

AUTOMATED CONE-BASED BREAST ULTRASOUND SCANNER FOR SCREENING AND BIOPSY

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ABSTRACT

Breast cancer is one of the most diagnosed types of cancer worldwide. Early and reliable diagnosis of breast cancer is of paramount importance for timely treatment since it reduces mortality and morbidity. Volumetric ultrasound breast imaging, combined with MRI can improve lesion detection rate, reduce examination time, and improve lesion diagnosis. However, to our knowledge, there are no 3D US breast imaging systems available that facilitate 3D US-MRI image fusion.

In this work, we introduce a novel Automated Cone-based Breast Ultrasound System (ACBUS) for breast screening and biopsy. The system facilitates volumetric ultrasound acquisition of the breast in a prone position without deforming it by US transducer. The image quality of ACBUS was compared to commercially available Siemens ABVS. We evaluated the quality of 3D US images in terms of signal-to-noise ratio (SNR), contrast-to-noise ratio (CNR), and resolution using a custom-made phantom. The ACBUS image data were registered to MRI data utilizing surface matching, and the registration accuracy was quantified using an internal marker. The ACBUS for breast screening was also tested in vivo.

Next, we assessed the feasibility of breast biopsy with an adapted ACBUS. The biopsy with the ACBUS comprises five steps: pre-procedure MR imaging, 3D ultrasound (US) imaging, MRI - 3D US image fusion, navigation, and needle intervention. We evaluated the biopsy approach by biopsying a custom made soft phantom with 6 stained lesions. Each lesion was biopsied by manually inserting a biopsy needle in an insertion shaft, which was automatically positioned such that the lesion and insertion shaft were in the same imaging plane. This enabled real-time ultrasound-guided guidance.

The phantom-based quantitative analysis demonstrated that ACBUS can deliver volumetric breast images with image quality similar to the images delivered by a currently commercially available Siemens ABVS. We demonstrate on the phantom and in vivo that ACBUS enables adequate MRI-3D US fusion.

All lesions were successfully biopsied, as confirmed by the presence of 7.00 ± 0.89 mm stained material in the biopsied samples.

To our conclusion, ACBUS might be a suitable candidate for a second-look breast US exam, patient follow-up, and US-guided biopsy planning.