ADAPTIVE POSITION ANTICIPATION IN A SUPPORT ROBOT FOR OVERGROUND GAIT TRAINING

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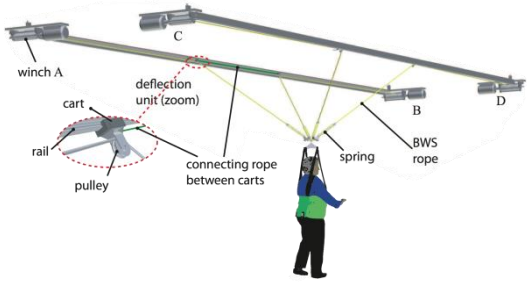
Abstract

Rehabilitation robots being developed nowadays rely on force and/or impedance control. The simplest mode of force control is when the robot has to be transparent. This contribution proposes a method to improve transparency on a support robot for overground training and surveys a paper presented to the ICORR conference 2013 [1].

Keyword(s): biomechanics – rehabilitation robotics

1 Support Robot

The robot used in this study is called FLOAT [3]. It can provide a vectorial (3D) force to support a human during walking, for instance during the therapy following a spinal accident.



The method proposed to increase the robot transparency requires adding predictive components to the existing layered force controller. More precisely, a *predictive layer* predicts the future position of the node with an estimator based on an adaptive oscillator. Thereafter, an *equilibrium layer* calculates the winch positions required to apply the reference force to the node, considering a static equilibrium for the estimated position. Finally, a *position layer* controls the winch positions calculated in the previous layer in order to provide the desired reference forces.

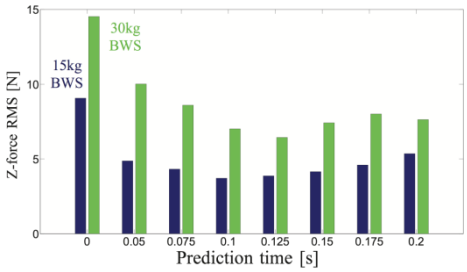
2 Predictive layer

The predictive layer is based on an adaptive oscillator. It is a dynamical system having the capacity to synchronize to a quasi-periodic input by learning its features in state variables [2].The learned features are the phases, frequencies, and amplitudes of the harmonics comprised in the input signal: $\theta(t) = \sum \alpha_i \sin(i\omega t + \phi_i)$. Consequently, the signal future at time $t + \Delta$ can be predicted by the following equation:

$$\hat{\theta}_\Delta(t) = \sum \alpha_i \sin(i\omega(t + \Delta) + \phi_i)$$

3 Results

Predicting the vertical component of the position signal enhances the robot transparency by decreasing the oscillations of the vertical force.



These encouraging results for the vertical direction motivate further extension of the concept also to the two other directions. Moreover, the learned frequency should be usable for the three directions.

References

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