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Research Paper

An efficient magnetic resonance brain image classifier using tetrolet transform and kernel support vector machine based on OTSU binarization

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Abstract

Classification of tumor from cancer causing to non-cancer causing, it plays a main role in diagnosing the disease effectively without any flaws. In this proposed paper, a novel methodology is presented in order to classify a given Magnetic resonant brain image as normal or abnormal using OTSU binarization segmentation with help of tetrolate transform. By replacing wavelet transform with tetrolate transform the classification is made efficient in case of images with geometric shapes. A good number of features are extracted by using OTSU binarization from edge-based segmentation, the more number of features makes the classification for effective and accurate. The image is finely segmented pixel by pixel for good accuracy and about 12 features like We calculate four different type of accuracy like RBF (Radial Basis Function), linear, polygonal and quadratic based on image features. We performed our proposed methods with four different kernels LIN (Linear), HPOL (Homogeneous Polynomial), and IPOL and GRB (Gaussian Radial Basis function) kernel to achieve the highest classification accuracy. The work is added with advancement by using Graphical user interface (GUI), which makes the user comfortable in accessing the method where most of the users are from clinical background and are not aware of any software and their usage.

Keywords: *Image Features; Kernel Vector Machine; Magnetic Resonance Image; Otsu Binarization; Tetrolate Transform.*

1. Introduction

Magnetic resonance imaging (MRI)[1][5] is an imaging approach where the pictorial representation of human body anatomical structure is produced added with extravagant instruction for the purpose of clinical diagnosis and biomedical experimentation. In case of MR Images of the brain, the most effective way to diagnose the tumor, brain tumors [2] are classified as benign and malignant. Where benign is a curable [6] brain tumor and malignant is a non-curable[3][4] brain tumor. Previously, there are methods to classify the brain images using various techniques, the last new method is applied using wavelet transform and Principle component analysis [15]. The present work is implemented reducing some of the issues with the previous work using Tetrolate [7] over 2D wavelet transform and Otsu segmentation over Principle component analysis. The traditional 2D wavelet transform unsuitable for operating upon images that possess geometric structures and therefore this disqualification is reduced using HAAR wavelet transform[10] also known as Adaptive tetrolate transform. Tetrolet transform [8] is an effectual adaptive methodology considering scantly storing the convincing coefficients through engaging on redundant wavelet support. The KSVMs[13],[14] plays a vital role in transformed feature space by allowing us to deserve the highest margin hyper plane. The transformation couldexist nonlinear and the distorted space far above the ground dimensional, therefore-from side to side the classifier is a overexcited plane in the dimensional characteristic space, it couldexist nonlinear in the unique-contribution space. Toclassify a given MR brain images as normal or abnormal, the segmentation process has been done using Otsu [17],[18],[19] binarization with help of tetrolate transform, where each pixel is clearly processed for the most accurate results. Sevral related image processing chniques are presented in [22]-[30].

2. Methodologyof Proposed Algorithm

In this section we discussed our overall proposed methodology based on tetrolet transform

This process consists of the following stages:

1.Image Segmentation
2.Feature Extraction
3.Feature Reduction

Image Segmentation:

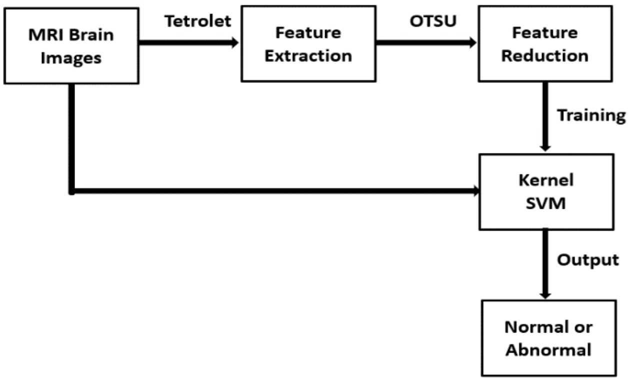
Segmentation is a method of partitioning an image into several segments of image knows as pixels. The main role of segmentation is to simply the process of analysis and accurate by analyzing every pixel. Image is segmented and labeled as different pixels and forms sets of pixels altogether forming the original image.

Feature Extraction:

Feature extraction involves reducing the number of resources needed to explain an outsized set of knowledge. once performing arts analysis of advanced information one among the main issues stems from the number of variables concerned. Analysis with an outsized variety of variables usually needs an outsized quantity of memory computation power, additionally it should cause a classification formula to overfit to coaching samples and generalize poorly to new samples. Feature extraction may be a general type for ways of constructing combos of the variables to induce around these issues whereas still describing the info with sufficient accuracy.

Feature Reduction:

Feature Reduction is obtained by reworking info set into a brand-new position of prearranged variables in keeping with their variances. This type of method have 3 belongings: The parts of the input vectors has orthogonalizedin sequence that not related with one another, it instructions the ensuing orthogonal parts in order that individualsby means of the most important variation return quickly and eliminates individuals parts causatives the smallest amount to the variation within the knowledge set. It ought to existrenownedto the participation vectors exist normalized to possess nonlinear mean and standard variance previous to activity PCA. The normalization may be anaverage operating process. Particulars concerning PCA may well exist seen in referee. [12],[13].



2.1.Tetrolet Transform

Tetrolet Transform [1] is an adaptive Haar Wavelet Transform[3] used for image approximation. We have many effective methods for image representation in previous years, where tetrolet is the most adaptive type. It is a type of Haar wavelet transform[3]. By using less number of attributes Tetrolet Transform can achieve similar reconstruction results as compared to tensor product wavelet transform. In Tetrolet transform the image is initially spliced into divisions of 4x4 and considers tetromino in each part. Then each of them is processed with Haar Wavelet Transform [10]. In order to gets a clear idea regarding Tetrolet Transform [8] we have to go through some Definitions and Notations.

2.2.Definitions AndNotations

Assume,

$$L = \{(m,n): m,n = 0,...,K - 1\} \subset Z2 \qquad (1)$$

The keyposition of a digital image a = (a[m,n])(m,n)∈L with K = 2N ,N∈K. We find a region of an index (m,n) ∈ L through K4(m,n):= {(m - 1,n),(m + 1,n),(m,n - 1),(m,n +1)}. An index that dishonesty at the borderhave three neighbours; an key at the vertex of the image have two neighbours. A set E = {I0,...,Ir},r ∈ K, of subsets Iν ⊂ I is a disjoint partition of I if Iν ∩ Iμ = ∅ for ν '= μ and !r ν=0 Iν = I. Here we have taken disjoint partitions of the index set I that satisfy two conditions for all Iν : 1. every separation Iν have four indices, i.e. #Iν = 4,2. each index of Iν has a adjacent in Iν ,i.e.∀(m,n) ∈ Iν ∃(m " ,n") ∈ Iν: (m " ,n") ∈ K4(m,n).

2.3. Kernel SVM

The origin of Support Vector Machine (SVM) is an indicator in the stream of machine culture. Kernel SVMs[13],[14] have the following welfare tasks extremelyfine in performance and have been successful in various fields for instanceusual language classification, computer vision added to bioinformatics, have only some tunable specifications and preparationfrequentlyoccupies convex quadratic optimization. therefore, the results are universal and more often than not exclusive, consequentlykeeping away from the convergence to restricted minima[9] displayed by additional statistical knowledge systems, for instance neural networks. SVM is advantages in giving higher accuracy, efficient mathematical tractability and geometrical interpretation [14].

The kernel is similar in the direction of the transform ϕ(xi) through the equation k(xi,xj) = ϕ(xi)ϕ(xj). The value w is furthermore in the transformed space, by means of w =Pi αi γi ϕ(xi). Dot products with w for specification can be computed by w · ϕ(x) = Pi αi γi k(xi,x).

In an additionalapproach, the KSVMs permit to fit the highest-margin hyper plane within a distorted feature space. The transformation is nonlinear and the transformed space more dimensional, consequently, the specification is a hyper plane within the more-dimensional characteristic space, it can exist nonlinear in the unique input space.

2.3.1 MoralityOf Linear Svms

Specified a p-dimensional N size preparation dataset of the type

$$\{(x_n, y_n) \mid x_n \in R_p, y_n \in \{-1,+1\}\}, \quad n = 1,..,N(2)$$

Where yn is moreover −1 or 1 related to the group of 1 or 2. Each xn be a p-dimensional vector. The highest-margin hyper plane which separates class 1 as of class 2 is the sustain vector machine we desire. Taking into considerationwith the intention ofsome hyper plane be able to designate in the form of

$$w \cdot x - b = 0 \qquad (3)$$

Where · indicates about the dot product and W the normal vector to the hyper plane. We want to consider the W and b on the way to increases the fringeamong the two comparable hyper planes as outsized as potentialasmotionless splitting the data. So we discribe both the similar hyper planes through the expressions as

$$w \cdot x - b = \pm 1 \qquad (4)$$

Consequently, the assignmentbe able toexist converted in the direction of an optimization difficulty, i.e., we desiretowards the increase of the spaceamong the two parallel hyper planes, cause to experienceput off data decliningaddicted to the margin. By means ofstraightforwardnumericalinformation, the difficultybe able to be formulated the same as

$$\min_{w,b} ||w||$$

$$\mathrm{s.t.}\, y_n\,(w.x_n - b) \geq 1, \quad n = 1, \ldots, N (5)$$

within practical situations the ||w||is frequently replaced through

$$\min_{w,b} \frac{1}{2} ||w||^2$$

$$s.t.\, y_n\,(w.x_n - b) \geq 1, \quad n = 1, \ldots, N \quad (6)$$

2.4. Principle Component Analysis

To minimize the characteristic vector magnitude added to enlarge the discriminative authority, the principal component analysis (PCA) was worn [20],[21]. PCA is used to minimize the dimensionality of the information and consequently minimizes the computational outlay of analysing original data [19]. PCA is an effective instrumenton the way todecrease the measurement of a data locate having a more numeral of consistent variables even as retaining the majority of the changes. To achieve a new set of ordered variables by transforming the data set respective to their variances. It is suppose to be identified so as to the contribution vectors exist normalized in the direction that contains zero signify and harmony variance previous tothe stageof PCA [20],[21]. The normalization is a averageprocess. informationconcerning PCA might be seen in Ref. [20],[21].

2.4.1. Otsu's Binarization

Otsu's[17],[18],[19] thresholding technique[16] corresponds to the linear discriminant criteria that assumes that the image consists of solely object (foreground) and background, and therefore the heterogeneousness and variety of the background is unheeded [12]. Otsu set the edge therefore on attempt to minimize the overlapping of the category distributions [12]. Given this definition, the Otsu's technique segments the image into 2 lightweight and dark regions T0 and T1, wherever region T0 may be a set of magnitude from zero to t or in set notation T0 = and region T1 = wherever t be that the threshold price, l is that the image most grey level (for instance 256). T0 and T1 are often allotted to object and background or the other way around (object not essentially continuously occupies the sunshine region). Otsu's thresholding technique [16] scans all the attainable thresholding prices and calculates the minimum value for the constituent levels all sides of the edge. The goal is to seek out the edge price with the minimum entropy for add of foreground and background. Otsu's technique determines the edge price supported the applied mathematics info of the image wherever for a selected threshold price t the variance of clusters T0 and T1 are often computed. The optimum threshold price is calculated by minimizing the add of the weighted cluster variances, wherever the weights area unit the chance of the several teams.
Given: p(i) as the histogram probabilities of the observed gray value i=1,...,N

$$P(i) = \frac{\mathrm{number}\{(r,c)|\mathrm{image}(r,c)=i\}}{(R,C)} \; (7)$$

Where r, c represents index for row and column of the image, correspondingly,
R and C is the number of rows and columns of the image, respectively.
wb(t), μb (t), and σ2 b(t) as the weight, mean, and variance of class T0 by means of intensity range from 0 to t, respectively. wf(t), μf(t), and σ2 f(t) as the weight, mean, and variance of class T1 by means of intensity value as of t+1 to l, respectively. σ2 w as the weighed sum of group variances. The best threshold value t* is the value with the minimum within class variance. The within class variance defines as following:

$$\sigma^2{}_\omega = \omega_b(t) * \sigma^2{}_b(t) + \omega_f(t) * \sigma^2{}_f(t) (8)$$

Where

$$\omega_b(t) = \sum_{i=1}^{t} P(i)$$

$$\omega_f(t) = \sum_{i=t+1}^{l} P(i)$$

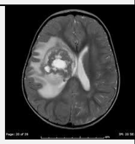
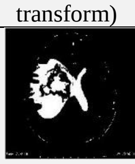
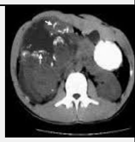
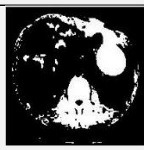
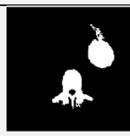
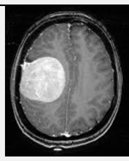
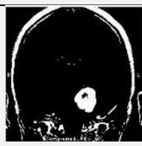
$$\mu_b(t) = \frac{\sum_{i=1}^{t} i * P(i)}{\omega_b(t)}$$

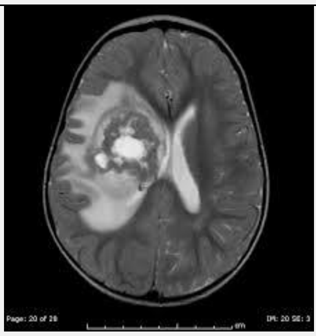
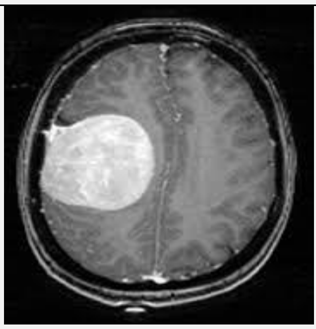
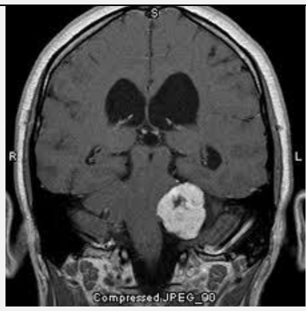
$$\mu_f(t) = \frac{\sum_{i=t+1}^{l} i * P(i)}{\omega_f(t)}$$

$$\sigma^2{}_b(t) = \frac{\sum_{i=1}^{t}\left(i - \mu_b(t)\right)^2 * P(i)}{\omega_b(t)}$$

$$\sigma^2{}_f(t) = \frac{\sum_{i=t+1}^{l}\left(i - \mu_f(t)\right)^2 * P(i)}{\omega_f(t)}$$

2.5 Results and Discussions

Type of disease	Original image	Existing work (Wavelet transform)	Proposed work (Tetrolet Transform)	Accuracies in %
Malignant				RBF 70 Linear 90 Polygon 80 Quadratic 80
Malignant				RBF 70 Linear 90 Polygonal 70 Quadratic 70
Benign				RBF 90 Linear 90 Polygonal 80 Quadratic 90
Benign				RBF 90 Linear 90 Polygonal 80 Quadratic 90

Type of disease	Original Image	Features
Malignant		Mean 0.00630907 Standard Deviation 0.0895928 Entropy 3.20515 RMS 0.0898027 Variance 0.00801767 Smoothness 0.959133 Kurtosis 12.2408 Skewness 1.10481 IDM 1.2156 Contrast 0.305895 Correlation 0.142097 Energy 0.786231 Homogeneity 0.937931
Malignant		Mean 0.00365066 Standard Deviation 0.0897405 Entropy 3.37095 RMS 0.0898027 Variance 0.00805956 Smoothness 0.931415 Kurtosis 7.35059 Skewness 0.635044 IDM -0.137806 Contrast 0.243326 Correlation 0.0932787 Energy 0.761293 Homogeneity 0.932884
Benign		Mean 0.0031107 Standard Deviation 0.0897608 Entropy 3.17346 RMS 0.0898027 Variance 0.00804787 Smoothness 0.920457 Kurtosis 7.32819 Skewness 0.469022 IDM -0.0576898 Contrast 0.208843 Correlation 0.199005 Energy 0.7621 Homogeneity 0.935159
Benign		Mean 0.0032427 Standard Deviation 0.0897562 Entropy 3.57973 RMS 0.0898027 Variance 0.00801859 Smoothness 0.923447 Kurtosis 6.27346 Skewness 0.633152 IDM 0.52567 Contrast 0.24416 Correlation 0.100677 Energy 0.740911 Homogeneity 0.926261

The proposed method of MRI image classification has been evaluated using MATLAB. Here we have taken two different types of disease like malignant and benign. Through the existing method the image has been segmented by Wavelet transform [4] and the accuracy is very low compare then our Proposed method. Which has used tetrolet transform It clearly identified the disease name based on the segmentation process and also in our Proposed method is clearly identifying RBF, linear, polygon and quadratic accuracy has been evaluated and same will be compared with existing work.

In the above tabular form, we can clearly observe the differences between the output of the existing work and proposed work. Initially we take an MR image and processed as shown in the block diagram. In existing work, the result is not up to the level and some part of the image is not processed properly. So, a doctor cannot get the required details and it may be dangerous to the patient. In proposing work we can get the exact result as we are using tetrolet transform and it classifies the type of disease such as malignant and benign and provides four different types of accuracies.

3. Conclusion:

In this paper an efficient Magnetic Resonant brain image has been classified with the help of tetrolet transform and Kernel support vector machine .Based on the simulation results our proposed method is clearly identifying the type of disease with the help of Otsu binarization and various Kernels method are used to achieve the highest classification accuracy. A good number of features are extracted by using OTSU binarization from edge-based segmentation, the more number of features makes the classification for effective and accurate. The image is finely segmented pixel by pixel for good accuracy and about 12 features like We calculate four different type of accuracy like RBF (Radial Basis Function), linear, polygonal and quadratic based on image features.

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