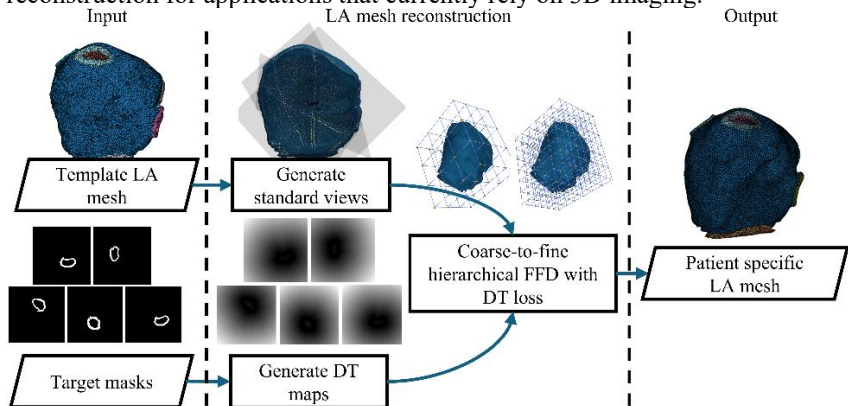


Patient-Specific Left Atrial Mesh Reconstruction from Echocardiographic Views by Hierarchical B-Spline Deformation

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Patient-specific left atrial (LA) meshes are relevant for medical applications such as electrocardiography imaging but are typically derived from 3D imaging modalities that are not routinely available in all clinical settings. In this study, we propose a framework for reconstructing patient-specific LA meshes from five 2D echocardiographic segmented views that specifically show the LA structures (the apical two-, three-, and four-chamber, the parasternal long-axis, and the short-axis at the aortic valve level). The method deforms an LA template using hierarchical B-spline free-form deformation and optimizes the match between template and target echocardiographic views using a distance-transform-based loss. The framework was evaluated on 20 CT-derived meshes and 949 statistical shape model (SSM)-generated meshes using relative surface area error ($\%SA_e$), relative volume error ($\%V_e$), average symmetric surface distance ($ASSD$), and 95% Hausdorff distance (HD_{95}). On CT-derived data, the method achieved $\%SA_e$ of $4.88 \pm 3.37\%$, $\%V_e$ of $2.33 \pm 1.89\%$, $ASSD$ of 1.68 ± 0.49 mm, and HD_{95} of 4.02 ± 0.98 mm. On SSM-generated data, the corresponding values were $\%SA_e$ of $1.83 \pm 1.40\%$, $\%V_e$ of $2.58 \pm 2.08\%$, $ASSD$ of 0.82 ± 0.17 mm, and HD_{95} of 1.92 ± 0.42 mm. In conclusion, the proposed framework demonstrates that patient-specific LA meshes can be reconstructed from standard 2D echocardiographic views, opening the possibility of more accessible personalized atrial mesh reconstruction for applications that currently rely on 3D imaging.



Overview of the proposed left atrium (LA) reconstruction