MRI of the breast with segmentation based uniformity correction (with Philips Healthcare MR)

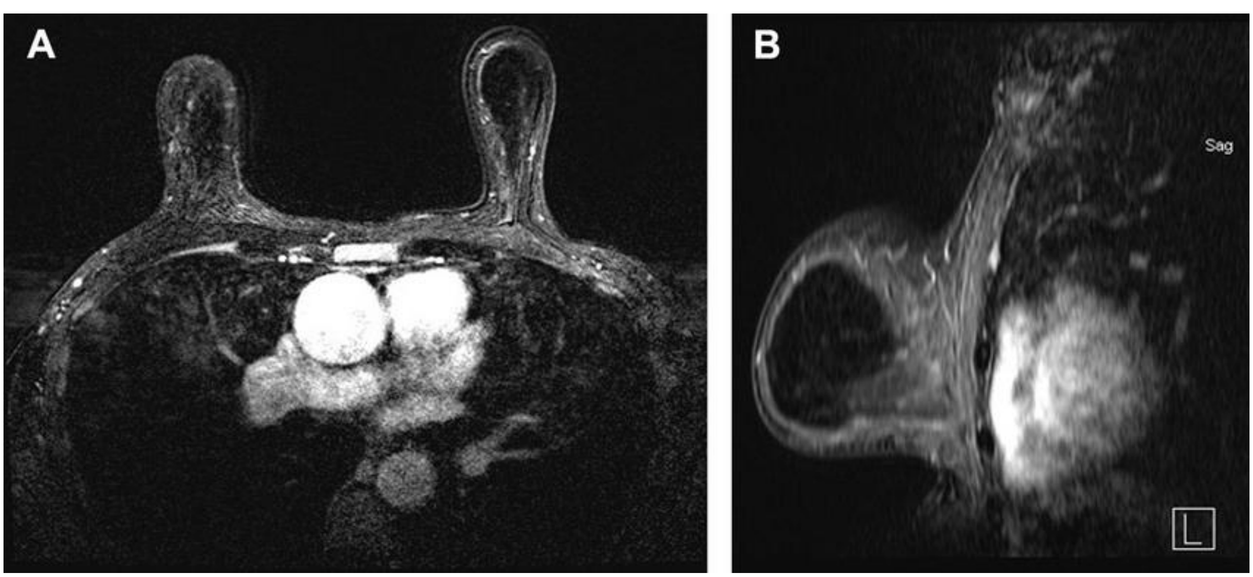
Current clinical practice of breast MRI

Women suspected to have breast cancer will undergo a contrast-enhanced MRI breast examination. During contrast administration, dynamic scanning is performed to check the tissue enhancement pattern. Often maximum intensity projections (MIPs) over the breast volume are created to oversee the whole volume at once. The radiologist checks focal spots for the enhancement pattern to analyze whether their enhancements are benign or malignant. In practice, these focal spots are often difficult to detect due to signal inhomogeneity over the volume due to strong blood enhancement in the heart and inherent inhomogeneity related to the MR coil topology with multiple elements.

Problem description

For MRI acquisitions multi-element surface coils are used. These coils have the benefit to be close to the anatomy resulting in high signal-to-noise images. It also allows to deploy parallel-imaging based scan acceleration to minimize the total acquisition time. The more elements a coil has, the higher the acceleration can be and, hence, the shorter the scan time. However, it also poses challenges to the image reconstruction as multiple local coil elements lead to varying signal levels over the anatomy for which uniformity correction needs to be performed. This also holds for breast imaging, where the patient is in prone position with the breasts surrounded with coil elements. As result, the signal intensities close to the skin are high and decrease going into the body.

The reason for performing breast MRI is to localize potential tumors, which can be anywhere in the breast, also close to the breast wall. Tumor type of lesions are clearly depicted when contrast agent is administered. Because of high vascularization, contrast arrives quickly and the lesions enhance. Here the issue arises. First the heart signal enhances, which is very bright, overwhelming all other signals in the image. When tumors are close the coil elements, the enhancement is strong as signals are strong. However, when tumors are close to the chest wall, the enhancement is very difficult to see as it is completely overwhelmed by the heart intensity. **The hypothesis is that when the enhanced blood signal in the heart can be suppressed, the overall lesion conspicuity in the breast will be improved**.



Example breast MR images – A: axial view, B: sagittal view

Envisioned solution

Images that have undergone uniformity correction for coil inhomogeneity will have very bright signal in and around the heart. The area with such bright signal must be identified (segmented) and its signal intensity must be suppressed, so that surrounding tissues become better visible. **The goal is to realize a segmentation algorithm and suppression function that will only suppress irrelevant, but disturbing signal in the thorax cavity, without hampering the other area in the image.** The axilla region as well as the chest wall should not be suppressed. A second step could be to explore suppression of cardiac pulsation artifacts in the axilla area. Ideally, a solution is developed that can be coupled to or integrated into the MRI scanner software environment.

Location and supervision

Primary supervisor at TU/e will be prof. dr. Marcel Breeuwer. The project will be performed in cooperation with the MR Clinical Science department of Philips Healthcare in Best, with Senior Clinical Scientist Dr. Hans Peeters as co-supervisor. The project will at least partly be performed at Philips Healthcare, Veenpluis 6, Best, The Netherlands. MR image data will be supplied by hospitals cooperating with Philips.

Expected skills and experience

• Medical image analysis (e.g. courses 8DC00, 2DMM10)

• Programming in Python, other languages (e.g. course BMB502417)

• Machine learning / deep learning (e.g. courses 8DM40, 8DM00)

• Experimental study design and algorithm validation (part of course 8DM20)

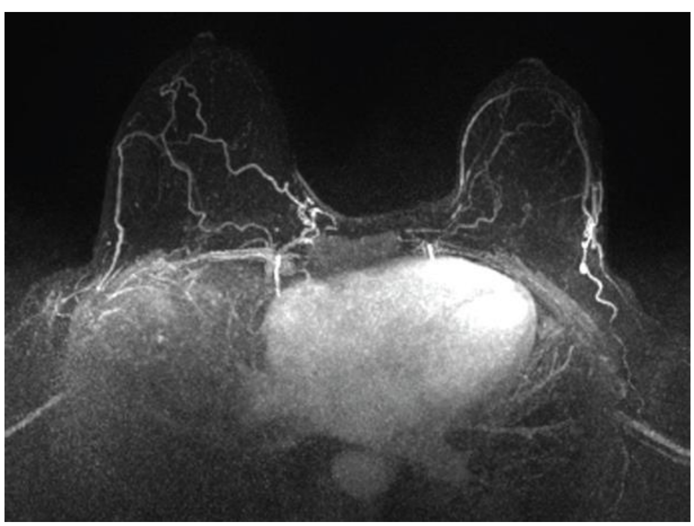
• Written and oral communication in English

Duration and start date

Duration: 60 ECT (10 months full-time)
Start date: can be determined in consultation

Contact

Are you interest in this project? Do you want more information? Please contact: m.breeuwer@tue.nl



Axial maximum intensity projection (MIP)