Geometric reconstruction methodology for the cerebro-vascular system based on computed tomography and magnetic resonance images

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Abstract

Detailed research studies on human brain vascular structures are of great importance and can significantly influence the quality of life of future generations. The seriousness of this field of investigation is highly connected with mortality rates which can be defined as the number of registered deaths in a specified country in one ear divided by the size of the population.

The main objective of this project is to develop a new method for 3D visualization and analysis of the cerebro-vascular system. Due to the lack of a computerized system for detailed analysis of the human cerebro-vascular system and the lack of standardized geometric description of the components there is a natural necessity for such solution. Existing software available in the radiological workstation does not meet expectations of radiologists. Using image data acquired using CT and MRI devices we provide geometrical reconstruction. Parametric description of reconstructed segments is also developed. It is of great importance that final solution should be accurate and reproducible and generate unambiguous results in a clinically acceptable time (time between the image acquisition and possible surgery).

On the basis of the volumetric representation of an isolated vascular system we have developed algorithms for skeleton extraction and optimization (in terms of number of branches smoothness and proper localization). Around the skeleton branches we define geometric objects representing a vascular object optimized in terms of quality and accuracy of matching with the original data. The next step involves defining and parameterization of n-furcation point in terms of vascular skeleton properties and joint creating vascular segments. In the last step we prepare cerebro-vascular description parameters in terms of the shape, position in space, the position relative to each other and to other anatomical structures.

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