Harmonic gradient coil for Parallel MR Microscopy

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Introduction

There are expanding applications using mouse models of human diseases. Because in vivo mouse MR microscopy can provide high-resolution images of anatomy and function, it is very important to use such images to study genomic expressions and pharmaceutical responses. For the purposes, high-throughput MR microscopy techniques are really desired. However, many previous parallel MRI systems [1] were not focused on developments of parallel gradient coils but multiple RF coils and/or receiver channels. In this study, we have developed the novel harmonic gradient coils, which have eight periodic imaging volumes.

Eight channel harmonic gradient coils for parallel MR microscopy

Figure 1 shows an eight-channel harmonic gradient coil for the 2.34T parallel MR microscope [2]. Figure 2 shows the schematic of the harmonic gradient coil. Eight Golay's coils (I.D. 4cm) are skillfully put closed in Gx and Gy directions and this have eight imaging volumes. While a typical Golay's coil provide gradient fields outside, the harmonic gradient coil make full use of the outside filed which can be the inside field.

Experiments

Imaging experiments were performed using a 2.34T/40cm superconducting magnet (homogeneous volume: 16 cm DSV) and the eight-channel MRI console [2] consists of an industrial PC for digital control and data acquisition, eight channel 100 MHz transceiver, gradient driver, and eight-channel wideband (10-200 MHz) class AB gated transmitter. The RF probes were exchangeable and 20 mm inner diameter saddle RF coils were used. Water phantoms were acquired using a 3D gradient echo sequence (TR=100ms, TE=7ms, NEX=1).

Results and discussion

Figure 3 shows 2D cross-sectional images selected from four 3D image data sets of the water phantoms. The image matrix is 128 x 128 x 128 and the voxel size is c.a. 200 x 240 x 500 micron cubed. This result shows that the harmonic gradient coil can create individual eight imaging volumes associated with linear Gx, Gy, and Gz. The measured gradient efficiencies are 0.5 G/cm/A(Gx, Gy) and 0.17 G/cm/A(Gz).

Because this harmoniousness can be extended to three orthogonal directions x, y, and z, large number of origins of coordinate axis are to be created, which solves aliasing effect [1] caused by use of large-bore gradient sets.

Conclusion

The harmonic gradient coil for eight-channel parallel MR microscope was developed and the imaging experiments were performed. The obtained eight individual images demonstrated that the system had a sufficient performance for large number of mice imaging. We have a plan to increase channel numbers for the harmonic gradient.

References

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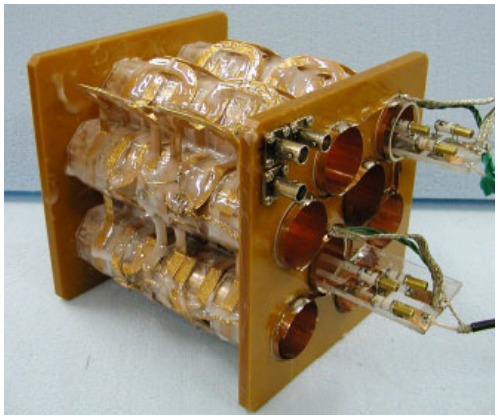

Figure 1

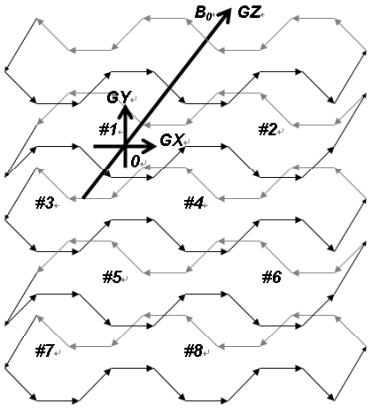

Figure 2

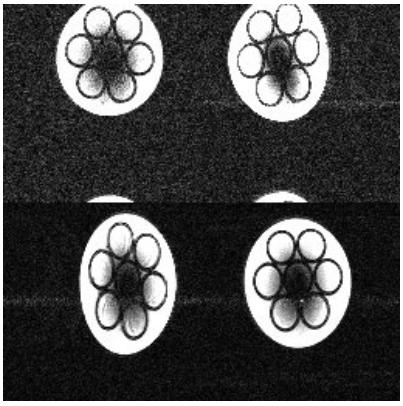

Figure 3

Fig.1. Eight channel harmonic gradient coil. Fig.2. Current distributions for a half side of Gy coils.

Fig.3. Water phantoms: 2D cross section in xy plane (x=0) of acquired 3D MR images at #1,#2, #3, or #4. The image matrix is 128 x 128 x 128 and the voxel size is c.a. 200 x 240 x 500 micron cubed.