Portable GPU programmable Phased-Array UT platform

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Ultrasound Phased-Array (PA) technique are now widely adopted by the industry for non-destructive testing. On the other hand, novel methods exploiting Full-Matrix Capture (FMC) are still struggling wider adoption. This is caused by the limited availability of the advanced acquisition and processing hardware. To address this issue, we developed a compact Phased-Array ultrasound system equipped with a fully-programmable embedded GPU (Nvidia Tegra X2). The platform enables acquisition of both classical Phased-Array data and FMC data. All the processing algorithms (e.g. image reconstruction) are implemented on the embedded GPU, providing full flexibility and adaptability for various application and scanning schemes. The device supports 32:128 ultrasound channels and is compatible with standard Olympus® Phased-Array probes. Internal system architecture is optimized for a high-speed data transfer and processing to overcome limitations of the currently available systems. The software can implement the traditional focal-law approach, as well as the Total Focusing Method (TFM) using FMC data. Programmability of the ultrasound front-end and the GPU processing support implementation of arbitrary scanning scheme and signal processing algorithm. The embedded GPU can be also integrated with open-source deep-learning frameworks to extend processing capabilities to machine learning – e.g for automated flaws detection and qualification. Thanks to built-in Linux computer and a set of external interfaces (USB, Wi-Fi) the platform can work in a stand-alone mode or as an ultrasound acquisition and processing front-end for wireless and remote applications. As a feasibility study, we applied the system for a wireless FMC scanning application. We have used a 5MHz, 128-element Olympus® NDT probe and a standard steel Phased-Array test block. The raw RF signal was sampled at 40MSPS. Nominal Wi-Fi bandwidth of 200-300Mbps is far too low to transfer raw RF FMC data (a single FMC dataset for 10cm imaging in stainless steel gives ~46MB, so B-mode image refresh is limited to 0.8Hz). Yet, by applying local GPU processing for the TFM image reconstruction, we were able to greatly reduce the amount of data to transfer, and achieved refresh rate of over 50Hz. We have shown the feasibility of applying FMC/TFM methods in portable Phased-Array UT device for real-time remote inspection and wireless data transfer. Remote and robotized inspection systems can benefit from advanced digital signal processing provided by a low-power GPU processing. In the next step, we are planning to evaluate the system performance in a real-world industrial setup.