Spline-based computational methods for image registration, neuron morphogenesis and tissue growth

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Abstract
A robust image-to-analysis paradigm is essential for the investigation of complex phenomena in computational engineering and sciences. The present state-of-the-art research in direct image to analysis is constrained by an inability to handle noisy data, computational inefficiency, inaccuracy in data analysis and limited use. Spline-based techniques are strong tools for developing smooth and accurate representations of solutions in the fields of image processing, geometric modeling, and simulation of real-world phenomena. First, I will talk about several efficient and accurate B-spline based methods for image registration and segmentation. A B-spline based image registration framework that can capture large scale deformations through local refinement has been carried out to achieve higher accuracy in less computational time. This framework has been directly applied towards patient-specific geometric modeling from clinical data. To achieve a better insight into the process of neuron morphogenesis and cellular morphology, I will talk about developing realistic computational models for neuron reconstruction and neurite growth using B-spline based phase field method. In the end, I will also talk about coupling biophysics with shape registration to capture the deformation of biological tissue from imaging data. This new coupling scheme is being used to study the growth of biological tissues, such as tissue expansion during skin reconstruction surgery and zebrafish embryo growth.

Biography
Dr. Aishwarya Pawar is a postdoctoral research associate in the School of Mechanical Engineering at Purdue University. She received her PhD and MS in Mechanical Engineering at Carnegie Mellon University and B. E. (Hons.) in Mechanical Engineering at BITS-Pilani University, India. Her research focuses on the integration of image analysis techniques with computational mechanics and isogeometric analysis with applications towards patient-specific modeling, computational neuroscience, and tissue growth. She has developed novel algorithms in these research areas and applied them towards patient-specific modeling, data-driven prediction of pediatric spinal deformities, additive manufacturing, computational neuroscience, tissue expansion in skin reconstructive surgery and embryo morphogenesis. Her research aims to facilitate a generalized framework that can efficiently handle arbitrary image data to generate accurate computational models and provide analysis for complex applications.

This seminar counts towards the ME 600 seminar requirement for Mechanical Engineering graduate students.