Combined use of radiomics and artificial neural networks for the three- dimensional automatic segmentation of glioblastoma multiforme

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Abstract. Glioblastoma multiforme (GBM) is the most prevalent and agressive primary brain tumour that has the worst prognosis in adults. Currently, the automatic segmentation of this kind of tumour is being intensively studied. Here, the automatic three-dimensional segmentation of the GBM is achieved with its related subzones (active tumour, inner necrosis, and peripheral oedema). Preliminary segmentations were first defined based on the four basic magnetic resonance imaging modalities and classic image processing methods (multithreshold Otsu, Chan–Vese active contours, and morphological erosion). After an automatic gap-filling post processing step, these preliminary segmentations were combined and corrected by a supervised artificial neural network of multilayer perceptron type with a hidden layer of 80 neurons, fed by 30 selected radiomic features of gray intensity and texture. Network classification has an overall accuracy of 83.9%, while the complete combined algorithm achieves average Dice similarity coefficients of 89.3%, 80.7%, 79.7%, and 66.4% for the entire region of interest, active tumour, oedema, and necrosis segmentations, respectively. These values are in the range of the best reported in the present bibliography, but even with better Hausdorff distances and lower computational costs. Results presented here evidence that it is possible to achieve the automatic segmentation of this kind of tumour by traditional radiomics. This has relevant clinical potential at the time of diagnosis, precision radiotherapy planning, or post- treatment response evaluation.

Keywords: Artificial Neural Networks, Automatic Segmentation, Glioblastoma Multiforme, Image Processing, Radiomics.

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