Post-doc in the LBMC UMR_T9406
(Laboratoire de Biomécanique et Mécanique des Chocs)
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Geometrical and kinematic modelling of the upper limb

The shoulder movements' amplitude and the soft tissues scapula coverage make particularly hard the accurate assessment of the kinematics of this joint, except using bone pins or medical imaging. These methods are invasive, cumbersome and cannot be applied in a clinical practice. For this particular joint, the methods minimizing the soft tissue artifacts (STA) based on a marker cluster on the acromion still give unrealistic scapular kinematics. In addition, the kinematic optimization (i.e., minimizing distances between measured and model-determined marker positions) performed with simple joint models (i.e., spherical joints) is not fully satisfactory. Indeed, the shoulder joint complex presents some very specific degrees of freedom.

The objective of this project is to develop a multi-body optimisation for the computation of the kinematics of the shoulder and forearm complexes. The geometrical parameters of the upper limb model (e.g., segment length, position of joint centres, orientation of joint axis, radius of idealized spherical or ellipsoid surfaces) will be defined based on literature data. These geometrical parameters will be then used in order to establish the constraint equations corresponding to the gleno-humeral, acromio-clavicular, sterno-clavicular and scapulo-thoracic, humero-ulnar, radio-ulnar and wrist joints. For instance, the collarbone simply brings a constant length between both acromio-clavicular and sterno-clavicular joints. The scapulo-thoracic joint can be considered as a punctual contact between a plane and an ellipsoid.
The kinematic constraints will be introduced in an optimisation framework previously developed for the lower limb in matlab. The constraint equations will be expressed with fully Cartesian coordinates. The minimization under constraints will be then performed by introducing the Lagrange multipliers and the Jacobians of both objective function and constraints. The solution shall be then obtained by few steps of a Newton-Raphson method.

The post-doc is financed by an ANR project. The monthly net salary is 2039 Euros. The candidate should have a thorough background and expertise in solid mechanics, multi-body system dynamics or robotics, including some experience in optimisation problem. A fair knowledge of biomechanics will be appreciated.

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