Annual Meeting of the IEEE-EMBS Benelux Chapter

Jointly with the 16th Belgian National Day on Biomedical Engineering

On November 30th and December 1st, the annual symposium of the IEEE-EMBS Benelux Chapter will be organized in Brussels. On Thursday November 30th, we meet in the Faculty of Medicine and Dentistry of UCL (Woluwé-Saint-Lambert) and, on Friday December 1st, we join the program of the Belgian Day on Biomedical Engineering in Brussels, Royal Belgian Academy of Arts and Sciences. Join us for 2 exciting days of the best biomedical engineering research the Benelux has to offer!

PROGRAM

THURSDAY, November 30th, 2017: **ASSISTIVE DEVICES AND BIONICS**	
9h00 – 9h30	Registration and coffee
9h30 – 9h40	Welcome word by Prof. Renaud Ronsse, UCL, Officer of the IEEE-EMBS Benelux Chapter
9h40 – 10h30	1st keynote lecture: **Yves Vandermeeren**, Institute of Neuroscience & Louvain Bionics, Université catholique de Louvain, *Engineering neurorehabilitation – A neurologist perspective*
10h30 – 11h50	Contributed lectures: E. De Raeve*, T. Saey, L. Muraru, V. Creylman, *Robotic motion simulator for testing orthopedic and prosthetic devices* C. Bayón*, T. Martín-Lorenzo, B. Moral, O. Ramírez, A. Pérez-Somarriba, S. Lerma-Lara, I. Martínez, E. Rocon, *Proposal of a robotic therapy for pediatric population with cerebral palsy* M. Boutaayamou*, O. Brüls, V. Denoël, B. Forthomme, J.-L. Croisier, J. G. Verly, G. Garraux, C. Schwartz, *A gait cycle partitioning method using a foot-worn accelerometer system* F. Sammali*, C. Blank, L. Xu, Y. Huang, B. Schoot, M. Mischi, *Experimental setup for objective evaluation of ultrasound speckle tracking in the uterus*
11h50 – 12h40	2nd keynote lecture: **Massimo Sartori**, Institute of Biomedical Technology and Technical Medicine, University of Twente, *Neuro-mechanical interfacing for neuro-rehabilitation technologies*
12h40 – 13h40	Lunch – Meeting of the IEEE/EMBS Benelux Chapter Committee
13h40 – 14h30	3rd keynote lecture: **Dirk Lefeber**, Department of Mechanical Engineering & BruBotics, Vrije Universiteit Brussel, *Use of compliant actuation principles for assistive and rehabilitation robots*
14h30 – 15h00	Posters teasers

A GAIT CYCLE PARTITIONING METHOD USING A FOOT-WORN ACCELEROMETER SYSTEM

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1. INTRODUCTION

Accelerometer-based systems have been proposed as a reliable solution for the human gait analysis. Their hardware part has the advantage to include low-cost, small, and lightweight accelerometer units with generally low power consumption. Yet, in the context of accelerometer-based algorithms, there is a current unmet need of a validated extraction of temporal gait sub-phases, e.g., temporal sub-phases of the swing phase time, using recorded data solely from accelerometers. In this work, we describe a newly developed algorithm to extract durations of (1) left (L)/right (R) stride (Sr), stance (Sa), swing (Sw), and double support (DS) phases, and (2) L/R sub-phases that refine the L/R stance and swing phases, using our foot-worn accelerometer system [1]. The extracted temporal sub-phases include durations of (1) HS2TS (heel strike (HS) to toe strike (TS)), (2) TS2MS (TS to mid stance (MS)), (3) MS2TO (MS to toe-off (TO)), (4) TO2MHC (TO to maximum of heel clearance (MHC)), (5) MHC2MTC (MHC to maximum of toe clearance (MTC)), and (6) MTC2HS (MTC to HS).

2. MATERIALS AND METHODS

In order to accurately and precisely quantify the aforementioned gait phase/sub-phase durations, it is important to extract accurate and precise moments of gait events involved in the calculation of these phase/sub-phase durations. The proposed extraction algorithm uses distinctive and remarkable features on both longitudinal and antero-posterior accelerations of the heel and toe for each foot. Depending on the nature of these features, a suitable method is employed to accurately and precisely extract gait events of interest. We examine these gait phase/sub-phase durations for 6 walking speeds ranging from 0.70 to 1.39 m/s in treadmill walking of a healthy subject (female, 24 years old); and we estimate linear regression parameters of the mean values of these gait parameters during the 6 walking speeds.

3. RESULTS AND DISCUSSION

The results demonstrate that the proposed algorithm successfully quantifies 6 relevant sub-phase durations refining the gait cycle time for the 6 walking speeds. Most of the extracted gait phase/sub-phase durations change significantly with speed (Table 1). To the best of our knowledge, this is the first study that demonstrates the extraction, on a stride-by-stride basis, of the sub-phase durations of the swing phase for different walking speeds, using an ambulatory gait analysis system based solely on accelerometers. The extracted temporal gait phases/sub-phases could be relevant for characterizing, e.g., the progression of a neurological disease such as the Parkinson's disease, and for an early prediction of, e.g., elderly falls.

Table 1: Results of the linear regression of the mean values of the L/R phase/sub-phase percentages (of the L/R stride duration) for the 6 walking speeds.

Newly extracted phases/sub-phases (%)		*a* (%/(m/s))	*b* (%)	R^2
L/R Sr phases	Sa	−6.0	72.8	0.97
	Sw	6.1	27.1	0.98
	DS	−6.0	22.8	0.98
L/R Sa sub-phases	HS2TS	0.6	6.5	0.26
	TS2MS	−0.7	12.4	0.18
	MS2TO	−5.3	53.5	0.97
L/R Sw sub-phases	TO2MHC	1.2	3.4	0.98
	MHC2MTC	5.7	20.4	1.00
	MTC2HS	−0.8	3.2	0.50

• *a* and *b*: the linear regression parameters with: gait phase/sub-phase duration = *a* * walking speed + *b*);
• R^2: the coefficient of determination.

References

[1] Boutaayamou, M. et al. *Biomedical Engineering Systems and Technologies*, Springer, 2017.