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Automatic classification of computed tomography brain images using ANN, k-NN and SVM

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Abstract Computed tomography images are widely used in the diagnosis of intracranial hematoma and hemorrhage. This paper presents a new approach for automated diagnosis based on classification of the normal and abnormal images of computed tomography. The computed tomography images used in the classification consists of non-enhanced computed tomography images. The proposed method consists of four stages namely pre-processing, feature extraction, feature reduction and classification. The discrete wavelet transform coefficients are the features extracted in this method. The essential coefficients are selected by the principal component analysis. The features derived are used to train the binary classifier, which infer automatically whether the image is that of a normal brain or a pathological brain, suffering from brain lesion. The proposed method has been evaluated on a dataset of 80 images. A classification with a success of 92, 97 and 98 % has been obtained by artificial neural network, k-nearest neighbor and support vector machine, respectively. This result shows that the proposed technique is robust and effective.

Keywords Computed tomography (CT) · Principal component analysis · Discrete wavelet transform · Artificial neural network · k-Nearest neighbor · Support vector machine

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1 Introduction

Computed tomography (CT) images are widely used for the diagnosis of intracranial hematoma and hemorrhage because CT is quick to perform and compatible with most life support devices. CT and magnetic resonance imaging (MRI) are the two modalities that are regularly used for brain imaging. In most instances, CT provides information required to make decisions during emergency (Kidwell and Wintermark 2010). Compared to MRI, brain imaging with CT is more reliable, less expensive, quicker and more accessible, especially in severe ill patients. Non-enhanced CT is often the first radiologic examination performed in case of suspicion of hematoma and hemorrhage (Liu et al. 2008; Perez et al. 2009). The use of CT in medical decision support is now widespread and pervasive across a wide range of the medical area, such as intracerebral hematoma, epidural hematoma, sub-arachnoid hemorrhage and subdural hematoma. Fully automatic normal and pathological brain classification can be obtained from CT images, which is very important for research and clinical studies.

Discrete wavelet transform (DWT) is an effective tool for feature extraction, because they allow analysis of images at various levels of resolution. This technique requires large storage and is computationally more expensive. In order to reduce the feature vector dimension and increase the discriminative power, the principal component analysis (PCA) has been used. Principal component analysis (Jolliffe 1986) is appealing since it effectively reduces the dimensionality of the data and, therefore, reduces the computational cost of analyzing new data. To perform the classification of the input data, the ANN, k-NN and SVM have been used.

There are many computer-aided detection systems for CT brain images in the literature, most of them are used to

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