Feasibility of High Frame Rate 3-D Intracardiac Echography using Fan-Beam Transmissions

Soozande, Mehdi; Ossenkoppele, B.W.; Hopf, Y.M.; Pertijs, M.A.P.; Verweij, M.D.; Vos, H.J.; Bosch, J.G.; de Jong, N.

Publication date
2019

Document Version
Final published version

Citation (APA)
Soozande, M., Ossenkoppele, B. W., Hopf, Y. M., Pertijs, M. A. P., Verweij, M. D., Vos, H. J., Bosch, J. G., & de Jong, N. (2019). *Feasibility of High Frame Rate 3-D Intracardiac Echography using Fan-Beam Transmissions*. Poster session presented at 2019 IEEE International Ultrasonics Symposium, IUS 2019, Glasgow, United Kingdom.

Feasibility of High Frame Rate 3-D Intracardiac Echography using Fan-Beam Transmissions

Soozande, M.; Ossenkoppele, B.W.; Hopf, Y.M.; Pertijs, M.A.P.; Verweij, M.D.; Vos, H.J.; Bosch, J.G.; de Jong, N.

Publication date
2019

Document Version
Accepted author manuscript

Published in
2019 IEEE International Ultrasonics Symposium (IUS)

Feasibility of High Frame Rate 3-D Intracardiac Echography using Fan-Beam Transmissions

Mehdi Soozande[1], Boudewine Ossenkoppele[2], Yannick Hopf[3], Michiel A.P. Pertijs[3], Martin D. Verweij[1, 2], Hendrik J. Vos[1,2], Johan G. Bosch[1], Nico de Jong[1, 2]
[1]*Biomedical Engineering, Thorax Center, Erasmus MC, Rotterdam, Netherlands.*
[2]*Laboratory of Acoustical Wavefield Imaging, Department of Imaging Physics, Delft University of Technology, Delft, Netherlands.*
[3]*Electronic Instrumentation Laboratory, Delft University of Technology, Delft, Netherlands*

Background, Motivation and Objective

Intracardiac echography (ICE) is widely exploited for RF ablation procedures to guide the electrophysiologist in navigating the ablation catheter. High frame rate (HFR) 3D ICE could provide 3D imaging of electromechanical wave propagation (EWI) with higher spatiotemporal resolution than conventional methods. Yet, 3D probes generally make trade-offs among channel count, image quality, and frame rate. In this work, we propose a 1D micro beamforming (MBF) approach in elevation (El) direction to reduce the channel count while maintaining a HFR and image quality comparable to a fully sampled acquisition (FSA).

Statement of Contribution/Methods

MBF is a well-established method to reduce the channel count while preserving the image quality and SNR for volumetric imaging. Generally, to suppress grating lobes and clutter, many narrow steered beams are transmitted. To achieve HFR for 3-D EWI (>1000Hz), the number of transmissions should be kept below 7 per volume. We propose a 1D MBF with narrow beams in El and a diverging wave in azimuth (Az) direction. We transmit a beam profile of 90°×25°, steered from -30° to 30°, in steps of 10°. Transducer aperture is 12.5×3mm (Az×El), consisting of 100×24 square elements, with a pitch of 125µm (7.5MHz). The final 3D image is formed by angle-weighted averaging of the sub-volumes reconstructed by voxel-based delay and sum per transmission. Image quality for different MBF sizes is compared to FSA based on lateral resolution, side-lobe levels, and contrast to noise ratio (CNR) in FIELD II simulations.

Results/Discussion

The combination of diverging wave in Az and narrow beam in El with MBF size of 3-6 elements can provide HFR 3D imaging with an acceptable image quality and a corresponding channel count reduction (Fig 1). The image quality degraded for larger MBF sizes. The lateral resolution was 4.6mm and 1mm (same as FSA) at 50mm depth for El and Az direction respectively. The side-lobe levels and CNR in Az was -15dB and 2.2 respectively.

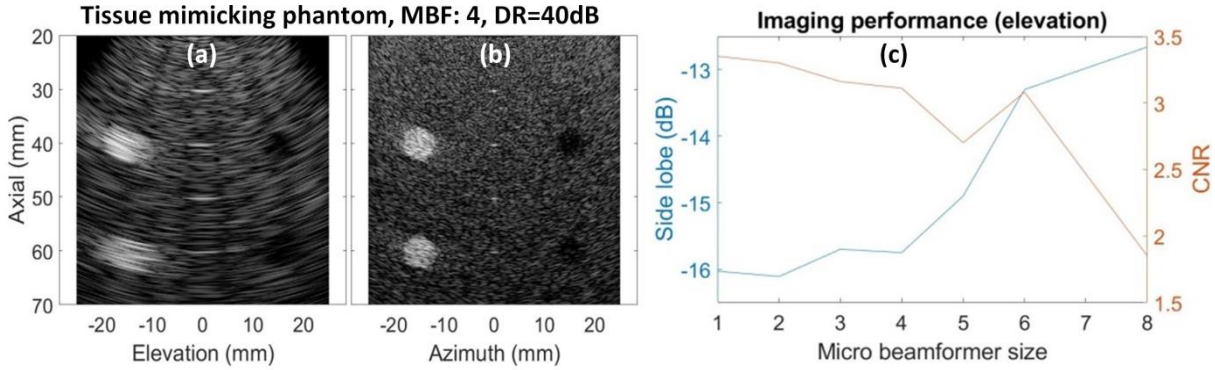

Figure1.a) A 3D simulated tissue mimicking phantom imaged by the proposed method in elevation and b) in azimuth direction. c) side lobe level and contrast to noise ratio vs. MBF size in elevation