227	216	-439.192	-66.116	680.5879	-785.421	-82.9462								
228	217	-439.431	-63.615	680.4869	-785.402	-80.2244								
229	218	-439.666	-61.1243	680.3757	-785.386	-77.5157								
230	219	-439.897	-59.1308	680.2546	-785.371	-74.8213								
231	220	-440.124		680.124	-785.358	-72.1427								
232	221	-440.345		679.9845	-785.346	-69.4811								
233	222	-440.561		679.8366	-785.334	-66.838								481.337
234	223	-440.772		679.6809	-785.321	-64.2149								-481.26
235	224	-440.976		679.518	-785.307	-61.6136								481.176
236	225	-441.173		679.3484	-785.292	-59.0357								481.084
237	226	-441.364		679.1729	-785.274	-56.483								480.983
238	227	-441.546		678.9922	-785.254	-53.9576								480.873
239	228	-441.721		678.8069	-785.231	-51.4615								480.754
240	229	-441.888		678.6179	-785.204	-48.9969								480.625
241	230	-442.047		678.4257	-785.174	-46.5662								480.486
242	231	-442.196		678.2312	-785.139	-44.1716								480.336
243	232	-442.337		678.0351	-785.1	-41.8158	665.0947	-555.882	-138.831	1034.586	-645.432	-145.786	1030.984	-480.176
244	233	-442.469		677.8383	-785.056	-39.5015	664.8397	-556.038	-136.756	1033.889	-645.631	-143.651	1030.284	-480.006
245	234	-442.592		677.6414	-785.007	-37.2312	664.5804	-556.19	-134.734	1033.2	-645.824	-141.567	1029.591	-479.825

$$y_{i+1} = y_i + \frac{\Delta y}{\Delta x}$$



Interpolation Sample - Excel

File | Home | Insert | Page Layout | Formulas | Data | Review | View | Foxit PDF | Tell me what you want to do... | Share

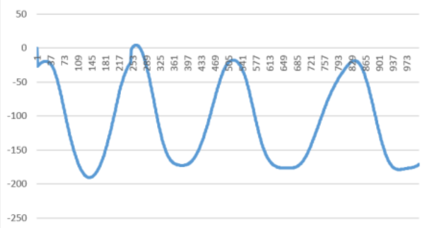
Paste | Calibri | 11 | Wrap Text | Merge & Center | General | $ % | Conditional Formatting | Format as Table | Cell Styles | Insert | Delete | Format | Sort & Filter | Find & Select

Clipboard | Font | Alignment | Number | Styles | Cells | Editing

C230 | fx | =C229+((C258-C229)/(A258-A229))

	A	B	C	D	E	F	G	H	I	J	K	L	M
229	218	-439.666	-61.1243	680.3757	-785.386	-77.5157							
230	219	-439.897	-59.1308	680.2546	-785.371	-74.8213							
231	220	-440.124	-57.1672	680.124	-785.358	-72.1427							
232	221	-440.345	-55.2352	679.9845	-785.346	-69.4811							
233	222	-440.561	-53.3367	679.8366	-785.334	-66.838							
234	223	-440.772	-51.4733	679.6809	-785.321	-64.2149							
235	224	-440.976	-49.6467	679.518	-785.307	-61.6136							
236	225	-441.173	-47.8586	679.3484	-785.292	-59.0357							
237	226	-441.364	-46.1108	679.1729	-785.274	-56.483							
238	227	-441.546	-44.4048	678.9922	-785.254	-53.9576							
239	228	-441.721	-42.7423	678.8069	-785.231	-51.4615							
240	229	-441.888	-41.1249	678.6179	-785.204	-48.9969							
241	230	-442.047	-39.5541	678.4257	-785.174	-46.5662							
242	231	-442.196	-38.0313	678.2312	-785.139	-44.1716	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
243	232	-442.337	-36.5581	678.0351	-785.1	-41.8158	665.0947	-555.882	-138.831	1034.586	-645.432	-145.786	1030.984
244	233	-442.469	-35.1358	677.8383	-785.056	-39.5015	664.8397	-556.038	-136.756	1033.889	-645.631	-143.651	1030.284
245	234	-442.592	-33.7657	677.6414	-785.007	-37.2312	664.5804	-556.19	-134.734	1033.2	-645.824	-141.567	1029.591
246	235	-442.705	-32.4493	677.4453	-784.954	-35.0077	664.3178	-556.339	-132.766	1032.522	-646.01	-139.535	1028.905
247	236	-442.81	-31.1876	677.2506	-784.895	-32.834	664.0531	-556.484	-130.854	1031.856	-646.189	-137.558	1028.228
248	237	-442.905	-29.9819	677.0582	-784.831	-30.713	663.7874	-556.624	-129	1031.203	-646.36	-135.637	1027.562
249	238	-442.991	-28.8332	676.8688	-784.762	-28.6474	663.5217	-556.76	-127.205	1030.564	-646.524	-133.775	1026.909
250	239	-443.068	-27.7427	676.6831	-784.688	-26.6405	663.2573	-556.891	-125.473	1029.941	-646.68	-131.974	1026.27
251	240	-443.136	-26.7113	676.5019	-784.609	-24.695	662.9952	-557.016	-123.804	1029.335	-646.828	-130.235	1025.646
252	241	-443.196	-25.7399	676.3258	-784.525	-22.8141	662.7367	-557.136	-122.2	1028.748	-646.968	-128.561	1025.041
253	242	-443.248	-24.8295	676.1555	-784.437	-21.0006	662.4829	-557.25	-120.663	1028.181	-647.1	-126.953	1024.454
254	243	-443.291	-23.9808	675.9916	-784.345	-19.2575	662.2349	-557.357	-119.195	1027.635	-647.223	-125.414	1023.888
255	244	-443.327	-23.1946	675.8348	-784.249	-17.5877	661.9939	-557.458	-117.798	1027.112	-647.338	-123.946	1023.345
256	245	-443.356	-22.4715	675.6856	-784.149	-15.9941	661.7609	-557.552	-116.472	1026.613	-647.445	-122.55	1022.825
257	246	-443.377	-21.8122	675.5446	-784.045	-14.4794	661.5371	-557.64	-115.22	1026.139	-647.543	-121.228	1022.331
258	247	-443.392	-3.312	[illegible]	-783.939	-13.0462	661.3235	-557.72	-114.044	1025.692	-647.633	-119.982	1021.863
259	248	-443.4	-2.18594	[illegible]	-783.83	-11.6973	661.121	-557.793	-112.944	1025.272	-647.715	-118.813	1021.424
260	249	-443.403	-1.14042	675.1751	-783.72	-10.4351	660.9308	-557.859	-111.922	1024.881	-647.788	-117.724	1021.014

	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE
229	481.586	21.29473	1012.173	-472.182	-56.1018	509.0411	-442.375	176.7158	1165.255	-812.875	169.5437	1177.164	-454.436	-94.2685	332.2801	-777.069	-103.755	325.32
230	481.532	23.9387	1012.81	-472.264	-53.9957	508.8512	-441.282	174.3992	1166.925	-813.899	166.7918	1178.699	-454.63	-92.9216	332.0821	-776.927	-102.342	325.19
231	481.472	26.54519	1013.414	-472.347	-51.901	508.6529	-440.21	172.0754	1168.452	-814.912	164.046	1180.097	-454.803	-91.5764	331.8898	-776.781	-100.93	325.05
232	481.408	29.11217	1013.986	-472.431	-49.8194	508.4463	-439.162	169.7466	1169.84	-815.912	161.3103	1181.36	-454.954	-90.235	331.7043	-776.633	-99.5208	324.91
233	481.337	31.63763	1014.526	-472.515	-47.7529	508.2318	-438.142	167.4154	1171.09	-816.898	158.5892	1182.49	-455.083	-88.8995	331.5261	-776.481	-98.1159	324.76
234	-481.26	34.11965	1015.035	-472.599	-45.7034	508.01	-437.151	165.0848	1172.205	-817.871	155.887	1183.491	-455.19	-87.5723	331.3561	-776.325	-96.7161	324.60
235	481.176	36.55632	1015.513	-472.684	-43.6728	507.7813	-436.191	162.7578	1173.188	-818.828	153.2087	1184.365	-455.276	-86.2556	331.1945	-776.167	-95.3224	324.45
236	481.084	38.94579	1015.961	-472.768	-41.6631	507.5463	-435.266	160.4382	1174.043	-819.769	150.5592	1185.117	-455.34	-84.9518	331.0419	-776.006	-93.9361	324.28
237	480.983	41.28628	1016.381	-472.852	-39.6762	507.3054	-434.375	158.1297	1174.774	-820.694	147.9437	1185.751	-455.384	-83.6633	330.8984	-775.842	-92.5586	324.11
238	480.873	43.57604	1016.772	-472.936	-37.7143	507.0595	-433.52	155.8364	1175.385	-821.603	145.3674	1186.272	-455.408	-82.3923	330.7641	-775.675	-91.1911	323.94
239	480.754	45.81334	1017.136	-473.019	-35.7794	506.809	-432.703	153.5627	1175.882	-822.493	142.8357	1186.685	-455.414	-81.141	330.639	-775.506	-89.8351	323.7
240	480.625	47.99656	1017.475	-473.101	-33.8735	506.5547	-431.922	151.3131	1176.27	-823.366	140.3541	1186.996	-455.402	-79.9116	330.5231	-775.335	-88.4922	323.59
241	480.486	50.12407	1017.788	-473.182	-31.9987	506.2974	-431.179	149.0921	1176.555	-824.221	137.9281	1187.211	-455.373	-78.7062	330.4159	-775.162	-87.1639	323.41
242	480.336	52.19434	1018.077	-473.261	-30.1572	506.0378	-430.472	146.9047	1176.745	-825.057	135.5632	1187.338	-455.33	-77.5264	330.3174	-774.988	-85.8518	323.23
243	-480.176	54.20586	1018.344	-473.338	-28.351	505.7767	-429.802	144.7554	1176.844	-825.873	133.2648	1187.382	-455.274	-76.3741	330.2269	-774.812	-84.5577	323.05
244	-480.006	56.15721	1018.588	-473.412	-26.5822	505.5148	-429.165	142.6491	1176.862	-826.67	131.0384	1187.35	-455.206	-75.2509	330.1442	-774.635	-83.2833	322.86
245	-479.825	58.04702	1018.812	-473.484	-24.8531	505.2531	-428.561	140.5906	1176.804	-827.447	128.8891	1187.251	-455.129	-74.158	330.0687	-774.458	-82.0304	322.68
246	-479.633	59.87396	1019.017	-473.554	-23.1657	504.9923	-427.988	138.5845	1176.678	-828.203	126.8221	1187.091	-455.043	-73.0968	329.9998	-774.281	-80.8007	322.50
247	-479.432	61.6368	1019.202	-473.62	-21.5222	504.7333	-427.444	136.6353	1176.493	-828.938	124.8422	1186.878	-454.95	-72.0684	329.9371	-774.104	-79.5962	322.32
248	-479.222	63.33437	1019.371	-473.683	-19.9246	504.477	-426.926	134.7475	1176.256	-829.652	122.954	1186.619	-454.852	-71.0737	329.88	-773.928	-78.4187	322.14
249	-479.002	64.96556	1019.524	-473.742	-18.3751	504.2242	-426.431	132.9252	1175.974	-830.344	121.1619	1186.322	-454.751	-70.1138	329.8281	-773.753	-77.2701	321.96
250	-478.775	66.52934	1019.662	-473.798	-16.8759	503.9758	-425.957	131.1725	1175.656	-831.012	119.4697	1185.994	-454.647	-69.1895	329.7808	-773.58	-76.1522	321.79
251	-478.54	68.02475	1019.786	-473.849	-15.4289	503.7326	-425.502	129.4929	1175.309	-831.657	117.8811	1185.642	-454.542	-68.3015	329.7379	-773.408	-75.0669	321.62
252	-478.299	69.45092	1019.898	-473.897	-14.0363	503.4956	-425.063	127.89	1174.941	-832.276	116.3991	1185.274	-454.438	-67.4508	329.6989	-773.24	-74.0162	321.45
253	-478.053	70.80706	1019.998	-473.94	-12.7001	503.2655	-424.637	126.3669	1174.56	-832.87	115.0264	1184.897	-454.335	-66.6379	329.6636	-773.074	-73.0018	321.29
254	-477.803	72.09245	1020.089	-473.98	-11.4223	503.0432	-424.222	124.9264	1174.171	-833.435	113.7651	1184.516	-454.234	-65.8636	329.6318	-772.912	-72.0256	321.14
255	-477.549	73.30645	1020.171	-474.015	-10.2047	502.8294	-423.816	123.5709	1173.782	-833.971	112.6168	1184.138	-454.136	-65.1287	329.6032	-772.753	-71.0894	320.9
256	-477.294	74.44853	1020.245	-474.045	-9.04948	502.6249	-423.419	122.3024	1173.4	-834.475	111.5824	1183.768	-454.042	-64.4337	329.5777	-772.6	-70.1949	320.85
257	-477.039	75.5182	1020.312	-474.071	-7.9583	502.4305	-423.027	121.1227	1173.029	-834.946	110.6624	1183.412	-453.952	-63.7795	329.5554	-772.451	-69.3439	320.71
258	-476.784	76.5151	1020.375	-474.093	-6.93296	502.2468	-422.642	120.033	1172.675	-835.381	109.8565	1183.075	-453.867	-63.1666	329.5361	-772.307	-68.538	320.58
259	-476.532	77.43891	1020.433	-474.11	-5.97516	502.0745	-422.261	119.034	1172.343	-835.778	109.164	1182.76	-453.787	-62.5957	329.52	-772.17	-67.7789	320.46
260	-476.283	78.2894	1020.487	-474.124	-5.08649	501.9143	-421.887	118.126	1172.036	-836.134	108.5835	1182.472	-453.712	-62.0676	329.5071	-772.038	-67.068	320.35

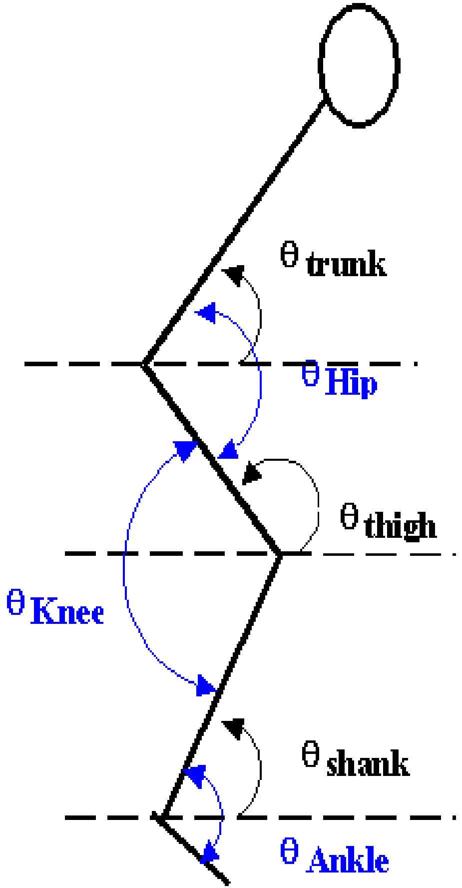


Sheet1

Ready | Average: -37.50752506 | Count: 28 | Sum: -1050.210702 | 60%

Calculation of angles from data

- **Absolute angle**
- For each segment two marker is necessary
- Horizontal equal to 0 degree
- All measure is in ccw
- In black line



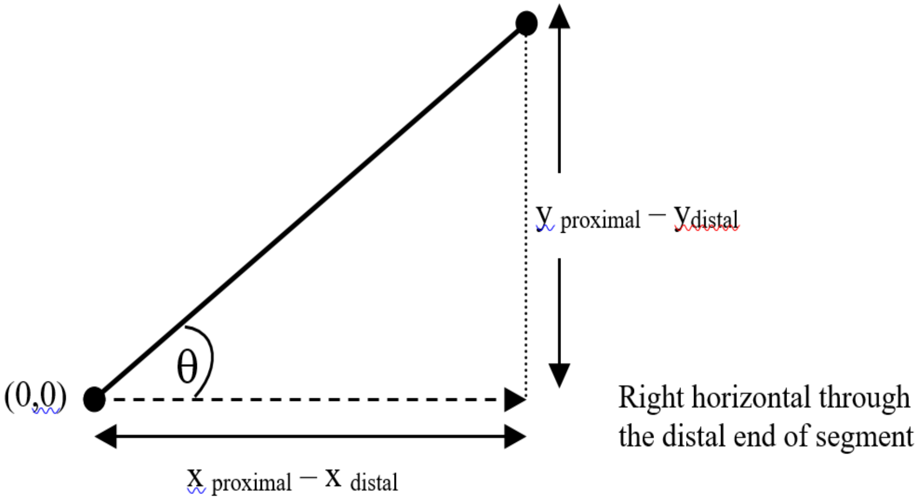
Absolute Angles:

To determine absolute joint angles, you need to define a reference system first. Here, we will choose the distal joint as our origin (0,0), and calculate the absolute segment (foot, shank, thigh, and trunk) angles from the right horizontal. Mathematically, the absolute angle can be calculated using the following trigonometric relationship:

$$\tan(\theta) = (y_{proximal} - y_{distal}) / (x_{proximal} - x_{distal})$$

taking the inverse tangent of both sides gives you:

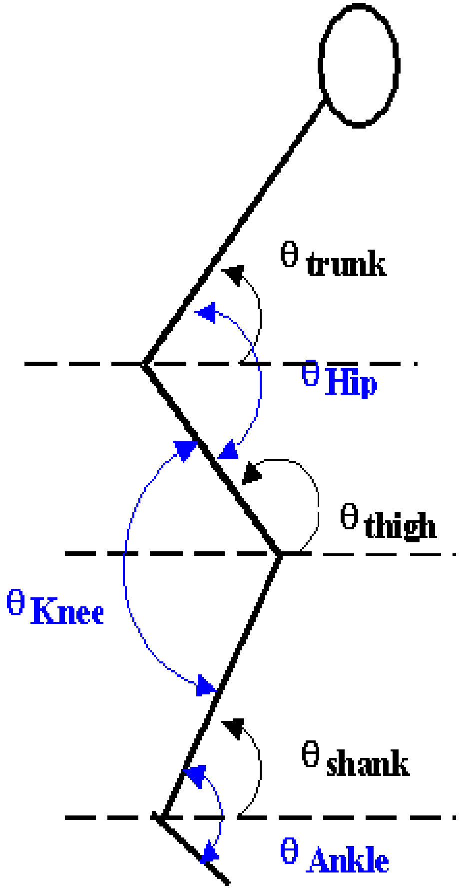
$$\theta = \tan^{-1}((y_{proximal} - y_{distal}) / (x_{proximal} - x_{distal}))$$



Calculation of angles from data

- **Absolute angle**
- For each segment two marker is necessary
- Horizontal equal to 0 degree
- All measure is in ccw
- In black line

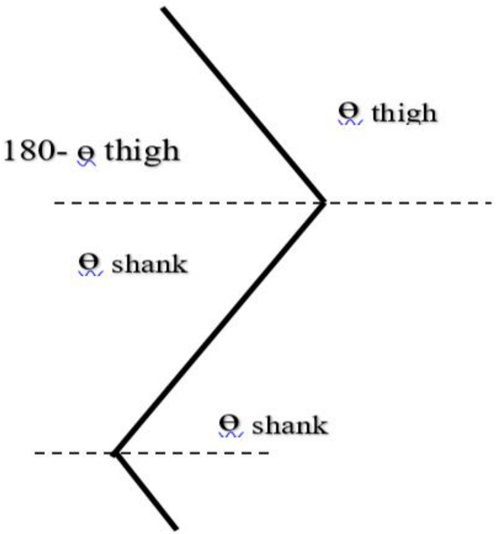
- **Joint angle**
- the included angle between the longitudinal axes of two adjacent segments
- Knee ext is when 0 deg flex
- In blue line



$$\theta_{hip} = \theta_{trunk} + (180 - \theta_{thigh})$$

$$\theta_{knee} = \theta_{shank} + (180 - \theta_{thigh})$$

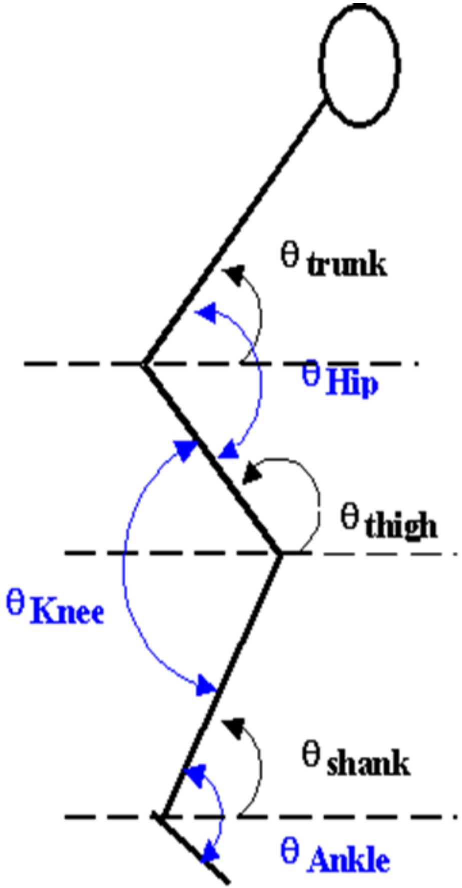
$$\theta_{ankle} = \theta_{shank} + (180 - \theta_{foot})$$



$$\theta_{hip} = \theta_{trunk} + (180 - \theta_{thigh})$$

$$\theta_{knee} = \theta_{shank} + (180 - \theta_{thigh})$$

$$\theta_{ankle} = \theta_{shank} + (180 - \theta_{foot})$$



Arc tang Sample - Excel

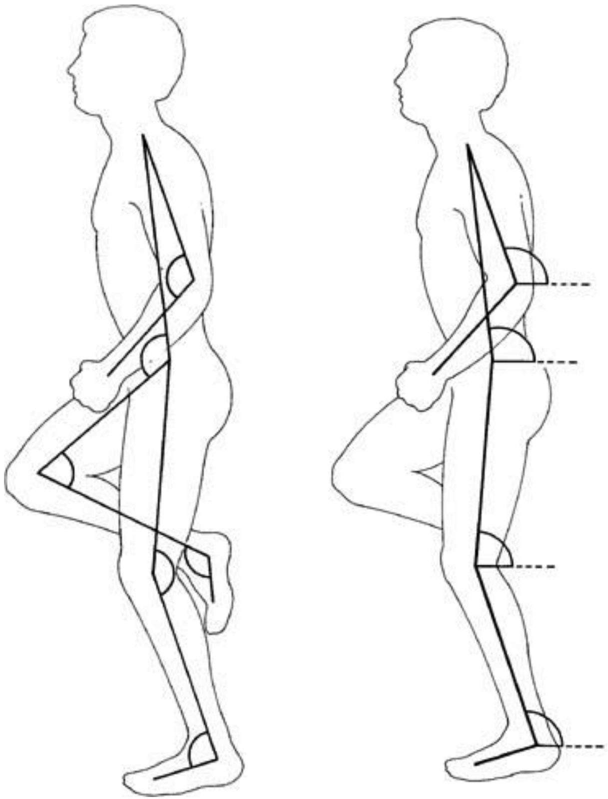
K12 =ATAN2(F12-C12,E12-B12)

	A	B	C	D	E	F	G	K	L
1	SLL								
2	Date:	40203							
3	Time:	0.586609							
4	Type:	dynamic							
5	Description:								
6	Notes:								
7									
8	TRAJECTORIES								
9	100	Hz							
10		RTHI			RKNE			ARCtang	degree
11	Field #	X	Y	Z	X	Y	Z		
12	1	-447.608	-26.8141	679.7376	-478.385	-27.6172	505.6722	-1.59689	-91.4949
13	2	-447.679	-26.1868	679.606	-478.416	-27.1458	505.6074	-1.60198	-91.787
14	3	-447.747	-25.5856	679.4804	-478.449	-26.6945	505.5466	-1.6069	-92.0684
15	4	-447.812	-25.0106	679.3606	-478.481	-26.2633	505.4897	-1.61162	-92.3391
16	5	-447.876	-24.4617	679.2469	-478.513	-25.8524	505.4367	-1.61615	-92.5988
17	6	-447.937	-23.939	679.139	-478.545	-25.4615	505.3877	-1.6205	-92.8476
18	7	-447.995	-23.4425	679.0371	-478.578	-25.091	505.3427	-1.62464	-93.0853
19	8	-448.051	-22.9723	678.9412	-478.611	-24.7407	505.3016	-1.6286	-93.3118
20	9	-448.105	-22.5286	678.8512	-478.643	-24.4108	505.2645	-1.63235	-93.5269
21	10	-448.156	-22.1114	678.7671	-478.676	-24.1015	505.2314	-1.63591	-93.7307
22	11	-448.204	-21.7212	678.6891	-478.709	-23.813	505.2023	-1.63926	-93.9229
23	12	-448.25	-21.3581	678.617	-478.742	-23.5456	505.1771	-1.64242	-94.1035
24	13	-448.294	-21.0226	678.551	-478.774	-23.2996	505.1561	-1.64536	-94.2723

Sheet1

Calculation of velocity

- Coordinate and smooth data
- $$V = \frac{\Delta X}{\Delta T} \qquad \Delta X = x_{i+1} - x_i$$
- This velocity does not represented v at either of sample time.
- So , $$v_{xi} = \frac{x_{i+1} - x_{i-1}}{2\Delta t}$$
- And $$A_{xi} = \frac{v_{xi+1} - v_{xi-1}}{2\Delta t}$$



Samples:

Indication in Ergonomics studies

”

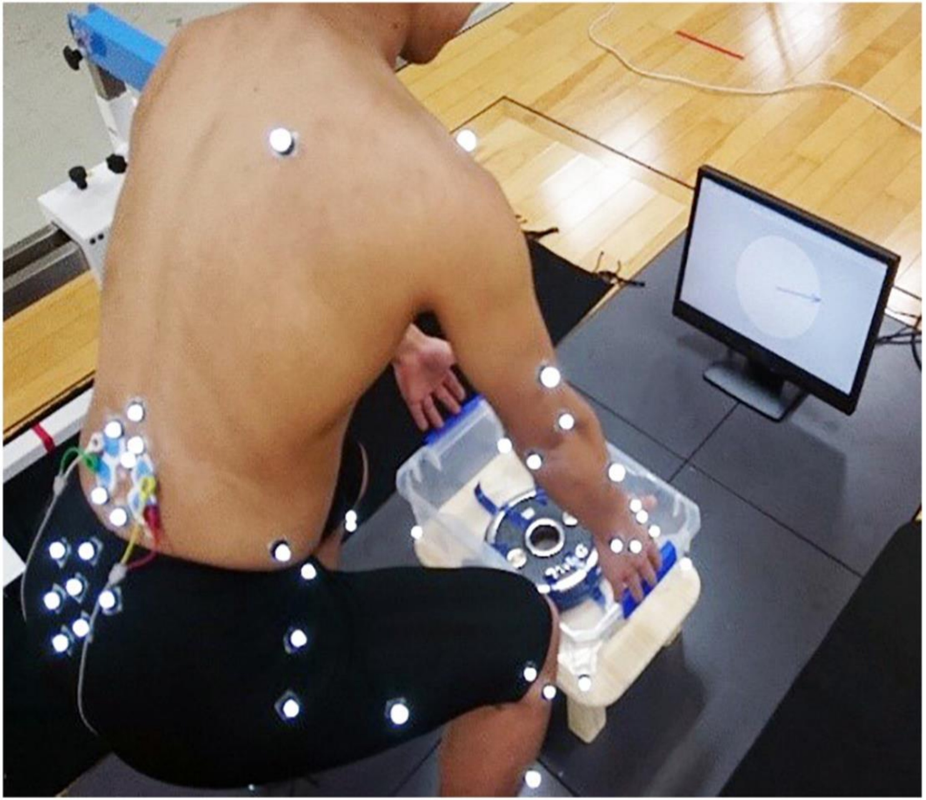
Relationships Between Trunk Movement Patterns During Lifting Tasks Compared With Unloaded Extension From a Flexed Posture

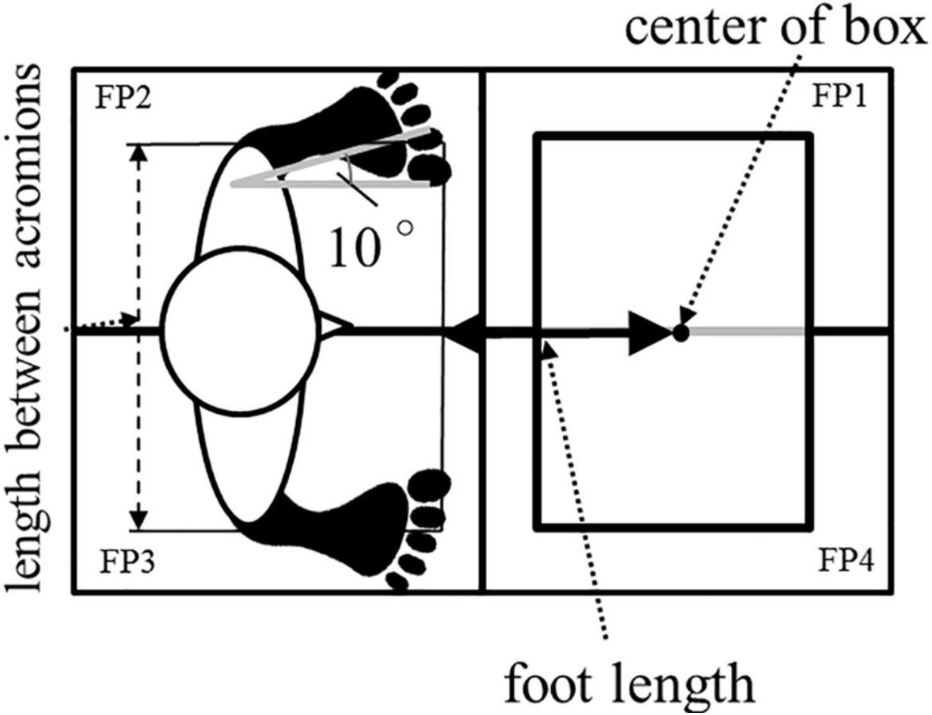
Yuta Ogata, MS,[a] Masaya Anan, PhD,[b] Makoto Takahashi, PhD,[b] Takuya Takeda, MS,[a] Kenji Tanimoto, MS,[a] Tomonori Sawada, MS,[a] and Koichi Shinkoda, PhD[a]

ABSTRACT

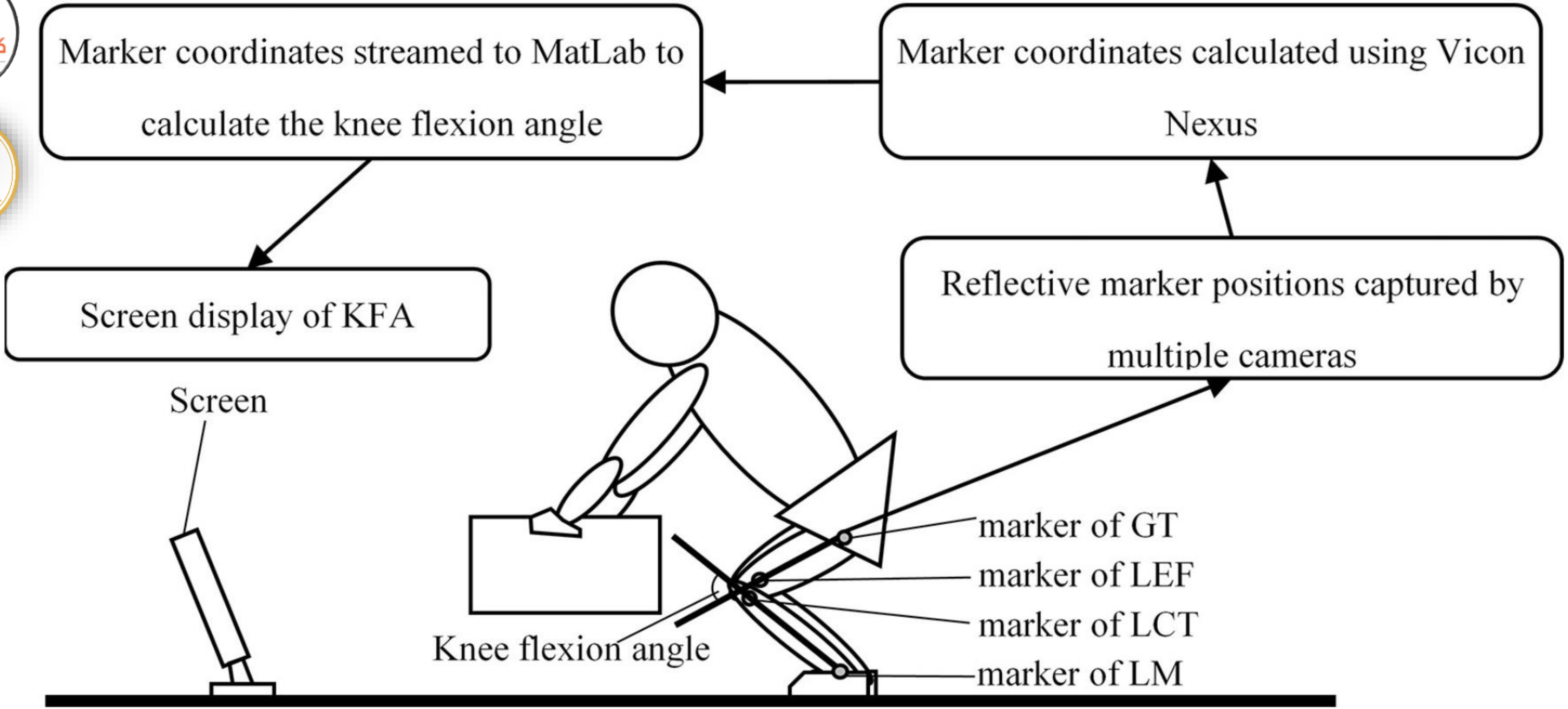
- Assessment of movement patterns during lifting (0,30,60,90 deg) and unloaded trunk flexion and extension
- 3-dimensional motion analysis system (Vicon Motion Systems)
- lift a box containing a 7.5-kg weight from half the height of their shank to half the height of their thigh at a comfortable speed

Posture in use



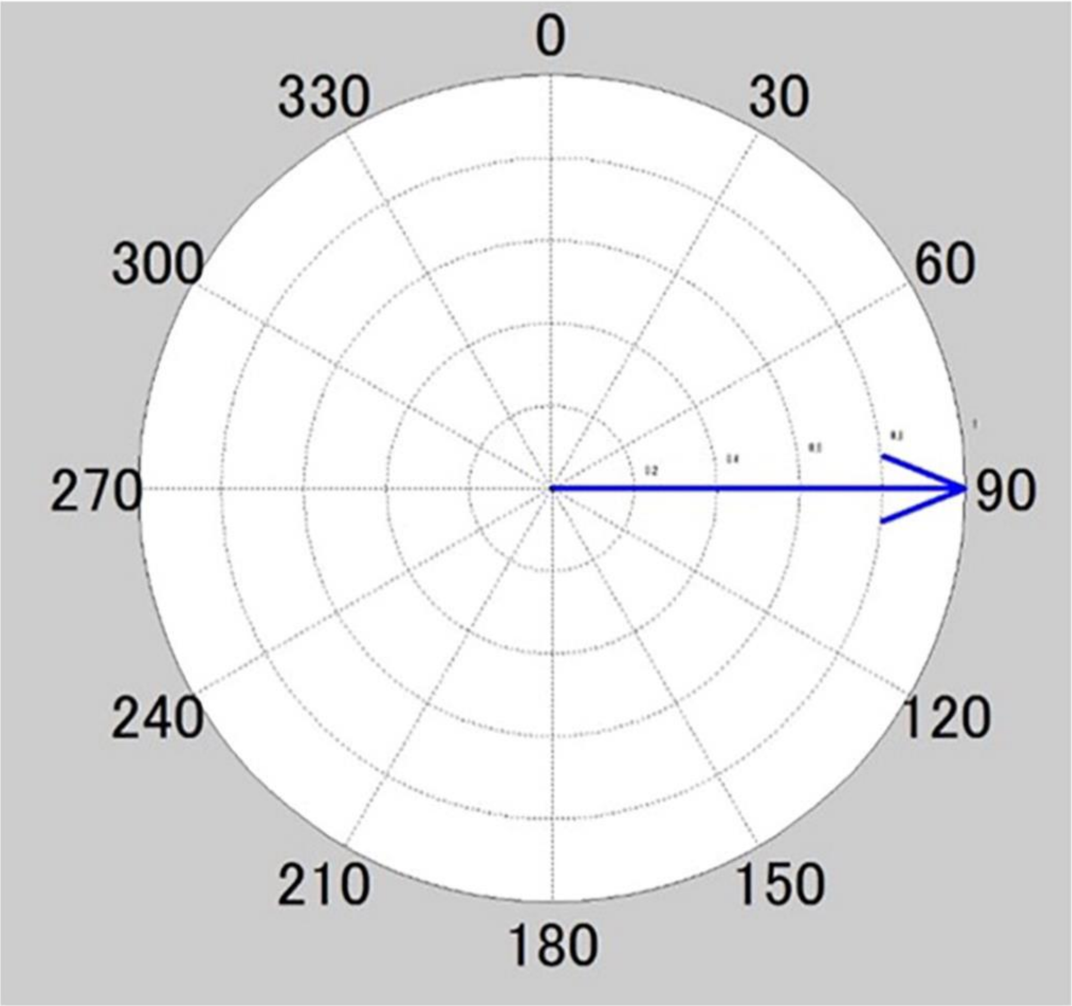


The definition of KFA and the processing flow of real-time feedback. GT, greater trochanter; KFA, knee flexion angle; LCM: lateral condyle of the tibia; LEF: lateral epicondyle of the femur; LM: lateral malleolus.

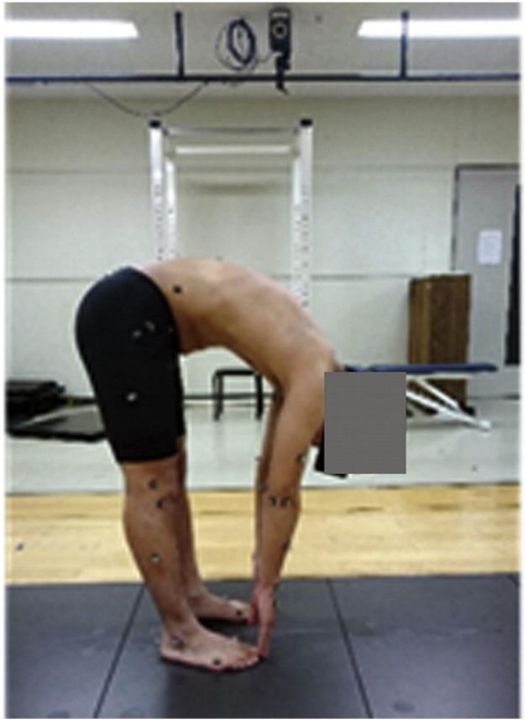


Reference

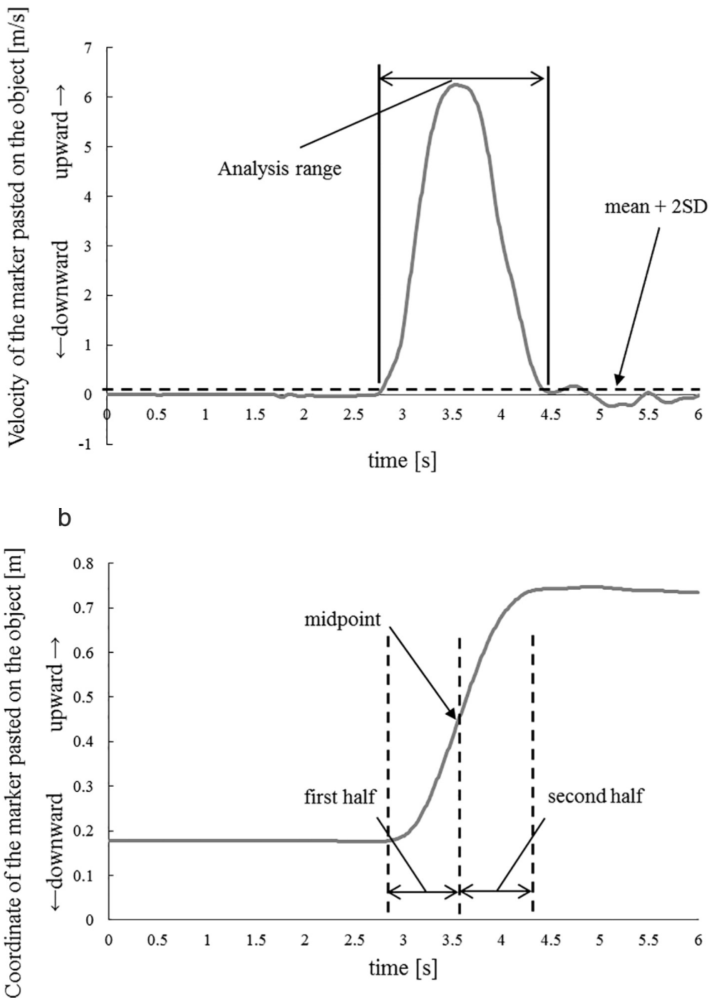
- The displayed knee flexion angle (clockwise rotation
- indicates increased knee flexion angle)



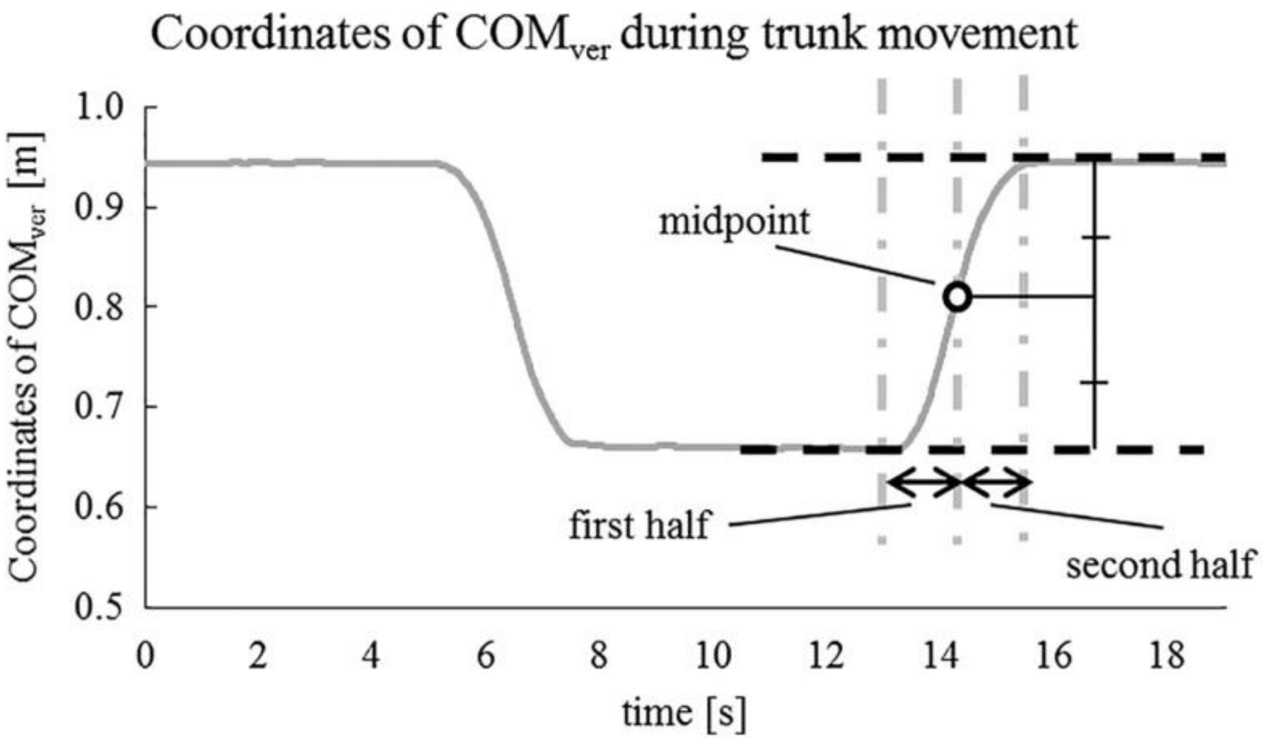
Flex-Ext posture

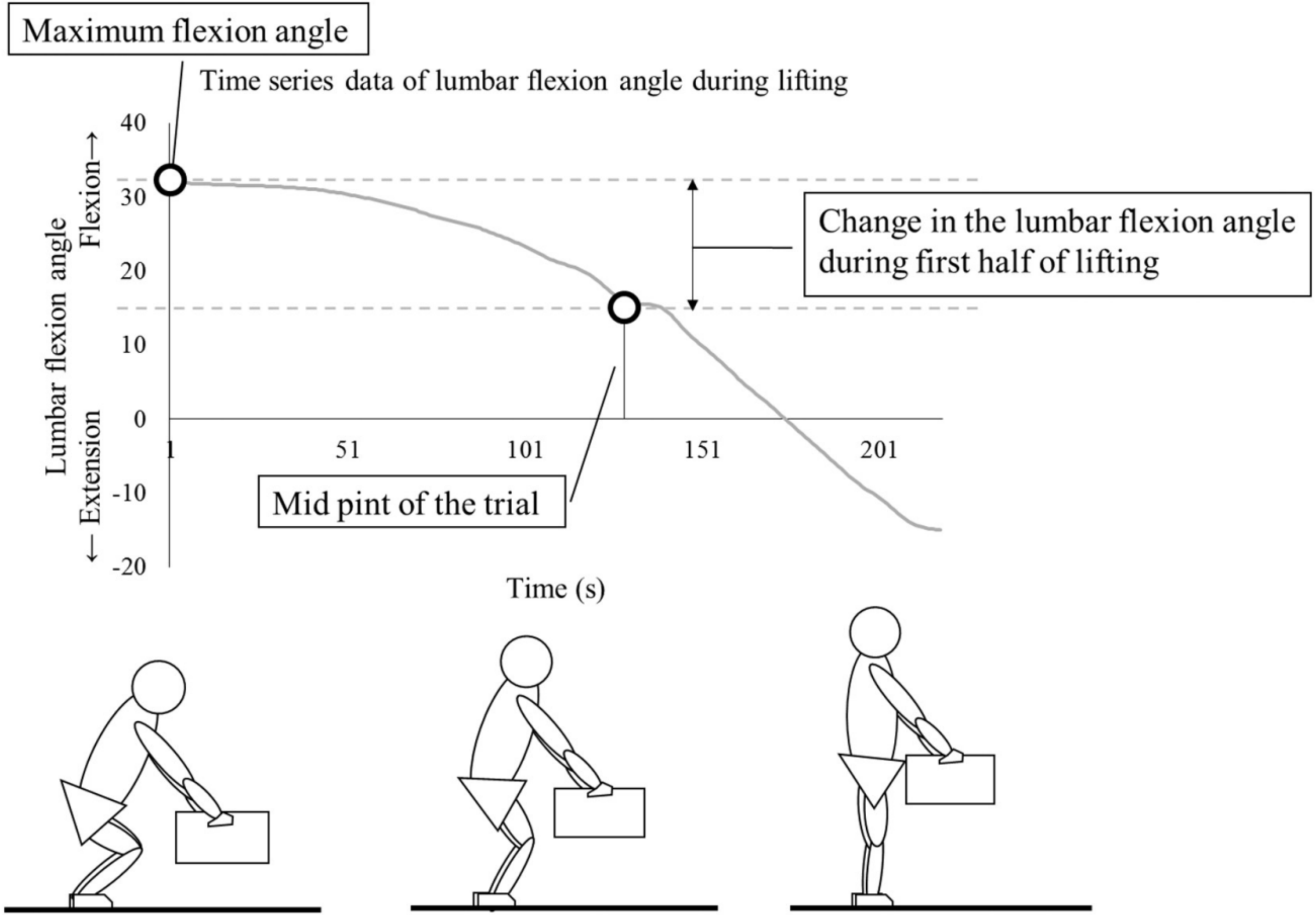


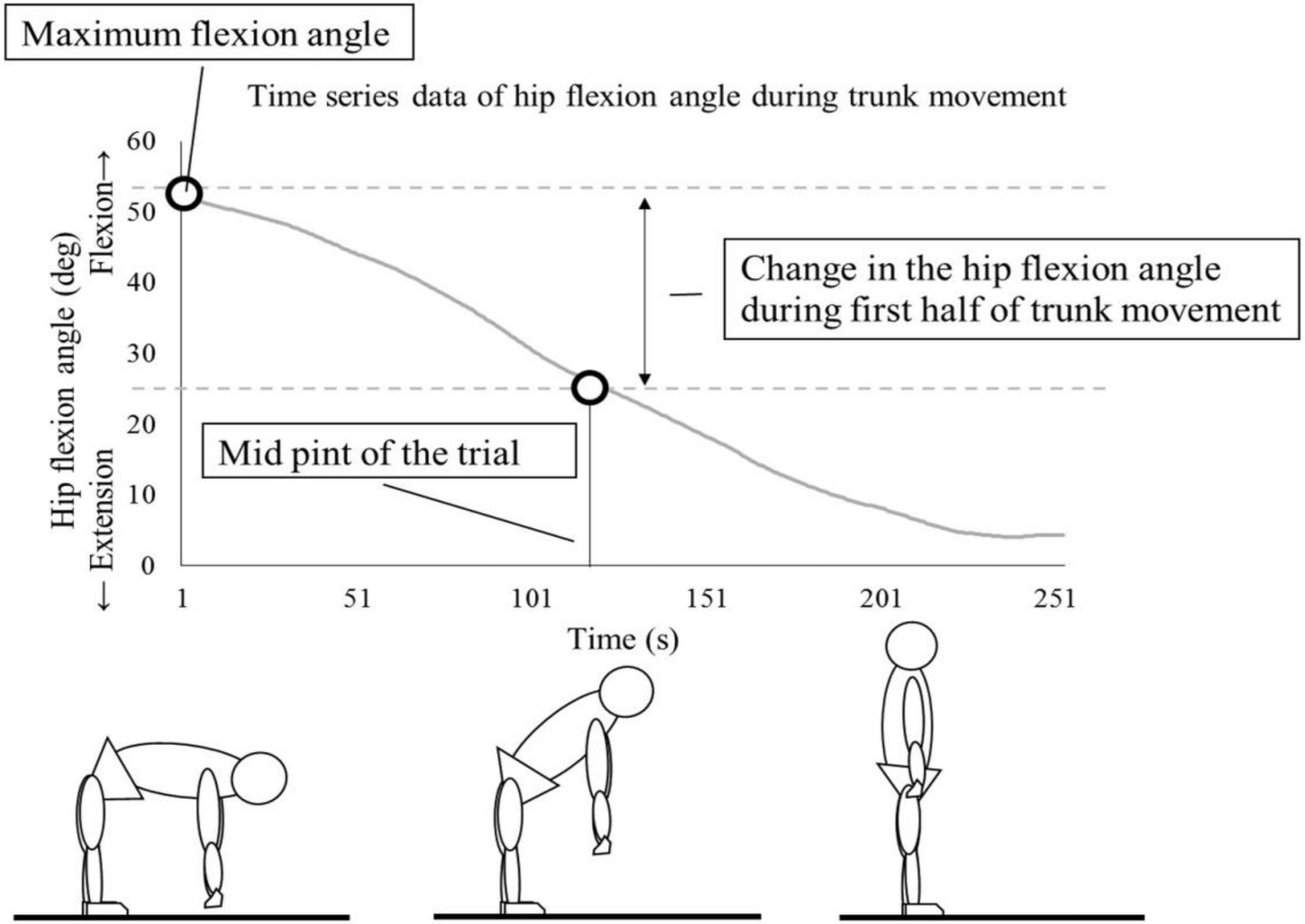
- **The beginning and end of lifting were detected using the velocity of the markers pasted on the object that was lifted**



- We detected the start and end of trunk extension from
- full unloaded flexion using the vertical coordinate of the
- COM




Maximum flexion angle
Time series data of lumbar flexion angle during lifting
Lumbar flexion angle
Flexion→
←Extension
40
30
20
10
0
-10
-20
1
51
101
151
201
Change in the lumbar flexion angle during first half of lifting
Mid pint of the trial
Time (s)


Maximum flexion angle
Time series data of hip flexion angle during trunk movement
Change in the hip flexion angle during first half of trunk movement
Mid pint of the trial
Hip flexion angle (deg)
Flexion→
↓ Extension
60
50
40
30
20
10
0
1
51
101
151
201
251
Time (s)

Applied Ergonomics 94 (2021) 103396

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journal homepage: http://www.elsevier.com/locate/apergo

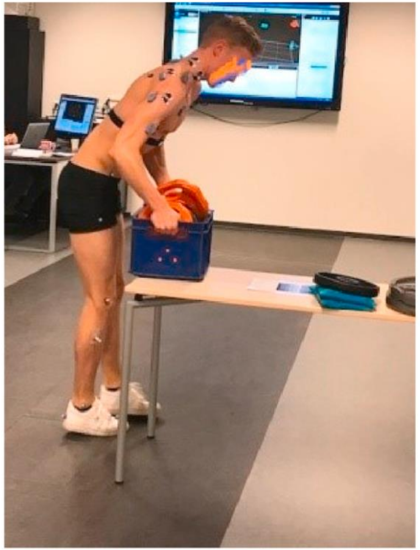
Changes in kinematics and work physiology during progressive lifting in healthy adults

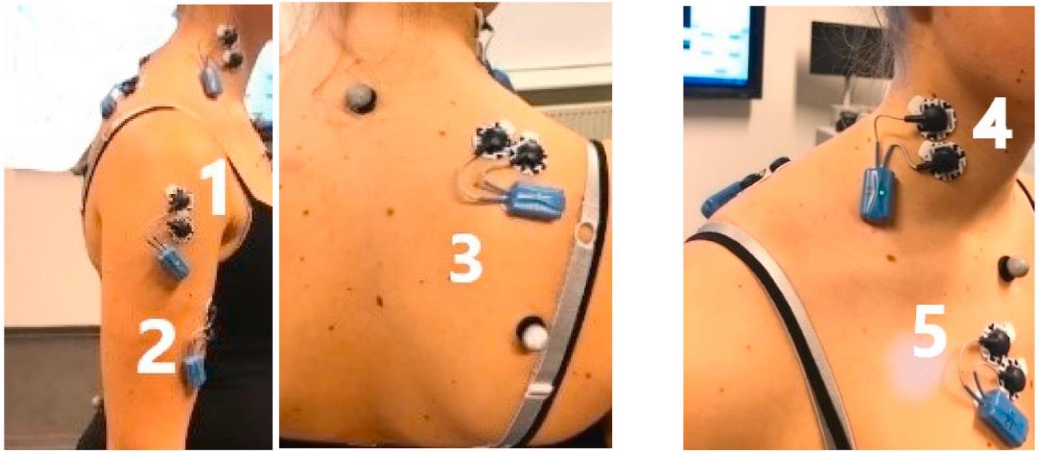
Hendrik.J. Bieleman[a,*], Noortje.H.M. Rijken[a], Michiel.F. Reneman[b], Frits.G.J. Oosterveld[a], Remko Soer[a,c]

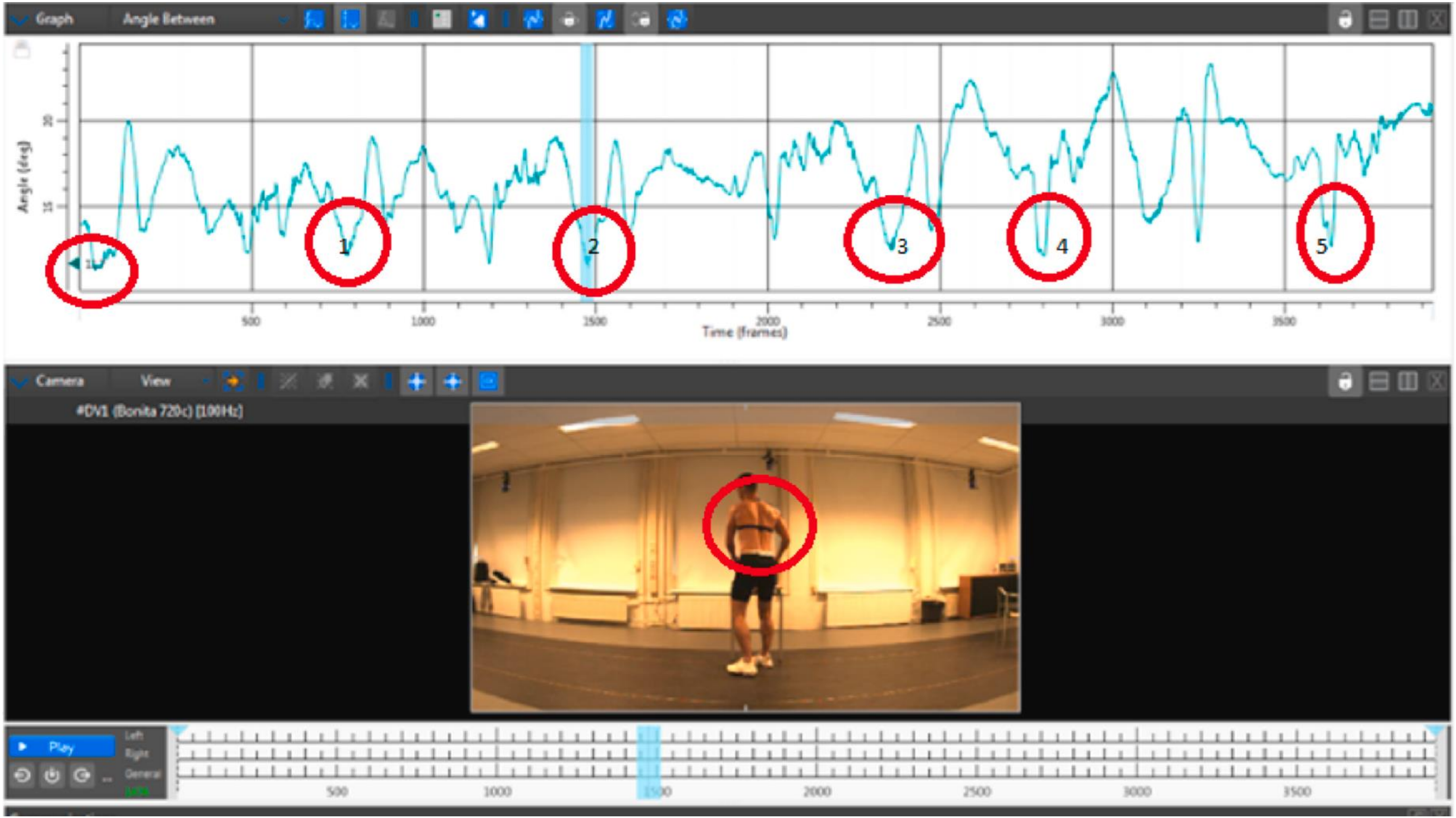
[a] Saxion University of Applied Sciences, Faculty of Health and Movement, Enschede, the Netherlands
[b] University of Groningen, University Medical Center Groningen, Department of Rehabilitation Medicine, Groningen, the Netherlands
[c] University of Groningen, University Medical Center Groningen, Pain Center, Groningen, the Netherlands

- The objective: to test progression of changes in kinematics and work physiology during progressive lifting in healthy adults.
- EMG, Movement pattern analysis, Hear Rate

- Eight infrared cameras (Vicon Vantage V5, 100 frames per second, Vicon Motion Systems, Ltd.,Oxford, UK) and two video cameras (Vicon Bonita 720c, 120 Hz, Vicon)
- Four markers were placed on the bony landmarks of C7, T10 and both PIIS.
- The angle between the line C7–T10 and the line PIIS-Th10 was presented.
- maximal extension angles during the sets were recorded to express posture of the spine.






Graph
Angle Between
Angle (deg)
20
15
1
2
3
4
5
500
1000
1500
2000
2500
3000
3500
Time (frames)
Camera
View
#DV1 (Bonita 720c) [100Hz]
Play
Left
Right
General

Rotate Right Ctrl+Shift++
Rotate the page view 90 degrees clockwise

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d Ergonomics

journal homepage: www.elsevier.com/locate/apergo

A kinematic comparison of gait with a backpack versus a trolley for load carriage in children

Check for updates

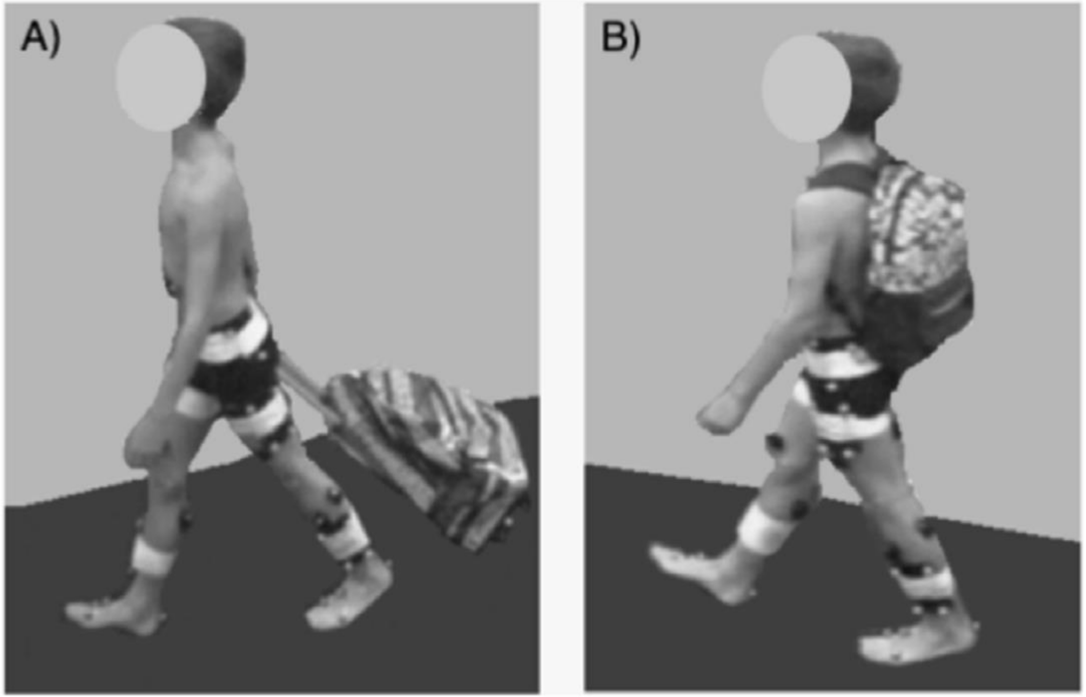
E. Orantes-Gonzalez[a,b,*], J. Heredia-Jimenez[a,b], M.A. Robinson[c]

[a] Department of Physical Education and Sport, Faculty of Education, Economy & Technology, University of Granada, Ceuta, Spain
[b] HubemaLab: Human Behaviour & Motion Analysis Lab. University of Granada, Ceuta, Spain
[c] Research Institute for Sport and Exercise Sciences, Liverpool John Moores University, United Kingdom

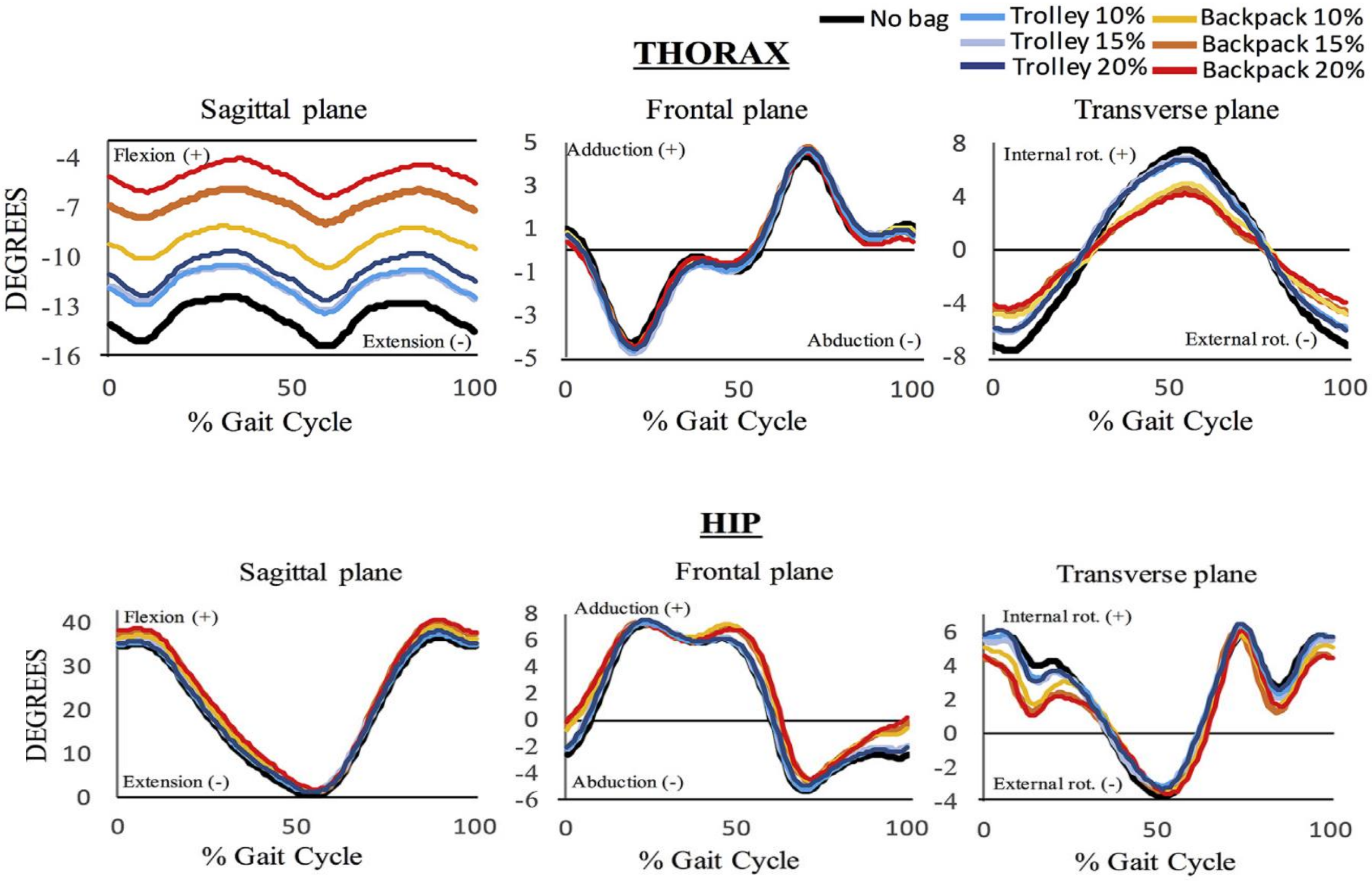
ARTICLE INFO

ABSTRACT

- Aims: evaluate gait kinematics of the lower limbs and thorax in children by first comparing various weights on a backpack or a trolley to unloaded walking and then comparing the backpack to the trolley condition directly with matched loads.



- A 3D-motion capture system (Qualisys AB, Göteborg, Sweden)
- different loads conditions: unloaded walking (as control), pulling a school trolley or carrying a backpack, both with 10%, 15%, and 20% BW loads.


No bag
Trolley 10%
Trolley 15%
Trolley 20%
Backpack 10%
Backpack 15%
Backpack 20%
THORAX
Sagittal plane
Frontal plane
Transverse plane
DEGREES
Flexion (+)
Extension (-)
-4
-7
-10
-13
-16
Adduction (+)
Abduction (-)
5
3
1
-1
-3
-5
Internal rot. (+)
External rot. (-)
8
4
0
-4
-8
0
50
100
% Gait Cycle
HIP
Sagittal plane
Frontal plane
Transverse plane
DEGREES
Flexion (+)
Extension (-)
40
30
20
10
0
Adduction (+)
Abduction (-)
8
6
4
2
0
-2
-4
-6
Internal rot. (+)
External rot. (-)
6
4
2
0
-2
-4
0
50
100
% Gait Cycle

Motion analysis samples

BMC Musculoskeletal Disorders

BioMed Central

Research article

Open Access

Lower extremity joint kinetics and lumbar curvature during squat and stoop lifting

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* Corresponding author

THANKS!

Any questions?

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