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EDITORIAL

Rapid change in environment for research on diagnostic ultrasound

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For progression of research, of course, experimental systems play an important role. Fifteen years ago, at the start of my research career, it was still difficult for researchers, maybe particularly for researchers in universities, to obtain an experimental system that was capable of acquiring beamformed ultrasonic radio-frequency (RF) echoes from an ultrasonic array transducer, due to the limitations of the available hardware, e.g., low sampling frequency and the limited memory of the analog-to-digital (A/D) converter. In our case, we were forced to use base-band signals (composed of in-phase and quadrature signals) to acquire ultrasonic signals for longer acquisition periods with a limited amount of memory because acquisition of beamformed RF signals required a higher sampling frequency and more memory. Even for acquisition of base-band signals, we needed to develop an expensive in-house acquisition system to acquire the base-band signals of beamformed ultrasonic RF echoes for several seconds. The sampling frequency and amount of memory for the in-house system were 10 MHz and 16 MB, respectively. There was a severe tradeoff between sampling frequency and the period available for acquisition (amount of memory). For example, for research on ultrasound imaging, it is desirable to acquire RF signals, which requires a high sampling frequency, and, thus, the number of frames acquired is reduced. On the other hand, in the case of research involving measurement of tissue motion, for example, it is necessary to acquire ultrasonic signals for a certain required period and the sampling frequency should be limited. Therefore, signals such as base-band signals were preferred because they did not require a high sampling frequency.

In the past decade, the capability of acquisition systems has improved dramatically. Now we are able to obtain an acquisition system with a much higher sampling frequency and more memory. At around the year 2000, such systems implemented acquisition of beamformed RF signals for a certain required number of frames, e.g., for several seconds. However, it was still difficult to acquire ultrasonic RF echoes received by each element of an ultrasonic array transducer (channel RF signal). Therefore, there were very few research groups who could develop and implement methods for diagnostic ultrasound imaging using RF signals obtained from array elements, though there should have been many good ideas on diagnostic ultrasound imaging based on array signal processing.

However, systems capable of acquiring channel RF signals and also controlling the transmitted ultrasonic field have become available at last due to further innovation in the capability of acquisition systems. Such systems are still not cheap, but now we are able to obtain such systems much more easily than before.

As described above, there was a severe tradeoff in the past, i.e., higher sampling frequency and shorter acquisition period to acquire RF echoes or lower sampling frequency and longer acquisition period based on base-band signals. However, now we have been freed from such limitations. Current ultrasound acquisition systems, which are able to acquire channel RF signals and control the transmitted ultrasonic field, will significantly broaden the opportunities for research on diagnostic ultrasound imaging, and the prevalence of such systems may lead to explosive progression in related research fields.

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