ACTIVATION PRIMITIVE-DRIVEN MUSCULOSKELETAL MODELLING OF HUMAN LOCOMOTION: TOWARDS MODEL-BASED CONTROL OF BIONIC LEGS

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Introduction

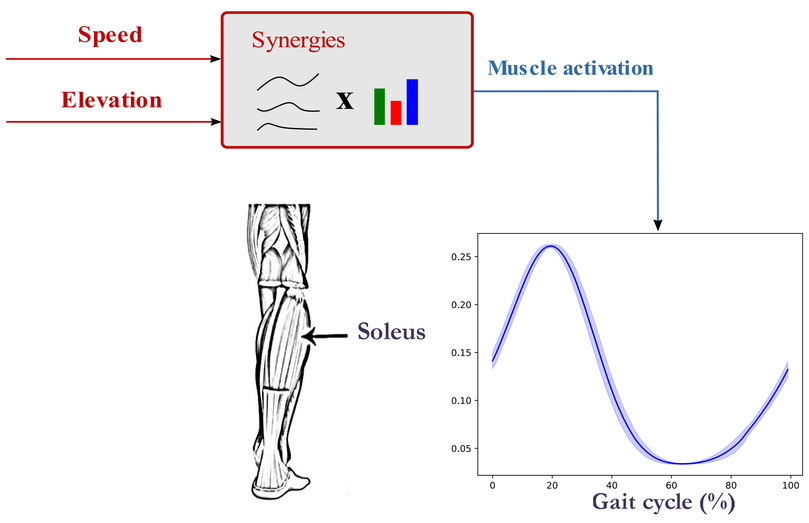
Problems with current prosthetic controllers:

1. long training sessions
2. non-natural compensatory movements
3. lack of comfort
4. higher energy requirements during walking and standing
5. cumulative trauma disorders
6. EMGs dependence is not practical and affected by noise

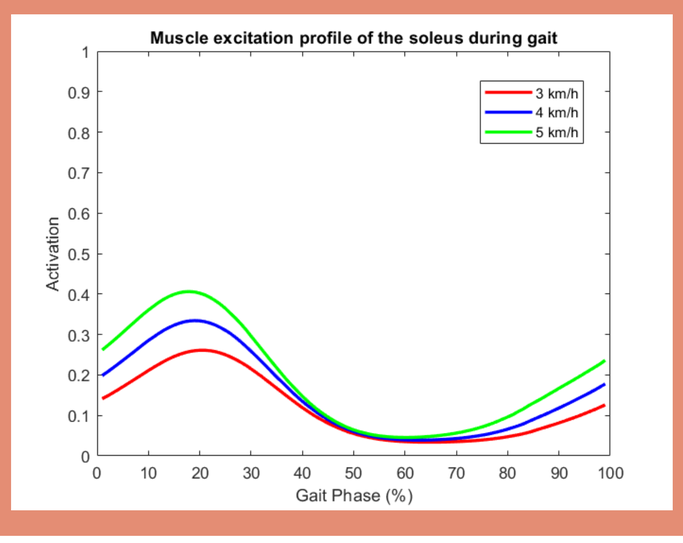
[1][2]

The aim of the current research is to interface the synergies model of the muscle excitations [3] with personalized musculoskeletal model to estimate muscle-tendon units forces and joint moments in real-time with no need for EMG sensing [4].

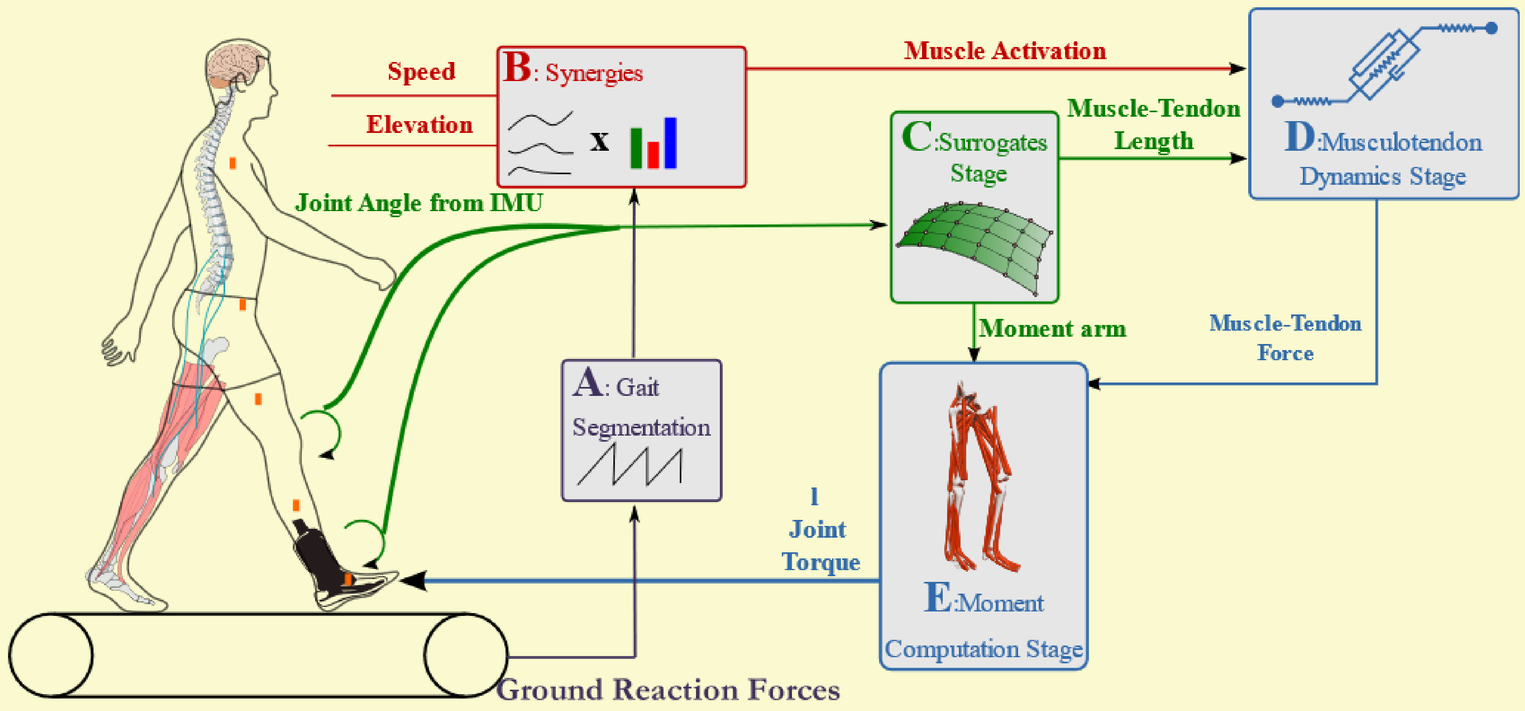
Method



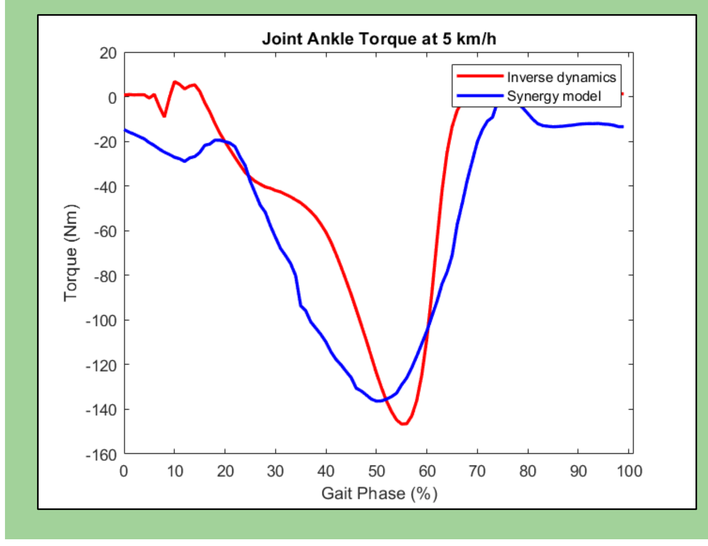
Activation of the soleus muscle, derived from the synergy model with no need for EMGs, at the three speed considered (3km/h, 4 km/h, 5 km/h) during the gait cycle



Experiment

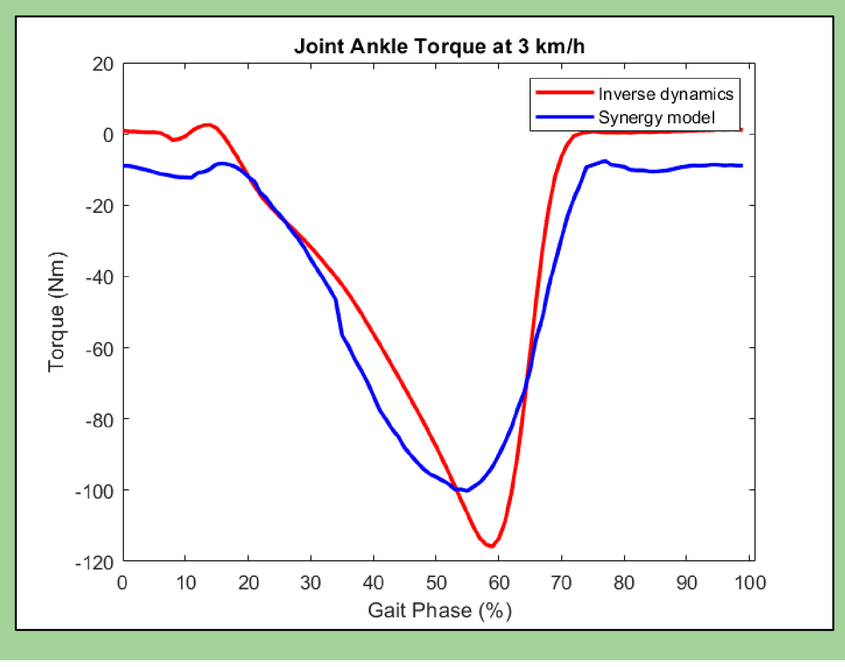


Schematic of the modeling framework : gait segmentation (A), plug-in system for synergies computation (B), data processing (C), joint torque computation (D-E). Inertial Motion Capture system were used to capture joint angles and moments. The synergies model was used to predict joint moments. At each timestep it requires an accurate gait phase estimation using sensory information from the treadmill, specifically ground reaction forces together with speed and elevation . Data from markers and Force plates were used to compute inverse dynamics and kinematics to validate our results.



Results

The differences in the ankle torques computation from inverse dynamics and the model were analysed for one leg, computing the root mean square error (RMSE) and correlation factor. The RMSE ranged between 0,175 and 0,367 Nm/Kg across the speeds (3 km/h, 4 km/h and 5 km/h) . The red moment represent the result of the inverse dynemics from motion capture systems. The blue line is the output of the synergy model given speed and gait phase information.



Acknowledgments and references

I wish to acknowledge the contribution of Lucas Avanci Gaudio for his help with the software development. I would like to thank Huawei Huang for his assistance. This work is supported by the Marie Skłodowska-Curie Actions (MSCA) Innovative Training Networks (ITN) H2020-MSCA-ITN-2019 - 860850 - SimBionics (Neuromechanical Simulation and Sensory Feedback for the Control of Bionic Legs)

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