Framework for Individualized Dynamical Modeling of Human Motion

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We are developing individualized musculoskeletal models to model movement dynamics based on non-invasive multi-modal measurements (e.g., motion capture, accelerometry, EMG, other wireless sensors). The models are aimed to provide information on kinematic constraints and range of motion and dynamic parameters relating to exerted forces and torques during a movement. Individualized musculoskeletal models inform on which muscles or muscle groups a subject is using during observed movement. Furthermore, we are developing automatic segmentation methods that partition continuous movement into motion primitives. The obtained segmentation can be used to analyze particular motion segments, e.g. during an exercise. This also requires development of metric for comparison between subjects or to assess pre-/post-therapy differences.

Our recent and current projects include the following:

- Development of an automated exercise system for elderly based on the Kinect camera which we deployed in 7 homes of elderly users over the course of 18 weeks.
- Motion segmentation of repetitive exercise data.
- Use of individualized kinematic model for human-robot interaction.
- Design and control of exo-skeletal assistive devices.
- Visualization of real-time musculoskeletal models based on individual's MRI data and multi-modal sensing.

We are proposing to develop a framework for dynamical modeling of human motion to support physical therapy by providing detailed information on patient's musculoskeletal performance obtained through non-invasive measurements. Such data could be applied to:

- characterize and quantify impairments of an individual patient,
- to monitor the minimal differences in performance
- to assist the therapist in the assessment and therapy to obtain better outcomes
- to determine which exercise contributes to the improvements
- to support exercise at home via real-time or just-in-time feedback