Breast cancer: Combining imaging techniques for quicker and gentler biopsies

November 4 2013

This shows an MR-compatible ultrasound research platform for multimodal imaging and a combination of the advantages of MR imaging and ultrasound imaging for ultrasound-supported movement tracking of internal organs during MRT imaging. Credit: Fraunhofer IBMT

How can you tell if a breast tumor is malignant? This isn't a question that ultrasound and X-rays, or even magnetic resonance scans, can answer alone. Doctors must often extract tissue samples from an affected area with a fine needle for detailed examination. This sort of biopsy is often undertaken with the help of ultrasound, with doctors observing a screen for needle guidance. Unfortunately, around 30 percent of all tumors are invisible to ultrasound. In some cases, magnetic resonance imaging (MRI) is used to ensure correct needle insertion. This process involves two steps: the imaging itself, which takes place inside the MRI scanner, and the insertion of the biopsy needle, for which the patient must be removed from the machine to insert the needle accurately. This process is often repeated several times before the sample is finally taken. This exhausts patients and is also costly, because the procedure occupies the MRI scanner for a significant period.

In the joint MARIUS project (Magnetic Resonance Imaging Using Ultrasound – systems and processes for multimodal MR imaging), experts from both the Fraunhofer Institute for Biomedical Engineering IBMT in St. Ingbert and the Fraunhofer Institute for Medical Image Computing MEVIS in Bremen are working together towards a quicker and gentler alternative.

Combining imaging techniques intelligently

The new technique would require just one scan of the patient's entire chest at the beginning of the procedure, meaning that the patient only has to enter the scanner once. The subsequent biopsy is guided by ultrasound; the system would transform the initial MRI scan and accurately render it on screen. Doctors would have both the live ultrasound scan and a corresponding MR image available to guide the biopsy needle and display exactly where the tumor is located.

The biggest challenge is that the MRI is performed with the patient lying prone, while during the biopsy she lies on her back. This change of position alters the shape of the patient's breast and shifts the position of the tumor significantly. To track these changes accurately, researchers have applied a clever trick: While the patient is in the MRI chamber during the scan, ultrasound probes, which resemble ECG electrodes, are attached to the patient's skin to provide a succession of ultrasound images. This produces two comparable sets of data from two separate imaging techniques.

When the patient undergoes a biopsy in another examination room, the ultrasound probes remain attached and continually record volume data and track the changes to the shape of the breast. Special algorithms analyze these changes and update the MRI scan accordingly. The MR image changes analogously to the ultrasound scan. When the the biopsy needle is inserted into the breast tissue, the doctor can see the reconciled MRI scan along with the ultrasound image on the screen, greatly improving the accuracy of needle guidance towards the tumor.

Ultrasound equipment suitable for use in an MRI Scanner

To realize this vision, Fraunhofer researchers are developing a range of new components. "We're currently working on an ultrasound device that can be used within an MRI scanner," says IBMT project manager Steffen Tretbar. "These scanners generate strong magnetic fields, and the ultrasound device must work reliably without affecting the MRI scan." Ultrasound probes that can be attached to the body to provide 3D ultrasound imaging are also being developed by the team as part of the project.

The software developed for the technique is also completely new. "We're developing a way to track movements in real time by means of ultrasound tracking," explains MEVIS project manager Matthias Günther. "This recognizes distended structures in the ultrasound images and tracks their movement. We also need to collate a wide range of sensor data in real time." Some of the sensors gather data about the position and orientation of the attached ultrasound probes while others track the position of the patient.

The team will showcase the entire concept and an initial demonstrator of the technology in November at the MEDICA 2013 trade fair in Düsseldorf at the joint Fraunhofer booth (Hall 10, Booth F05). The next version is set to be completed next year. Whereas the IBMT team is developing the hardware and new ultrasound techniques, the MEVIS working group is concentrating on the software.

The primary objective of MARIUS is to develop ultrasound tracking to aid breast biopsies. Nevertheless, the developed components could also be used in other applications. For instance, the MARIUS system and its movement-tracking software could allow slow imaging techniques such as MRI or positron emission tomography (PET) to accurately track the movements of organs that shift even when a patient is lying still. Aside from the liver and the kidneys, which change shape and position during breathing, this includes the heart, whose contractions also cause motion. Thanks to a technique applied to reconstruct the image, the heart would appear well defined on MRI scans instead of blurred. The jointly developed technology could also be applied to treatments that use particle or X-ray beams. For tumors located in or on a moving organ, the new technology could target the rays so that they follow the movement.These beams could hit the tumor with more precision than currently possible and reduce damage to healthy surrounding tissue.

Provided by Fraunhofer-Gesellschaft

cancer-combining-imaging-techniques.html