Bio-inspired Model for Locomotion Assistance

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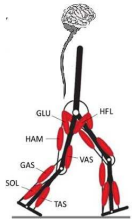
Objective

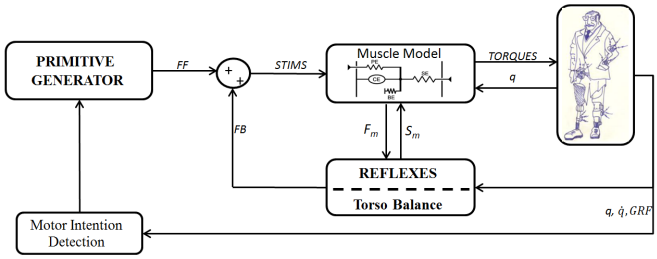
Obtaining a framework to provide **bio-inspired torque assistance** to disabled humans during walking and stair ascending/descending. Data comes only **from wearable sensors**.
The method is based on a bio-inspired model copying the natural dynamics of leg muscles, and containing a torso stabilization mechanism.



Adapted from: Geyer and Herr (2010), Capellini et al. (2010) and Dégallier et al. (2011)

Method

Assistive torques (τ_s) are obtained from recorded kinematics $(q, \dot{q})$ and ground reactions forces (GRF).



The **Muscle model** provides the assistive torques

- Muscle Forces (F_m)

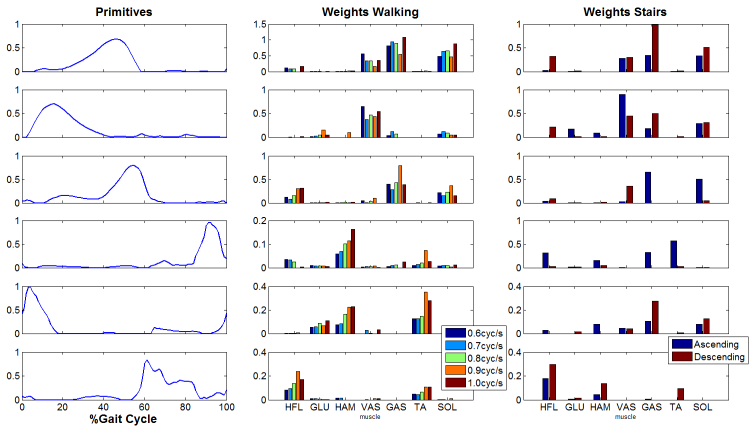
$$F_m = F_{SE} = F_{CE} + F_{PE} - F_{BE} \;\; ; \;\; F_{CE} = S_m F_{\max} f_l(l_{ce})\, f_v(v_{ce})$$

- Torques (from the geometric model)

$$\tau_s = r_m(\varphi)\, F_m$$

Stimulations (S_m) for muscles have different sources:

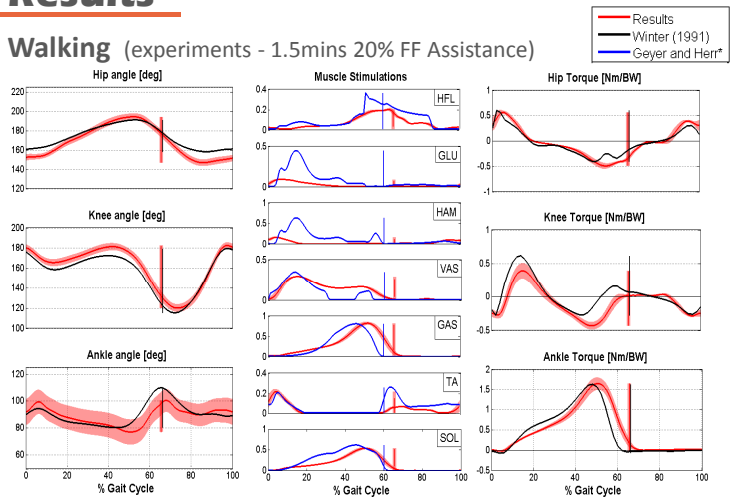
- **Feed-forward (FF) -** Primitives generator



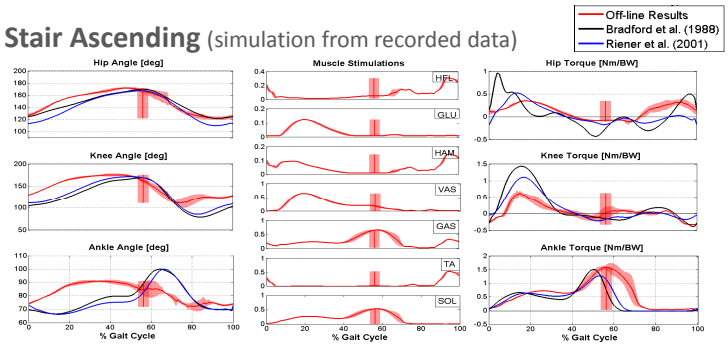
- **Feedback (FB):** Short-Loop Reflexes* + Torso Balance

Results

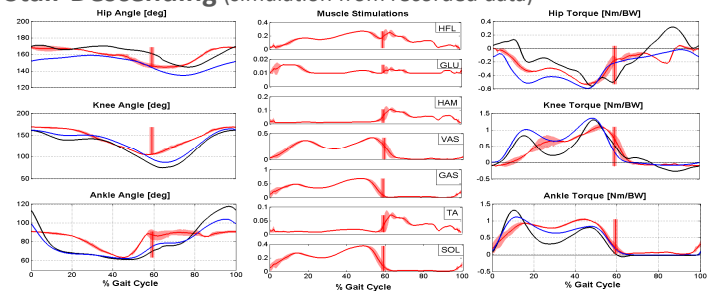
Walking (experiments - 1.5mins 20% FF Assistance)



Stair Ascending (simulation from recorded data)



Stair Descending (simulation from recorded data)



Conclusions

The proposed method allows to compute the muscles stimulations and torques from kinematics recorded with wearable sensors. **A portion of these torques can be applied depending on the desired level of assistance**.
This model proved to run in real time while integrated in the general CYBERLEGs cognitive control unit and provided assistance through a pelvis orthosis to healthy subjects.

On-going work is now focusing on **experiments** to test the effectiveness of the assistance compared to other methods. Future work will focus on complementing the stimulation data base and adapting the reflexes to stair maneuvers.

*Geyer and Herr. IEEE transactions on neural systems and rehabilitation engineering, 2010;18(3): 263-273.

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