COMPARISON STUDY OF INTENSITY NON UNIFORMITY CORRECTION METHODS FOR 3DT1 MRI ACQUISITIONS

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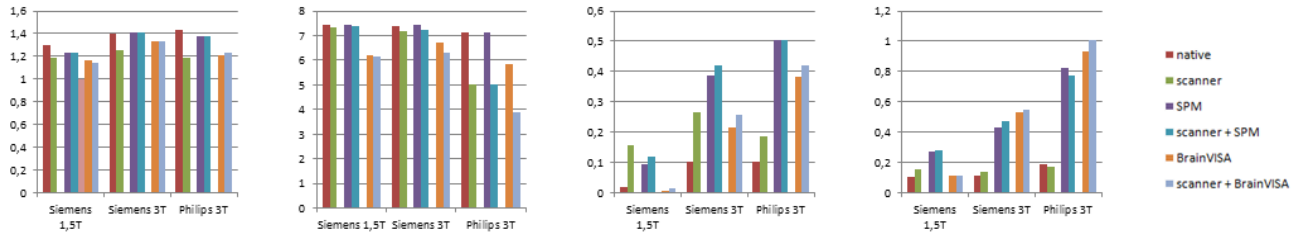
INTRODUCTION - In order to better understand pathological mechanisms and detect significant changes over time, multicentre studies are undertaken more and more often, with an embedded imaging project involving several manufacturers. Advanced morphological analyses based on MRI acquisitions often rely on a 3DT1 sequence, and depend on intensity characteristics either to derive segmentations [1][2] or other measures (BSI method [3], for example). MRI structural acquisitions suffer from intensity non uniformity artifact due to B1-field inhomogeneity. Manufacturers provide different solutions in order to reduce this artifact and allow the clinicians to better visualize the acquired datasets. Nevertheless, these methods differ between manufacturers and may not be sufficient to remove the artifact. Thus, image processing softwares often include their own non uniformity correction; reviews of available methods show that many algorithms have been developed [4].

Two major drawbacks may be faced when using manufacturer-based corrections: multicenter datasets would be collected with different algorithms inherent to the manufacturer and two pre-processing steps would be done sequentially, thus potentially combining the drawbacks from both. Nevertheless, the influence of manufacturer correction method has not yet been fully assessed. The goal of this study was to evaluate combinations of manufacturers and freely available post-processing methods (the T1 bias correction from BrainVISA [1] and the bias correction derived from the unified segmentation of SPM8 [2]) on image quality, as given by indices based on gray/white contrast, entropy and histogram analysis. It was undertaken within the Center for Acquisitions and Image Processing (CATI), which handles major neuro-imaging multicentre projects, in order to determine if manufacturer-based corrections were compulsory in multicentre research protocols (as ADNI [5] for example).

METHODS - We evaluated the intensity corrections strategies with respect to intensity characteristics of the corrected images. Acquisitions from the MEMENTO study pilot stage were used here. Three MRI scanners were considered: a Philips Achieva 3T (CHRU Lille), a Siemens VERIO 3T (CENIR) and a Siemens Symphony 1,5T (CHU Marseille) scanner. For each center, 5 subjects were chosen for the evaluation. Six images were considered for each subject: 1. native image with no correction, 2. scanner corrected image, 3. native image with SPM correction, 4. scanner corrected image with SPM correction, 5. native image with BrainVISA correction, 6. scanner corrected image with BrainVISA correction. The brain mask (White Matter, WM, and Gray Matter, GM) was obtained from the native image using BrainVISA segmentation and used for all images; it has been visually checked for every subject.

Four indices are reported for evaluation. The contrast between WM and GM was computed on two ellipsoid ROIs manually placed in the hippocampus(for GM) and in an homogeneous subcortical white matter area at corresponding sagittal and coronal location (for WM): C = <WM>/<GM>; the contrast needs to be preserved while continuous intensity changes are corrected. The entropy over the whole image was determined, as increased homogeneity will decrease tissue variation and decrease entropy. The last pair of indices aimed at characterizing the intensity histogram computed on the brain mask. To do so, the way the GM and WM modes can be differentiated was quantified using three values: the probability of the GM mode, PmodeGM; the probability of the WM mode, PmodeWM, and the probability of the "valley" between both modes, PValley. This allows defining two indices named "peak/Valley" P/V_WM and P/V_GM, computing the difference between mode and valley probabilities; they are defined as. P/V_WM = (PmodeWM – PValley) / (PmodeWM + PValley). For a given contrast, inhomogenetities will tend to cause the modes to be wider and merge together, reducing the valley between the two modes.

RESULTS - Values for evaluation indices are displayed in figure 1, in order to visually compare the effect of each correction or combination of corrections on image quality. Contrast appeared to be decreased with the manufacturer correction but maintained/restored with the SPM method, for all scanners. SPM did not appear to modify image entropy, while BrainVISA systematically reduced it more than the manufacturer methods. Finally, the histogram on the brain mask was overall sharper for the two post processing methods, apart from the 1.5T datasets, with SPM derived histogram modes being more balanced.



a-Contrast on ellipsoid ROI b-Global image entropy c-Peak/Valley index for GM d-Peak/Valley index for WM Corrections

Figure 1: indices value averaged for the five subjects in each center, for the six images

CONCLUSIONS - In conclusion, different non uniformity correction strategies have been compared on data from three MRI scanners from two manufacturers and at 3T and 1.5T. This preliminary evaluation indicates that postprocessing strategies appeared to perform correctly on either native or scanner corrected data. Manufacturers strategies increase image quality for visualisation, but may not be sufficient for advanced automatic quantitative analyses. Post processing strategies may allow obtaining better intensity uniformity, and may be sufficient for multicentre studies; comparison between the two approaches revealed complementary advantages and weaknesses, which could be explained by their underlying methods.

REFERENCES

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