RAPID AND SENSITIVE MEASUREMENT OF MAGNETIC FIELD HOMOGENEITY THROUGH ECHO PLANAR IMAGING

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Motivation:

Inhomogeneity in main magnetic field in MRI systems leads to artifacts such as:

- Geometrical distortion
- Inhomogeneous fat suppression
- Intensity non-uniformities
Motivation:

Recognizing these problems measurement of B0 homogeneity is an important part of the annual system performance measurements Required by the American College of Radiology (ACR).

- Full width at half maximum (FWHM)
- Phase difference method (Δϕ)

Problems:
- Technique Not available
- In patients may take too long (~ 20s)
- May fail for too large inhomogeneity Δϕ > 2π
Motivation:

Routing testing of magnetic field homogeneity on clinical MRI system*
Dr. Chen

Bandwidth-different method

\[ \nu_0 = \frac{\gamma}{2\pi} B_0 \]

\[ G_x = \frac{2\pi}{\gamma} \left( \frac{BW_x}{FOV_x} \right) \]

\[ \frac{\gamma}{2\pi} = 45.576 \text{ MHz/T} \]

Gyromagnetic ratio

*Med.Phys.33(11), Nov. 2006
Motivation:

Bandwidth-difference method:

\[ x' = x + \Delta B_0(x, y)/G_x \]

\[ G_x = \frac{2\pi}{\gamma} \left( \frac{BW_x}{FOV_x} \right) \]

1\text{st scan @ minimum } BW_1

2\text{nd scan @ maximum } BW_2

\[ H_B (ppm) = \frac{BW_1 \cdot BW_2 \cdot (x'_1 - x'_2)}{\gamma \cdot B_0 \cdot FOV_x \cdot (BW_2 - BW_1)} \]

Assumption:

- Geometric distortion solely due B0 inhomogeneity
- Gradients are linear with distance.
- Shape of the field inhomogeneity is linear in distance
Motivation:

Bandwidth-difference method:

Problems?!

Turbo/Fast Spin Echo (frequency encode direction is X)
Motivation:

Echo planar imaging

- Very sensitive to inhomogeneity in phase encode direction
- Very short acquisition time
Method:

1. On a 1.5T Siemens MRI
2. Adjust all gradient to optimized homogeneity
3. Adjust one linear field gradient Gy in PE direction
4. Acquired a single shot EPI
5. Measured dimension of the phantom in distorted direction
6. Calculated field gradient from distortion
Result:

Average difference between measured and nominal gradient field: 
0.62 ± 0.43 μT/m
Result:
Result:
Conclusion

We found a method that has a one-to-one linear relation between nominal field gradient & measured. The result demonstrate the accuracy of the method.

Future work

Quadratic Gradient

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Thank you
Accuracy from Changing Gy

\[
y = 1.0021x - 0.5631 \\
R^2 = 0.9999
\]