Internship at LBMC (Laboratoire de Biomécanique et Mécanique des Chocs)

Master's Title	Comparative evaluation of constitutive model implementations for Finite Element muscle models
Lab/Team	LBMC (UMR T9406) https://lbmc.univ-gustave-eiffel.fr/
Specifics	Specific scholarship available to candidates to the "MuSkLE" MSc
Location	LBMC, Bron, France
Supervisor	Bertrand Fréchède (MCF) Tel. : 04 7244 8093/04 7865 6900, email : bertrand.frechede@univ-lyon1.fr
Keywords	Modeling, Finite Elements, Mechanical behaviour, Soft tissue, Muscle.

Context :

The Biomechanics and impact mechanics Lab (LBMC UMR_T9406) is a joint research unit between Université Gustave Eiffel and Université Lyon 1 (leading French University in medical sciences). LBMC conducts its research both in the fields of transportation, aiming at improving the comfort and the safety of the users, and in the field of orthopaedics and functional rehabilitation, to face the challenges of mobility and health in the future. Within LBMC, a multi-disciplinary team of clinicians and researchers in biomechanics focuses its work on the thematic of "maintaining functional capabilities through life". These research works aim at contributing to quantify and objectivate the quality of the either healthy or degraded motor and physiological functions, in a context of healthy ageing, and be it for the healthy subject, patient, sportsman, etc… In this context segmental and full body human FE models are being developed that aim to explore this biomechanical behaviour. Active skeletal muscle models and their constitutive mechanical behaviour relations need to be implemented and evaluated in order to account for their actions and contributions when predicting loads in either the osteo-skeletal system or in modelled medical devices[1].

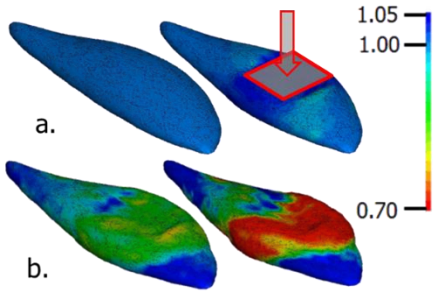

Figure 1 : influence of a transversal load on the lengthening of a. passives b. activated[2] muscle fibres

Objectives : Previous FE modelling work[2] at LBMC (Cf. Fig. 1) has led to the development and implementation of functional active FE muscle models, coded as UMATs in the explicit FE code LS-DYNA. At their core, they are based upon the combined use of passive hyperelastic material laws and e.g. an active Hill model-based part. Recent versions of LS-DYNA include new material laws that need to be comparatively evaluated to these implementations for their target behaviour and their robustness. The tasks will thus be to:

1) conduct an update of the prior literature review on existing/published active FE muscle models
2) acquire some hands-on ability and expertise in using the existing active FE models:
    a. Use of LS-DYNA (MAT_295) on sample phenomenological simulation test-cases
    b. Discovery of Fortran LBMC's user UMAT implementation
    c. Use of LBMC's user UMAT on similar simulation setups
3) transfer this process to actual muscle geometries and modelling of experimental setups for comparative evaluation
4) Application to phenomenological accounting of ageing

Selection criteria : the candidate will need to have a solid background in continuum mechanics, with some knowledge in Finite Element modelling and coding. Some earlier experience in biomechanics, using an explicit FE code, and coding in Fortran will be a strong plus.

Human/material ressources : Access to Hyperworks and LS-DYNA Licences/softwares, as well as to the computational facilities of P2CHPD (Mechanics Department, UCBL).

Applications : send a CV, letter of motivation, to B. Fréchède. Reference contact details are welcome.

References :

[1] https://avicenna-alliance.com/publications/

[2] Maamir M, Siebert T, Tomalka A, Lafon Y, Fréchède Y, 2021. A rat muscle finite-element model to account for transverse loading effects. Proc Int Symposium Comp Meth Biomech Biomed Eng CMBBE 2021. Paper C10.2