Innovative approach of 3D electro-anatomical heart imaging enthused by mixed reality

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Background: With increasing quality and resolution in medical imaging the 3D reconstruction of organs becomes within clinical and educational reach. Medical imaging provides many 2D (DICOM) views on the 3D heart, leaving the 3D interpretation to the medical experts. Detailed anatomical models in combination with the ECG derived average position of the electrical activity of the heart over time, PathECG, provides a novel 3D functional image of the patient specific cardiac anatomy. We aimed to develop of a unified pipeline to obtain detailed anatomical models in combination with 3D representation of the ECG.

Methods: Image data is being segmented using 3D Slicer (Release 5.2.2). Contrast-enhanced computed tomography (CT) was provided with isovoxel (3D) sequences in sagittal, coronal, and axial planes. The model was divided into several separate components, e.g. left/right atrium, left/right ventricle, and arteries. The 3D activation of the heart (PathECG) was derived from the 12-lead ECG in combination with the patient specific heart/torso model, using CineECG software (version 6357, ECG-Excellence BV, Netherlands). Finally we implemented a new triangle mesh optimization method for the 3D models, resulting from the limitation of displaying images in mixed reality by Hololens2 to 500,000 triangles with limited loss of the anatomical details.

Results: We demonstrate the result our pipeline using the data of a patient with permanent AF and congenitally corrected transposition of the great arteries eligible for a His-bundle pacing therapy. The output of this system was used around the procedure, in order to increase the effectiveness and safety of the procedure. The implantation of the His-bundle procedure took about 15-minutes.

Conclusion: The relative short time of the implantation procedure is an indication of the effectiveness of the 3D reconstruction and visualization pipeline. In our ongoing study we aim to apply this procedure in about 30 patients eligible for His-bundle pacing.

3D model of congenitally corrected transposition of the great arteries (ccTGA) demonstrating atrioventricular and ventriculoarterial discordance.

Pulmonary Artery

Aorta

AP view

Septum
Start Path ECG and target
His Bundle Pacing position

functional imaging
PathECG with the 3D patient specific heart model