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Use of Machine Learning Algorithms to Pediatric MR Images for Tumor Classification

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Abstract : Introduction: Brain and central nervous system (CNS) tumors form the second most common group of cancer in children, accounting for 30% of all childhood cancers. MRI is the key imaging technique used for the visualization and management of pediatric brain tumors. Initial characterization of tumors from MRI scans is usually performed via a radiologist's visual assessment. However, different brain tumor types do not always demonstrate clear differences in visual appearance. Using only conventional MRI to provide a definite diagnosis could potentially lead to inaccurate results, and so histopathological examination of biopsy samples is currently considered to be the gold standard for obtaining definite diagnoses. Machine learning is defined as the study of computational algorithms that can use, complex or not, mathematical relationships and patterns from empirical and scientific data to make reliable decisions. Concerning the above, machine learning techniques could provide effective and accurate ways to automate and speed up the analysis and diagnosis for medical images. Machine learning applications in radiology are or could potentially be useful in practice for medical image segmentation and registration, computer-aided detection and diagnosis systems for CT, MR or radiography images and functional MR (fMRI) images for brain activity analysis and neurological disease diagnosis. Purpose: The objective of this study is to provide an automated tool, which may assist in the imaging evaluation and classification of brain neoplasms in pediatric patients by determining the glioma type, grade and differentiating between different brain tissue types. Moreover, a future purpose is to present an alternative way of quick and accurate diagnosis in order to save time and resources in the daily medical workflow. Materials and Methods: A cohort, of 80 pediatric patients with a diagnosis of posterior fossa tumor, was used: 20 ependymomas, 20 astrocytomas, 20 medulloblastomas and 20 healthy children. The MR sequences used, for every single patient, were the following: axial T1-weighted (T1), axial T2-weighted (T2), FluidAttenuated Inversion Recovery (FLAIR), axial diffusion weighted images (DWI), axial contrast-enhanced T1-weighted (T1ce). From every sequence only a principal slice was used that manually traced by two expert radiologists. Image acquisition was carried out on a GE HDxt 1.5-T scanner. The images were preprocessed following a number of steps including noise reduction, bias-field correction, thresholding, coregistration of all sequences (T1, T2, T1ce, FLAIR, DWI), skull stripping, and histogram matching. A large number of features for investigation were chosen, which included age, tumor shape characteristics, image intensity characteristics and texture features. After selecting the features for achieving the highest accuracy using the least number of variables, four machine learning classification algorithms were used: k-Nearest Neighbour, Support-Vector Machines, C4.5 Decision Tree and Convolutional Neural Network. The machine learning schemes and the image analysis are implemented in the WEKA platform and MatLab platform respectively. Results-Conclusions: The results and the accuracy of images classification for each type of glioma by the four different algorithms are still on process.

Keywords : image classification, machine learning algorithms, pediatric MRI, pediatric oncology
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