

Exploring 2D Ultrasonic Blood Flow Visualisation in the Newborn's Heart by means of Multi-Physics Modeling.

Joris Van Cauwenberge, Lasse Lovstakken, Patrick Segers and Abigail Swillens (EA06)

Ultrasonic (US) blood flow imaging is a preferred tool to detect abnormal intracardiac blood flow patterns in newborns. Unfortunately, current techniques are limited to 1D velocity measurements at low temporal resolution. Our goal is to investigate whether recent advances in scanning technology can conquer these limitations. For this purpose, we generated synthetic US images via multiphysics modeling, integrating computational fluid dynamics (CFD) and US imaging simulations. This approach allows to test new imaging algorithms in an environment where the fluid-dynamics behind the image is known (CFD-data), simultaneously disposing of full flexibility at the level of the imaging setup. The US simulation software represents blood flow as point scatterers on which the US waves reflect. These scatterers are propagated during the simulated scanning using the velocity data from a dynamic CFD-simulation in a 3D neonatal left ventricle. A real-life cardiac probe with an innovative high frame rate acquisition was implemented. Finally, the simulated US data were processed using a block-matching technique to form 2D blood velocity images. We showed that neonatal intracardiac blood flow patterns can be accurately tracked throughout the cardiac cycle (deviations on average smaller than 0.08 m/s for both velocity components) and are hardly hampered by imaging artifacts.