

SYMMETRY BASED PROSTATE CANCER DETECTION

Y. Xie^{1,2}, Y. Dang¹, F. Li³, B. Fan³, L. Yang², J. Zhang^{1,4}, X. Wang^{1,3}, and J. Fang^{1,4}

¹Academy for Advanced Interdisciplinary Studies, Peking University, Beijing, Beijing, China, People's Republic of, ²Dept. of Electronic Engineering, Chengdu University of Information Technology, Chengdu, Sichuan, China, People's Republic of, ³Dept. of Radiology, Peking University First Hospital, Beijing, Beijing, China, People's Republic of, ⁴College of Engineering, Peking University, Beijing, Beijing, China, People's Republic of

Introduction: Early detection of suspected prostate lesion is critical in improving patient's survival rate. In recent years, some useful approaches have been introduced to evaluate MR based suspected prostate lesions [1]. Small limited studies, however, have provided efficient clinical assessment by utilizing the prostate T2WI features. It is not difficult to realize the fact that bilateral symmetry exists in normal prostate, and as for a developing lesion, asymmetry gradually appear with symmetry breaking down. In this retrospective study, texture bilateral symmetry of prostate T2W Images is employed to screen the suspected prostate tumor, and its validity is evaluated by the cross-correlation coefficients of the left and right half sides of prostate zones.

Materials and Methods: In this retrospective study, we included 66 patients who are with pathologic results of ultrasound guided biopsy. The mean patient age was 72 years in the control group consisted of 33 patients (range, 51–80 years) whose histological diagnosis indicated no histological abnormal. The mean patient age was 72 years in the prostate cancer (PCa) group consisted of 33 patients (range, 56–85 years) whose diagnosed histopathologically of biopsy were with 7 or higher Gleason score. MR imaging of transverse T2WI of the prostate and seminal vesicles were performed by using a 1.5 Tesla (T) whole-body MR imager (SignaTM;GE Medical Systems, Milwaukee, WI). Using a body coil, Patients were imaged in a supine position to excite, using a pelvic phased-array coil (GE Medical Systems) for getting signal reception. With the following parameters, a fast spin-echo sequence was used : echo train length, 12–16; field of view, 26 cm; matrix, 320 256 ; section thickness, 3 mm; repetition time ms/echo time ms, 3800/139; intersection gap, 0 mm; field of view, 26 cm; matrix, 320 256 ; and four signal averages were acquired. The total MR acquisition time was about 3 min generally. The proposed approach was divided into three steps: Firstly, the proposed localized level-set model was used to improve segmentation accuracy of whole prostate zone. As this new model did not only take the advantages of the classical Chan-Vese (C-V) and the Geometric Active Contour (GAC) models, also emphasize the effects of local intensity information. Secondly, the primary component analysis (PCA) was employed to estimate the symmetry axis of prostate zone. With the estimated longitudinal symmetry axis, prostate zones can be separated into two parts: left and right sides. Finally, the maximum cross-correlation between these two parts was evaluated by classical image correlation. The diagram of processing was present in Fig. 1.

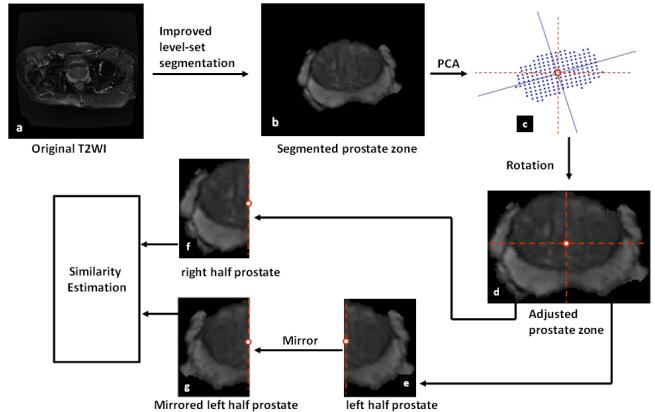


Fig. 1 Diagram of the proposed processing for prostate cancer screening

Results: Results of 33 prostate zones from the prostate cancer (PCa) group were contrasted with those of 33 prostate zones from the control group. Fig. 2 explains the symmetric features by means of box plots to appear the statistical distributions of the cross-correlation. When contrast cross-correlation of these two groups, the difference is apparent. The means and Standard deviations (SDs) of the symmetric for the cancer group and control group ROIs are (0.6137 ± 0.0108) and (0.8051 ± 0.0025) , respectively. It shows that the cancerous prostate zones appear lower mean values than the control cases. The t-test results indicate that the contrast of cross-correlation between two groups is very apparent ($P < 0.001$). ROC curves were obtained as shown in Fig. 3, which yielded an Az value of 0.97 for cross-correlation, at the cut-off point, Sensitivity=88%, Specificity=90%. The estimated standard errors of the Az values was 0.02. At 95% confidence level, the confidence interval is (0.92, 1.0).

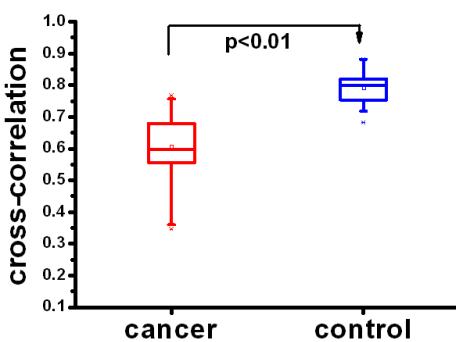


Fig.2 Box-plots of statistical distributions for cross-correlation, in the ROIs of control group and PCa group

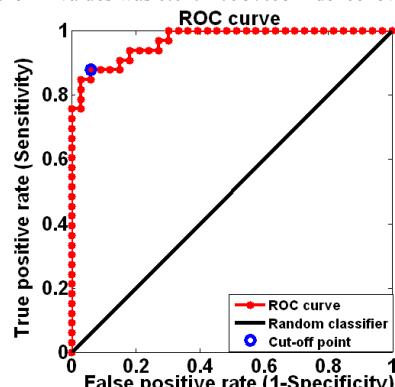


Fig.3 The ROC curves obtained from cross-correlation the classification of the control group and the cancer group ROIs (66 ROIs)

Conclusion: In this retrospective study, we propose a novel prostate lesion screening approach by using texture bilateral symmetry analysis of prostate T2WI. Meanwhile, the improved level set model has proven effective to extract the prostate zone automatically. The result of cross-correlation shows a statistical significant difference between cancerous and the control group on prostates T2WI, and the ROC curve indicates the extent of symmetry of prostate zone have a screening ability with a high-sensitivity and high-specificity. As characterized by its symmetry, cancerous tissue tends to be less symmetrical in image texture and intensity distributions than normal tissue, which is consistent with clinical experiences. The symmetric feature of prostate should be, although simple but useful for improving prostate cancer screening.

References:

[1] Richard J. Babaian, Zhen Zhang. Computer-Assisted Diagnostics: Application to Prostate Cancer Molecular Urology. 2001;5:175-180.