Automated Breast Ultrasound: MRI and Ultrasound CT Imaging Similarities

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· INTRODUCTION
Breast imaging plays a crucial role in the early diagnosis of breast cancer, the most common cancer in women. Currently, the gold standard for general diagnostics and screening is mammography, whose findings can be complemented with handheld ultrasound and MRI. All of these methods have complementary strengths in terms of diagnosis and screening reliability and efficiency (mammography), high specificity (handheld ultrasound) and sensitivity in dense breast tissue (MRI). However, each method also has inherent disadvantages: use of ionizing radiation (mammography), operator dependency (handheld ultrasound), high costs and high rate of false positive findings (MRI) [1]. Therefore, exploration of new diagnostic techniques continues, trying to combine positive features of the existing ones and avoiding their disadvantages. One example of a new breast diagnostic modality is examined in our study of a prototype automated breast ultrasound computed tomography (USCT) system. Preliminary results of the first 70 patients have helped to build a knowledge pool of characteristic features of pathologic findings in the breast, which in some cases revealed intriguing similarities between USCT and MRI image features.

· METHODS
The pilot study examination protocol includes breast USCT, handheld ultrasound and mammography for every patient. MRI is used when recommended for diagnostic purposes. USCT imaging was provided by the Warm Bath Ultrasound (WBU) scanner (Techniscan Medical Systems, Salt Lake City, Utah, USA). This automated system acquires a volume image dataset of both transmission and reflection ultrasound of the whole breast [2-4]. The patient lies in a prone position with her breast placed in a water bath. The transmission/receiver array revolves around the breast and one-side transmission and reflection data are acquired, going upwards from the nipple to the chest wall in a 7° interval on average. An inverse scattering algorithm [5] generates 3D maps of both speed of sound and attenuation, along with a 3D reflection map geometrically registered with the previous ones, as shown in Fig. 1. Imaging voxel size is 0.8 mm by 0.8 mm in the coronal view and 1 mm along the anterior-posterior direction, but, due to the presence of noise and due to the convergence tolerance of the nonlinear algorithm, some smearing is expected, leading to an actual spatial resolution of about 1.2 mm by 1.2 mm in plane and 3.3 mm in the third direction. MRI images were acquired with a 1.5 T Espree MRI scanner (Siemens Medical Solutions, Erlangen, Germany). The protocol follows clinical routine scanning with axial acquisition of 2D TIRM images and a multiphase T1-weighted 3D FLASH sequence (6 time points every 90 s) after application of contrast agent, providing data for subtraction imaging and allowing to calculate region-of-interest uptake curves. Typical spatial resolution is 0.8 mm by 0.8 mm in plane with 6 and 1.5 mm respective slice thickness. Acquisition time is about 15’.

· RESULTS
WBU USCT reliably depicts typical breast findings like cysts, fibro-adenomas and carcinomas, whenever the lesion is inside the currently available field of view. Lesion characteristics differ markedly from handheld ultrasound and may present imaging features closer to MRI rather than handheld ultrasound.

· DISCUSSION & CONCLUSION
Several common features contribute to the similarities between WBU and MRI imaging. First, the prone, pendent position of the breast allows a good matching of reflection data up to the chest wall in a 7° interval. Moreover, being an automated examination, it is endowed with the key features of objectivity and reproducibility.

· REFERENCES