A novel combined level set model for automatic MR image segmentation

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Introduction

Medical image processing comes along with object segmentation, which is one of the most important tasks in that field. Nevertheless, noise and intensity inhomogeneity challenge the segmentation procedure in magnetic resonance images.

Methods

The level set method has been widely used in object detection. The flexible integration of energy terms affords the level set method to deal with variable difficulties. In this paper, we introduce a novel combined level set model that mainly cooperates with an edge detector and a local region intensity descriptor. The noise and intensity inhomogeneities are eliminated by the local region intensity descriptor. The edge detector helps the level set model to locate the object boundaries more precisely.

Results

The proposed model was validated on synthesized images and magnetic resonance images of in vivo wrist bones. Comparing with the ground truth, the proposed method reached a Dice similarity coefficient of > 0.99 on both image tests, while the compared segmentation approaches failed the segmentations.

Conclusion

The presented combined level set model can be used for the object segmentation in magnetic resonance images.

Investigating the influence of dielectric pads in 7T magnetic resonance imaging – simulated and experimental assessment

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Introduction

Dipole radiofrequency (RF) elements have been successfully used to compose multi-channel radiofrequency coils for several different imaging targets, especially for ultra-high fields (UHF) magnetic resonance imaging ($B_0 \geq 7T$). At UHF the magnetic (B_1) components of RF fields can be very inhomogeneous, since the wavelength becomes comparable to the dimensions of the head. To improve the B_1 efficiency and homogeneity, dielectric pads with high dielectric constants can be used as a passive B_1 shimmimg technique, because they induce a strong secondary magnetic field in their vicinity. Their use influence not only the B_1 field, but also the specific absorption rate (SAR) and consequently, the temperature distribution. To study these effects a 29 cm-long transmission dipole RF coil element terminated by two meander and optimized dielectric pads were used for 7T MRI. Simulated and experimental results were obtained to analyse the B_1 field distribution inside an agarose-gel based phantom for different configurations: with and without dielectric pads. Specific absoption rate (SAR) predictions were done to estimate energy absorption inside the object.

Methods

A single dipole RF element was used for RF signal transmission. A bottle filled with agarose-gel and dielectric pads (suspension of calcium titanate and deuterium oxide) were used for the experimental analysis. Numerical analysis simulating the same experimental setup were performed using the software Ansys.

Results

B_1 maps for the different configurations were acquired inside the phantom and compared with the simulations, indicating a good confidence in the simulation setup and revealing that dielectric pads improve B_1 homogeneity distribution. Estimations of local SAR indicate a different distribution when using dielectric pads.

Conclusion

Numerical and experimental investigations indicate that dielectric pads improve B_1 homogeneity and address higher B_1 magnitude for regions where it was previously not high enough. Simulations inform that local SAR distribution will change when using dielectric pads.