Title: Texture-based prostate cancer classification on MRI: how does inter-class size mismatch affect measured system performance?

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Structured Abstract:

Introduction: Prostate cancer (PCa) is one of the most prevalent cancers in men. Diagnosis depends on a trans-rectal ultrasound (TRUS)-guided biopsy, which has a high false negative rate and is confounded by sparse sampling. Multi-parametric magnetic resonance imaging (mpMRI) maps the prostate in 3D, but has inter-observer variability in lesion localization and scoring. Computer-aided diagnosis (CAD) systems have been developed as a potential solution and have been shown to boost diagnostic accuracy. In our previous work towards classification of malignant vs. benign regions on mpMRI, healthy tissue was manually delineated by approximately matching the size and shape of the tumour on the contralateral side of the prostate [1]. In this project, we aim to investigate the performance of a CAD model trained on regions generated without any selection or spatial bias. Furthermore, we aim to interrogate the effect of inter-class area mismatch and how it affects overall system performance.

Materials and Methods: We used a prostatectomy cohort of 61 patients with T2-weighted MRIs and apparent diffusion coefficient (ADC) maps. Genitourinary pathologist-verified contours of malignant regions of interest (ROIs) on histology were mapped to the mpMRI using our previously developed registration pipeline [2]. Healthy tissue was generated through the development of an unbiased, automated, iterative sampling algorithm. In each ROI, we extracted 22 first and 33 second order texture features. We trained a logistic linear classifier (LOGLC), support vector machine (SVM), k-nearest neighbour (KNN) and random forest classifier (RFC) using 1-10 features from forward feature selection, for a total of 40 different classifiers. We performed 4-fold and leave-one-patient-out cross validation and reported the misclassification rate (MCR), false positive rate (FPR), and false negative rate (FNR) for the classifier with the highest area under the receiver operating characteristic curve (AUC) for both the peripheral zone (PZ) and central gland (CG). Furthermore, healthy tissue was eroded radially by ~0.3mm (1 px) iteratively and system performance was plotted against the number of erosions.

Results and Conclusion: A computer aided diagnosis system for classifying prostate lesions on mpMRI using unbiased training samples had a measured AUC of 0.80 in the PZ and 0.82 in the CG. Classification in the PZ was based primarily on first-order statistical features and the CG was based primarily on gray level run length features. All selected features were extracted from the ADC maps. Although no lesion size features were used, system performance artificially improved as a function of size differences between malignant and benign regions, suggesting the importance of size matching when conducting radiomics studies using texture features.