4D CMR in Mixed Reality: an ultimate cardiac imaging tool for a beating heart visualization

A. Złahoda-Huzior[1,2], Ł. Kownacki[3], M. Stanuch[1,2], K. Janc[1], J. Pawłowski[1], M. Kierepka[1], M. Kurzyna[3], S. Darocha[3], A. Torbicki[3], D. Dudek[4]

[1]MedApp S.A., Krakow, Poland

[2]AGH University of Science and Technology, Krakow, Poland

[3]European Health Center, Otwock, Poland

[4]Jagiellonian University Medical College, Kraków, Poland

Computed tomography (CT) of the heart is an essential tool for pre-procedural planning thanks to the fact that it contains the 3D structure of the organ. Cardiac magnetic resonance (CMR) is a well established alternative to CT known for the lack of radiation and iodine contrast exposure, higher temporal resolution and tissue contrast compared to CT. On the other hand, CMR is characterized by a lower spatial resolution and higher complexity of the imaging protocol. To overcome these limitations we present a novel CMR imaging method and data post-processing approach using a "four-dimensional data acquisition" (4D CMR) and data visualization in mixed reality environment.

Five 4D-CMR datasets were obtained using Philips Achieva 3 Tesla MR scanner. Multiple breath-hold SSFP (B-TFE) ECG-triggered acquisitions resulted in axial cine multislice stacks covering entire heart with the following main scan parameters: TR-3ms, TE-1.5ms, flip angle-45deg, (FOV-380mm, slices-60, voxel:1.5x1.5x2.5mm, 25 cardiac phases).

4D stacks were imported into CarnaLife Holo software (MedApp S.A.), post-processed and presented as holograms using the Microsoft HoloLens headset. Additional data post-processing and 'cut smart' mode allowed real-time data cutting using a cut plane generated perpendicularly to the operator's sight direction which resulted in a totally free beating heart penetration through the almost isovolumetric 4D dataset. The obtained image temporal and spacial resolution resulted in high data quality. Advanced volume rendering options were tested to improve the holographic data visualization. Data manipulation (rotation, translation, scaling) using voice commands and hand geastures allowed an accurate navigation through the dataset with the visual structural and functional assessment.

4D CMR holographic visualization of the beating heart creates the opportunity for faster and more accurate diagnosis. Further works must be performed to add volume and quantitative parameters calculations to the holographic visualization software.