

Computational tools for signal processing of human gait

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Human locomotion control is a complex task affected by age and health conditions disturbing the somatosensorial inputs (e.g. Ménière's syndrome, diabetes) or the performance of the muscle-skeletal system (e.g. hip transplant) [1].

The goal of this work was to implement a system of computational tools capable of aiding physical therapist or other medical personnel in diagnosing and quantitatively evaluating the recovery of people with impairments affecting locomotion [2,3].

The system developed can receive and synchronize input data from a set of force plates that measure the ground reaction forces (GRF) during several consecutive steps as well as from surface electromyographic sensors.

The combination of the multiple GRF records allows the computation of the subject's center of pressure (CP) and center of mass (CM) trajectories. The dynamic comparison of the CP and horizontal projection of the CP can be used to evaluate the (re)equilibrium mechanisms [4]. The sagittal evolution of the CP, as well as the external power by the independent limb or the combined limb methods, can be used to evaluate gait efficiency and energy recovery [5]. Gait symmetry can also be investigated from the three-dimensional CP trajectory. All these possibilities have been implemented in our computational system.

The GRF records allow for the identification of the main muscular groups to investigate further by surface electromyography (sEMG). The combination of sEMG and GRF data simplifies a causal diagnosis. In our system, the surface EMG data is wavelet decomposed (Morlet complex waves) and analyzed in the time-scale (frequency) space. This allows for the exploration of the neurological control mechanisms and stability.

Legendre transformation of the wavelet data included in the system also allows the identification of the (multi)fractal signature of the EMG records for a better identification of equilibrium stability and adaptation to therapy.

The developed computational system, Fig. 1., is now under clinical evaluation and the results have been very promising.

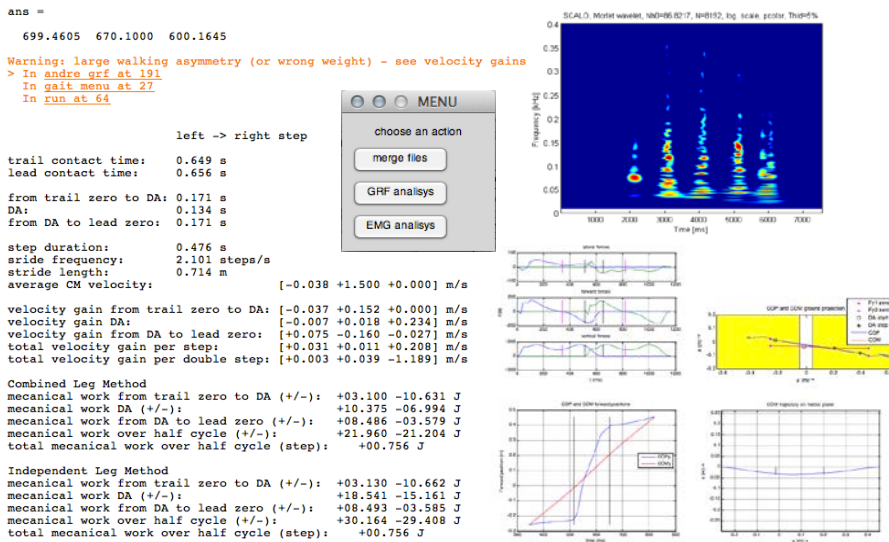


Fig. 1 – Example of the developed computational system input and output.

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