Section: **Segmentierung, Registrierung**

ID: 97

Abstract-Title:
A SEMI-AUTOMATIC SEGMENTATION TOOL FOR CENTRELINE VESSEL EXTRACTION FROM STATIC 2D X-RAY ANGIOGRAMS.

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Abstract-Text:
Purpose:
X-ray angiography is still the gold standard to diagnose cardio-vascular diseases, such as coronary artery sclerosis and stenosis. The extraction of the coronary artery tree from these images is, most of the time, a previous and necessary step for computer assisted systems. In this context, the aim of this work is to provide a tool for the segmentation of vessel centrelines from static 2D X-ray angiograms, which is precise in detecting the coronary vessels.

Method:
Our method is based on the automatic computation of a medialness map which guides a following interactive tool for vascular segment extraction.
First, the medialness map represents the probability that a pixel of the image belongs to a vessel centreline. It is well known that the Eigen analysis of the Hessian matrix calculated for each image pixel allows to describe different object shapes, for example elongated structures like blood vessels. The Eigen values give the local intensity variation along the Eigen vectors. The Eigen vectors provide the directions parallel and perpendicular to the vessels. Combined to a multiscale analysis in order to extract blood vessels of different sizes, we propose a medialness response based on the gradient value and shape assessed in the direction perpendicular to the vessel.
In a second step, the physician is asked to provide the start and end points (proximal and distal end), called seed points, of a vascular segment. A searching graph algorithm detects the minimum total cost path which links both seed points within a local search window. The resulting path has a high medialness response and is parallel to the vessel.

Results:
Our segmentation algorithm was tested on static images (1024*1024 pixels) of five patients acquired using standard or biplane X-ray angiographs in clinical conditions. For each patient we selected the images where the entire coronary artery tree is visible and which include the less of vessel crossings and overlappings because it makes the segmentation more difficult.
Figures 1 and 2 depict the obtained vessel centrelines (red) on healthy right and left coronary trees. The seed points (yellow crosses) are typically tagged at starting- and end-points of the vascular segments or at vessel bifurcations. Here, additional seed points are necessary, especially for the left coronary tree, because of the curved blood vessels. The second example (Figure 3) shows a diseased and calcified left coronary tree. The blood

vessels are thin and because of low blood flow due to stenosis, the filling with contrast agent is slow, resulting in bad image quality. Few seed points are provided here. In both cases, the algorithm succeeded to extract the vessel centrelines with a high accuracy.
In general, a left coronary tree, which is relatively complex, is segmented with less than 30 seed points in 30 minutes. Since this tool is dedicated for a preoperative use, the running time is not a critical point here. However, efforts will be done in the future to improve it. Moreover, due to the complexity of the searching graph algorithm, the running time decreases when using more seed points, which consequently reduces the size of the searching windows.

Conclusion:
We proposed a semi-automatic segmentation tool images for preoperative planning. It requires very simple interaction, allowing the physician to choose the arteries of interest and to correct inaccuracies. As a result, the coronary artery centrelines in 2D X-ray angiograms are provided with a high accuracy. Moreover, we could demonstrate on real cases that the algorithm succeeds on healthy and diseased coronary trees.

Bild 1/JPG

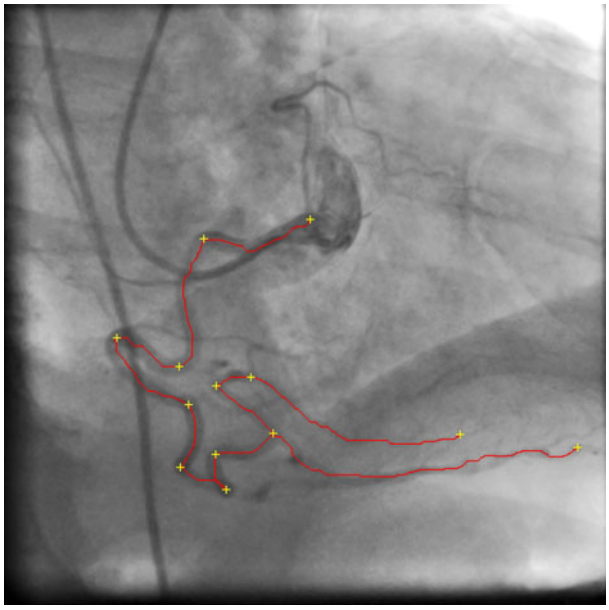

Bild 2/JPG

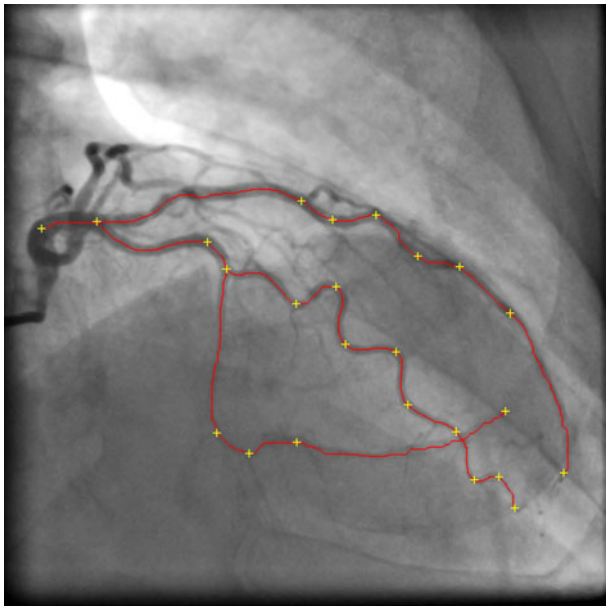

Bild 3/JPG