

# EXPERT SYSTEM FOR GAIT EVENT DETECTION BASED ON THE GAIT CYCLE OF BOTH LOWER LIMBS

Vassilis Moulianitis<sup>1,3</sup>, Vasileios Syrimpeis<sup>1</sup>, Nikolaos Aspragathos<sup>1</sup>, Elias Panagiotopoulos<sup>2</sup>,  
Maria Basia<sup>3</sup>, Ioannis Fournianakis<sup>4</sup>

<sup>1</sup>Mechanical & Aeronautics Eng. Department, University of Patras, Hellas

<sup>2</sup>Orthopaedics Department, General University Hospital of Patras, Hellas

<sup>3</sup>Department of Products & Systems Design Engineering, University of the Aegean, Hellas

<sup>4</sup>Department of Computer Engineering & Informatics, University of Patras, Hellas

## Introduction

The design of closed-loop control systems for the rehabilitation of lower limbs depends on the full knowledge considering the gait phases and events of the gait cycle. The detection of those phases and events affects the correct timing of the stimulation of the pathological muscles or nerves. An Expert System (ES) that supports the conceptual design of control systems was presented in [Moulianitis, 2009]. The knowledge inserted in this system was based on the normal EMG behavior of a single limb during a gait cycle. The present paper extends the knowledge base of the ES examining the motion of both lower limbs.

## Methods

Knowledge concerning the human locomotion is acquired from the literature [Perry, 1992] & [Syrimpeis, 2006] and by interviewing experts. It is assumed that the gait cycle of every limb is leading (or lagging) 50% of the gait cycle of the contra-lateral limb. For every muscle per limb gait phase detection is determined based on EMG data. The methods and tools used to develop the ES are the same as those presented in [Moulianitis, 2009].

## Results

A knowledge base that connects both lower limb muscles and the gait phases is developed and inserted in an expert system. In Table 1 part of the knowledge base is presented for three muscles of every limb. Three quantitative values are used to map the quality level [1, 0.6, 0.3]. The empty cells show no activation at all of the muscles during the corresponding gait phase. The system is exporting ranked sets of muscles based on the constraints imposed by the user and the functionality of the muscles.

## Discussion

In this paper, the knowledge base of an ES is presented to support the development of closed loop controllers for the rehabilitation of lower limb disabilities using knowledge from both

lower limbs. In the presentation, a case for the conceptual design of a controller using the results of the introduced ES will be presented and discussed.

	IC	LR	MS <sub>t</sub>	TSt	PS <sub>w</sub>	IS <sub>w</sub>	MS <sub>w</sub>	TS <sub>w</sub>
TA (R)	1	1			0.6	0.6	0.6	1
EHL (R)	0.6	0.6			0.6	1	0.6	0.6
PT (R)		0.6	0.3	1				
TA (L)	0.6	0.6	0.6	1	1			0.6
EHL (L)	0.6	1	0.6	0.6	0.6			0.6
PT (L)					0.6	0.3	1	

Table 1: Part of the knowledge base concerning the gait phase detection of three muscles per limb. TA: Tibialis Anterior, EHL: Extensor Hallicis Longus, PT: Posterior Tibialis, R: Right, L: Left.

## References

- Moulianitis V.C. *et al*, "An Expert System for Supporting the Conceptual Design of Controllers for Lower Limbs Rehabilitation Systems", IEEE 17th Mediterranean Conf. on Control and Automation, 2009.
- Perry, J. "Gait Analysis: Normal and Pathological Function", SLACK Incorporated, USA, 1992.
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