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Review Article

A NOVEL METHOD FOR CLASSIFICATION USING MULTI CLASS-SVM CLASSIFIER WITH MULTI FEATURES

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Abstract

A proposed novel technique for classify using multi class SVM classifier with multi-features such as HOG (Histogram of Oriented Gradient), Color moment, Gabor and wavelet. Initially, the color feature is extracted from the segmented image using bounding box algorithm. Texture features are extracted using dominant HOG, Gabor and Wavelet then the feature selection methods are separately classified. Hence in this paper proposed a novel Multi class SVM technique is used in that initially classifies the different class from the database and get the accuracy of the image based upon the feature of the image. The fundamental performance metrics like accuracy, sensitivity and specificity are taken into comparison. The proposed method has higher accuracy when it is compared to the accuracy of other feature based SVM.

Keywords: Anisotropic Filter, Bounding Box, Watershed Transformation, Multi Features and Multi Class-SVM.

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INTRODUCTION

A lot of researches proposed various methodologies in the field of Image classification. Now-a-days the CAD is fetching a source of precise and fast. To improve the performance of the brain image, quite a lot of techniques have been developed. These techniques are helpful in classifying an images.

Akash et., al [1] research paper demonstrate the CBIR (Content Based Image Retrieval) of variety of classes with SVM (Support Vector Machine) classifier and the combination of Ant Colony Optimization Techniques and DTCWT (Dual-Tree Complex Wavelet Transform). This article image is retrieved based upon the color and texture extraction of different classes of images, the advantage of this research is to reduce the optimization time of the image. The demerit of this paper is that the accuracy and efficiency is less. Suresh et., al suggested automatic segmentation for shape approach. From this technique, the shape of the region information is collected based on computer vision & pattern recognition [2]. Erchan Aptoula utilize Morphological texture descriptor for retrieving the image depending upon the different classes the disadvantage of this paper, to increase the efficiency and also does not concentrate the color related satellite image [3].

Yun Wei in this research paper Harr and Histogram of Oriented Gradients (HOG) are combined with SVM to collect and classify the particular type image from the satellite image or video image but the accuracy of the classification is less but this technique need less execution time.

Eakins P. J et al., [7] studied about the color histograms are insensitive to slight variations in camera position and are computationally efficient. A Color Coherence Vector (CCV) described a split histogram and this CCV partitions every histogram bucket according to its spatial coherence. Using CCV's, a database with 15,000 images has the ability to query in 2 seconds. Roshi et al., [8] proposed a novel set of evaluation methods to converge a diverse and flexible set of image properties such as texture, color and location in a retrieval structure and permits end users to substantially control over their use. Different tests are established for image retrieval. It is mainly focused on enhancing the relevancy of the retrieval images for certain queries. Daga, Monika et al.,[9] have proposed novel features for similarity assessment such as rotation-invariant texture feature, directionality, and regularity. An efficient method for CBIR using these features is proposed and validated with various applications. At last, rank of the images is allotted according to its final scores and the images which top the rank list are shown to the user as the resultant retrieval. Jisha et.,al, has been explained GLCM (Gray Level Co-Occurrence Matrix)for texture feature extraction[10].

Manoharan implementing various filter in pre-processing section for enhancing the original images, after calculating the features based on color and gray [11]. Wang et al.,[12] proposed four feature. Color feature along with texture feature are combined using an image retrieval method. The retrieval results are more appropriate to the characteristics of human visuals. Thereby decreasing the matching error and also its weight assignment is logical. CBIR system implemented with only one content feature does not give satisfying retrieval accuracy.

Recently, the usage of online remote sensing images are rarely used because low efficiency whereas text-based searches method dominates in the DataBase (DB) management [13]. The PACS (Picture Archiving and Communication System) algorithm is implemented for medical security purposes [14]. At present, the medical images are stores in the form of text for security purpose. [15]. N. Santhi has been explained new Shape representation technique in which the shape can be represented by integrating the modified octagonal tracing algorithm and disk selecting algorithm[16]. C. P. Dalmiya et.al., suggested SPCH algorithm is used for detecting the information without loss. SPCH feature is used to extract the structural properties of the images. [17]. Santhi N has been proposed Adaptive Clustering Algorithm [18]. Sathyabama et.al., has been explained combination of phase congruency (PC) and LBP (Local Binary Pattern) to extract the values in the images [19]. K. Ramar has been proposed SFDWT (Spatial Frequency Discrete Wavelet Transform) . Here, the images are fused based on spatial frequency. [20].

From the literature survey, it is noticed that the classification is performed only after the retrieval process thereby consuming

more time for retrieval process. This research addresses this problem very efficiently.

The Highlights of the proposed research includes, the following contribution.

i) Brain images are used since it produces a detailed segmentation and classification accuracy.
ii) Extracting useful information from images we use feature extraction such as color and texture. Color is considered as an effective feature because of its following characteristics: robustness, effectiveness, simplicity in implementation and low storage requirements.
iii) Multi class SVM produced an accurate and robust classification results based on theoretical analysis, even when input data are non-linearly separable and non-monotone. Multi class SVM technique is used to improve the accuracy of retrieval rate.

The organization of the work: From section II, proposed architecture is given. In Section III, detail explanation of proposed method, multi class SVM is presented. In Section IV, explain the result part and analysis of proposed method is presented and Section V concludes the paper.

System model

From figure 1 indicates the proposed system architecture, initially read the images. The brain input images is pre-processed by using anisotropic filter. After pre-processing the segmentation algorithm is carried out. Bounding Box and watershed transformation method is used for segmenting the tumor. Further different feature are extracted by using different feature extraction algorithm, which contain HOG, color moment, Gabor and wavelet transform features. Finally classification is perform by using multi class SVM technique.

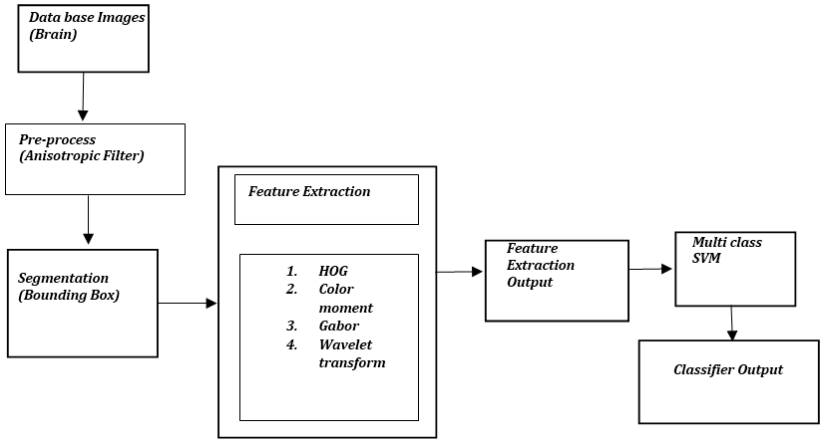

Figure 1: Proposed Architecture of the system

After performing similarity matching done to obtain the result that is similar. On the other hand proceed the same step from query images and compare both the feature extraction result of the query and image database. Finally obtain the retrieved image.

Image Pre-processing

For reading input image in data set, the input images should be pre-processed using anisotropic filter. Anisotropic filter is used in order to increase the brightness of the center pixel kernel. The tumor pixels in the foreground region are white and the background region is normally color. Contrast of the image is defined is given by,

$$\boldsymbol{c} = \frac{(\boldsymbol{f_m} - \boldsymbol{b_m})}{(\boldsymbol{f_m} + \boldsymbol{b_m})} \qquad (1)$$

f_m = Mean color level of foreground region

b_m = Mean color level of background region.

Contrast Improvement Index (CII) is a prominent benchmark used to measure the efficiency of image enhancement algorithm. CII is defined as the ratio between contrast of enhanced output images to the contrast of input image.

$$\boldsymbol{CII} = \frac{(\boldsymbol{C_p})}{(\boldsymbol{C_{in}})} \qquad (2)$$

C_p = contrast of processed image.

C_{in} = Contrast of input image.

Image Segmentation

The segmentation method is used for detecting the tumor region. Here, two segmentation algorithm are used which contain bounding box and watershed transformation algorithms.

Bounding Box Segmentation

A Bounding Box segmentation algorithm should detect all tumor even in low quality images. The Bounding Box algorithm does this work accurately and with high robust. It contains shaped borders and lowered variations and mostly these are regions. The method used in this algorithm is tumor detection in brain images. The number of co-variant regions can be extracted from an brain image. It is a connected component of gray-level sets of image. This algorithm considers the regions of similar threshold value which is the stable connected component. The bounding box algorithm is fitted with the elliptical frames by including ellipses in the regions. These are the features which can be described by the regions. To find the intensity of the image the extremal property of this algorithm is used. It finds the extreme regions in the tumor whether it is bright or dark regions which also meant as to find higher or lower. In clear and separated boundaries having similar regions this algorithm performs well. If the image is a blur image or could be an out of focused image, then the probability of region detection level is automatically decreases. It is the faster detectors since has refine invariance, strong repeatability and smart implementation.

Watershed Transformation Segmentation

Watershed algorithm is a common method for lung image segmentation. It uses morphological operation for segmentation. Image regions are separated by watershed lines called dams.

Major benefits of the method are accuracy and complexity decrement. In some cases, over segmentation is reported and different modalities of watershed algorithm has been developed to overcome this issue. This algorithm is used the mixture of watershed algorithm and edge detection to segment lung image accurately. It is developed a probabilistic model of watershed algorithm which provides good segmentation results in the presence of noise. This technique used matrix computation along with watershed algorithm to optimize intensity inhomogeneity.

Extracting features

Feature extraction method is the best part in CAD system. The extracted features are separated and to obtain the better result. Here, four features are extracted. The proposed feature is HOG, and the remaining features are color moment, Gabor and wavelet transform.

HOG Features

The proposed feature extraction method is HOG feature. This feature are very simple, and used for various applications. In the first step, the point of image is detected using Harris detector. After calculating the points, the pixel is set by 16 X 16. Initially the region is spitted into 4 X 4 regions. The HOG features can be defined below,

$$\boldsymbol{h(k) = \sum d_{x,y} \in e_k m_{x,y}} \quad (3)$$

$$\boldsymbol{m_{x,y} = \sqrt{dx^2\, x,y + dy^2\, x,y}} \quad (4)$$

$$\boldsymbol{d_{x,y} = arctan \frac{dy_{x,y}}{dx_{x,y}} - D} \quad (5)$$

$$\boldsymbol{dx_{x,y} = I_{x,y} - I_{x,y+1}} \quad (6)$$

$$\boldsymbol{dy_{x,y} = I_{x,y} - I_{x,y+1}} \quad (7)$$

$$\boldsymbol{D = arctan \frac{\sum d_{x,y} dy_{x,y}}{\sum dx_{x,y}}} \quad (8)$$

Where, $I_{x,y}$ is the x, y pixel value of each sub-region, $m_{x,y}$ is the gradient magnitude, $d_{x,y}$ is the gradient direction.

Color moment feature

In CBIR system, color moment feature extraction is a low level color feature, HOG provides only the texture information of the image. While encoding, we can improve the power of color index using inclusion algorithm. Initially the original image is divided into non-overlapping of three regions. In this way to extract the features from non-overlapping sub-regions. The color moment features are extracted by using the below equations.

$$\boldsymbol{E_i = \frac{1}{N} \sum_{y=1}^{N} S_{x,y}} \quad (9)$$

$$\boldsymbol{\sigma_i = [\frac{1}{N} \sum_{y=1}^{N} (S_{x,y-} E_x)2]^{\frac{1}{2}}} \quad (10)$$

Where, The value of the x^{th} color moment at the y^{th} image pixel is $S_{x,y}$.

Gabor feature

The simplest extraction method used in image processing is Gabor features. This Gabor feature extraction algorithm can be classified into two types which contain spatial time domain and spatial frequency domain.

Wavelet Transform feature (WT)

Wavelet Transform (WT) is a resolution oriented feature in multiscale function. It analyzing different resolution level of images.

Multi class SVM Classification

After extracting HOG, color moment, Gabor and wavelet transform from the brain images, these feature vectors are used to classify the database. In this proposed technique, multi class SVM classification algorithm is used.

$$\boldsymbol{g(x) = w.x + b} \quad (11)$$

$$\boldsymbol{w.x + b = 0} \quad (12)$$

Where the input vector is x, weight vector is w, and the bias is indicated b.

$$\boldsymbol{\min_{w,b,\xi} \frac{1}{2} w^T w + C \sum_{i=1}^{N} \xi_i} \quad (13)$$

Subject to

$$\boldsymbol{y_i(w^T \phi(x_i) + b) \geq 1 - \xi_i} \quad (14)$$

Where $\xi_i \geq 0$ and $C > 0$ are the penalty parameter of the error term. Here training vectors x_i are mapped into a high dimensional space function $\varphi : \Re^d \rightarrow \Re^f$, where $f > d$ or f could even be infinite.

$$\boldsymbol{x_i . x_j \rightarrow \phi(x_i)^T \phi(x_j) = K(x_i . x_j)} \quad (15)$$

Where, K is a Kernel function. The SVM classification function is stated by,

$$\boldsymbol{f(x) = sign\left(\sum_{i-1}^{N} \alpha_i y_i K(x_i, x) + b\right)} \quad (16)$$

EXPERIMENTAL RESULTS

The proposed method has been implemented using the Matlab 2016a. Brain image data set are used in the proposed system. It has also been tested on dataset of real brain MR images consisting of benign and malignant brain tumor images. There are two categories of tumor based on the origin primary and secondary brain tumors. Primary brain tumors are originated from the brain and are named for the cell types from which they originated. They can be benign (non-cancerous) and malignant (cancerous).

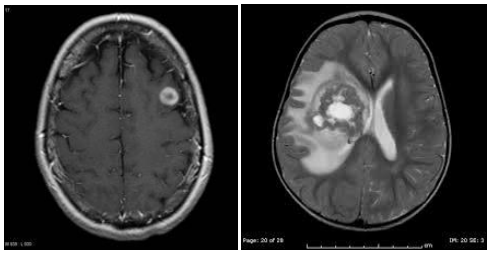

Fig. 2: Samples Database for benign Tumor and Malignant Tumor

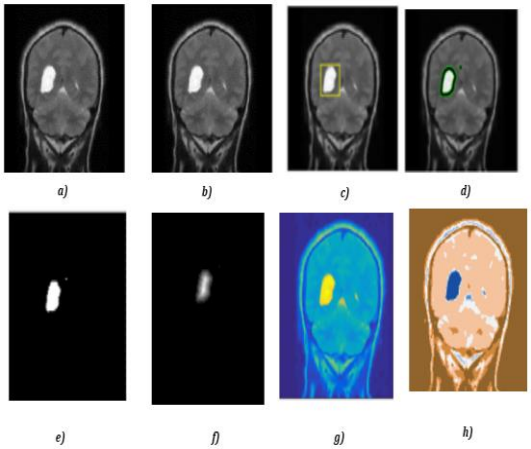

Fig. 3: Experimental result of benign brain tumor image (a)MRI image of tumor affected brain (b) Anisotropic filter image (c)Locating Boundary Box image (d) Bounding Box image (e) Segmented tumor region image (f) Distance Transform image (g) Watershed transformation Image (h) Final color output Image

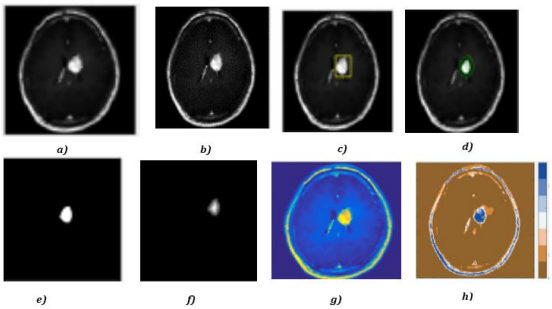

Fig. 4: Experimental result of malignant brain tumor image (a)MRI image of tumor affected brain (b)Anisotropic filter image (c)Locating Boundary Box image (d)Bounding Box image (e)Segmented tumor region image (f)Distance Transform image (g) Watershed transformation Image (h)Final color output Image

The HOG based multi class SVM classifier is the best method by comparing the existing method. The below figure shows the confusion matrix of the HOG features based multi class SVM classifier. The confusion matrix of brain image is shown in below.

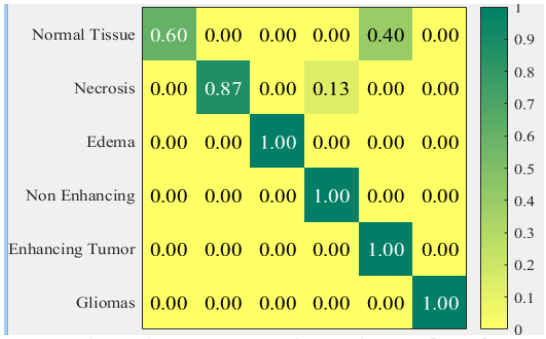

Figure 5: Confusion matrix of Muti-feature based SVM classifier

From figure 5 shows that, multi features based multi class SVM classification in brain image data set, with the software MATLAB. Brain image data set confution matrix is shown in figure 5. The proposed system accuracy can be determined by using,

$$Accuracy = \frac{N-X}{N} * 100 \quad (17)$$

Here, N be the True Positive and X be the True Negative

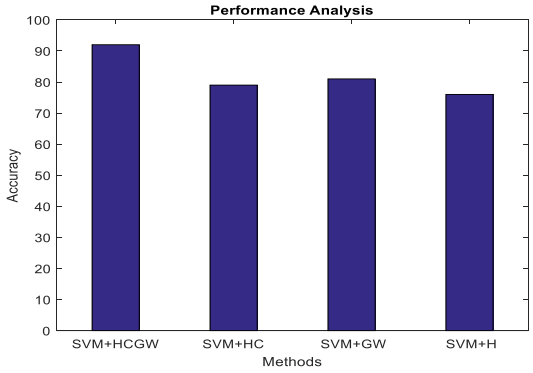

Figure 6: Performance analysis of accuracy

The proposed method has been implemented on MATLAB 2016a. To evaluate the results, the customary measures sensitivity, accuracy and specificity are used in different forms.

Specificity

The percentage of the actual background skin.

$$\text{Specificity} = \frac{TN}{TN+FP} \text{x } 100\% \quad (18)$$

Sensitivity

Sensitivity can be defined by

$$\text{Sensitivity} = \frac{TP}{TP+FN} \text{X } 100\% \quad (19)$$

Table 1: Result in Multi-feature descriptor using different parameter

Parameters	Methods			
	Multi class SVM+HCGW	Multi class SVM+HC	Multi class SVM+GW	Multi class SVM+H
F-score	0.9227	0.7953	0.8115	0.7693
Sensitivity	0.9000	0.7992	0.8117	0.7857
Specificity	0.9886	0.9771	0.9787	0.9643
Precision	0.8964	0.7945	0.8136	0.7641
Error	0.1029	0.2058	0.1914	0.2210
AUC	0.8291	0.7122	0.7236	0.6517

CONCLUSION

This paper proposed system named Multi-Feature such as Hog, Color moment, gabor and wavelet combine with multi class SVM in applications. For the input images the color features and texture features are extracted both of which are classified separately. In the existing methods, the image accuracy is less. The proposed Multi-features based multi class SVM technique provides a clear value. The network was successfully trained for brain images with an average classification accuracy of 92.3% is obtained using multi class SVM, classifier by comparing with the state of arts in MATLAB software.

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