Chapter 19
Brain Tumor Detection Based on Multilevel 2D Histogram Image Segmentation Using DEWO Optimization Algorithm

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ABSTRACT

Brain tumor detection from magnetic resonance (MR)images is a tedious task but vital for early prediction of the disease which until now is solely based on the experience of medical practitioners. Multilevel image segmentation is a computationally simple and efficient approach for segmenting brain MR images. Conventional image segmentation does not consider the spatial correlation of image pixels and lacks better post-filtering efficiency. This study presents a Renyi entropy-based multilevel image segmentation approach using a combination of differential evolution and whale optimization algorithms (DEWO) to detect brain tumors. Further, to validate the efficiency of the proposed hybrid algorithm, it is compared with some prominent metaheuristic algorithms in recent past using between-class variance and the Tsallis entropy functions. The proposed hybrid algorithm for image segmentation is able to achieve better results than all the other metaheuristic algorithms in every entropy-based segmentation performed on brain MR images.

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1. INTRODUCTION

In modern era, clinical experts take help of e-healthcare and automated systems to provide better diagnosis to the patients. Inspection of abnormalities in internal organs is a tedious job that require invasive/non-invasive imaging approach. These abnormalities are extensively recorded using magnetic resonance (MR) imaging, after which the images are processed to infer the location and severity of disease in the internal organs. In healthcare domain, image examination is an integral procedure where pre-processing, investigation, categorization and post-processing of medical images is performed. Medical image segmentation is the widely adopted technique in many real time applications as the pixel gray level value for objects in an image and the pixel gray level value for the image background are substantially different. This can be exploited to get various homogeneous regions in a medical image for synthesis and analysis (Heimann et al., 2009). Image segmentation can be performed by various methods such as threshold, edge detection, region growing, split and merge, neural networks, clustering, compression and histogram techniques. Thresholding techniques extract objects based on the gray level of pixels by differentiating objects from other objects and background in an image (Sezgin & Sankur, 2004). Some of the prominent domains where thresholding can be applied are: medical imaging applications like cell images (Sieracki et al., 1989), x-ray computed tomography (Oh & Lindquist, 1999), con-focal microscopy using laser scanners (Jubany et al., 2009), Cancer and tumor prediction (Al-Tarawneh, 2012), etc. Multilevel thresholding technique is one of the prominent approaches of image segmentation as it extracts more than one region of interest in a simple and efficient manner. Some of the criterion functions that are optimized in thresholding are class variance (Otsu, 1979), classification error (Kittler & Illingworth, 1986), or entropy (Pun, 1980). Some of the prominent entropy thresholding functions include Kapur's entropy (Wong & Sahoo, 1989), Renyi's entropy (Sahoo & Arora, 2004), Tsallis entropy (Tang et al., 2009), and Otsu's thresholding method (Otsu, 1979). The major drawback of entropy-based thresholding functions is that they only use the gray level distribution of an image resulting in same histogram and thresholds for different images. This drawback was addressed by Abutaleb (1989), by developing the concept of a 2D histogram that contains spatial information in addition to gray level distribution information. 2D histogram-based techniques ignore information related to edges and only consider objects and background information. Non-local means based 2D histogram techniques are provided with better post filter clarity of images with better results (Mittal & Saraswat, 2018). Conventional multilevel thresholding techniques require exhaustive computation and hence are time-consuming (Kapur et al., 1985). This drawback is addressed by using threshold level as a spatial dimension for metaheuristic algorithms. Over the last few years, many researchers have shown interest in solving multilevel thresholding segmentation problem using different metaheuristic algorithms like Simulated Annealing (SA) (Fengjie et al., 2009), Ant Colony Optimization(ACO) (Wang et al., 2005), Genetic Algorithm(GA) (Maulik, 2009), Firefly Algorithm (FA) (Xiao-Feng et al., 2016), Artificial Fish-Swarm (AFS) (Xiao-Feng et al., 2016), Swallow Swarm Optimization (SSO) (Panda et al., 2017), Bacterial Foraging Algorithm (BFA) (Sathya & Kavalvizhi, 2011), Differential Evolution (DE) (Sarkar & Das, 2013) etc. In this study, a new hybrid algorithm DEWO, which is a combination of Differential Evolution and Whale Optimization (WO) algorithms is proposed for brain tumor detection using an efficient 2D histogram multilevel thresholding technique based on non-local means filter and Renyi entropy. Results obtained from the proposed hybrid algorithm has been compared with some prominent metaheuristic algorithms like Cuckoo Search (CS), DE, Artificial Bee Colony (ABC), and WO. Further, the proposed hybrid algorithm is analyzed for different entropy functions like Tsallis entropy and between-class variance. The brain MR images used in this study for

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