Segmentation of Ultrasonic Prostate Images using a Probabilistic Model based on Markov Random Processes

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Segmentation of prostate images can provide important information about the size and the shape of the gland and indicate capsular penetration by malignant tumors. Furthermore, automated contour detection of the prostate boundary serves as a preprocessing step for tissue characterization algorithms.

Different approaches to extract contours from a given ultrasonic video image are documented in the literature. Simple methods such as gradient based type of search algorithms are successfully applied in other areas of pattern recognition, e.g. robotic vision. However, the interpretation of ultrasonic images suffers from errors introduced by inevitable speckle artifacts. Other methods, known as active contour models or “snakes“ minimize a model dependent energy term, but do not incorporate statistical information of the imaging process. These algorithms can be adequately applied using high contrast images such as images of human vessels or the human heart. Due to the low contrast and the partly developed speckle in prostate images a model should be used which incorporates both statistical and shape based information.

With our work we adapted and extended a probabilistic method which was first described by Dias *et al* in 1996 for the estimation of heart wall motion and thickness. Hereby, the contour sequence is assumed to be a two-dimensional first-order Markov random process and prior knowledge about the contour shape is incorporated by clique potentials defined on a neighborhood system. The contour is estimated iteratively based on the *maximum a posteriori* principle. To reduce calculation time the optimization problem is solved by a Bellman-Ford based algorithm.

One advantage of the implemented algorithm is the incorporation of three-dimensional information, i.e. neighboring slices of a volume scan are used for the contour estimation in three dimensions which yields improved results in two dimensions and volume information about the three dimensional shape of the object. We discuss the advantages and limitations of the proposed algorithm with results obtained from clinical in-vivo data.

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