Multipurpose 4+4 Channel Array Setup for Parallel Imaging in 3D

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Introduction:

Array-coil imaging is an advanced method for acquiring high resolution images with high SNR in a comparatively short time. Several coils are used to cover a defined volume simultaneously. In a second step, the data for the array is combined to form the final image. Since the sensitivity of each single array-coil in its detection area is better than that of one single volume coil, increased SNR can be expected [1]. This concept has become more and more popular for many applications using various specialized array-coils. The objective of this work was to develop a pair of coil arrays for multipurpose applications feasible for many different small regions of the human body.

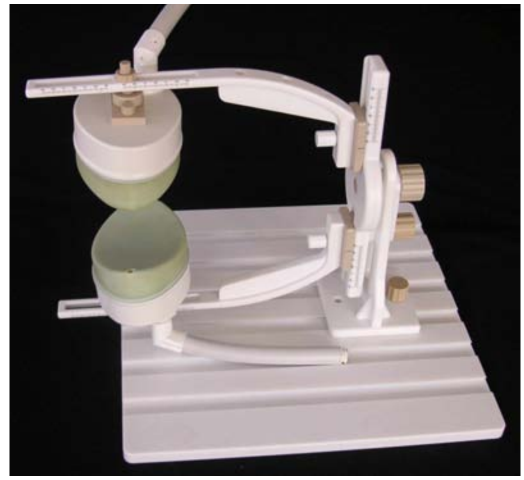

Figure 1: positioning system permits parallel orientation of coil planes

Concepts and Design:

A positioning system with rotary hinges (figure 1) was built to ensure the parallel orientation of the two coil planes with respect to each other. Thus, many different positions can be chosen and fixed while making use of the advantages offered by parallel imaging techniques, especially in 3D.

A pair of two four-channel proton array-coils (figure 2) was designed for a 1.5 T whole body NMR scanner, equipped with an active decoupling circuit, a fuse, RF chokes in the DC-line, and a shield trap for the RF signal line in each channel. The four circular loops have an inner diameter of 50 mm and are decoupled from each other via overlap of adjacent coils (isolation of about -25 dB), capacitive decoupling of next nearest neighbors (isolation of about -16 dB), and built-in low input impedance preamplifiers. An approximately elliptical area of about 120x92mm^2 of an object´s surface is covered by the four channels of one array. The penetration depth, where high SNR can be expected, is about 130mm for one array. Thus, an object with a diameter of up to approx. 240mm can be imaged by positioning the parallel arrays on both sides. The coil plane is slightly bent to fit to the patient's body better. The coupling network with phase shifters and the preamplifiers reside on a second and third plane above the loops and were implemented as an additional double sided circuit board (figure 2). This design was chosen to keep each four channel array shell compact. One shell can also be used stand-alone, as a surface array-coil.

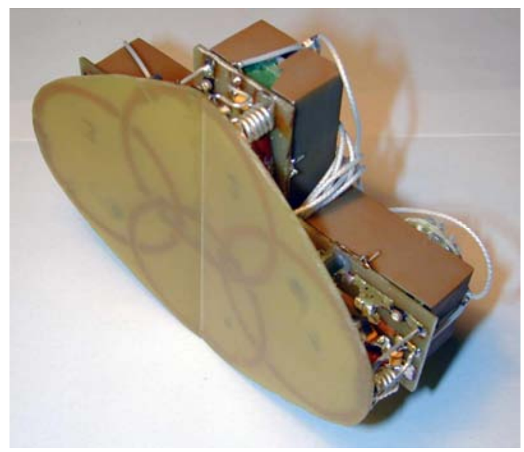

Figure 2: 4 channel array-coil with overlapping loops

Results:

Adequate isolation of all eight channels of the array was achieved and images of the covered area show high SNR. Encoding in one dimension using acceleration factors of R=2 to 4 with the GRAPPA algorithm [2] resulted in high-quality images as shown in figure 3.

Conclusions and Prospects:

The proposed coil design provides sensitivity variations in all spatial dimensions and therefore is highly suitable for volumetric parallel imaging. For 3D imaging and data reduction in two phase encoding directions scan-time reductions of factors R=6-8 are expected to provide reasonable image quality. Applications for the 4+4 channel system are high resolution imaging of wrist, knee, elbow, pediatric heart, ankle, ear, carotids etc. An additional pneumatic ECG-sensor can also be used for triggering in pediatric heart-imaging.

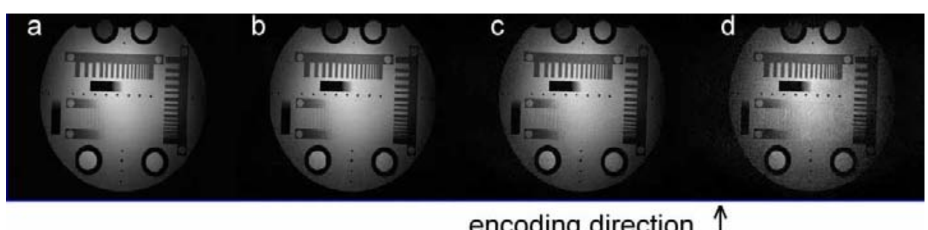

Figure 3: reference phantom image (a) and accelerated images R=2 (b), R=3 (c) and R=4 (d) after GRAPPA reconstruction.

References:

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[2] Griswold MA, Jakob PM, Heidemann RM, Nittka M, Jellus V, Wang J, Kiefer B, Haase A: Generalized autocalibrating partially parallel acqusitions (GRAPPA). *Magn Reson Med* 2002; **47**: 1202-1210

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