Development of Models of Activities of Daily Living

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This presentation looks into the future of biomechanical musculoskeletal models.

A rough history of the development of musculoskeletal models reveals that the first models were quite simple and were programmed bottom-up for a single purpose. Then came dedicated modeling systems, such as AnyBody, which enabled users to create models without explicitly formulating and programming the mathematics and, within these systems, generic body models for multiple purposes based on systematic cadaver studies were created. Those models are much more detailed, and the anatomical data are more accurate than in the early models.

However, investigating a specific activity of a specific individual, say an osteoarthritis patient, still requires much more work, i.e. weeks or months, than is possible in a clinical setting. A more subtle challenge is that the clinical questions often concern the future, for instance prediction of a surgical outcome. From this insight, three research questions can be identified:

1. How can we quickly and with the best possible validity make our generic models reflect the anatomy of a given patient?
2. How can we quickly and with minimum input make the models replicate the activities of daily living that are relevant to the patient?
3. How can models become predictive, i.e. independent of experimental input such as motion capture data and measured ground reaction forces?

Recent work has shown that ground reaction forces can be predicted with surprisingly good accuracy for a number of bipedal activities, provided the kinematic and anthropometrical parameters are accurate. This is a major step forward because, by definition, we cannot possess ground reaction force data from activities and circumstances that have not occurred yet.

We can furthermore observe that anatomy and motion are connected. For instance, tall people tend to take longer steps and joint pain influences the movement pattern. Recent ideas and developments from the field of big data might help resolving consistent anatomical and kinematic data. These ideas will be presented, and preliminary results concerning running patterns will be demonstrated.