Comparative assessment of performance of algorithms for registration of pancreatic tumor

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Background, Motivation and Objective

Early detection of vasculature changes in pancreatic cancer may improve life expectancy of patients by enabling early treatment. Contrast enhanced ultrasound (CEUS) is a commonly used imaging modality to observe vasculature structures and detect small changes in the vascular system morphology and blood flow. Yet, organ movement hampers such measurements. Image registration is essential to overcome rigid and elastic motion of tissue occurring during the acquisition process. Herein we present a comparative assessment among three registration algorithms, applied to pancreas B-mode ultrasound clip, as the 1st stage for registration of CEUS in sub-harmonic mode.

Statement of Contribution/Methods

Data - Data was acquired with a curved linear transducer (at 4MHz, for the fundamental frequency) from patients (after IRB approval). The pancreas clips were taken after injecting the ultrasound CA to the patients. The registration was performed on a 40 frames clips, with image size of 177X216 pixels.
Methods -Three registration algorithms were compared: B-spline non–rigid spatial-temporal registration (STR) termed here *(Alg.1)*; B-spline affine + non-rigid registration, based on free-form deformation (*Alg.2*), and non-rigid Morphon algorithm (*Alg.3*). Whereas the first two algorithms are based on minimization of intensity differences, the 3rd algorithm is using a local-phase difference to stabilize the images.
Histogram equalization was applied to the data prior to registration in order to improve contrast for the intensity based registrations.
All the methods were applied to the cine-loops (39 frames) in an attempt to minimize the difference as compared to the reference frame (#40). This frame has demonstrated the highest correlations with other frames prior to the registration. The cross-correlation to this frame was also used to evaluate the registration.

Results/Discussion

Alg. 1 resulted in the best correlation of the cine-loop to the reference frame and best stabilization of the pancreatic tumor ischemic region and large vessels, while other algorithms resulted in a better registration in the tissue area. *Alg.3* produced a similar correlation as *Alg.2* with less tissue distortion, and preserved more details than *Alg.1*. Expectedly, histogram equalization has not affected the performance of *Alg.3*.

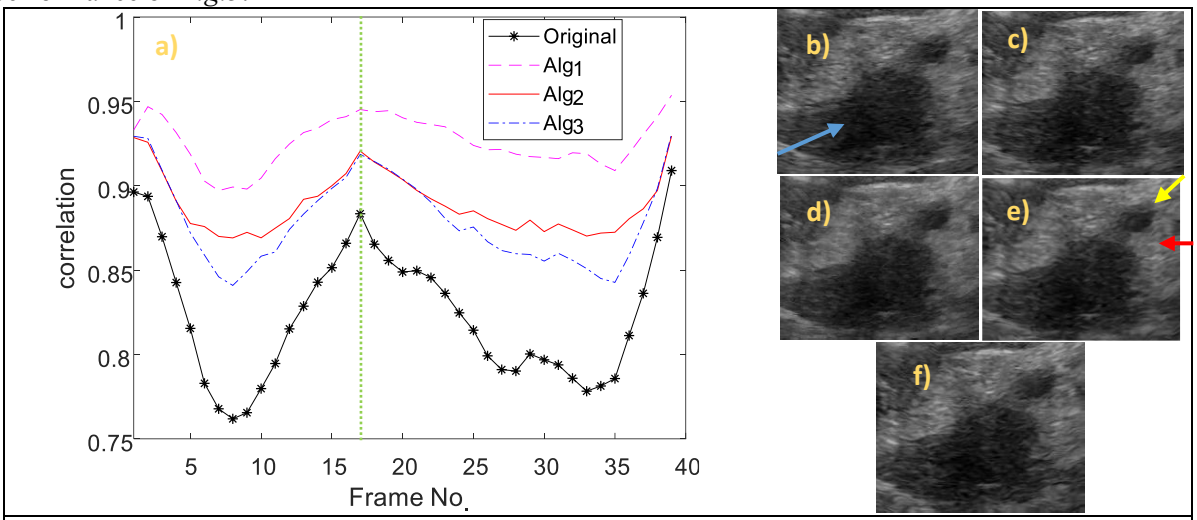

Fig. 1. a) Correlation graphs for all the algorithms; b) Fixed frame; c) Moving frame before registration; d) Moving frame after registration (*Alg.1*); e) Moving frame after registration (*Alg.2*); f) Moving frame after registration (*Alg.3*). Green dashed line in (a) indicates correlation values obtained for the fixed and moving frames. Blue arrow (b) indicates pancreatic tumor, yellow and red arrows point out large vessel and tissue distortion, respectively.