AUTOMATION IN MORPHING FINITE ELEMENT MODEL OF A DETAILED HUMAN SPINE TO A PATIENT SPECIFIC SPINE

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ABSTRACT –
Finite element (FE) analysis has been extensively used to investigate clinical and injury biomechanics of the human spinal column. Anatomically accurate patient-specific FE models of spine have great potential to assist clinicians in treatment planning. However, such models typically require long development times and technically challenging mesh generation processes. These challenges make it impractical for clinicians to utilize this potential tool in their daily treatment planning process. This limitation warrants developing clinician-friendly tools with the ability to generate case-based patient specific models with least development times. This would assist clinicians in decision-making, resulting in better clinical outcomes.

This paper presents the unique techniques, tools, and automation methodology developed by BETA CAE Systems USA in collaboration with Medical College of Wisconsin. This methodology allowed a fast and easy way of morphing and adapting a generic baseline spine model to a specific spine of a given patient. The patient specific information obtained from CT scans were used in a template driven process for performing global and local shape changes. These models can then be used to study the outcomes of various surgical techniques, instrumentation, and device placement. These studies are expected to provide researchers and clinicians the insight that is difficult, if not impossible, to gain experimentally. ANSA morphing, automation, and kinematics tools were utilized in tandem with a graphical user interface to programmatically adapt the baseline spine model to a patient specific model. The baseline model development utilized robust ANSA tools such as Hexa Block solid meshing. This tool was used to build a pure hexahedral mesh and was incorporated in the optimization task to aid in DOE studies. Finally, the benefits of the new automation process in terms of significantly lowering the development times, ability to interactively morph the local surfaces of the vertebrae to represent local anatomical variations, and clinical accuracy achieved by the use of kinematics mechanism were demonstrated.