25th Umbrella Symposium

for the Development of Joint Cooperation Ideas „Modeling and Simulation with emphasis on High PerformanceComputing and Grid Computing"

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Title: Physically based multiscale modeling of bone micro-structures for patient-specific diagnosis and visualization

Bone is a hierarchical bio-material whose architecture differs at each level of hierarchy and whose mechanical properties can vary considerably, even on the same specimen, due to bone heterogeneity. Because of their complexity and large number of details, these models are considered to be large-scale models. Modeling, visualization and diagnosis of such models is challenging, since a large amount of data must be processed rapidly. Moreover, if physically based modeling is required, material properties are also included in the computational model in addition to geometrical data, making the task more difficult. Therefore, advanced technology and computational methods including parallel computing techniques are required for efficient, reliable and robust visualization and diagnosis.

In this lecture a new method for 3D multiscale domain-based modeling will be described. The proposed method efficiently integrates geometric multiresolution modeling and multiscale computational analysis into a single physically based method. The method is based on a multiresolution geometric model that generates intermediate structural levels. Moreover, a new method has been developed for estimating multiscale material properties, to facilitate reliable and efficient mechanical analysis. The proposed method can be used for finite element analysis as well as for physically based animation and similar processes at any given scale. In addition, the multiscale method has been integrated with the domain based approach, facilitating subdivision of a large-scale model into sub-domains processed in parallel.