A Model-Independent, Multi-Image Approach to MR Inhomogeneity Correction

P.A. Bromiley and N.A. Thacker
Imaging Science and Biomedical Engineering, University of Manchester, Manchester, UK

Introduction

Inhomogeneity correction in MR images is a necessary pre-processing step for any algorithm that assumes consistent intensities across each tissue. The accuracy of the correction will be dependent upon signal-to-noise ratio, which will be higher in high-intensity tissues. In some cases it may be possible to acquire multiple images with consistent inhomogeneity fields, and with high intensities in all tissues across the set as a whole. Inhomogeneity correction can then be performed simultaneously across the image set, taking advantage of the increased information content to produce a more accurate result.

Method

Assume a mean regional intensity $g$, a smoothly varying multiplicative gain $G(x,y)$, and additive noise $n(x,y)$,

$$I(x,y) = g(x)G(x,y) + n(x,y)$$

Use a (-1,1) kernel to estimate intensity shifts, normalised to the intensity,

$$\Delta^x_{rel}(x,y) = \frac{2(I(x,y) - I(x-1,y))}{I(x,y) + I(x-1,y)}$$

Error propagation gives

$$\sigma^2_{rel}(x,y) = \frac{(I(x,y) + I(x-1,y))^2}{16 \sigma^2(I(x,y)^2 + (I(x-1,y))^2)}$$

Use errors to combine information from each image, then smooth

$$\Delta^x_{reg}(x,y) = \frac{S \otimes \Delta^x_{rel}(x,y) + 0_{reg}}{S \otimes (\sigma^2_{rel}(x,y) + \sigma^2_{reg})}$$

Reintegrate to obtain bias correction.

Results

T1 and T2 weighted Brainweb simulated data, and histograms for individual (top) and joint (bottom) inhomogeneity correction.

Conclusion

Joint inhomogeneity correction can provide superior results due to the increased information content in the joint data set.

www.tina-vision.net