



Blood Pool Identification In Contrast-enhanced Imaging Using Spectral Clustering



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Background

Patients with acute heart failure require urgent in-hospital treatment to treat symptoms, often due to congestion. There is urgent need for quantitative and minimally invasive techniques for the assessment of thoracic fluid status [1]. **Indicator dilution theory allow quantification of thoracic fluid volumes. However, the definition of regions of interest (ROIs) in the dynamic contrast-enhanced images is a time demanding task, often performed manually. A method for automatic ROI identification is proposed.**

Methodology

Contrast-enhanced ultrasound (CE-US) recordings from 11 patients were obtained using a scanner with a trans-thoracic probe (Philips Healthcare); bolus injections of US contrast agent were administered. Contrast agent presence was detected by automatic thresholding of the standard deviation of the pixel intensity versus time. Subsequently, **indicator dilution curves (IDCs) are clustered using k-means in a subspace defined by principal component analysis.** IDCs were fitted by the local density random walk (LDRW) model. The method was validated comparing the obtained IDCs with those obtained manually.

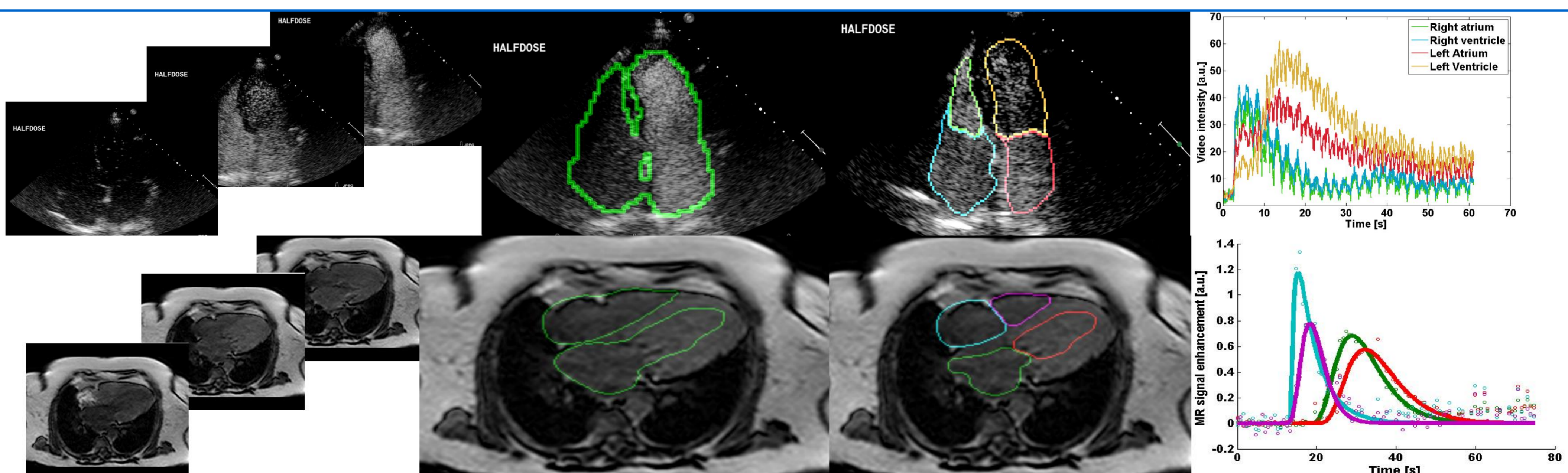


Figure 1: From top left to right: sample images from a CE-US recording; detection of areas of contrast agent passage; ROI obtained by clustering of the individual IDCs; signal intensity versus time obtained averaging the image intensities in the identified ROIs. **Bottom row:** similar results for DCE-MRI.

Results

An example of automatic defined ROIs is shown in Figure 1. The average correlation coefficient between the automatically extracted IDCs and manually defined ones were 0.958 ± 0.003 and 0.938 ± 0.003 , for LV (left ventricle) and RV (right ventricle), respectively. The average difference between manual and automatic MTTs was $-0.24 \pm 1.00\%$ and $-2.42 \pm 3.60\%$ for the RV and LV, respectively. Preliminary results suggest the applicability of the method also on dynamic contrast-enhanced magnetic resonance images.

Conclusions

The extracted IDCs correlate well with the manually extracted ones. Derived parameters show good agreement as well.

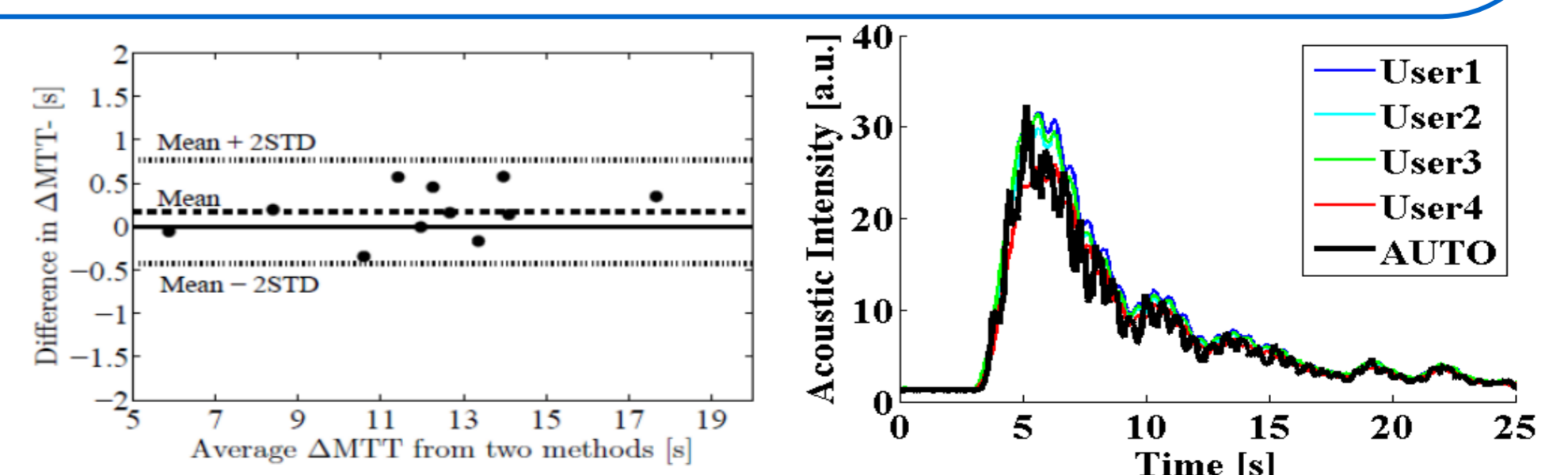


Figure 2: Left: Bland-Altman plot comparing trans-pulmonary MTT estimated from manually drawn and automatically derived ROIs. **Right:** RV IDC derived from a contrast ultrasound recording; the automatic derived IDC is compared to four obtained from manual expert annotations