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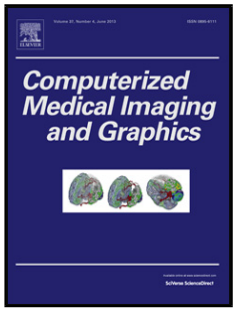

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Computer-Aided Diagnosis of Cavernous Malformations in Brain MR Images

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Abstract

Cavernous malformation or cavernoma is one of the most common epileptogenic lesions. It is a type of brain vessel abnormality that can cause serious symptoms such as seizures, intracerebral hemorrhage, and various neurological disorders. Manual detection of cavernomas by physicians in a large set of brain MRI slices is a time-consuming and labor-intensive task and often delays diagnosis. In this paper, we propose a computer-aided diagnosis (CAD) system for cavernomas based on T2-weighted axial plane MRI image analysis. The proposed technique first extracts the brain area based on atlas registration and active contour model, and then performs template matching to obtain candidate cavernoma regions. Texture, the histogram of oriented gradients and local binary pattern features of each candidate region are calculated, and principal component analysis is applied to reduce the feature dimensionality. Support vector machines (SVMs) are finally used to classify each region into cavernoma or non-cavernoma so that most of the false positives (obtained by template matching) are eliminated. The performance of the proposed CAD system is evaluated and experimental results show that it provides superior performance in cavernoma detection compared to existing techniques.

Keywords: Cavernous malformation, computer-aided diagnosis, skull stripping, template matching, principal component analysis, support vector machine

1. Introduction

Epilepsy is the fourth common neurological problem (after migraine, stroke, and Alzheimer's disease) [1], which affects about 1% of the population worldwide [2]. Epilepsy may have significant impacts on people's lives as it is reported [3] that the rate of sudden unexpected death in epilepsy is two times higher than that in the general population. A large number of epilepsy patients suffer from physical injuries including cuts, bruises, burns, head injury, broken bones and others. Furthermore, people with epilepsy are more likely to have mood (such as depression) and sleeping problem. Although most of the causes of epilepsy are still unknown, some epileptogenic lesions are typically found in images obtained by brain magnetic resonance imaging (MRI). An important epileptogenic lesion is cavernous malformation or cavernoma that arises due to vascular abnormality involving a cluster of abnormal vessels in brain [4]. MRI is a frequently used imaging method to diagnose cavernomas in hospitals because of the high image quality of soft tissues in the brain. Fig. 1 shows three T2-weighted (T2W) image with cavernous malformations surrounded by square boxes. In a T2W image, a cavernoma typically looks like a popcorn with black surrounding due to the presence of hemosiderin. In typical brain lesion detection, the task is to detect the presence of a malformation and determine its location [5]. However, visual identification of cavernomas in a large set of MRI slices is a tedious and time-consuming task that may result in a slow diagnosis and even misdiagnosis. Therefore, computer-aided diagnosis (CAD) that can process the input MRI images using a computer to generate diagnosis results is highly desirable to improve the efficiency and accuracy of diagnosis.

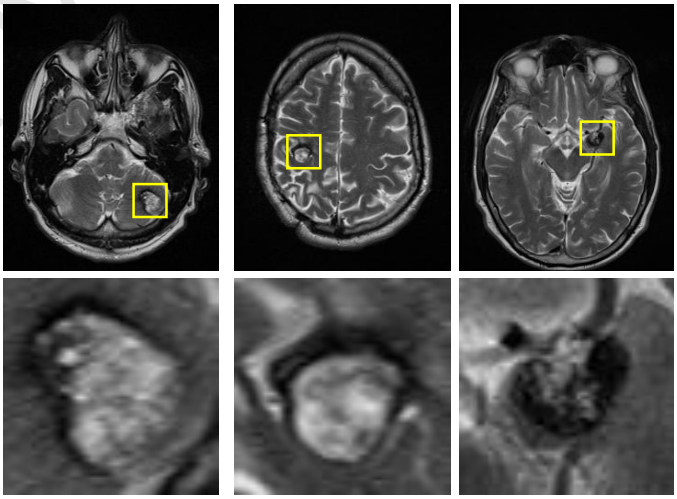

Figure 1: Three examples of cavernous malformations in T2W images. Top row: original images with cavernomas in yellow boxes. Bottom row: enlarged cavernoma regions.

To the author's knowledge, there is no CAD technique in the literature specifically for the detection of cavernous malformations. However, several CAD systems for other brain diseases have been proposed by researchers, such as those for brain tumor [6–9], Alzheimer's disease [10–12], vascular dementia and

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