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Plenary Lecture

IN VIVO BARYCENTREMETRY FOR SUBJECT SPECIFIC MUSCULO-SKELETAL MODELLING

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Summary: Subject specific musculo-skeletal modelling is of paramount importance in various areas of biomechanics including sport, ergonomics and medicine. Among the various issues raised by such modelling, there are two main scientific and technical challenges : the first one is dealing with the well known muscle redundancy problem : too many unknown muscle forces with regard to the limited number of equilibrium equations. This issue drives very active research on quantification of muscles activation both using various modelling methods, and/or experimental techniques.
The second one, which is the object of this talk, is feeding the models with subject specific data, related both to internal information such as vertebrae locations or muscle geometry, and to body segments inertial parameters (BSIPs). Complex methods involving data fusion between different imaging modalities (among which MRI) are progressively set to get subject specific external and internal geometry. Using the resuting datasets, further methods consider deformation of templates and/or statistical analysis and machine learning to simplify the problem and get internal information from external envelope.
BSIPs are generally estimated from databases collected on a limited number of samples : the mass is defined as a given percentage of global body mass. Both center of mass (COM) location and inertial parameters are generic or roughly scaled.
Recent development of bodyscanners and of biplanar X-Rays, associated to 3D reconstruction methods including the external envelope, open new perspectives for subject specific modeling. Mass, COM and other BSIPs scan be computed from the external envelope using automatic accurate processing to delimitate body segments, together with density models per body segment (revisited for the thorax). Computation of barycenter of body segment above a given body segment and direct postural or dynamic analysis allows subject specific quantification of gravitational loads that apply at each body level and for each individual, providing powerfull means of analysis. This talk will focus mainly on barycentremetry, with examples of clinical and basic applications related to spine and musculoskeletal disorders.