Customer Testimonial

Fusion Imaging: Now a Reality

Clinical Experience Report:
Interdisciplinary Ultrasound Center
University of Munich-Klinikum
Grosshadern, Germany

SIEMENS Healthineers

The Clinical Utility of Multi-Modality Fusion Imaging

Ultrasound is recognized as the most patient-friendly imaging modality of all options, but understanding and assessing an ultrasound image can be challenging, particularly when locating anatomy in space and time. 3D navigation can assist by using computer technology to fuse live ultrasound images with computed tomography (CT) or magnetic resonance imaging (MRI) datasets. With Siemens Healthineers eSieFusion™ imaging, clinicians can potentially improve patient care, reduce radiation exposure, facilitate diagnosis, and save time by integrating the application of multi-modality 3D multi-planar rendering (MPR) imaging to the dynamic ultrasound assessment.

Using ultrasound for medical diagnoses requires an ability to think multidimensionally. While a CT scan consists of a series of horizontal slices cut in parallel through the body every few millimeters, an ultrasound image appears in real-time and can be more complicated to understand. But this represents no problem for experienced ultrasound users like Dirk-André Clevert, MD, Professor of Radiology and Section Chief of the Interdisciplinary Ultrasound Center at the University of Munich's Klinikum Grosshadern, Germany.

To understand ultrasound images, clinicians need to be able to picture in their minds a 3D model of the anatomy during every second of the procedure, and they must be able to look at this virtual model from any direction. On a CT or MRI image, a normal abdominal aorta has nearly the same appearance as in reality, and in a standard projection, it is always located close to the spinal cord. With ultrasound, the visualization of the aorta relative to other organs is partially dependent on a patient's body habitus, the operator, and also the transducer's scanning angle.

Ultrasound is quick, comparably cost-effective, and patient-friendly, and CT/MRI provides a complete overview of the anatomy. This raises the question: **Why not bring both imaging modalities together, and have the best of both worlds?** Why not do the diagnostic ultrasound and CT or MR imaging simultaneously, just like positron emission tomography-computed tomography (PET-CT)?

Fusion Ultrasound Ready for Clinical Use

Clevert has been working with fusion ultrasound since 2005. "The concept of fusion ultrasound is straightforward. I use ultrasound in the same way I always do, but in addition, the ultrasound system superimposes a CT or an MRI data set onto the ultrasound image. This means that I am no longer confined to the limited field of view that ultrasound offers. Because of the superimposed CT or MRI anatomy, I always get the whole picture. The technology has evolved impressively, and I really think that it is has developed into a routine exam procedure practicable not only for big academic centers like ours, but also for smaller hospitals and radiologists in private practices."

"I really think that fusion ultrasound has become interesting for smaller hospitals and for radiologists in private practices," says Dirk-André Clevert, MD, Professor of Radiology, Section Chief, Interdisciplinary Ultrasound Center, Klinikum Grosshadern, University of Munich, Germany

To understand the scope of fusion ultrasound and how it has become so interesting for hospitals, we must look at the different scenarios in which the technology can be used. Patients with a liver tumor, for example, have their livers screened regularly to identify morphological changes early. Patients who have undergone an operation on an aortic aneurysm and have a stent graft implanted in their aortas also need to be monitored because of the risk of dangerous leakage.

The traditional way to perform this kind of monitoring is to perform CT scans at predefined intervals. "But this means exposing the patient to radiation repeatedly, which is far from ideal," says Clevert. Ultrasound can do the job in many cases, but comparing one ultrasound screening to another later on, or to a CT or MRI scan that has been done previously, can be challenging.

This is why many radiologists still prefer CT or MRI imaging for this kind of follow-up diagnosis. "With fusion imaging, we can use ultrasound and still have all the advantages of CT and MRI imaging. Most liver or aneurysm patients have had a CT or MRI scan at some point in the past. We take their historical data sets, feed them into the ultrasound system, and do the actual follow-up screening using ultrasound only."

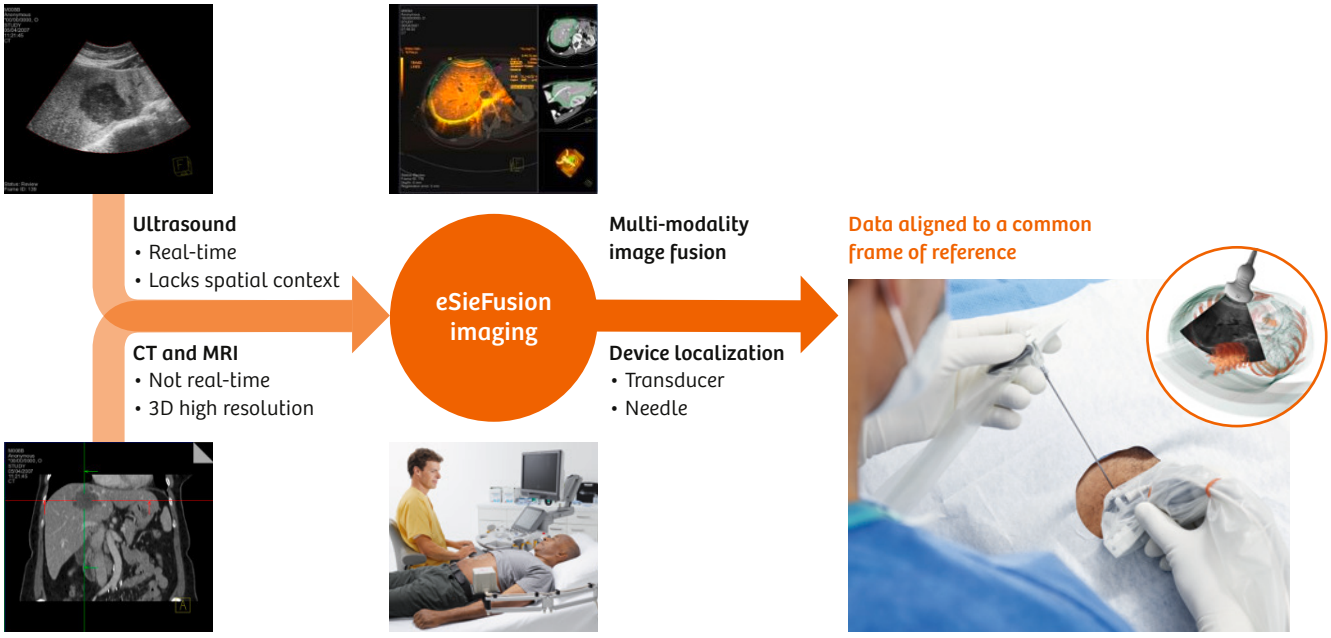
What Clevert then sees on-screen is no longer the standard ultrasound image, but a "fused image"—an ultrasound image embedded into the CT or MRI anatomy. Fusion imaging provides clinicians with all the spatial information they are familiar with from CT or MRI, but without the need for additional radiation or the additional use of nephrotoxic contrast media.

In addition to diagnosis and follow-up, image-guided interventions are the second area in which fusion imaging can revolutionize daily imaging routines. "Using fusion imaging during interventions means that we can be far more confident when we place a needle, for example, without having to constantly apply fluoro-scopy," says Clevert. "This reduces the amount of radiation for the patient, and it means less need for iodine contrast media and thus less strain on the kidneys. And it is also good for interventional radiologists who are exposed to a cumulative radiation dose due to the many procedures they have to perform on a daily basis."

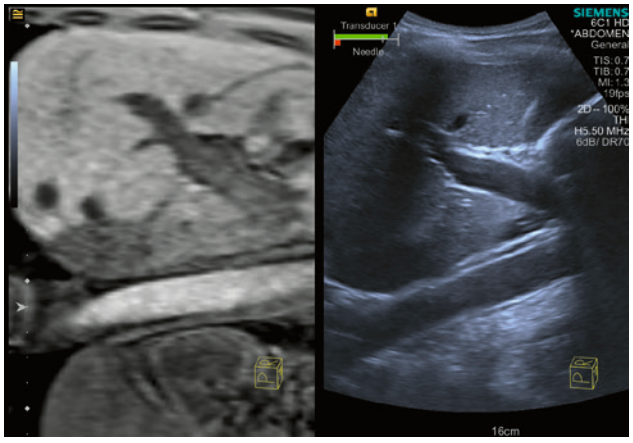
On-Demand Fusion Ultrasound: No Longer a Dream

Given its numerous advantages, how is it that fusion imaging has not already become a mainstream tool in clinical routines? One answer is that the use of fusion imaging has been hampered by cumbersome workflows. With some ultrasound fusion systems, fiducial markers must be placed on the skin during the CT screening to help register the ultrasound images with the CT images later on. This is not practical, since it requires clinicians to know at the time of the CT that they intend to use fusion ultrasound at a later time.

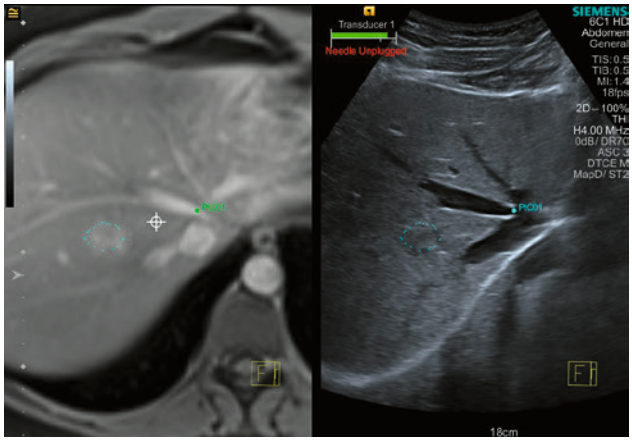
Historically, problems such as these have prevented the theoretical advantages of fusion imaging from being implemented because they often necessitated detailed planning well in advance. Today, Clevert and other clinicians are using advanced ultrasound technology for state-of-the-art fusion imaging. "Patients bring



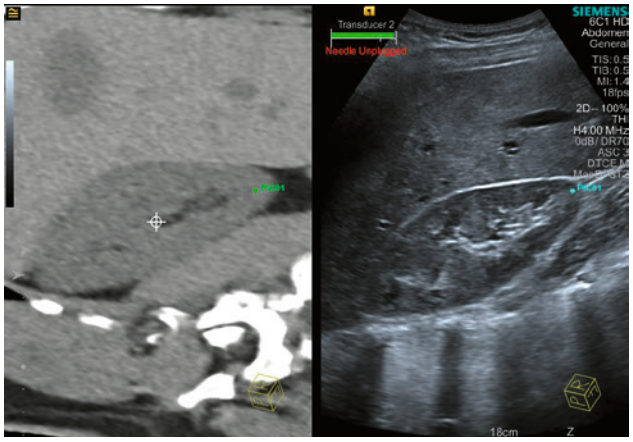
Multi-modality image fusion brings image and sensor data from different modalities into a common frame of reference.



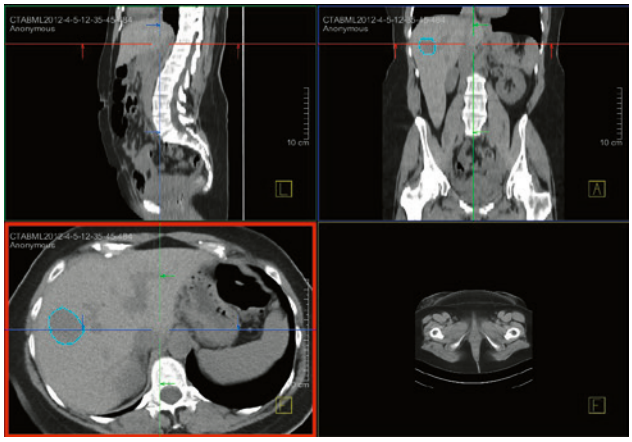
Example of merging MRI with ultrasound for real-time guidance during the procedure to improve procedural accuracy.



Exclusive 3D markers help to track multiple lesions on both MRI and ultrasound image, improving diagnostic confidence.



Multiple methods of alignment are optimized for speed to streamline the fusion process with these CT and ultrasound images.



CT Data showing simple modes that include Scan, Plan, and Fuse assist in planning the best approach, maximizing procedural efficiency.

us DVDs or USB sticks with their CT or MRI scan, and we decide whether or not fusion ultrasound would be helpful for this particular patient. Feeding the data into the system takes just a minute, sometimes even less." The important point is that this works with every CT or MRI data set that fulfills the conventional DICOM standard, regardless of whether the scan was taken in a hospital – in which case it can be retrieved directly from the picture archiving and communication system (PACS) – or in a private practice of a radiologist, weeks beforehand.

Best of Both Worlds

Siemens Healthineers ACUSON S3000™ HELX Evolution ultrasound system can perform fusion imaging quickly and in great detail. Existing fusion techniques require bulky transmit-and-receive equipment to track a patient's anatomy in real time. Also, patients must lie completely still for the duration of the exam. Any movement requires elaborate manual realignment of the images before the screening can continue.

The ACUSON S3000 system overcomes these limitations using a magnetic field generator placed at the patient's side. Its innovative automatic registration software eliminates manual points or plane registration. This auto-registration process provides fast, automatic registration of the data, allowing quick and easy re-registration should the patient's position change, helping to minimize screening time.

For data registration, the DICOM data set from the CT or MRI is uploaded to the ultrasound system. Standard DICOM volume data sets of all cross-sectional CT or MRI screenings can be used for image fusion. Most patients are screened in the supine position to mimic the CT or MRI setting. After successful registration and image fusion, the registered CT or MRI images are displayed simultaneously with the respective ultrasound sectional plane on the ultrasound monitor. Two CT or MRI planes can be used simultaneously to improve visualization. Additionally, advanced ultrasound applications such as color Doppler and contrast-enhanced ultrasound can be integrated in image fusion screening.

Auto-Registration Reduces Fusion to a Matter of Seconds

After uploading, the CT or MRI data set can be registered (or superimposed) with the ultrasound data. Like uploading data, registration in fusion ultrasound has long

Fusion imaging provides clinicians with the spatial information familiar to them from CT or MRI, without additional radiation or the additional use of nephrotoxic contrast media.

been a time-consuming procedure. "There are some systems that require a point-based registration, which means the clinician has to manually mark corresponding points on the CT or MRI and on the ultrasound images to properly superimpose both modalities," Clevert says.

In contrast, registration with Siemens Healthineers technology is fast and fully automatic. **Registering the ultrasound with the CT images can now be done in a matter of seconds,** thanks to the auto-registration procedure and its magnetic field generator, which allows the system to "know" the exact position of the ultrasound transducer.

Potential to Save Time and Money

Given all the advantages of fusion ultrasound, Clevert is convinced the time has come for the technology to enter clinical routine across the board. "A lot of time can be saved if we do not have to organize an additional MRI or CT screening, and fusion imaging helps us to provide better and less-intrusive care." Clevert has no doubt that fusion ultrasound is cost-effective as well. "It is easy to calculate: Not having to do one or two unnecessary MRI examinations per day due to the availability of fusion ultrasound not only saves money, but also reduces MRI waiting lists, thereby improving patient care."

While Clevert uses fusion ultrasound predominantly for patients with abdominal diseases, specializing in patients with liver disease, he says the scope of the technology is not limited to the abdomen. "A clinician can also use it on other organs, for example, the musculoskeletal system." A number of publications [1, 2] have reported on positive experiences in patients with joint disease. Interventions in patients with soft tissue pathology could also be good candidates for image fusion, according to Clevert. Learning the technology is not difficult for someone who knows how to handle ultrasound: "After the third patient, I felt comfortable."

Summary

Challenge:

- Optimize the clinical workflow of fusion imaging
- Enable on-demand use of the technology without the need for lengthy planning

Solution:

- Provide fusion imaging on a workflow-savvy system, with easily accessible controls at a clinician's fingertips
- Provide an innovative auto-registration procedure that superimposes ultrasound and CT/MRI data sets within seconds

Result:

- Improved image quality and comparability due to automation, particularly during follow-up
- Potential for less radiation exposure both during diagnoses and interventions
- Potential for reduced costs by decreasing the need to repeat MRI or CT screenings and instead combining them with ultrasound

1 Klauser AS, De Zordo T, Feuchtner GM, Djedovic G, Weiler RB, Faschingbauer R, Schirmer M, Moriggl B. Fusion of real-time US with CT images to guide sacroiliac joint injection in vitro and in vivo. Radiology. 2010 Aug;256(2):547-53. Epub 2010 Apr 14.

2 Iagnocco A, Perella C, D'Agostino MA, Sabatini E, Valesini G, Conaghan PG. Magnetic resonance and ultrasonography real-time fusion imaging of the hand and wrist in osteoarthritis and rheumatoid arthritis. Rheumatology (Oxford). 2011 Aug;50(8): 1409-13.

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