

Quadrature filter enhanced B-spline registration applied to prostate multimodal images

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Purpose

Needle biopsy of the prostate is guided by Transrectal Ultrasound (TRUS) imaging. The TRUS images do not provide proper spatial localization of malignant tissues. Therefore, preacquired Magnetic Resonance (MR) image information with improved soft tissue contrasts are displayed on the TRUS images by registration. This paper presents a novel method of deformable registration method applied to prostate multimodal images.

Methods

The registration method involves b-spline deformations [1] with Normalized Mutual Information (NMI) as similarity measure. Unlike NMI being computed from raw intensity images, texture images obtained from the amplitude responses [2] of 4 directional log-Gabor quadrature filter pairs [3, 4, 5] are used.

Results

Registration accuracy of the proposed method is evaluated by computing the Dice Similarity coefficient (DSC) values for 15 patient datasets and Target Registration Error (TRE) for 9 patients only where homologous structures are visible in both the TRUS and transformed MR images. The proposed method shows significant improvement in TRE when compared to b-spline using NMI computed from intensities with $p = 0.01$ and average and standard deviations of TRE values

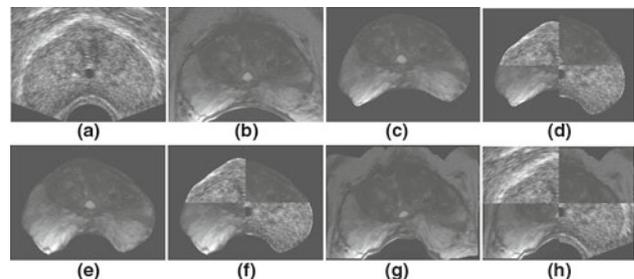


Fig. 1 Qualitative b-spline registration using NMI from intensity images, NMI from texture images and TPS registration. (a) & (b) are the reference TRUS and the moving MR corresponding slices respectively. (c) & (d) are the results of b-spline registration with NMI from intensity images [1], (e) & (f) are the results of b-spline registration with NMI from quadrature texture images (our method), and (g) and (h) are the results of TPS registration [5]

2.24 ± 1.68 mm and 4.41 ± 3.38 mm respectively. Comparison with thin-plate splines registration provides a similar TRE of 2.49 ± 1.82 mm. The average DSC values obtained for the proposed method and b-spline with NMI from intensities are similar with 0.940 ± 0.038 and 0.943 ± 0.036 respectively (see Fig. 1).

Conclusion

The texture energy computed from the quadrature filter pairs provides global information of the image and therefore, the joint entropy of the images is reduced that is a step forward to the maximization of NMI. Low TRE values of the proposed registration method adds to the feasibility of being used during TRUS guided biopsy.

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