Vascular Image Processing

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Abstract

The talk will focus on multiscale and model-based image analysis techniques applied to vascular image processing.

In order to image the human vasculature, a multitude of imaging modalities is available. Digital Subtraction Angiography, in which X-ray projection images with high temporal resolution showing the passage of a contrast agent are acquired, has for long been the golden standard. In recent years, MRA, CTA, rotational X-ray systems and ultrasound have seen rapid development in the field of three-dimensional visualization of the human vasculature. Additionally, phase contrast MRA and Doppler ultrasound provide blood velocity measurements, thus allowing to obtain dynamical information.

With the increasing information present in these images, image analysis procedures for objective quantification, visualization, and therapy planning have become more important. Currently, most quantitative measurements are still performed manually, which often implies tedious procedures, prone to inter- and intraobserver variability. The aim of (semi-)automated image processing procedures is to aid the clinician (e.g. by minimizing manual work), and improve accuracy and reproducibility of measurements.

In this talk, several vascular image processing techniques will be presented. First, we will discuss enhanced visualization procedures. Hereto, techniques that enhance curvilinear structures are considered. These techniques locally measure the likeliness that a region of an image belongs to a vessel. A multiscale feature has been developed to be able to define the likeliness of a region to be part of a vessel, irrespective of the size of the feature. This feature definition is derived from a general theory, called "scale space theory" which gives a firm mathematical basis to extract geometrical information from an image. The concept underlying this theory are briefly discussed.

Based on the vessel-feature, smoothing procedures can be devised which reduce noise, but minimize smoothing accross the boundaries of vessels. This procedure visually improves the image, and can be an important preprocessing step for three-dimensional visualization and quantification.

The second part of the talk is devoted to vessel quantification and segmentation. This is of primary importance for stenosis grading and aneurysm quantification, relevant both for diagnosis and therapy planning. Deformable model-based segmentation will be introduced. In this technique, prior model information can be incorporated in the segmentation procedure. Results on coronary arteries, iliac arteries and the aortoiliacal trajectory will be shown. Also, ways to evaluate the performance of these techniques is discussed.

The talk is summarized with an overview of the current and future role of image processing techniques in medical imaging, with the focus on vascular application.