Interactive Co-Registration for Multi-Modal Cancer Imaging Data based on Segmentation Masks

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MOTIVATION
Endometrial cancer is the most lethal gynecological malignancy worldwide

Radiomic Tumor Profiling
Extract features from multi-modal images to find new tumor biomarkers

More personalized treatment

→ Acquisition of multiple sequences per patient

PROBLEM
Poor Co-Registration Quality

• Reason: Internal organ movements
• Automatic approaches → unsatisfying results

CONTRIBUTIONS: Web-based Application MuSIC (Multi-Sequence Interactive Co-Registration)

AUTOMATIC SHAPE MATCHING
• We search for the shape of the tumor segmentation in the different sequences that can vary in rotation and translation parameters
• Characterized by high gradient in the border area
• Based on Simulated Annealing

Before

After

INTERACTIVE SHAPE MATCHING
• If needed, the user can adapt the proposed positioning of the segmentation mask with the keyboard (rotation and translation)
• Support for visualization and simultaneous processing of multiple sequences
• Quality assessment of the future registration outcome via a magic lens showing the reference sequence
• Updates on user interaction

CO-REGISTRATION
• We use the indices of the original and transformed segmentation mask as landmarks for registration with Elastix
• Rigid or deformable registration
• In contrast to other approaches using deformable registration, we avoid tumor deformations due to our landmark-based approach

USER INTERFACE
Main view with 3 slicing directions (sequence can be switched)
Selection of reference sequence
Customizable grid layout

DATA Upload and result saving
Segmentation Opacity
Indications about translation and rotation parameters

Reset changes for current sequence
Grouping of multiple sequences [bold blue border]

USABILITY ANALYSIS
• Participants: 5 medical experts, 2 machine learning experts
• Average SUS Score: 95.4
• Medical experts want to use MuSIC in the future
• Magic lens and multi-modal processing support were highly appreciated
• Analysis revealed additional advantage: Assessment of segmentation quality

Future work: make segmentation mask adaptable for combined multi-modal segmentation and registration