Image Processing for MR-guided Gynecologic Interstitial Brachytherapy in AMIGO

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Purpose: Interstitial brachytherapy, the delivery of planned radiation dose directly to the tissue via hollow needles inserted into the tumor and surrounding anatomy, is an effective treatment for gynecological cancer [1]. The purpose of the software module described here is to provide assistance to the physician in determining the optimal distribution and insertion depth of needles that provide maximal tumor coverage, while minimizing dose to the surrounding organs of interest such as the rectum, the bladder, and the sigmoid colon.

Methods: 3D Slicer [2] is a free and open source software package for medical image analysis and visualization. iGyne is a 3D Slicer module designed for MR-guided interstitial brachytherapy planning for gynecologic cancer in the Advanced Multimodality Image Guided Operating Suite (AMIGO) at Brigham and Women's Hospital. Use of the iGyne in AMIGO includes the following steps 1) CAD models of the interstitial template and vaginal obturator are loaded, 2) MR scan of the patient with the template sutured to the perineum and the obturator placed in the vaginal canal is transferred to 3D Slicer using the DICOM protocol, 3) an initial rigid registration is computed from 3 corresponding point pairs provided by the user on the template holes, 4) the registration is refined using the Iterated Closest Point [reference] algorithm for rigid registration, 5) optionally, segmentation and visualization of 3D models of the tumor are obtained rapidly using editing capabilities of 3D Slicer, and 6) finally, virtual needles are selected on a schematic of the template and rendered in the 2D and 3D views, with the insertion depth independently adjustable for each needle. This allows for ease of visualization of spatial relationships among the needles, tumors, and surrounding anatomical structures can be clearly observed, and hence ease in determination of the optimal number and positions of the needles, as well as insertion depth (as shown in Figure).

Results: A software module for MR-guided gynecologic brachytherapy has been developed for the established 3D slicer open source software platform using well-regarded toolkits in computer graphics and medical image processing such as VTK, ITK, CTK, and QT. Furthermore, a semi-automatic registration method is presented to register the CAD template model to the MRI image volume.

Conclusions: While the current version of iGyne address some important aspects of the planning task, including robust registration, needle visualization, user-friendly interface, it remains under active development for additional features such as integration with needle tracking hardware, which are essential in order to realize its full benefit for MR-guided needle guidance in AMIGO.

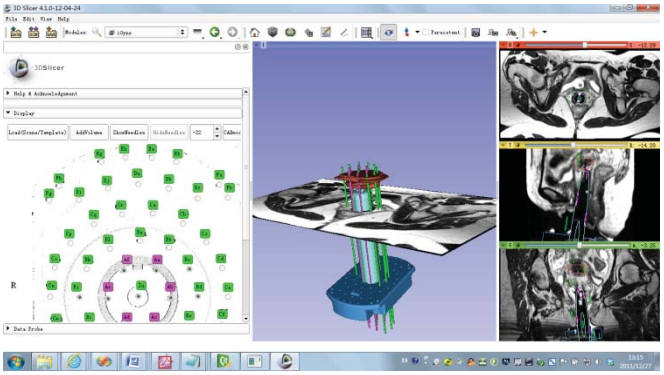

Figure : Screenshot of needle visualization for MR-guided brachytherapy in AMIGO

References:

[1] A.N. Viswanathan, C. Kirisits, B.E. Erickson, and R. Pötter. Gynecologic Radiation Therapy: Novel Approaches to Image-Guidance and Management. Springer. 2010.

[2] http://www.slicer.org

[3] P. Besl and N. McKay. A method for Registration of 3-D Shapes. IEEE Transactions on Pattern Analysis and Machine Intelligence. 1992; 14(2):239 – 256