

Supervised Machine Learning for Brain Tumor Detection in Structural MRI

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BACKGROUND

Brain tumor detection from MRI data is tedious for physicians and challenging for computers. Detection of small tumors, which often form early primary neoplastic or metastatic disease, is particularly difficult and has only recently been a focus of state-of-the-art work [1][2].

EVALUATION

Starting with skull-stripping and midsagittal plane alignment, tumor candidates as blobby structures are obtained by 3D image convolution using multi-scale LoG filters. We then compute the blob shape, compactness, asymmetry and intensity statistics, generating a set of 21 features (9.5 min).

For training, Sequential Forward Selection, wrapped around a Quadratic Discriminant Analysis classifier, is performed on the feature set (8 sec). For testing, 5 classifiers (LDA, QDA, Naive Bayes (linear, quadratic), Mahalanobis) are used in the selected feature space (average 8.2 features, 1.3 sec). Our data consists of 20 T1-weighted enhanced brain MRIs with a total of 86 tumors (2-38 mm diameter). We perform 100 random training-testing splits where 85% of the tumors and an equal number of non-tumors are used for training; the remaining data is used for testing. The average sensitivity and specificity rates are 97.5%(+4.7) and 94.7%(+1.4) respectively.

DISCUSSION

The small performance variance among different classifiers demonstrates the collective discriminative power of the automatically chosen features. Our sensitivity rates and time (9.6 min) outperform those reported by [1] (89.9%, 30 min) and [2] (90.1%).

CONCLUSION

Our contribution is a complete, versatile and fast computer algorithm that is able to automatically identify discriminative features for brain tumor detection and achieve high tumor detection rates from a single modality of clinical volumetric MRIs. Future work will focus on false positive reduction to make such an algorithm more robust in clinical practice.

[1]Ambrosini and Wang, Computer-aided detection of metastatic brain tumors using automated three-dimensional template matching. J.of MRI, 2010.

[2]Sugimoto, et al. Computerized Detection of Metastatic Brain Tumors on Contrast-Enhanced 3D MR Images by Using a Selective Enhancement Filter. World Congress on Medical Physics and Biomed Engr, 2010.

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