Evaluating MACC for improved MS rater agreement

D. S. Wack[1], M. G. Dwyer[1], N. Bergsland[1], S. Hussein[1], and R. Zivadinov[1]
[1]University at Buffalo, Buffalo Neuroimaging Analysis Center, Buffalo, NY, United States

Introduction: Operator differences in *outlining* Multiple Sclerosis (MS) T2 hyper-intense lesions can account for more than five times the amount of error by volume, than differences in lesion detection. In most cases, good delineation of lesions can be specified by a single value, which is the value along an iso-contour curve about the lesion. We evaluate Minimum Area Contour Change (MACC) software for use in evaluating lesions, and give two use cases for MACC: 1) *Creation of ROIs on follow up scans.* 2) *Improved inter-rater agreement.* We also evaluate whether MACC introduces a substantial bias to the analysis.

Methods: *Software:* The MACC program first bounds (spatially) the solution path; forms 250 contour curves, based on 250 equally spaced contour values; then selects the best contour value to outline a lesion. It is valid to have multiple ROIs formed from one input ROI, or the opposite. MACC calculates the ratio of the square root of the area of a conforming contour, with the square root of the area of the immediately lower valued conforming contour. MACC selects the pair of contours whose ratio is closest to 1; and chooses the inner (higher valued) contour to be the "MACC" contour of the lesion. MACC outputs can then be edited. *Scans and Human raters:* T2 hyperintense lesion masks were formed by two trained operators, on two serial 1.5T scans, on a sub-sample of 13 subjects enrolled in a phase II clinical trial. *Measures:*OER = 1 – (intersection/union) of intersecting ROIS. DE = sum of ROI areas which do not intersect with the opposite set of ROIs. Additionally, Similarity Index (SI) is used.

Results: Initial agreement between operators drawing separate sets of ROIs for time 1 scans is given in Table 1, row A. If both operators ROIs are processed through MACC, the resulting ROIs have improved agreement, row B, while the MACC and original version maintain high agreement, row C. Figure 1, shows the ROI size distributions between rater1 and rater 2. Both curves are relatively symmetrical, showing an equal distribution in how both raters sized their ROIs, both before and after MACC. The peak at zero difference, is much higher for the MACC processed ROIs. Using rater's 1's ROIs, to create ROIs on image 2, yields high agreement with ROIs drawn separately, row D.

Discussion: MACC performs similarly to another human rater. Trial use has shown MACC to execute in approximately 20 seconds per scan. ROI inspection and editing is substantially faster than an all manual operator approach. The resulting ROI have better inter-operator agreement, and do not exhibit a size bias with original operators ROIs.

	ROI Sets	Detection Error mm^2	Outline Error Rate	SI
A	ROIr1_im1 v ROIr2_im1	747	.41	.64
B	MACC(ROIr1_im1, im1) v MACC(ROIr2_im1, im1)	704	.20	.72
C	MACC(ROIr1_im1, IM1) v ROI1_im1	29.8	.38	.80
D	MACC(ROIr1_im1, IM2) v ROI1_im2	384	.42	.65

Table 1

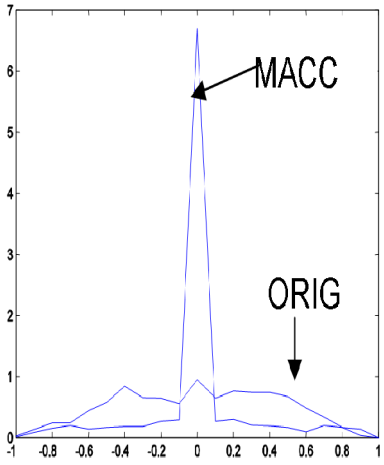

Figure 1