Rotating Transmission Line Elements for Optimized Parallel Imaging

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INTRODUCTION: A number of recent papers [1-3] comprehensively described the design of array coils for parallel imaging. For transmit arrays, independent amplitude and phase control can be used in a variety of ways achieve a homogeneous excitation distribution. For a receive array, however, manipulation of sensitivity distributions and the g-factor require variation of the coil geometry. Stemming from work with stripline transmission line elements [4-7], we propose a new type of transmission line element which can be used to optimize the field distribution and g-factor easily by adjusting the orientation of the coils in the array.

METHOD: In this paper, we adopted a transmission line element geometry with a round cross-section. As shown in Fig. 1, we modeled the human head in an array of eight of these elements. Three examples of one coil element oriented to 0^o, 20^o, and 45^o are also given at the bottom of Fig. 1. Rotation of each coil element will change the sensitivity distribution and therefore change the g-factor distribution. The simulation work was performed using CST Microwave Studio (CST GmbH, Germany). A simple optimization procedure was used to determine the orientation of all elements to minimize the maximum g-factor.

RESULTS AND DISCUSSION: The g-factor distributions before and after optimization at different acceleration rates are presented in Fig. 2. From the results, it is clear that the g-factor maximum values and distribution are very sensitive to element orientation. The maximum g-factor can be decreased by 14.6% to 44.7% depending on the acceleration rate. This proposed coil design should be easily realized in hardware, and a coil prototype is currently being built. During MRI, this coil can be easily adjusted to minimize the g-factor and thus increase the SNR of the image or improve the practically-achievable acceleration rate.

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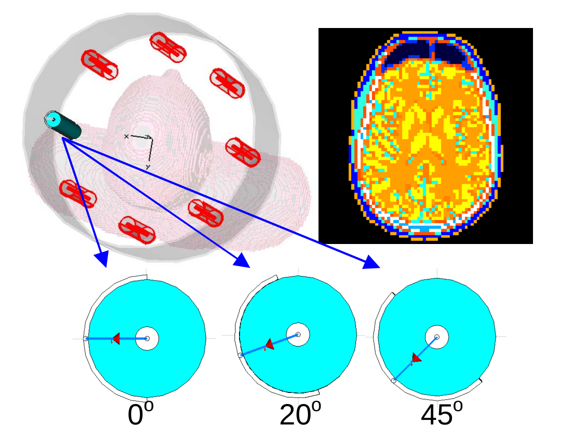

Figure 1 Coil geometry (top left) and axial slice through the human head model (top right). A close-up view of three different orientations for one element are shown at the bottom, where the dielectric substrate is blue, the conductive element fills the white region at the center of the substrate, and the semi-cylindrical ground plate appears as a white "C" at the outer edge of the substrate.

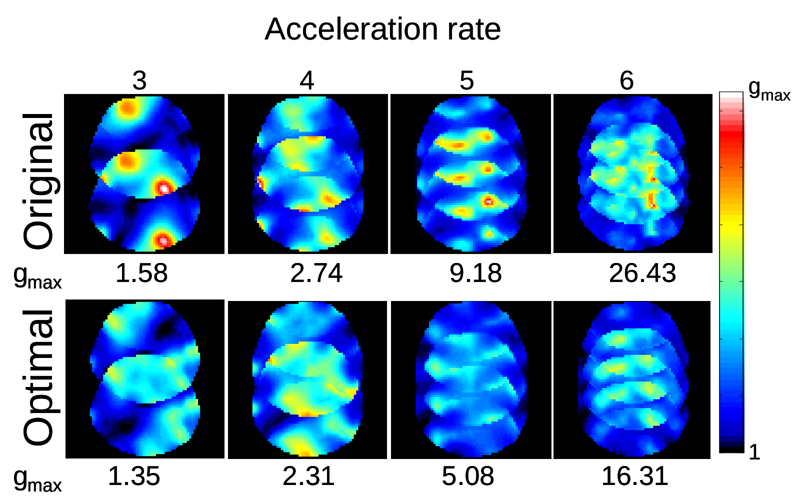

Figure 2 g-factor distribution at different acceleration rates for the central slice of the head before (top) and after (bottom) optimization by rotating the semi-cylindrical microstrip coil elements. For each acceleration rate, the g_{max} for the Original case is used in the color scale for both Original and Optimal cases.