Post doc subject:

Supervision of the Motion of the Musculoskeletal System using Non-contact Technique coupled with a Biomechanical Model

Post doc Advisor:

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Context of the study:

In silico medicine based on the multi-physical model of the human body is a current research challenge in the field of biomechanics. This aims to perform objective and personalized evaluation as well as to propose appropriate and optimized treatment prescription for musculoskeletal disorders (facial disfigurement, low back pain, etc.) [1, 2]. The development and the use of such a complex multi-physical model need a system of systems (SoS) including a data acquisition and management system, a multi-physical modeling system and a graphical user interface (GUI) system (Figure 1.). It is important to note that the simulation of multi-physical model needs to be performed in real-time with accurate results and without high performance computing (HPC) resources. Consequently, the design of our technical SoS needs to be optimized at different levels such as data acquisition and multi-physical modeling.

![Fig. 1 System of systems for monitoring of the motion of the musculoskeletal system](image)

The motion of the musculoskeletal system is commonly acquired using 3D motion capture technique (e.g. VICON, OptoTrack, Motion Analysis). This technique provides a good precision but the set up protocol is complex (e.g. use of skin-based markers). Moreover, this technique is commonly coupled with a rigid multi-bodies model with modeling simplifications and assumptions.

The objective of this project is to develop a methodology for the supervision of the motion of the musculoskeletal system using a non-contact technique coupled with a numerical deformable model describing rapidly the “accurate” behavior of biological soft (muscle, fat) and hard (bone) tissues. Thus, the non-contact technique will make the data acquisition easier and rapid. The modeling of tissue behavior will optimize the behavior of the multi-physical modeling system. The first case study is the monitoring and evaluation of facial mimics.

Post doc description:

The postdoc project aims to achieve the following technical objectives:
1) Development of a “Digital Multi-Physical Patient Avatar”: For this task, a data fusion (3D geometries and motion) derived from a video camera system (Kinect system) will be performed.

2) Integration and coupling with a multi-physical model: this task aims to model the accurate behaviors of biological tissues using rheological visco-elastic models (e.g. Kelvin-Voigt and Maxwell) for soft tissue behavior. The main goal is to optimize the tissue deformation behavior using reduced physical-based models (model reduction of both geometry and behavior). The simulation result needs to be in agreement with the result of Finite Element Analysis [1, 2].

The developed methodology will be integrated into the whole system of systems to create a simulation platform for the analysis, monitoring and evaluation of musculoskeletal disorders (facial disfigurement, lower limb pathologies, low back pain, etc.).

Candidate’s profile:
PhD in the following fields: Computer Graphics, Computational Biomechanics, Applied Mathematics
The candidate needs have the following experiences:
ıld 3D geometric and physical modeling, visualization, texture rendering and animation
ıld Advanced programming experiences in Visual C++ or Visual C#

Documents required to apply:
To apply, please send to hobatho@utc.fr, alain.rassineux@utc.fr, tien-tuandao@utc.fr the following documents:
- Curriculum vitae, motivation letter and at least one copy of a peer-review journal publication
- At least two references and/or recommendation letters
- A statement of research experience and interests

Location:
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References:
