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Ultrasound Technology Made to Measure

Scientists at Fraunhofer-Gesellschaft have developed a multichannel ultrasound platform that uses a modular configuration so that it can be adapted to a set of applications that are entirely different from each other. This innovation means researchers can now cover a wide range of applications, from sonar systems to medical ultrasound technologies and all the way to the high frequency range — such as real-time treatment monitoring.

Depending on the application, a variety of technologies can be used. "Complete systems are typically developed, based on unique customer specifications. Within this context, that only allows them to be used for a very limited area, however, the development expenditure is really quite high," said Steffen Tretbar of the Fraunhofer Institute for Biomedical Engineering IBMT in St. Ingbert (Germany).

The new modular system uses basic components like main board, power supply, and control software that always stays the same. "Then we put application specific components — the front-end boards — into this main board, like with a building-block system," Tretbar explained. With this innovation, "we can both quickly respond to customer requests for the widest array of applications, and also offer money-saving solutions," Tretbar said.

The various modules are ready for deployment, and companies from the medical field have signalled their interest in such developments. In order to turn the technology into concrete products, the IBMT team offers two approaches:

- IBMT applies software interfaces to the ultrasound systems that are integrated directly into the customer's system, or
- IBMT integrates the customer's application into the software of the ultrasound system and then creates a software product for the entire application.

As part of the research platform, IBMT's development expertise covers all technology components — from ultrasound transducers and new ultrasound technologies to complete systems and their certification or approval as a medical product.

Ultrasound technologies make visible what remains hidden from the naked eyes: physicians study tissue changes in humans with the aid of sonography; submarines use sonar systems to get their bearings in the darkness of the deep sea; and for materials and components testing, ultrasound provides a non-destructive alternative to costly technologies that are not real-time capable.

In order to adapt an application, the frequency range of the ultrasound waves is a key regulating screw, Tretbar pointed out. Sonar systems typically move within the low-frequency range (from the kilohertz range to about two MHz). "This way, you admittedly do not get a high spatial resolution of the images; however, you can 'see' up to several hundred metres deep," said Tretbar.

Unlike with its use in medicine (ie the physician needs records with the highest possible resolution), the sound waves do not have to traverse any long stretches, but instead just penetrate a couple of centimetres into the body. For this reason, medical ultrasound typically hovers within a frequency range of between 2 to 20 MHz. Very high frequencies, up to the 100 MHz range, enable resolutions in the µm-range (e.g., for materials testing or the imaging of small animals that is needed with the development of new technologies). The IBMT experts have developed corresponding front-end boards for all three areas.

In order to fine-tune the system, the software must be configured accordingly. "We have realised very fast interfaces to the PC. This way, we can control the systems in real time, enable very swift signal processing with repeat rates in the kHz/range, and simply implement new software algorithms that have been adapted for various applications," according to Tretbar.

The new ultrasound modular platform offers another advantage. Scientists can refer back to not only classic image data, but also to the unprocessed raw signals of each element in the ultrasound array. This allows them to develop completely new technologies.

Source: Fraunhofer-Gesellschaft
Image Credit: Fraunhofer IBMT

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