AbstractID: 13093 Title: Automatic Shape-based 3D Level Set Segmentation for Needle Tracking in 3D TRUS Guided Prostate Brachytherapy

Prostate brachytherapy is an effective treatment for early prostate cancer. The success depends critically on the correct needle implant position. We have devised an automatic shape-based 3D level set segmentation tool for needle tracking in 3D trans-rectal ultrasound (TRUS) images, which uses the shape information and 3D level set technique to localize the needle position and estimate the endpoint of needle in real-time. Automatic initialization of the level set technique for ultrasound image is not trivial. We assume that the needle is most likely at the position with the highest intensity of a 3D TRUS difference image with subtraction of the 3D TRUS image prior to the insertion of the needle. The initial point must meet two criteria: 1. Its intensity must above certain threshold; and 2. The volume around the intitial point extracted by thresholding must above the size of 5x10x3 voxels. (1 x 1 x 1 voxels = 0.2 x 0.1 x 5 mm). Otherwise, it is regarded as either noise or needle insertion failure. The 3D TRUS images used in the evaluation of our tools are obtained using a 2D TRUS transducer from Ultrasonix and a computer controlled stepper motor system from Thorlabs. The accuracy and feedback mechanism have been validated using prostate phantoms and compared with 3D positions of these needles derived from expert segmentations. The ground truth used in this study is the expert segmentation of needle positions from 3D CT images. The experiments were performed with 19 inserted needles. The mean errors of both automatic and expert segmentations are within 1 voxel for 16 out of 19 needles. Three needles failed to be detected because of poor image quality. Hence our automated method allows real-time TRUS -based needle placement within 20% of the needle diameter compared to manual expert segementation.