Densely-Populated Transceiver Surface Coil Array for the Human Brain Studies at 7 T.

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Introduction: Transceiver surface coil arrays have been shown to improve transmit performance (B_1/√kW) and B_1 homogeneity for head imaging up to 9.4 T (1,2). To further improve the SNR and facilitate parallel imaging, the number of array elements has to be increased as the size of individual coils is reduced. Overlapping the adjacent elements helps maintain reasonable coil size and, thus, not compromise the loading and the penetration depth. At the same time, overlapping complicates the decoupling. First, the adjacent overlapped surface coils generate substantial mutual resistance when loaded and cannot be decoupled using common capacitive or inductive decoupling methods, which compensate only for the mutual reactance. Second, in a densely-populated overlapped array, strong coupling exists between non-adjacent surface coils. In this work we have developed a single-row (1x16) transceiver head array of small overlapped surface coils with decoupling of both the adjacent and the next-to-one neighboring elements.

Methods: The transceiver phased array (Fig.1) consisted of 16 (9 cm – length, 5.6 cm - width) evenly spaced rectangular surface coils (Fig.2), circumscribing the head. The array measured 19.5 cm in width and 23 cm in height. In order to decrease radiation losses, the array was shielded with a shield located 4 cm away from the coils. Adjacent surface coils were partially decoupled by overlapping (12 mm overlap). Residual coupling was compensated using a novel resonance inductive decoupling (RID) technique, which was shown previously to compensate for both the reactive and the resistive components of the mutual impedance (3). Next-to-one neighboring surface coils were decoupled using conventional non-resonant inductive decoupling (Fig.2) (1). All data was acquired on a Varian Direct Drive 7T human imaging system.

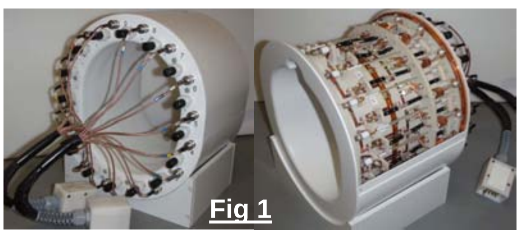


Fig 1

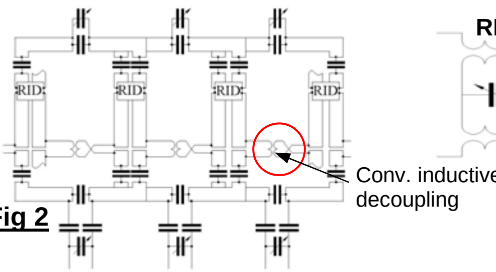
Fig 2


Fig 3

Results: Decoupling between adjacent surface coils loaded with a phantom or a human head was limited to -11 to -13 dB when only the conventional non-resonant inductive decoupling or overlapping was used. For unloaded coils, both methods provided decoupling better than -20 dB. Decoupling better than -24 dB was obtained for all loaded adjacent elements when overlapping in combination with the RID technique was used. Decoupling of -22 dB or better was obtained for all next-to-one neighboring surface coils. All other elements were decoupled to a level of -19 dB or better. Fig.4 shows axial B_1^+ maps (amplitude and phase) of individual array elements indicating excellent decoupling. Figs 5 and 6 show image and corresponding B_1^+ map of the entire array, demonstrating very good homogeneity. Homogeneity was evaluated as the standard deviation of the B_1^+ over the entire slice and measured 9.2 %.

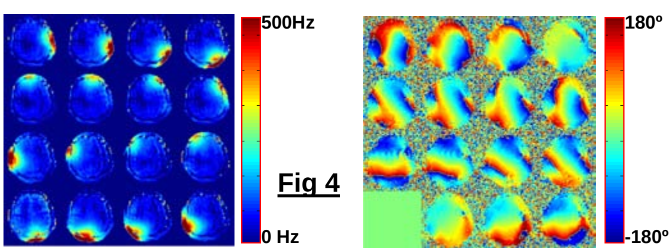


Fig 4

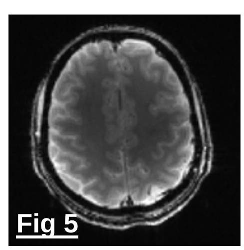


Fig 5

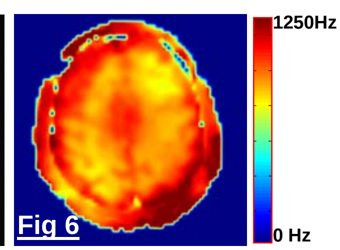


Fig 6

Conclusions: As a prove of concept, we have developed and constructed a single-row (1x16) transceiver head phased array consisting of small overlapped surface coils with decoupling of both the adjacent and the next-to-one neighboring elements. Using overlapping in combination with the novel RID method, we obtained decoupling better than -24 dB between all adjacent surface coils. Next-to-one neighboring surface coils were decoupled using conventional non-resonant inductive decoupling to a level of -22 dB or better.

References: 1) Avdievich N et al, Appl. Magn. Reson., 41(2):483-506, 2011. 2) Shajan G et al, Proc. ISMRM 2012, p.328. 3) Avdievich N et al, Proc. ISMRM 2012, p.2806.