A new deformable model based on fractional Wright energy function for tumor segmentation of volumetric brain MRI scans

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1. Introduction

Medical imaging is a powerful technology used for gaining a direct insight into medical abnormalities by creating visual illustrations of the internal organs or tissues of the human body [1]. Brain tumors are considered one of the most difficult tumors to diagnose due to their complicated pathology [2,3]. This difficulty arises from the fact that some pathological tissues appear heterogeneous (i.e. overlap) with normal tissues of the brain. Accurate classification and segmentation of brain tumors can help to understand the lesions-deficit relationship in order to predict clinical diagnosis and prognosis, and chart the response of brain pathology over time. The MRI is a powerful imaging technology for brain tumor diagnosis due to its capability to distinguish the soft tissues in a non-invasive manner [4]. MRI differentiate itself from other medical technologies by using different image acquisition protocols to produce various MRI modalities simultaneously of the same brain tissue with different contrast visualization. These modalities provide additional anatomical information that assist the clinicians in their diagnosis. Most common MRI modalities that are used for brain tumors diagnosis include: fluid attenuated inversion recovery (FLAIR); T2 weighted images; T1 weighted images, and T1 weighted images with contrast enhancement [2,5]. The brain tumors look as a hyper-intense in T2-weighted images due to high water content, and are not distinguishable from T1 and T2 weighted images because of similarity with the surrounding brain tissue [2,6]. Therefore, a Gadolinium-based contrast material is needed to boost tumors’ boundaries against the enclosure normal tissue on T1 weighted images [7], where it shortens the T2 and T1 relaxation times and the resulting contrast-enhanced tumors look as hypo-intense, and hyper-intense in T2 and T1 weighted images respectively [6].

The proper delineation of brain tumors due to the similarities in the distribution intensities of tumors and healthy tissues of the brain white matter (WM) and the brain gray matter (GM) is consider as major challenge for brain tumor medical imaging [2]. Several automated brain tumors segmentation methods have been