Purpose: Deformable registration of histology to MRI is an essential tool to validate in vivo prostate cancer imaging. However, direct registration of histology to in vivo MR is prone to error due to geometric differences between the tissue sections and the in vivo imaging planes. To increase the accuracy of registration, an ex vivo high resolution MRI is acquired to compensate for the direct registration difficulties. A novel intensity-based deformable registration algorithm based on local variation in image intensities is proposed to register the histology to ex vivo MRI of prostatectomy specimens.

Methods: Four sets of ex vivo MR and whole mount pathology images from four patients were used to investigate and validate the technique. In addition, 9 synthetically deformed ex vivo MR images were used. The standard deviation in local windows within the images was calculated to generate intermediate images based on both MR and histology. The intermediate images were registered using the Drop package (Munich, Germany). To further increase the accuracy, a final refinement of the registration was performed using Drop with a finer B-spline grid. The registration parameters were tuned to achieve a visually acceptable registration. Magnitude of Differences (MOD) and Angular Error (AE) were used to validate the synthetic data, and the Target Registration Error (TRE) of manually indicated landmarks was used for the clinical data.

Results: MOD of 0.6mm and AE of 8.3 degrees showed the efficacy of using intermediate images, compared to 0.8mm and 10.0 degrees achieved with Drop without the intermediate images. The average mean±std TRE among the four patients was 1.0±0.6 mm using the proposed method compared to 1.6±1.1 mm using Elastix (Utrecht, The Netherlands).

Conclusions: An intensity-based deformable registration algorithm which uses intermediate images was evaluated on prostatectomy specimens and synthetically deformed clinical data, indicating improvement in overall accuracy and robustness.

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