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Research Paper

Deep CNN based MR image denoising for tumor segmentation using watershed transform

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Abstract

Magnetic Resonance Imaging (MRI) is considered one of the most effective imaging techniques used in the medical field for both clinical investigation and diagnosis. This is due to the fact that MRI provides many critical features of the tissue including both physiological and chemical information. Rician noise affects MR images during acquisition thereby reducing the quality of the image and complicating the accurate diagnosis. In this paper, we propose a novel technique for MR image denoising using Deep Convolutional Neural Network (Deep CNN) and anisotropic diffusion (AD) which we will refer to as Deep CNN-AD. Watershed transform is then used to segment the tumorous portion of the denoised image. The proposed method is tested on the BraTS MRI datasets. The proposed denoising method produced better results compared to previous methods. As denoising process affect the segmentation process therefore better denoised images by proposed technique produced more accurate segmentation with an average Specificity of 99.85% and dice coefficient of 90.46% thus indicating better performance of proposed technique.

Keywords: *Deep CNN Denoising, Brain Tumor Segmentation, Anisotropic Diffusion, BraTS MRI, Rician Noise.*

1. Introduction

Magnetic Resonance (MR) image is an effective, non-invasive imaging method to capture and analyse different body tissues which helps the physician to diagnose and cure the disease. Brain is the most critical and complicated part of the human body and relatively advanced techniques are required to observe the internal parts and tissues of it. The most common technique used by doctors for the diagnosis and treatment of tumors is the MR Imaging (MRI) Technique.

Two main types of tumors exist namely the primary brain tumor and secondary brain tumor. Primary brain tumor which is also known as malignant tumor; it is usually formed inside brain nerves [1]. Secondary brain tumor is originated from any other body part but spread through to the brain, e.g. tumor in lungs or breast spreading through to the brain causing secondary brain tumor [2]. Primary brain tumor has two main types. First one is malignant gliomas, which is generated inside glial cells of central nervous system and this is the most deadly brain tumor type [3]. Second type is Non-gliomas which does not arise from glial cells therefore it is considered as less dangerous compare to malignant gliomas [4]. Both types of tumor have different type of curing procedures and it is very critical for the doctors to identify the correct tumor type. In the presence of noise, the task of tumor classification is extremely difficult; therefore de-noising the MR image is very important and crucial to identify the correct brain tumor type.

Images of the brain internal structure and tissues are generated by powerful magnetic field in MR imaging technology. Noise is generated during the image acquisition and transmission phase. Thermal noise fluctuating the image in a random manner is generated due to magnetic field. Impulse noise is also observed during acquisition and transmission. These noise factors can affect the features of the MR images which are necessary in the classification of tumor type [5]. Minute variation of pixel intensity exist in grayscale image making the segmentation task a complex problem. Therefore, noise reduction in pre-processing stage, from MR images is pivotal. Besides thermal and impulse noise, there are other noises included in MR images, such as Speckle noise, Gaussian noise, Salt and Pepper noise and Rician distribution noise of MR images. Different filters and methods are used to suppress such noise types [6-7].

A number of methods for brain segmentation has been proposed and research work on this topic is still ongoing to design an automated system. Methods like Deep Convolution Neural Networks (CNN), Water shed transformation, and many other techniques has been used in this area [8-9].

The main motivation for this work is to enhance the automated accurate segmentation of the tumorous portion of MR images. Accurate segmentation and subsequent classification of tumorous image assists in the automated accurate diagnosis of tumor classes which affects the medication process and could lead to live saving applications. The accurate segmentation is directly affected by the quality of the MR images. Unfortunately, MR image get affected by noise during the image acquisition and transmission phase. Denoising the images sometimes degrades the quality of the image increasing the complexity of the segmentation. We propose in this paper a novel and simple denoising technique that results in de-