"Direct Imaging" Method for Bilateral Breast Imaging using Micro-Strip Coils

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Introduction: For clinical breast cancer screening, contrast enhanced dynamic breast MR imaging should be conducted bilaterally in order to screen both breasts of a patient in a single clinic visit. The contrast enhanced dynamic curve requires the acquisition of multiple 3D image sets in a short period of time, normally about 10 minutes. To do the bilateral breast imaging, either parallel imaging or TR interleaved bilateral imaging techniques [1] have been used. The parallel imaging method uses a single large volume that includes both breasts. As the empty space between the breasts is also imaged, the imaging time is still long. On the other hand, the TR interleave-technique images two slabs, each of which covers a single breast volume (Figure 1). Because the volume selection gradient switches from one slab to the other every TR, both breasts are imaged simultaneously although twice as much time is required as for single breast imaging. In this work, we present a possible "Direct Imaging" method which takes advantage of the excellent isolation properties of micro-strip coils to obtain images of both breasts in the time usually required to scan a single breast.

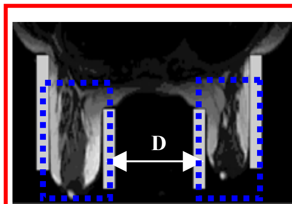

Figure 1 *Breast imaging using parallel surface coil. Medial surface coils separated by a distance D. Two slabs are selected.*

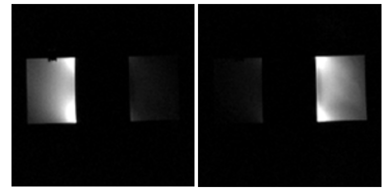

Figure 2 *Isolation property of the micro-strip coil. Each coil receives primarily signal from phantom that is adjacent to it.*

Theory: A micro-strip transmission line coil [2, 3] consists of a conductive ground and a strip coil on either side of the low loss, high permittivity material such as Teflon. Its structure is similar to the virtual shielding coil proposed by [4] and therefore has good decoupling and isolation properties. Thus, if micro-strip coils were used as medial coils in the bilateral breast imaging geometry shown in Figure 1, they would show good decoupling over a wide range of inter-coil separations, D. Experiments show that the micro-strip coils also have very good isolation properties (Figure 2). Almost all of the signal received by a given medial micro-strip coil comes from the tissue adjacent to it; <1% of the signal comes from tissue on the opposite side. This isolation property provides us with a possible "Direct Bilateral Imaging" method to obtain bilateral breast images by scanning only a single breast slab and thus reducing the imaging time. The principle is shown schematically in Figure 3. If FOV#1 including only object A is selected for imaging, the object B in FOV#2 will be aliased into the image. However, if micro-strip coils are used, coil#1 will receive primarily the signal of A and coil#2 will receive primarily the signal of B. If signals from each coil are recorded individually, both objects A and B can be obtained simultaneously in the time usually required to scan one. A similar method for multiple-mouse imaging is described in [5].

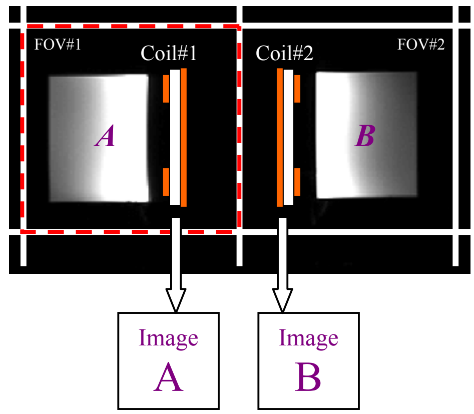

Figure 3 *Schematic principle of the 'Direct Imaging" method for bilateral breast imaging OnlyFOV#1 is selected, object B in FOV#2 will be received simultaneously as an aliased image. Due to the isolation property, coil#1 receives mainly A from FOV#1and coil#2 receives mainly B from FOV#2.*

Method: The medial micro-strip coils and phantom set-up are shown in Figure 3. The phantoms were made by adding 7.5g of NaCl and 0.04g of MnCl to each liter of de-ionized water. All images were obtained with a GE 1.5T scanner (GE Medical Systems, GE-Healthcare, Waukesha, WI). FOV#1 in figure 3 was prescribed, and the phase encoding direction was selected to be right-left in order to produce an 'aliasing effect'. Signals from each coil were recorded individually.

Results: The result of the "Direct Imaging" is shown in Figure 4. Images (a) and (b) are from coil#1 and coil#2 respectively. Low intensity aliasing ghosts (<1%) of the opposite phantom can be seen in each image. The ratio R of the ghost intensity to the true image intensity was measured by the image intensity ratio of coil#2/coil#1 in Figure 3 or from large FOV scanning as in Figure 2**.** To correct the aliasing ghost in image A, the main object in image B is selected by setting a threshold, namely B_0. The previously measured ghost ratio image R is applied to B_0, the corrected image A' is then calculated simply by taking away the ghost part from the image A, or $A'=A-B_0*R$. The same process is applied to the image B. Figure 4(c) and 4(d) show the corrected images A and B, respectively.

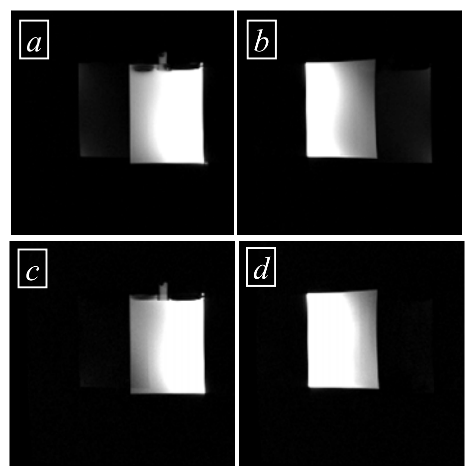

Figure 4 *"Direct Imaging" images.*
(a), (b) *images of coil#1 & #2 respectively;*
(c), (d) *images (a) and (b) after ghost correction.*

Discussion and Conclusion: This "Direct Imaging" method using micro-strip transmission line coils could be used in contrast enhanced bilateral breast imaging to reduce scan times in bilateral breast imaging by a factor of two. The increase in temporal resolution would lead to greater specificity and efficiency in breast cancer screening.

References:
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