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Original Research Article

Extracting tumor in MR brain and breast image with Kapur's entropy based Cuckoo Search Optimization and morphological reconstruction filters

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1. Introduction

Q2 Medical image segmentation is about dividing an image into many homogeneous parts, which are used for analysis and synthesis of various real-time applications. It employs various methods such as threshold, clustering, compression, histogram, edge detection, region growing, split and merge, and neural networks techniques. Clustering is an important method applied in medical image processing. It is defined as the process of organizing the objects into various groups and share common characteristics among members of a group. Similarly, optimization is the process of modifying a system into features so as to work more efficiently within given constraints and to maximize the desired parameters and to minimize the undesired parameters that are involved as discussed in Yang et al. [1,2]. Cuckoo Search Optimization is used to optimize the objective function, and also choose the segmentation threshold for achieving the best segmentation result. It avoids exhaustive search and is useful in identifying the solutions for non-linear problems. It supports multi-objective optimization techniques.

Mathematical morphology is used in various images processing operations and has become the foundation of biomedical computing. Image segmentation is a vital component of image analysis, which partitions the whole image into disjoint regions based on potential features such as color, texture, and gray value as reported by Roushdy [3]. Pratheeba et al. [4] applied Cuckoo Search Optimization for classifying the healthy and pathological tissues in Magnetic Resonance Image (MRI) brain images. EliseeIlunga-Mbuyamba et al. [5] proposed an active contour model driven by multi-population Cuckoo Search algorithm to segment the tumor part and rectangular shape is preferred for processing the segmentation and it yields better segmentation accuracy.

Zhang et al. [6] identified the pathological brain from the normal brain by applying fractional Fourier entropy with multi-layer perception classifier and achieved 99.53% segmentation accuracy. A study by Nilanjan Dey [7] investigates the Cuckoo Search Optimizations and finds the tumor part in MR brain images based on the contrast of the input image.

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Modified tracking algorithm and Hybrid Center Weighted Median Filter are used for pre-processing and Markov random field is used as the central pixel for Cuckoo Search.

Brain tumor detection can be divided into three types, namely semi-automatic, fully-automatic and expert segmentation. Jin Liu et al. [8] used multi parameter watershed segmentation to detect 2D and 3D MRI brain images. Ramathilagama et al. [9] recommended using distance maximum algorithm to reduce the number of iterations before evaluating the segmented MRI brain images. Vishnuvarthan [10] applied fuzzy inference rules to segment the tumor part of MRI brain images in minimum time. Krishnapriya [11] applied Fuzzy C-Means (FCM) clustering method based on the region growing approach to classify the pixels into various segments. FCM is an unsupervised clustering technique suitable for all images including medical images of various modalities [12]. Serra [13] compared FCM and improved FCM with MRI brain tumor and concluded that CPU processing time is reduced when improved FCM clustering is applied to the input image, but in some cases, it does not guarantee the continuation of boundaries. Sudha [14] extracted the features of texture, histogram, radial, and shape of the breast cancer by applying enhanced Cuckoo Search technique, and it was compared with harmony search and Cuckoo Search yielded better accuracy. Osman et al. [15] suggested FCM clustering for identifying the presence of abnormalities in the breast including mass lesions and Micro Calcification Clusters. Gubern-Merida et al. [16] found the breast density and fibro-glandular tissues of MR breast images using ATLAS segmentation and proved its reliability by measuring the density from MR and Mammogram images. Ahmed et al. [17] applied multi-channel Markov field along with belief propagation and conditional mutual information for segmenting the tumor region in the breast. Cascio et al. [18] proposed neural network concept for classifying the lesions of breast cancer by applying contour based searching segmentation. Panetta et al. [19] applied NLUM (Non-Linear un-sharp masking) scheme to enhance mammogram contrast for detecting the tumor in mammogram images. There is a need for improving the performance of the segmentation with less time by testing the abnormal parts present in MR brain and breast images. For achieving better performance of medical image segmentation, Kapur's entropy [20], which is suitable for segmenting the tumor part in both MR brain and breast images is used, as it maximizes the summation of entropy based on information theory. It always produces the positive probability and global maximum value and provides better average scores than any other non-destructive sample images.

Kavitha used Genetic segmentation with SVM classifier [21] to classify the tumor as benign or malignant with limited set of images. In [22] entropy, features are combined with LSDA to identify normal, FLD and cirrhotic liver from US images and yields 97% accuracy with PNN classifier. Mahalakshmi [23] used MR Brain DICOM images and segment the axial and coronal plane using PSO and extracted the tumor part by filtering methods. It was observed that the average elapsed time for segmentation ranges from 15 to 17 s and proved that the coronal plane takes less time than the axial plane for segmentation. Nagesh et al. [24] utilized charged fluid model method to segment the region of interest using Ostu's algorithm for both MR brain and breast images. In their study, they focus only region of interest of charged fluid model and segmentation takes 0.326 s. Mookiah et al. [25] discussed the importance of GA and Particle swarm Optimization (PSO) in detecting the hard exudates, blood vessels, textures and entropies in diabetic retinopathy images.

Higher order spectra (HOS) fuzzy entropy was applied by Rajendra et al. [26] which are used to classify the normal and abnormal fatty liver diseases. Muthu Rama Krishnan et al. [27] suggested discrete wavelet transform (DWT) coefficients like energy, entropy, Gini index and various statistical moments like mean, variance, skewness, Kurtosis are applied to classify age related macular degeneration. In recent research studies [28,29] Kapur's Entropy function has been used to segment the gray level images and RGB images with the threshold values (2,3,4,5) and performed segmentation with minimum duration. FCM is a soft clustering approach, which minimize the objective function and iterations than other clustering algorithms. The major drawback of FCM is that numbers of clusters are not known in advance for finding cluster centroids is discussed by Ajala et al. [30]. PSO is a global optimization technique, which simulates the behavior of birds flocking. It solves number of medical applications more efficiently. Daamouche et al. [31] suggested PSO technique for feature extraction and select the informative features obtained by morphological profiles for classification. In some applications PSO leads high-dimensional space and has a low convergence rate in the iterative process. Many researchers focus single modal of image for processing, but we combine the working principle of Kapur's entropy with CS optimization and morphological filters for multimodal images. Ratna Raju [32] applied Bayesian fuzzy clustering approach for segmentation and harmony crow search optimization with multi SVNN classifier for classification and produces 93% of classification accuracy Jyotsna Dograa [33] utilized k-means clustering and graph cut algorithm for segmenting the MR brain tumor using centriod points for initialization and applied various quantitative measures to ensure the accuracy of segmentation. Odelin Charron et al. [34] applied deep network approach to detect and segment the brain metastases on multimodal MRI. Aboul EllaHassanien et al. [35] introduced a hybrid system of adaptive ant based clustering for segment the tumorous part of breast and classify the benign and malignant images with multilayer perceptron neural network approach.

2. Methods and methods

2.1. *Scope of our work*

The main goal of our study is to combine two different methodologies into single automated system to segment the tumor part present in both MR brain and breast images. No other researchers applied a single method to segment the multimodal images, with same parameters with different modalities of images. Our automated algorithm is very helpful for a radiologist to understand the severity of the diseases in T1 axial, T2 axial, T1 enhanced, T2 enhanced images for MR brain, post processed and T1 post contrast images for breast. Our algorithm assists the radiologist to understand and prevent the severity of diseases in early stage. CS, FCM and

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