ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

CRL
Computational Robotics Lab

Master Thesis

Biomechanics in the Wild with Personalized Avatars

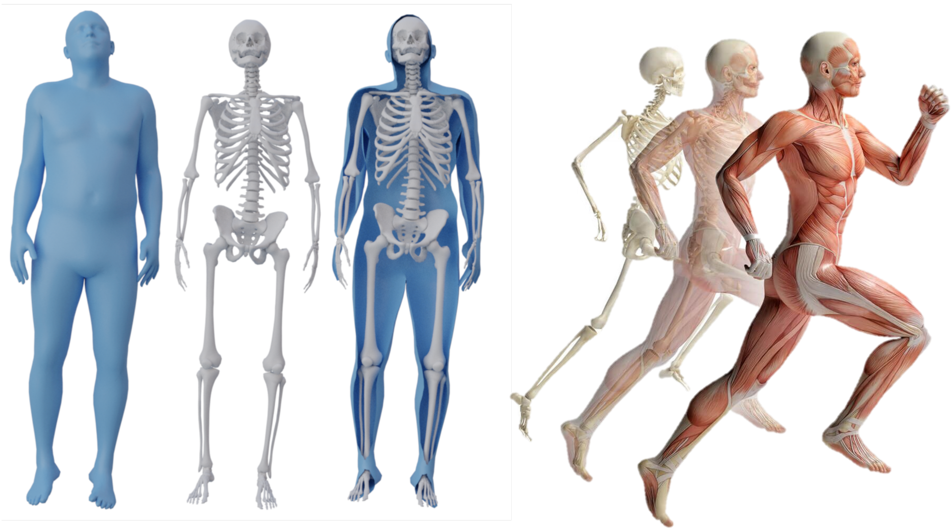

Figure 1: The goal of this project is to enhance an existing parametric body model with a complete musculoskeletal structure and simulation capabilities.

Introduction

Personalized avatars are becoming increasingly common in digital environments, and they have significant implications in the real world. Currently, these avatars can primarily mimic the shape and posture of individuals, with some basic simulation of skin and tissue. However, the potential of personalized digital representations of humans extends beyond simple animation. To unlock their widespread applications in fields like biomechanics and medicine, we need to develop more comprehensive personalized avatars with the necessary anatomical structures to simulate activities such as walking, sports performance, product safety, and rehabilitation.

The goal of this project is to enhance an existing parametric body model like SMPL or STAR by adding a complete musculoskeletal structure and simulation capabilities that can explain existing and generate new motions in a biomechanically meaningful manner.

Task Description

This project builds upon the freely available SMPL/STAR body models. These models can be customized to fit large variety of body shape and they can be posed and animated. The initial step involves integrating an existing parametric skeleton model (OSSO) with SMPL. This skeleton model will then be enhanced with tendons, ligaments, and hill-type muscles. Initially, these muscular components will not have a physical shape but will exert forces and constraints between attachment points on the bones. Subsequent stages of the project may refine these components to include realistic geometry.

Once the musculoskeletal template model is established, we will explore methods for explaining motion data obtained through experiments using biomechanical simulations. We will initially consider simple actions such as lifting an arm, then proceed more complex movements like sitting and walking. To achieve this, we will formulate constrained optimization problems, which will be solved using nonlinear programming techniques. This will help us understand and replicate various movements with a focus on biomechanical accuracy.

Skills

- Experience in computer graphics and/or geometry processing
- Experience with numerical simulation and/or optimization
- Very good programming skills in C++

Contact

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