LightABVS:
A Digital Ultrasound Transducer for Multi-Modality Automated Breast Volume Scanning

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Background, Motivation and Objective

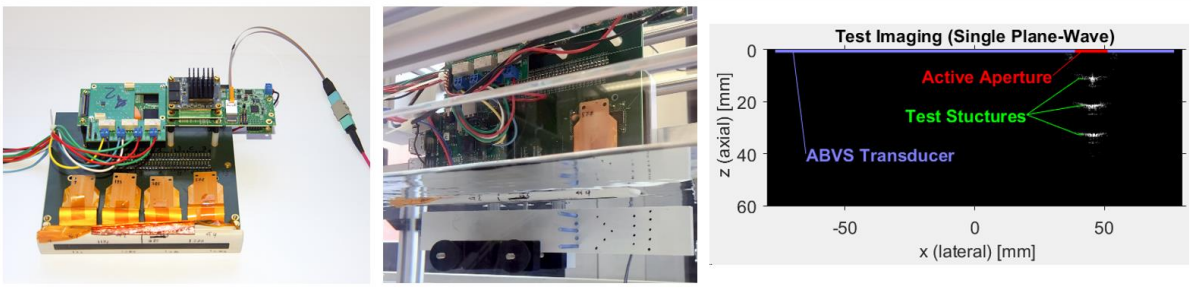
One in eight women will develop breast cancer at least once in their life. Early detection of breast cancer is crucial in order to reduce mortality and to enable less invasive treatments. Thus, periodic screening programs have been established in many health systems. As of today, the gold-standard for breast cancer screening is x-ray mammography, even though it has known limitations. Ultrasound can provide complementary information to x-ray especially in dense breasts, but if performed manually, it is time-consuming, requires a specialist and results in non-standardized image data.
A promising approach to make ultrasound accessible for screening are automated breast volume scanners (ABVS), in which a transducer scans the breast controlled by a robotic unit. There have been research ABVS prototype systems developed that can be integrated into the established mammography workflow. However, both systems are operated independently of each other.
In this work, we investigate how mammography and ultrasound can be integrated more closely and at a lower cost. To achieve this, we replace the currently-used cart-based ultrasound system with an ultrasound probe with in-probe digitization. This allows software-defined X-ray and ultrasound imaging sharing the compute-resources of one PC.

Statement of Contribution/Methods

We present a 768-element ABVS prototype system for multi-modality screening.
The proposed system features 192 RX/TX channels and a 4:1 multiplexer, integrated into the transducer head of the robotized scanner. The head features two 100 Gbit/s Ethernet links to provide sufficient data-bandwidth to stream the digitized raw data to the connecting PC. The system is based on the LightProbe presented at IUS2017, a 64-channel hand-held probe with in-probe digitization. However, the LightABVS system presented here features a more versatile TX frontend, an improved receive frontend and faster transceivers for 100G Ethernet. We present early imaging results of a reduced channel (64) prototype using the 768-element ABVS transducer.

Results/Discussion

The results with our reduced channel prototype confirm the proper operation of the RX/TX frontend as well as the fiber optics link. The Figure shows the prototype and a first output image.
Without any power management active, the system consumes 9.1W.
Currently, the larger 192-channel system is under development.



(a) (b) (c)

(a) The ABVS transducer with the frontend electronics and the cabling required for operation (optical fiber for raw data streaming and power). (b) The test setup with the transducer submerged in water and simple test structure (three plastic tubes). (c) The reconstructed single plane-wave image shows the three test structures below the active area of the transducer.