Section: **Segmentierung, Registrierung**

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Abstract-Title:
RECONSTRUCTION OF CERVICAL SOFT TISSUE STRUCTURES FROM TOMOGRAPHIC DATA

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Abstract-Text:
IntroductionFor simulation in preoperative planning or intraoperative support, segmentation of soft tissue structures is a prerequisite for less invasive interventions. Manual segmentation on MRI images is a very time-consuming task which makes it difficult to integrate into clinical routine. There are a few approaches for soft tissue segmentation in literature [1][2]. In this paper, an automatic knowledge-based segmentation method is presented which extracts all relevant soft tissue structures of the human cervical spine from MRI images (intervertebral discs, trachea and spinal cord). Additionally, blood vessels have been registered from an atlas for a deeper insight into the anatomy. Muscles have been reconstructed using an analyzer algorithm which identifies natural landmarks on the surface of a vertebra.Methods
By the use of the generalized Hough-Transform and a Principal Component Analysis (PCA) we are able to robustly locate the intervertebral discs (IVD) in a single, selected MRI slice. Next, we use a snake approach to identify the borders between the trachea, the spinal column and the spinal cord. Subsequently, we are able to initialize our 3D segmentation process on the basis of Active Shape Models (ASM) combined with a Fuzzy Connectedness method. This combines a region based segmentation technique with a model and edge based technique. ASM use a statistical model, which is taught in beforehand, to specify allowable deformations of the shape. The shape model consists of a set of points and their possible variations. The grey level appearance is represented by 1D grey value profiles, centered at the points of the shape model and normal to the contour of the shape. During the adaptation process the similarity of the grey value profiles of image and shape model is optimized regarding the deformation constraints. To localize structures that are impossible to segment automatically in MRI images gained with standard sequences - like blood vessels - an atlas data set is registered. The atlas data set is taken from the Meet Man project. The marginal points of the intervertebral disc and of the spinal cord, at the height of every intervertebral disc, are taken as landmarks for registration.Muscles are reconstructed using a knowledge based algorithm which searches for natural landmarks on the surface of the vertebra. This is done by normalizing its position and orientation and then using a database of anatomical knowledge and a resolution scheme to identify the attachment points. Thus we are able to connect attachment points belonging together with a virtual muscle.
Results A combination of several segmentation techniques and knowledge about the neighboring anatomical structures allows us to segment and reconstruct the relevant soft tissue structures in cervical spine surgery. Also we have shown that automatic segmentation of soft tissue structures from MRI images is possible. The algorithm has

been proven on 9 MRI images: T1 and T2 weighted images, a patient in extension and in flexion pose, an image with an hernia and an image of a younger child. In these experiments the algorithm has demonstrated robust behavior. The execution time for MRI images (256x256x128) has been in average 50 sec on a Pentium 2, 1.6 GHz computer. [1] Archip, N.; Erard, P.; Egmont-Petersen, M. & Haefliger, J.A.G. (2002), 'A knowledge-based approach to automatic detection of the spinal cord in CT images', IEEE Transactions on Medical Imaging 21, 1504 - 1516.[2] Valdes, R.; Yanez-Suarez, O. & Medina, V. (2000),Trachea segmentation in CT images using active contours, in '22nd Annual International Conference of the IEEE Engineering in Medicine and Biology Society', pp. 3184 - 3187.

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