Optimal Sensor Design Using Patient-Specific Images

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In diseases such as hydrocephalus, the cerebral ventricles enlarge. The treatment options for these patients are presently based on pressure, which has limited capabilities. We present the design of a volume sensor as an alternative monitoring option. Through the use of computer aided design and simulation, we optimized a sensor in silico with fewer resources. Specifically, we designed a sensor for animal experimentation with a scalable procedure for human sensors. In this paper, we present a rational design approach for a sensor that integrates advances in medical imaging. Magnetic resonance data sets of both normal and diseased subjects were used as a virtual laboratory. Finite element simulations were performed under pathological disease states of the brain as a contribution toward an accelerated device design. An optimized sensor was then fabricated for these subjects based on the outcome of the simulations. In this paper, we explain how a computer aided subject-specific design was used to help fabricate and test our sensor.

Statistical Shape Modeling of Femurs Using Morphing and Principal Component Analysis

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In this paper, we describe a method for automatically building a statistical shape model by applying a morphing method and a principal component analysis (PCA) to a large database of femurs. One of the major challenges in building a shape model from a training data set of 3D objects is the determination of the correspondence between different shapes. In our work, we solve this problem by using a morphing method. The morphing method consists of deforming the same template mesh over a large database of femur geometries, which results in isotopological meshes and one to one correspondences; i.e., the resulting meshes have the same number of nodes, the same number of elements, and the same connectivity in all morphed meshes. By applying the morphing-based registration followed by PCA to a large database of femurs, we demonstrate that the method can be used to derive a low dimensional representation of the main variabilities of the femur geometry.

