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Breast Cancer Biopsies Made Easier By Combining Imaging Techniques

Fraunhofer scientists working on the MARIUS project are in the process of developing a new tissue sample extraction method that is both easier on the patient and more cost-effective, and they are scheduled to present their innovative technology which combines MR and ultrasound imaging at MEDICA 2013 in Düsseldorf.

Whether a breast tumor is malignant or not can only be determined through a combination of examination methods, and biopsies from affected areas are a major contributing diagnostic factor. This tissue sample extraction with a fine needle is frequently conducted with the assistance of ultrasound. The doctors observe a screen for needle guidance; however with roughly 30% of all tumours invisible to ultrasound it is magnetic resonance imaging (MRI) that provides improved assistance.

The two steps involved in this process are 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. Before finally obtaining a sample this process is frequently repeated a number of times, exhausting the patient and incurring costs due to the prolonged period of use of the MRI scanner.

Experts from the Fraunhofer Institute for Biomedical Engineering IBMT in St. Ingbert are working in collaboration with the Fraunhofer Institute for Medical Image Computing MEVIS in Bremen in the joint MARIUS project (Magnetic Resonance Imaging Using Ultrasound – systems and processes for multimodal MR imaging), with the aim of researching a faster and gentler alternative.

In the new technique only one scan of the patient's entire chest would be required at the beginning of the procedure, reducing the number of a patient's scanner visits to just one. The subsequent biopsy is guided by ultrasound; the system would transform the initial MRI scan and accurately render it on screen. To correctly guide the biopsy needle doctors would have both the live ultrasound scan and a corresponding MR image displaying exactly where the tumor is located.

The most important challenge experts face is that the MRI is performed with the patient lying face down opposed to the biopsy position of lying on her back, resulting in an alteration of the patient's breast shape and subsequent shift of the tumour's position. To accurately track these changes, the researchers have attached ultrasound probes, which resemble ECG electrodes, to the patient's skin with the target of obtaining a series of ultrasound images.

Two comparable sets of data from two separate imaging techniques are thus produced and 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, significantly enhancing the accuracy of needle guidance towards the tumor since the examining doctor can view the reconciled MRI scan along with the ultrasound image on the screen during the procedure.

IBMT project manager Steffen Tretbar explains that Fraunhofer researchers are developing a range of new components in order to achieve their vision. Their current projects include the design of an ultrasound device that can be used within an MRI scanner in order to avoid cross-interference of the scanners' strong magnetic fields generated during an examination. Also being developed are ultrasound probes that can be attached to the body to provide 3D ultrasound imaging.

An entirely new software was designed for the technique and MEVIS project manager Matthias Günther says that the team are working towards tracking movements in real time by means of ultrasound tracking. He adds: "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."

While the concept and technology will initially be presented at the joint Fraunhofer booth at Düsseldorf's MEDICA 2013 trade fair in November, the next version of the concept is expected to be completed next year.

MARIUS's main target is to develop ultrasound tracking to aid breast biopsies, however the developed components could also be used in other applications. 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 immobile. Organs which change shape and position during the breathing process are the liver and the kidney, whereas the heart's motion is caused by its contractions.

A new image reconstruction technique would allow the heart to appear well defined on MRI scans instead of blurred, and the innovative technology could be used for treatments that use particle or X-Ray beams, hitting the tumour with more accuracy than currently possible and reducing damage to healthy surrounding tissue for tumours situated in or on a moving organ.

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