# Three-Dimensional Representation of Atrial Anatomy and Electrophysiology Enhanced by Mixed Reality

Klaudia Proniewska[1,2], Peter van Dam[1], Danila Potyagaylo [1]

[1] Center for Digital Medicine and Robotics, Jagiellonian University Medical College, Krakow, Poland
[2] Department of Bioinformatics and Telemedicine, Jagiellonian University Medical College, Krakow, Poland

**Introduction:** Teaching cardiac anatomy and electrophysiology involves conveying complex three-dimensional (3D) structures, which are fundamental for understanding cardiovascular function and disease. Their crucial role in ECG genesis has also received wide acknowledgement in both clinical and computer modelling communities. In this context, study of P wave morphology is becoming increasingly important due its potential in predicting atrial fibrillation.
**Methods:** The P wave morphology is affected by multiple factors, including the sinoatrial node (SAN) location and extent, points of myocardial capture, fast conductive bundles' architecture and physical characteristics of the atrial chambers. For three exemplary ECGs extracted from the PTB-XL database - normal, inverted / negative and an intertribal block (IAB) P waves, we performed CineECG analysis on a highly detailed generic anatomical atrial model. We qualitatively evaluated SAN exit points locations and corresponding activation trajectories and sequences. The results were exported into the Mixed Reality HoloLens's 2 system for enhanced visualization.
**Results:** As expected, normal and negative P waves were found to feature superior and inferior SAN capture points with top-down and down-top average activation trajectories, respectively. The considered IAB provided a markedly distinct excitation pattern with the right-left pattern. These differences were further highlighted by visualising the complex electro-anatomical interplay of cardiac excitation in the immersive mixed reality environment (Fig.1).
**Conclusions:** This work presents novel mixed reality 3D visualization options for atrial anatomy in high spatial resolution augmented by the respective P wave genesis.

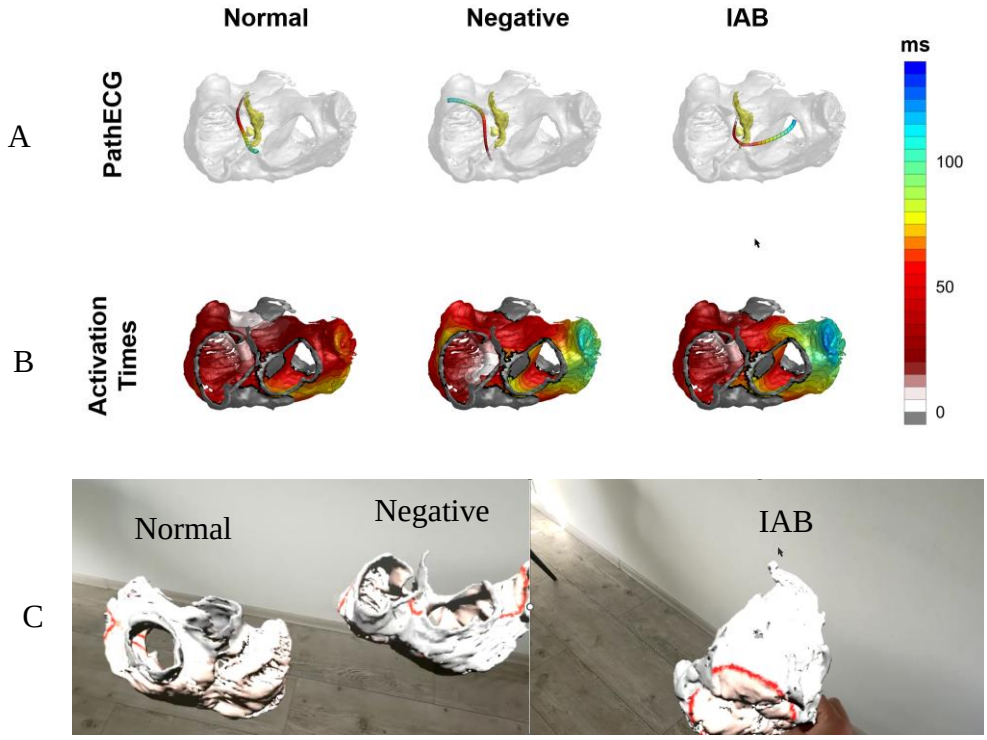


Fig. 1 Atrial Anatomy Enhanced by ECG and 3D Visualization in several views: a) PathECG b) Activation Times c) Mixed Reality HoloLens's 2.