

BIOENG-404 - Homework 4: SCONE

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1 Healthy Gait

The solution provided by the optimization process (which converges relatively fast) is quite good. The gait appears natural when played as a video but a close examination of the gait parameters (pelvic tilt, hip, knee and ankle flexion as well as ground reaction forces, displayed in figure 1) show that the model gives results slightly off compared to measured data in humans. The curves have the approximate shape of the real-life data but their amplitude and timing is slightly off. Furthermore one observes that the ankle flexion displays a dip in angle at $\sim 25\%$ of the gait cycle that simply doesn't exist in humans. This model seems more useful as a toy-model, to rapidly test out hypotheses rather than as an accurate prediction tool (as is often the case when modeling complex dynamical systems).

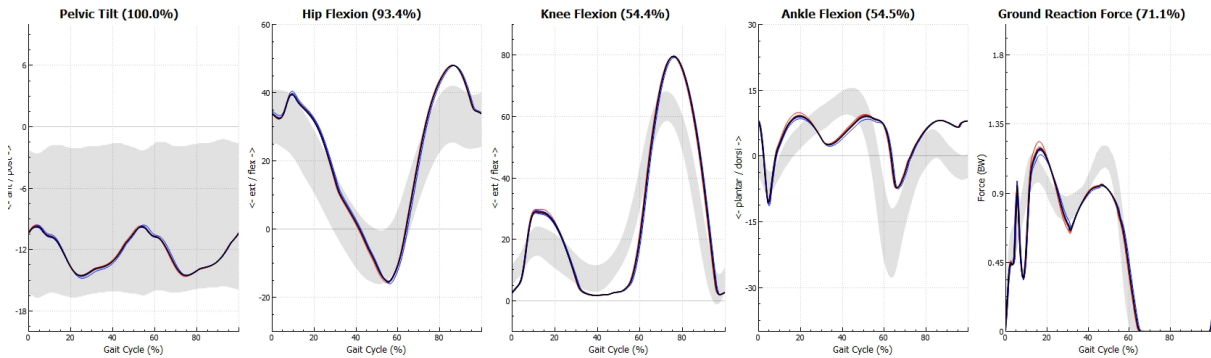


Figure 1: Gait parameters as observed in the SCONE simulation of the gait of a healthy subject. The grayed-out area show distribution of gait parameters in healthy humans, the colored lines show the gait parameter evolution over multiple gait cycle for our optimal solution.

2 Pathological Gait : Plantarflexor Muscle Atrophy

We reduce the maximum force that can be produced by the plantarflexor muscles (*gastrocnemius* and *soleus*). The principal kinetic adaptation is (quite obviously) a reduction of the amplitude of plantarflexion as is clearly visible on

3 Pathological Gait : Hyperreflexia

4 Pathological Gait : Heel / Toe Walking

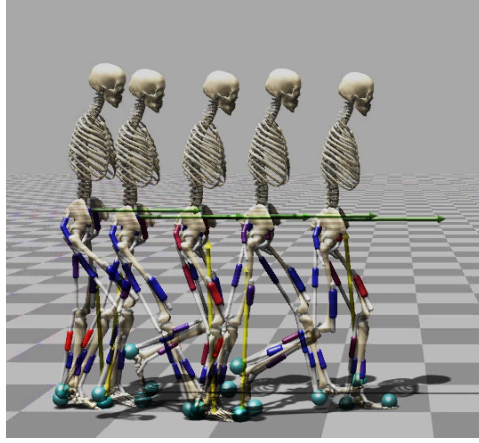


Figure 2: Rendering of the optimization solution produced by the healthy model and controller.

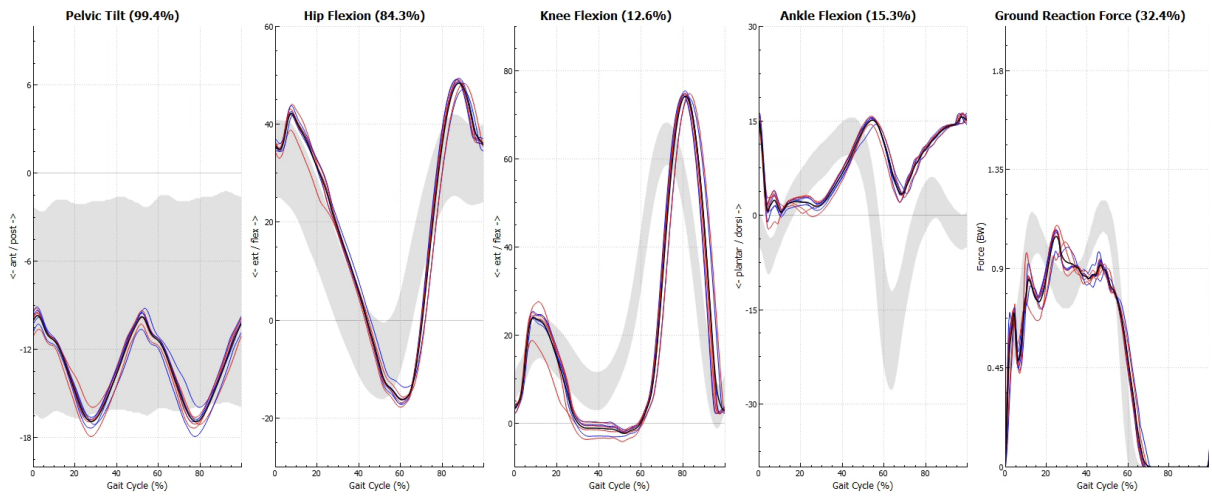


Figure 3: Gait parameters as observed in the SCONE simulation of a subject with a gait affected by PF muscular atrophy.

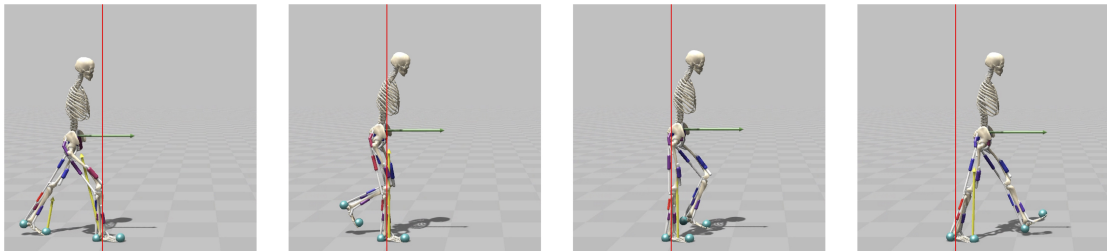


Figure 4: Rendering of the optimization solution produced for the PF muscular atrophy model.

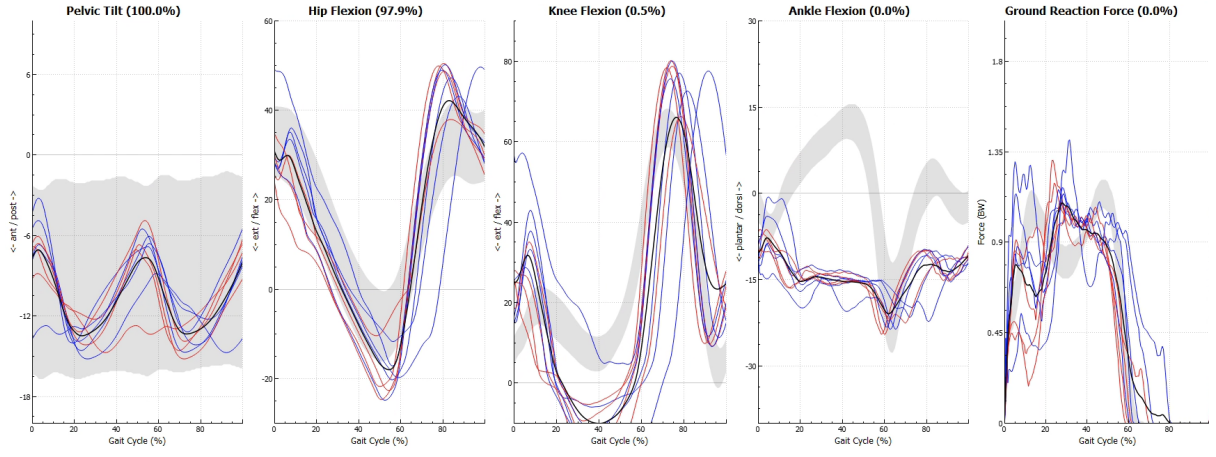


Figure 5: Gait parameters as observed in the SCONE simulation of a subject with a gait affected by hyperreflexia.

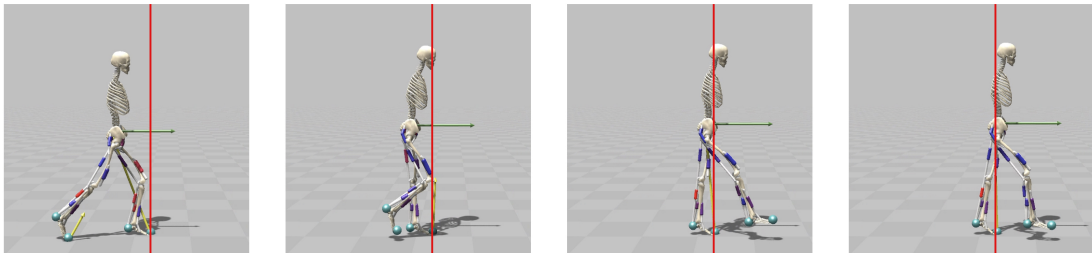


Figure 6: Rendering of the optimization solution produced for the hyperreflexia model.