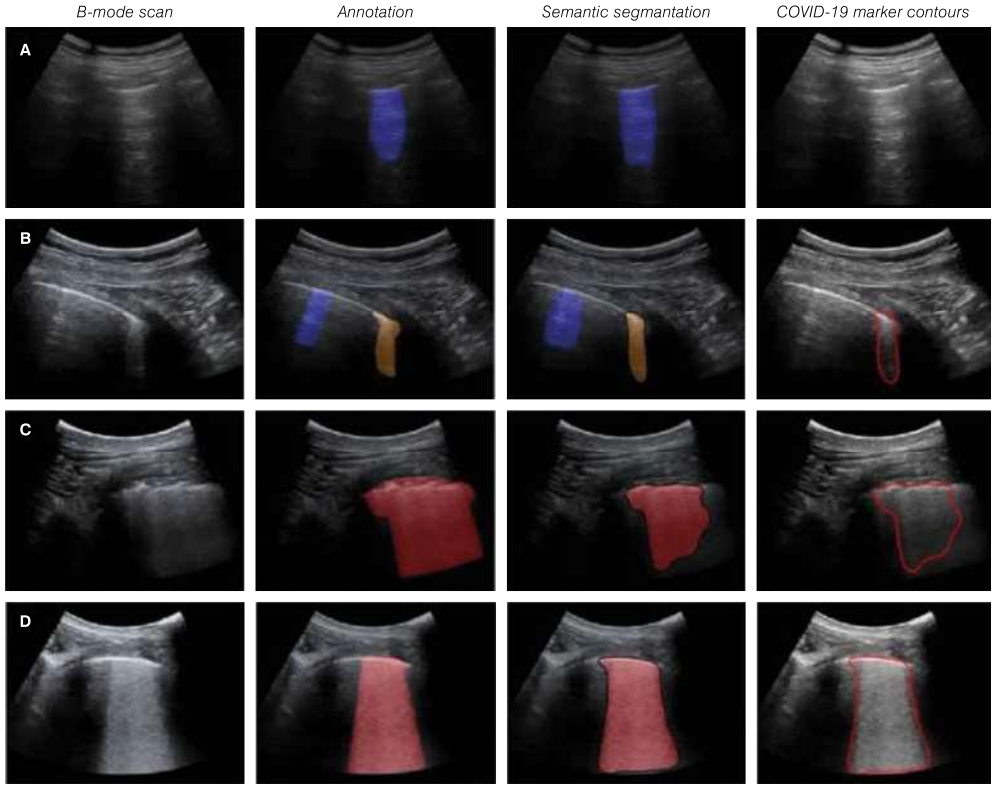


Figure 6: Column 1 and 2 show lung ultrasounds without and with annotated COVID-19 biomarkers (orange: moderate, red: severe). Columns 3 and 4 respectively show the semantic segmentations and contours of COVID-19 markers by means of deep learning analysis. Image: TU Eindhoven.

3.3 AI for Ultrasound imaging

Roadmap and goal

The WHO estimates that two-thirds of the world's population lack access to any form of medical imaging. This is even worse for high-quality imaging, such as MRI: about 90% of the world does not have access. Global access to high-quality imaging is a challenge, and MRI is not likely equipped to fill that gap due to its high costs, poor scalability, and low portability.

Ultrasound has strong potential to provide this access. The problem is that ultrasound image quality is low, much worse than MRI. Expanding to less-skilled users, with devices that are smaller and cheaper, and the increasing prevalence of obesity, all further deteriorate image quality. Consequently, any paradigm-shifting advancement that enables ultrasound with excellent image quality will have a big impact on the field of medical imaging. In e/MTIC applications are explored in the cardiovascular and perinatal domains.

"Because it is a self-learning algorithm it will become smarter with every new diagnosis, and thus generate even more accurate images"

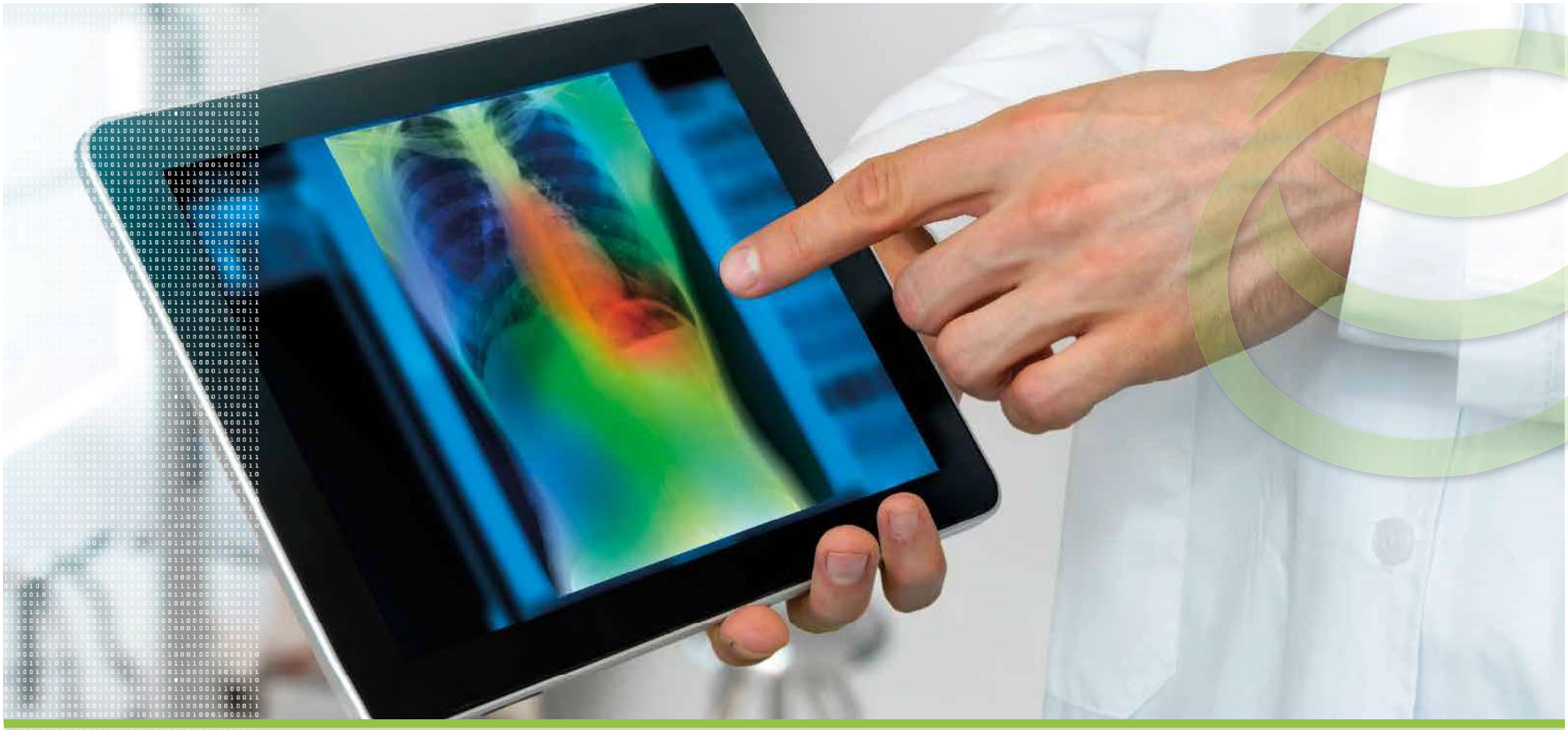
Ruud van Sloun

Approach

Ruud van Sloun, Assistant professor Machine Learning for signal processing at TU/e, introduces how the e/MTIC team intends to improve ultrasound imaging.

"Now imaging techniques perform the same trick for every patient, time and time again. A probe sends soundwaves and builds an image out of the obtained data. I strongly believe that we can improve imaging drastically by making the system 'closed loop'. Closed loop processing obtains data by sound waves and decides in real time how to use that information to get new, more accurate information. The system itself decides what to measure to maximize data on, for example, a pathology."

This closed-loop system is a process of perception, interpretation and action. "We are manipulating specific characteristics of the sound waves, changing the way the system measures. Machine learning models predict properties of the object to perfect the image. In a controlled test set up we try to validate the concept, the added value and most importantly the inefficiency of current system architectures."



Ruud van Sloun

At the core of the research is artificial intelligence to make a system so smart it can perform things people do not have the bandwidth for. “It is my fascination with technology, to observe the human brain mechanism and translating the outcome to mathematics, algorithms and eventually create efficient, valuable solutions for people to benefit from.

Results

The research is leading to higher-quality ultrasound images from fewer measurements, which should ultimately lead to more effective and more efficient diagnostics with ultrasound. In the coming years we will continue this research line with follow-up e/MTIC projects focused on AI for ultrasound in obstetrics and cardiology. For this research e/MTIC truly accelerates the path from early technology to clinical innovation and widespread use. Next to the access to relevant datasets required for large-scale deep learning, the ability to innovate on Philips platforms, and business support is making all the difference.

It is the quintessence of e/MTIC says Ruud: “The hospital partners provide user needs and data, Philips contributes its relevant market and product expertise, and the university provides inspired research capabilities. Together we provide a comfortable red carpet for solutions to reach the hands of the doctor and the health of patients.”

Ultrasound diagnostics has shown a remarkable progress over time. Initially requiring highly specialized equipment, not only for the transducer/receiver but also for the signal processing, a breakthrough was achieved when the transducer/receiver became a ‘USB pluggable’ device connected to a standard computer. This created a much wider access for people to imaging. Now, with the use of AI algorithms, images become much more meaningful and can be tuned to the application.