Automatic Focal Cortical Dysplasiav(FCD) detection by Magnetic Resonance Image (MRI)

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Nowadays, approximately 50 million people are suffering from epilepsy all over the world, of whom 30% have Focal Cortical Dysplasia (FCD), a malformation that occurs during brain cortical development. In clinical treatments, FCD lesions often have to be removed by resective surgery. Magnetic Resonance Imaging (MRI) is the most important clinical tool for identifying FCD lesions, and has allowed the diagnostic detection of FCD lesions in an increasing number of patients, leading to increased rates of successful resective surgery.

However, detection of FCD lesions is still a challenging task because of various factors such as extremely subtle FCD malformations, complex convolutions of human cerebral cortex and partial volume effect due to imaging.

Several computational models of MRI features have been developed to improve FCD lesion detection. Cortical thickening is detected by measuring the thickness of Gray Matter (GM), blurry Gray-White matter Boundary (GWB-blur) is modelled by analysing gradient magnitude, and the area with hyper-intensity T1 signal is emphasized through relative intensity. All these MRI features have been created for enhancement of FCD lesional areas. To perform automated FCD lesion detection, previous attempts include the development of a Bayesian classifier which is driven by MRI features of FCD lesions and texture analysis of images. Then, these regions are expanded towards GM boundary by level set framework. However, it is necessary to compare MRI features of Patients with that of Healthy controls since these MRI features also exist in Healthy controls. Comparison of Patient and Healthy controls at voxel-level have been applied in previous work. However, Comparison at voxel-level highly depends on accuracy registration and is error prone, because brain structure are complex convolutions.

Motivated by the previous works, we developed a novel way to achieve fully automatic FCD detection. First, to reduce False Positive of FCD lesions, we use a method of brain-atlas based segmentation to remove some brain tissues. These brain tissues are irrelevant to FCD regions according to the literatures. Second, to overcome the drawback of voxel-wise comparison, we propose to compare the MRI features of Patients with that of Healthy controls at connected region level. These regions are generated by Fast Generalized Fuzzy C Means (FGFCM) and morphology analysis. Then, we get a new FCD feature map called Relative z-score of GM thinckness. Third, we calculate the probability of observed regions being GM or FCD by Multivariate Gaussian Membership Function. Every observed region has 7 MRI features (Gradient map, GM thickness, Relative Intensity Map, GWB thickness, z-score of GM thickness, z-score of GWB thickness and Relative z-score of GM thinckness). Finally, we make the decision of observed regions being GM or FCD according to its probabilities. Such that observed regions in healthy controls should belong to GM, while the observed regions in FCD patients should be GM and FCD.

As a results, we improve the similarity index than the previous method. Sensitivity and specificity are also improved by proposed work. The proposed work can be a useful clinical tool to assist FCD detection.