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Evaluation of Golden Gait Approximation using Smart Clothing

Sofia Scataglini[1,2,4]*, Guillaume Abran [3], Eddy Roosens[1,3], Damien Van Tiggelen[1], Robby Haelterman [1,2], Stijn Verwulgen[4]

[1]Military Hospital Queen Astrid, 1120 Brussels, Belgium
[2]Royal Military Academy, 1000 Brussels, Belgium
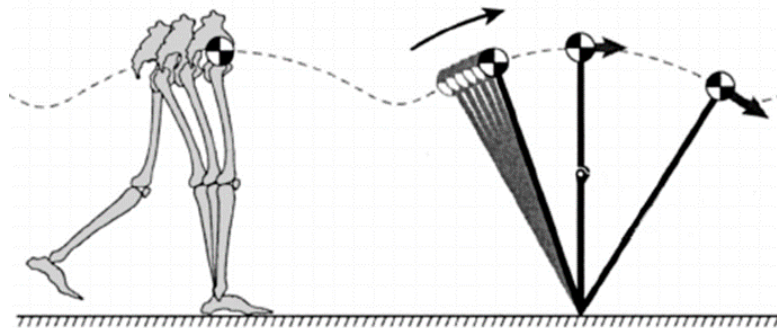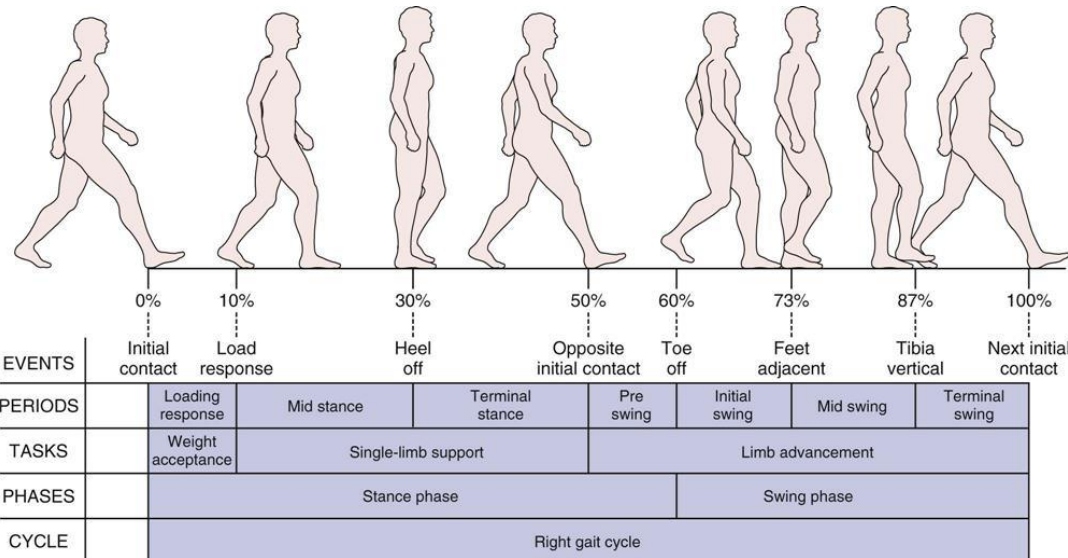[3]Haute Ecole Libre de Bruxelles Ilya Prigogine 1070 Brussels, Belgium
[4]Department of Product Development, Faculty of Design Sciences, University of Antwerp, Antwerp, Belgium

Gait analysis and Spatiotemporal parameters

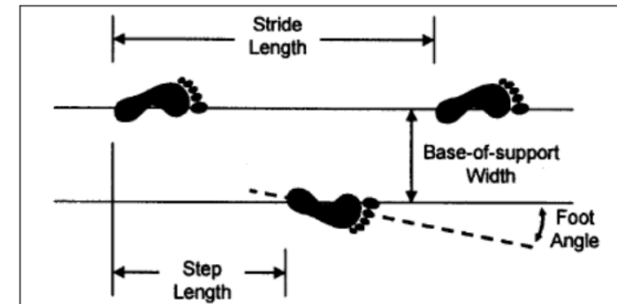## Spatial Parameters of Gait:

Step length - Right heel to left heel
Stride Length - Right heel to right heel
Step width - parallel distance between two heel strikes
People will increase their base if they're unstable
Gait / Foot angle

Temporal(time) Parameters of Gait: Cadence (steps per minute)
Velocity (distance covered in a given time)

Stride Time - heel strike on left to heel strike on left
Step time - heel strike on left to heel strike on right
Swing and Stance phase time

Golden ratio

$$\phi = \frac{1+\sqrt{5}}{2} = \text{stance/swing} = 1.618\ldots$$

$$\phi = \text{Gait cycle/stance} = 1 + \cfrac{1}{1 + \cfrac{1}{1 + \cfrac{1}{1+\ldots}}}$$

Iosa, M., Morone, G., & Paolucci, S. (2017). Golden Gait: An Optimization Theory Perspective on Human and Humanoid Walking. Frontiers in Neurorobotics, 11.

Methods

Eighteen healthy male adults participated as volunteers to the study (mean age 26.33±4.40 years, body mass 74.66±5.62 kg) signing the informed after ethical committee approval.

Table.1 Anthropometric data (cm).

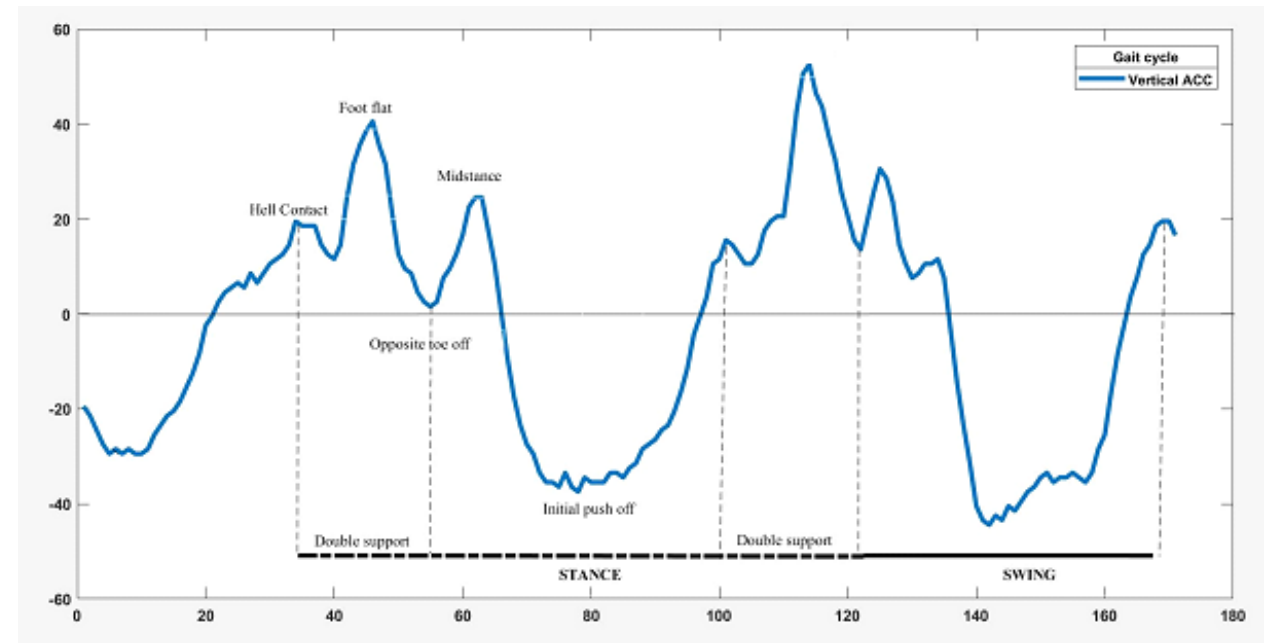| Variable	Mean	SE Mean	SD	Variance	CV	Minimum	Maximum
Stature	180.28	0.44	6.51	42.40	3.61	171.00	192.00
Leg length	93.94	0.35	5.14	26.39	5.47	84.00	105.00
Chest-feet length	130.94	0.38	5.67	32.12	4.33	122.50	143.00

Fig.2 Example of identification of the gait cycle and related gait phases using the vertical acceleration in one subject that wore the smart shirt

Results

Table.2 Spatiotemporal gait parameters calculated using the smart shirt (ST=stance, SW=swing, speed(m/s), %ST= percent of stance, %SW= percent of swing).

Variable	Mean	SE Mean	SD	Variance	CV	Min	Max
ST	0.65	0.00236	0.03	0.001	5.31	0.54	0.74
SW	0.43	0.00217	0.03	0.001	7.41	0.32	0.52
% ST	60.29	0.141	2.07	4.32	3.45	55.11	67.93
%SW	39.70	0.141	2.07	4.32	5.24	32.06	44.88
Speed	1.37	0.00704	0.10	0.010	7.53	0.14	1.57

Table.3 Pairwise Pearson correlations between anthropometric data, step length and speed.

Sample 1	Sample 2	Correlation	95% CI for ρ	p-value
Leg length	Stature	0.865	(0.827, 0.895)	0.0001
Chest-feet length	Stature	0.885	(0.852, 0.911)	0.0001
Speed	Stature	0.230	(0.100, 0.353)	0.0010
Chest-feet length	Leg length	0.741	(0.674, 0.796)	0.0001
Step length	Leg length	0.865	(0.827, 0.895)	0.0001
Speed	Leg length	0.174	(0.042, 0.301)	0.0101
Step length	Chest-feet length	0.885	(0.852, 0.911)	0.0001
Speed	Chest-feet length	0.220	(0.090, 0.344)	0.0010
Speed	Step length	0.230	(0.100, 0.353)	0.0010

Results and conclusions

Table 4. Gait ratios

Variable	Mean	SE Mean	SD	Variance	CV	Minimum	Maximum	Range
GC/ST	1.66	0.003	0.056	0.003	3.39	1.47	1.814	0.34
ST/SW	1.52	0.009	0.138	0.019	9.05	1.22	2.11	0.89
SW/DS	2.70	0.755	11.10	123.21	410.87	1.00	164.97	163.97

Fig. 3 Describes the golden equilibrium as intercept between stability(SW/DS) and advancement(SW/ST) for the entire population.