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ABSTRACTS

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Abstracts appear in alphabetical order according to title. An (O) or (P) after the title indicate respectively whether the abstract was accepted for an oral or poster session.

1. 2D/3D Registration of Ultrasound and Fluoroscopy: is image preprocessing useful? (O)

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Motivation: In prostate brachytherapy, transrectal ultrasound (TRUS) is used to visualize the anatomy, while implanted seeds can be seen in C-arm fluoroscopy. Intra-operative dosimetry optimization requires reconstruction of the implanted seeds from multiple C-arm fluoroscopy images, which in turn requires estimation of the C-arm poses. We proposed to estimate the relative pose of C-arm images by the registration of the 2D fluoroscopy images to the 3D TRUS volume, and by doing so we estimate the poses of C-arm images in a coordinate system fixed to the prostate. This paper investigates whether pre-processing the TRUS images increases registration performance. Methodology: We implemented 7 different filters for the TRUS volume to investigate whether image pre-processing is a requirement. The baseline for comparison is no filtering (US-0). US-1 is a noise reduction filter based on two successive thresholdings. US-2 is a phase congruency filter. The beam profile filter (US-3) accounts for the finite thickness of the ultrasound beam and the focusing in the elevational and lateral directions. In US-4, we combine parallel noise reduction, phase congruency and beam profile filters in a Bayesian model. In US-5 noise reduction is followed by phase congruency. In US-6, noise reduction is followed by beam profile filtering. Finally, in US-7 we cascade noise reduction, phase congruency, and beam profile filtering. Experiments and Results: A commercial phantom was implanted with seeds and imaged with TRUS and CT. Ground-truth registration was established between the two modalities by fiducials. Synthetic ground-truth fluoro images were created from the CT volume and registered to the 3D TRUS using normalized correlation metric. The US-0 baseline provided best results for pose estimation: the average rotation and translation errors were $1.1 \pm 1.2^\circ$ and 1.1 ± 0.6 mm. The US-6 filter followed with average rotation and translation errors of $3.1 \pm 3.9^\circ$ and 3.2 ± 3.4 mm. In human patient data, the measured registration error compared to the manually selected seed locations by the clinician was 2.86 ± 1.26 mm when not filtering TRUS. Conclusion: Fully automated image-based C-arm pose estimation was demonstrated in prostate brachytherapy where accuracy and robustness was excellent on phantom andadequate in human patient data. We conclude that pre-processing of the TRUS images did not yield significant improvement in the process.

2. 3D needle guidance with cone-beam ct: results in 41 patients suspected of renal malignancy (O)

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Background: The incidence of renal tumors is rising, mostly by the increase of abdominal imaging. Many of

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before, during and after the expansion of the resonant stent (GE Signa HD) using a GE body coil and FGRE with TR300ms, TE5ms and FA of 15°–30°. Results: Due to the good preservation of the Thiel embalmed cadaver's vascular system (e.g. plasticity) resonant stent was successfuly implanted under MRI control. Using active MRI marker on the catheter the position for the resonant stent could be found in the femoral artery of the cadaver. After the expansion of the balloon the resonant stent was visualized with locally enhanced MRI contrast. The non resonant balloon expadable stent is causing a large artifact and precludes lumen visualization MRI. Both stents are equally visible in XRay. Conclusion: Thiel cadavers are suitable for vascular interventional experiments and allow the implantation of stents under realistic conditions similar to the living body. Active stents tuned to the resonance frequency of the MRI can be implanted and monitored during therapy solely using MRI. The enhanced contrast of the stent lumen allows to overcome the MRI artefacts in this area and enables the evaluation of the stent lumen (e.g. restenosis).

29. Compilation of a pathological validation database for ultrasound monitoring of tumour ablation. (O)

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Background: Percutaneous thermal ablation is a treatment technique that uses localized thermal energy in the management of soft tissue cancers. There is currently no practical way to track the ablation progress, and so it goes unmonitored, often leading excessive or insufficient ablation. This has stimulated investigation into the use of US as a potential ablation tracking technology. Objectives: It was thus the objective of this study to facilitate the development of US-based monitoring methods through the compilation of an ex-vivo, spatially correlated ground-truth database of US and histopathology imagery. Methods: This was accomplished through development of a practical implementation of a previously generated proof-of-concept (PC) design. The PC design faced methodology problems including geometric distortions resulting from loss of marker system integrity and problematic pathology imaging technique. The marker material chosen was too hard and would shift upon slicing and the pathology images were taken using a standard digital camera on a stand, introducing errors from external lighting and shifts in stand position. This study introduced a marker material that sliced very easily yet was still strong enough to maintain system integrity. A CCD scanner was used for pathology imaging with the gel block containing the tissue sample and markers wet mounted on top of the scanner glass. This technique eliminated glare and provided very clear images. 3D reconstruction of tissue sections was accomplished using a MATLAB computer program. Percentage overlap values were compared to those of the PC. Results: A practical implementation of the PC design was successfully generated. The average percentage overlapping volume achieved was 90.6%, an increase of 3.4% from the PC. It is important to note that the overlap results of the PC were acquired after additional registration calculations were done to compensate for marker shift. This study did not use these compensatory calculations, which speaks to the strength of this study's developments. Implications: Demonstration of the feasibility of US as a tracking technology will lead to increased availability of thermal ablation as a successful treatment option with lower risk of side effects due to insufficient tracking. Although thermal ablation is the primary context of this platform, this set-up could also be applicable to a wide range of treatments, especially when combined with other imaging modalities.

30. Concept of Multimodality Image Guided Diagnostic and Therapy for Cancer (P)

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Purpose: A new Clinical Research Centre has been established with a unique combination of the 3 Tesla MRI, PET/CT and an interconnecting Interventional Surgical Suite. Materials and Methods: A room layout has been developed that provides access for diagnostic purposes to the MRI Suite, PET/CT and further connection into an interventional room for x-ray, ultrasound or endoscopy. Interventional tumour ablation probes can be placed under ultrasound or fluoroscopy imaging and tumour ablation performed under MRI guidance. Alternatively, a procedure that initially starts with MRI imaging i.e. for planning may proceed into the Interventional Suite and procedures carried out using MRI imaging for planning purposes to access tumours or other pathology. To refresh the imaging data the patient can be moved back to the MRI, data acquisition takes place and the patient returned to the Interventional Suite and the new imaging data can be used to either complete the procedure. Results: The current set up allows