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Localization Techniques and Imaging Methods for MR-guided Prostate Biopsies

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In this work, a new passive tracking technique is proposed which detects the position of a prostate biopsy passive marker (PBPM) in two slices using the phase-only cross correlation (POCC) algorithm and automatically repositions an imaging slice aligned with the biopsy needle. The new sequence is characterized in phantom experiments where it proved to be robust to angulations of the tracking slice in relation to the PBPM. It could detect the passive marker position even with low SNR values (>4). In a precision experiment it provided an accuracy of about 1.5 mm. A complementary marker system was developed to allow for 3D estimation of the biopsy needle. In phantom experiments this marker system allowed the detection of the needle tip position with a precision of about 1.8 mm.

The passive tracking technique was used in a clinical study with seven patients. On average, the duration per patient was less than 50 minutes even if the learning curve associated to this new technique is not considered. Furthermore, it allowed for improved targeting of lesions where suspect regions with less than 10 mm of diameter could be successfully targeted and prostate cancer was detected in 40% of the patients.

Finally to improve the SNR of imaging and spectroscopy in the region of the biopsy, an inductively coupled coil was developed to be connected to the PBPM. In phantom and in vivo experiments this coil provided an SNR gain of up to 80%.

The use of POCC to track the prostate biopsy device provided a simple and cost-efficient alternative to existing tracking system which together with the proposed self resonant coil might help to increase the precision, safety, SNR and patient throughput in MR-guided prostate biopsies.