Dynamic muscle model for virtual human animation

MSc research project

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This project will be carried out within the SAARA research team of the LIRIS lab in Lyon (Doua Campus).

Presentation of the project:

This project concerns the accurate and real-time simulation of real human movement. To perform such simulation, we need a model of the real human in the virtual world of the simulation. Different models can be used depending on the intended application. In this project, we focus on models involving the anatomy and inner working of the human body.

The purpose of this project is to design a new model of muscle action line for the real-time simulation of virtual characters. The currently used muscle model uses line segments (called action lines) which represent only within a certain limit the action that a muscle can produce [Hill1938, Zajac1989]. These limits are reached when muscle attachments are large, or when the muscle fibers have a complex arrangement or when they follow a complex routing (e.g. wrapped around bones or other muscles, see Figure 1). Some muscle-based simulation platforms use predefined primitive surfaces around which these action lines can wrap [OpenSim2007], but these are still rough approximations of the deformations that are involved in the human body.

Nevertheless muscle-based simulations are very sensitive to the directions of the muscle forces, and the routings of the action lines define the direction of the applied forces. Different action lines routings have a significant effect on the simulations [GvdPvdS2013].

This project will investigate the benefits of using dynamic action lines i.e. that adapt to the posture. These adjustments will be estimated from the geometric deformations of the muscle. As these deformations are expensive to compute, they will be part of an off-line preprocess, and only a pre-calculated table of each muscle moment arms will be used according to the current posture of the virtual character.

Expectations for this project are threefold. (1) The student will use a geometric method to calculate the deformations of the action lines. (2) The student will then assess the impact of this new model on muscle function (i.e. are the differences in forces significant?). (3) Finally, demonstration scenarios will be developed to validate the model and support the results.

Keywords:

Physics based animation – real-time motion control – muscle model

Applications:

This type of simulation is accurate enough and manipulates relevant enough data to allow applications both in the field of life science and animation for films and video games. Upon completion, the developed model should be able, for instance, to assist in the training of people exhibiting gait pathologies.

Continuation of the project: This project can be pursued as a PhD thesis.

Prerequisites and technical information:

The developments will be primarily done with C++ or C# on Windows. The knowledge of an OO programming language is therefore required. The project is mainly about physics based animation, so an interest in software development for this type of environment is desirable. Prior knowledge about biomechanics is not required.

Preliminary work for this project have been already done within the research team. The student will for example have access to projects studding mass-spring modeling of muscle deformation and its impact on the routing of muscle fibers and action lines.

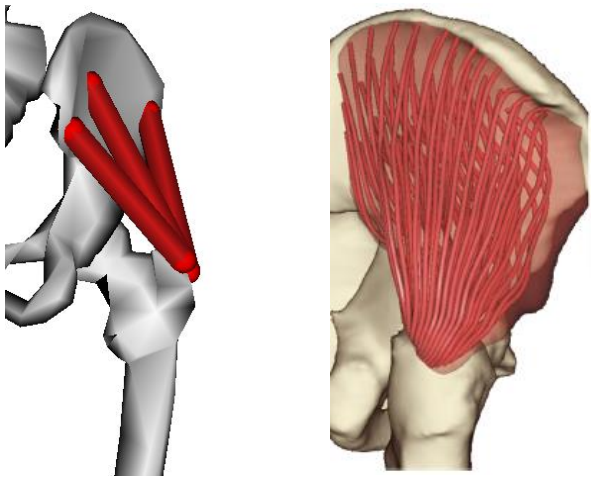

Figure 1: The *gluteus medius* muscle represented by three lines of action (left) [OpenSim2007] and thirty fibers (right) [Kohout2014]

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