Medical Imaging Summer School 2014

28 July - 1Aug 2014 Favignana, Sicily

Medical Imaging meets Computer Vision

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Lecture 1: Shaping up! Introduction into Shape Analysis

Syllabus: Shape modeling, shape analysis, shape statistics

The study of shape and structure is a key research topic in image analysis and computer vision, and a crucial component in image processing applications related to biology, medicine, image indexing and searching, industrial inspection and robot vision, just to name a few. This presentation will give an overview of basic principles and concepts of shape modeling, morphometric analysis, and shape statistics. This includes the discussion of general shape and landmark representations, morphometric shape metrics, morphic transformations, shape descriptors, shape spaces, shape distributions, questions of homology, correspondence-free shape analysis, and concepts of shape recognition and classification.

Lecture 2: Quantification of Object Dynamics by Spatiotemporal Shape Analysis

Syllabus: Shape analysis, spatiotemporal analysis, shape regression, statistics of shape trajectories, mixed effect modeling

Rapid advances in image acquisition and shape capturing technology provide continuous or time-discrete series of 3D volumetric images and/or surfaces, requiring novel spatiotemporal image and shape analysis methods to quantitate and model shape change trajectories. Segmentation and shape modeling of time-varying objects makes use of the inherent correlation and causality of repeated acquisition but can also include domain-specific information on expected smoothness and characteristics of deformations.
This research talk will discuss work in progress of the development of 4D image analysis methodologies that carry the notion of linear and nonlinear regression, now applied to complex, high-dimensional data such as images, image-derived shapes and structures, and a combination thereof. We will address concepts for regression of 4D shapes from time-discrete data, issues of establishing explicit point correspondence versus correspondence-free methods, and discuss preliminary work towards statistical analysis of sets of 4D shape trajectories. This includes statistical concepts of longitudinal data analysis such as linear and nonlinear mixed-effect modeling (NLME) now extended from scalar data to complex shape structures, and reduction of dimensionality of feature space via sparse parameterization.

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Particular driving applications can be found in medical image analysis, where clinical assessment routinely uses terms such as growth trajectory, development, aging, degeneration, disease progression, recovery or prediction. This terminology inherently carries the aspect of dynamic processes, suggesting the need for longitudinal imaging and spatiotemporal quantitative analysis.