AngioPlan: A Software Assistant to Support the Treatment of Arterio-Venous Malformations

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Purpose

Minimally-invasive procedures are considered as the standard treatment for arterio-venous malformations (AVM). The procedure involves the accurate positioning of a catheter within the nidus of the malformation. Subsequently, the catheter delivers coils or toxic sclerosants (e.g. ethanol) in order to close the malformations. Pre-interventional images are supporting the navigation during the procedure. We developed a software assistant that produces pre-interventional 3D planning models from MRI or CT data. The main focus of our software is set to the segmentation of complex vascular structures.

Methods

The AngioPlan prototype was developed using the software platform MeVisLab. For semi-automatic segmentation of vascular structures, vesselness filters are combined with an adaptive region growing algorithm. The user initializes the algorithm by setting seedpoints. Afterwards, the segmentation result can be incrementally improved in the following manner: setting of further seedpoints or deleting unwanted seedpoints, threshold adaption or manual post-processing by means of eraser and brush tools. Eraser and brush tools are part of every simple image processing software and are thus intuitively known to every user. After obtaining the segmentation, a 3D model is generated on the basis of the segmentation's skeleton. For spatial orientation, 3D surface models of bones and skin are generated additionally. The models either base on simple threshold segmentation or - in case of bone segmentation in MRI datasets - on live wire segmentation. If multiple datasets for one patient exist, they need to be aligned accordingly. A manual registration tool allowing for affine transformation enables the alignment. After the registration and segmentation is completed, a virtual trajectory can be defined within the 3D viewer. For this purpose, the user selects an entry point on the skin model and a target point on the vascular model.

Results

An example result for the segmentation can be seen in Figure 1. We evaluated the developed software assistant using MRI and CT datasets from different body regions. In general, the vessels could be well segmented. Problems only occurred with some CT datasets where the intensity range of the vessels was not high enough to be distinguished from the other tissue by the region growing approach. The software assistant was already used for the planning of a real interventional procedure. The physicians considered the vessel segmentation as very helpful for the spatial location and orientation of the malformation.
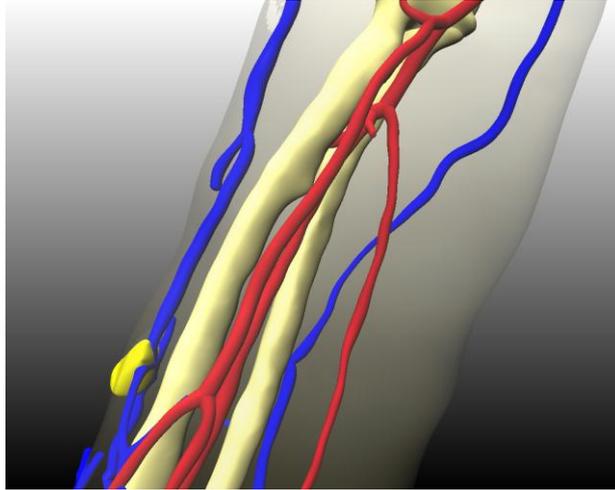
Figure 1: *Example result for a segmentation of vessels and a venous malformation in MRI series of the right arm. Veins are illustrated in blue, arteries in red.*

Conclusion
We presented AngioPlan, a software assistant for the planning of minimally invasive interventions of arterio-venous malformations. The location of the malformation in a 3D model consisting of the main veins and arteries, bones and skin, is considered as a significant support for physicians. Because our preliminary results indicate that AngioPlan facilitates a better understanding of target and risk structures, it might improve the minimally invasive treatment of arterio-venous malformations in the future.