

Brain Tumor Classification Using Machine Learning

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Abstract: Medical imaging has becoming as a transpire discipline in diversified medical diagnosis. It has been plays a vital role in automatic detection, which bestows information about abnormalities for further treatment. The traditional approach of detecting MRI has been based on manual inspection, which has become inappropriate for vast volume of data. Automated tumor detection has gaining importance that conserves the time of radiologist. In this paper, brain tumor has been detected from MRI images by utilizing classification technique based on Support Vector Machines (SVM). The performance of SVM has been compared with the neural classifier such as back propagation network. Here feature extraction from MRI Images has been done by gray scale and texture features. This intelligent system improves accuracy rate and reduces error rate of MRI brain tumor using SVM.

Keywords: MRI, Support vector machines, Filtering, Bounding box

1. INTRODUCTION

The human body comprised of several types of cells with each cell has a precise function. The cells in the body grow and divide in an orderly manner which forms new cells to keep the human body in good physical condition. While few cells cease their capability to control their growth and they grow in an improper fashion which leads to extra cells formed form a mass of tissue which is called tumor. Brain tumors are a solid neoplasm inside the skull which usually they grow in the brain or grow in other places such as in lymphatic tissue, in blood vessels, in the cranial nerves, in the brain envelopes. Brain tumors may grow as a result of the spread of cancers primarily located in other parts of the body [1]. Brain tumors can be classified according to the tumor location or the type tissue which the tumor created or whether the tumor is malignant or benign, and other considerations [2]. The tumors may be either benign or malignant in which malignant tumors lead to cancer while benign tumors are not cancerous. In most cases, cancers that spread to the brain to cause secondary brain tumors arise in the kidney, lummy and breast or from melanomas in the skin [2].

Medical imaging techniques like X-ray, CT scan and MRI are the source of medical image data which is used in medical diagnosis. Magnetic field excitation and RF coil pulses produces MRI image [3]. On comparing with CT scan MRI seems to be powerful for diagnosis since it doesn't utilize radiation. MRI images present a unique perception that determines whether brain tumor is present or not [4]. Manual examination of MRI image is a time consuming job, prone to error while manipulating huge scale of data. Moreover MRI accommodates noise results in flawed classification. In order to analyze large volume of MRI, automation is inevitable which results in economic analyzer. High accuracy of tumor detection is required, because human being is involved. Two common techniques used to classify the MR Images, they are supervised techniques such support vector machine, k-nearest neighbors, artificial neural networks, and unsupervised techniques such fuzzy c-means and self-organization map (SOM). Many research used both supervised and unsupervised techniques to classify MR Images either as normal or abnormal. [5].

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R. J. Ramteke, KhachaneMonali Y[6] proposed a method to detect the brain tumor automatically on the basis of image features and automatic abnormality detection. K-Nearest Neighbour (K-NN) classification technique is modest technique which produces reasonable classification accuracy. Khushboo Singh, SatyaVerma[7] proposed and incorporated Support Vector Machines (SVM classification techniques) to brain MRI image by employing the features vector.

Prime objective of the SVM learning is to reduce the structural risk maximization. Instead of minimizing an objective function based on the training samples (such as mean square error), the SVM attempts to minimize the bound on the generalization error. ShwetaJain[8] classified brain tumor by manipulating Artificial Neural Network (ANN) in MRI images of patients. The gradient-descent method is applied with perceptron a network where updates the weight systematically. This is a way where the error is propagated back to hidden unit. Classification like K-Nearest Neighbor [9] (KNN), Artificial Neural Network (ANN) are implemented in several applications such as digit, speaker, object and face identification. It is also used in text classification and too in medical diagnosis.

In this paper, the SVM is exploited for MRI image classification to detect whether the image is normal and abnormal. The proposed Support Vector Machines (SVM) method is employed to brain image classification and segmentation is done by using Histogram based. The feature extraction from MRI Images is done by gray scale, symmetrical and texture features. The foremost objective of SVM is to provide an excellent outcome of MRI brain cancer classification.

2. PROPOSED METHOD

It is most vital criteria to have best quality of images for accurate observations for the given application.

Pre-processing: It is the first step of the proposed technique. Anisotropic diffusion filter is a method for removing noise which is proposed by Persona and Malik [10]. This method is for smoothing the image

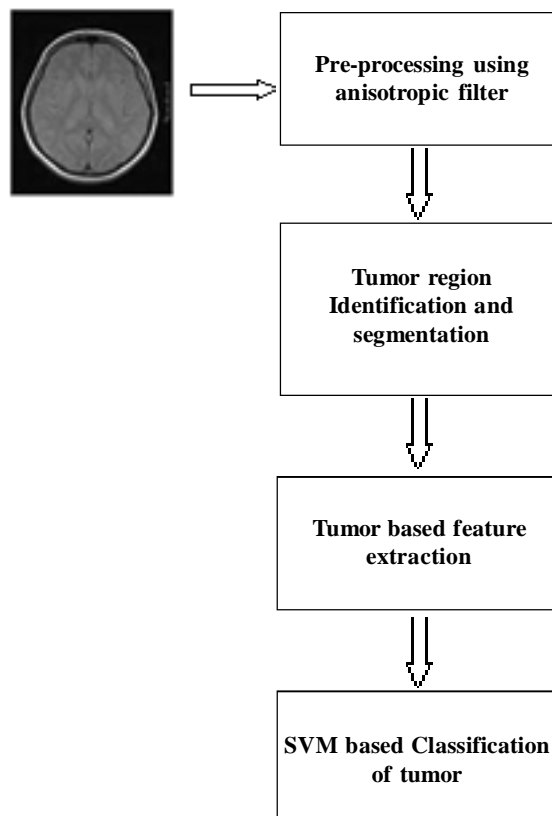


Figure 1: Proposed method

by preserving needed edges and structures. The purpose of these steps is basically Preprocessing involves removing low-frequency background noise, normalizing the intensity of the individual particles images, removing reflections and masking portions of images. Anisotropic filter is used to remove the background noise and thus preserving the edge points in the image. Diffusion constant which is related to the noise gradient and smoothing the background noise by filtering, so an appropriate threshold value is chosen. A higher diffusion constant value is taken to compare with the absolute value of the noise gradient in its edge [11].

Segmentation: Segmentation is a significant process to extract pertinent information from intricate medical images. Segmentation has extensive application in medical field [12]. As the result of image segmentation, set of segments which collectively covers entire image. Segmentation accuracy determines the eventual success or failure of computerized analysis procedure. Segmentation algorithms performances are ranked based on one of two basic properties of intensity values discontinuity and similarity [13].

The normalized image undergoes process of noise removal by anisotropic filter. After that the noise removed image undergoes the process of image segmentation. The edge segmentation and Connected Component Pixels are incorporated for image segmentation. Initially the image is partitioned on the basis of abrupt changes in intensity (edge). Portioned images are converted to regions which are homogeneous according to predefined criteria.

Texture analysis Feature extraction is nothing but transformation of an image into its set of features where important features of the particular images are extracted from and used for classification. It is a challenging task to extract good feature set for classification. There are several techniques are available for feature extraction e.g. texture Features[14][15], some of them are feature based on wavelet transform[16], principal component analysis, minimum noise fraction transform, discriminant analysis, decision boundary feature extraction, non-parametric weighted feature histogram. Histogram is local in nature which is used in primary level and second method is based on co-occurrence matrix which is called as second order texture feature.

$$\text{Mean } \mu = \sum^{G-1} ig(i) \quad (1)$$

$$\text{Variance } \sigma^2 = \sum^{G-1} (i-\mu)^2 g(i) \quad (2)$$

$$\text{Skewness } \mu_3 = \sigma^{-3} \sum^{G-1} (i-\mu)^3 g(i) \quad (3)$$

$$\text{Kurtosis } \mu_4 = \sigma^{-4} \sum^{G-1} (i-\mu)^4 g(i) - 3 \quad (4)$$

$$\text{Energy } E = \sum^{G-1} [g(i)]^2 \quad (5)$$

$$\text{Entropy } H = -\sum^{G-1} g(i) \log_2[g(i)] \quad (6)$$

Histogram feature does not consider spatial information into consideration since gray-level spatial co-occurrence matrix based features are defined which are known as second order histogram based features. These features are based on the joint probability distribution of pairs of pixels.

Features are extracted from the tumor regions of MRI images which involves in minimizing the quantity of data required to describe a large set of data accurately. The obtained features are used as inputs to classifiers which assign them to the class which they represent. The motto of feature extraction is to minimize the original data by measuring positive properties which discriminate one input sample from another sample. If the features are excessively used for classification it will lead to shoot the computation time and storage memory is also increases.

Classification of Tumor: SVM is one of the classification technique applied on different fields such as face recognition [18], text categorization [19], cancer diagnosis [20], glaucoma diagnosis, microarray gene expression data analysis. SVM utilizes binary classification of brain MR image as normal or tumor

affected. SVM divides the given data into decision surface, (i.e. a hyper plane) which divides the data into two classes. The prime objective of SVM is to maximize the margins between two classes of the hyper plane.

Dimensionality reduction and precise feature set given as input to the SVM on the duration of training part as well as during the testing part. SVM is based on binary classifier which employs supervised learning to provide better results.

3. SIMULATION RESULTS

The image input has been applied to the anisotropic filter Fig. 2 shows the filtered output.

Filtered image passes through the bounding box algorithm, SVR classifier extract the tumor feature from the image as shown in Fig 3. Another two images have been tested, outputs are shown in Fig 4 and Fig 5.



Figure 2: Filtered image of sample1

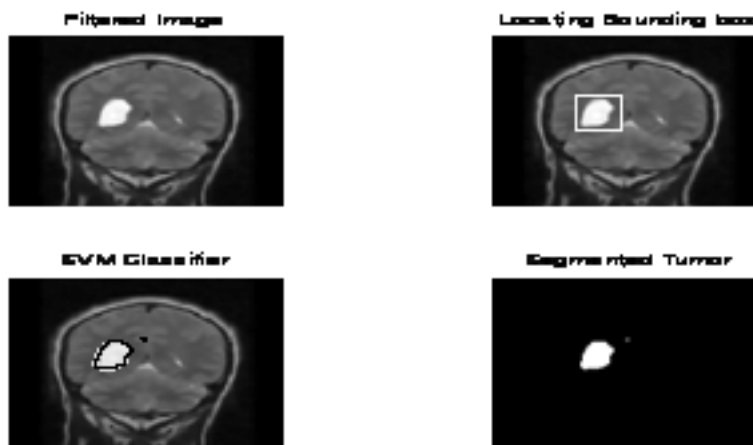


Figure 3: Tumor detection

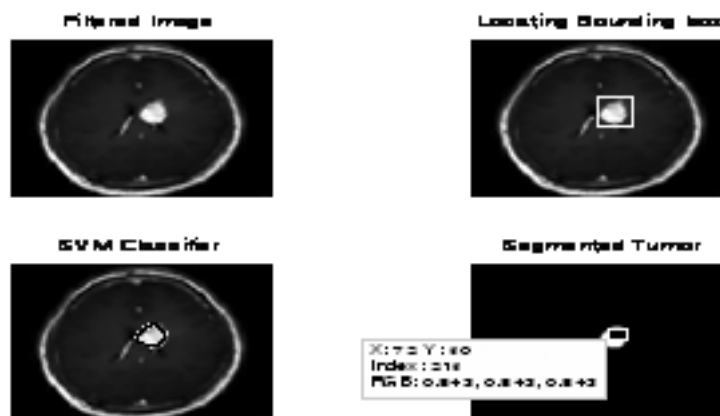


Figure 4: Tumor detection of sample2

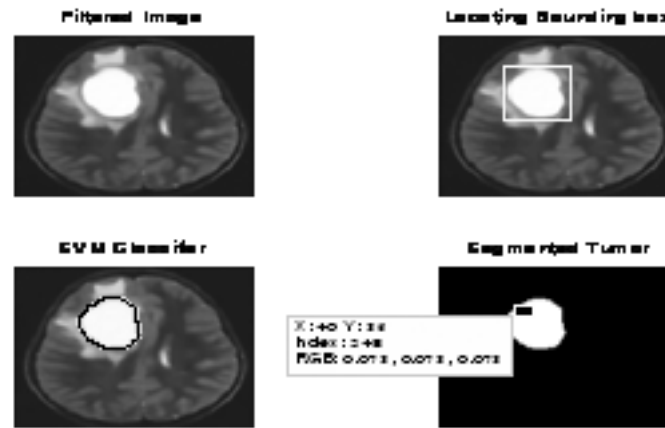


Figure 5: Tumor detection of sample3

The texture analyses for the samples have been performed, and their values are tabulated in table 1. From the table 1 it has been inferred that the feature values obtained from the sample images are well within the acceptable range present in the literature.

Table 1
Texture analysis

Samples	Mean	Standard deviation	Entropy	RMS	Variance	Skewness	Kurtosis	Energy	correlation	contrast
Sample 1	0.00496669	0.0896681	2.6225	1	0.00806	5.31589	58.2712	0.749253	0.0460305	0.581301
Sample 2	0.00349141	0.0897377	2.9673	1	0.00806	5.27227	55.9794	0.748509	0.0363913	0.578285
Sample 3	0.00527774	0.0896503	2.82055	1	0.00806	5.16985	55.9722	0.73453	0.0556032	0.565172

The performance of the proposed method has been analyzed using the performance metrics accuracy. Then the results are compared to the ANN classification methods. Three ANNs were designed and trained, which Feed Forward Back Propagation (BPNN), gradient descent, Levenberg–Marquardt (L-M) optimization are incorporated. Feed-forward networks commonly use the back-propagation supervised learning algorithm to dynamically alter the weight and bias values for each neuron in the network [21]. A back-propagation neural network has been created to classify the images has been presented in [22]. The number of layers, nodes and activation functions are determined according to the application needed and there is no specific rule for choice.

Outcome of the comparison are presented in Table 2. The accuracy of any neural network classifier depends on the type of neural network, the number of hidden layers and the hidden neurons and training function used. A feed forward neural network with back-propagation was used for each classifier. For training function, three most widely used training algorithms were analyzed. Table 2 shows the overall performance (which is the percentage of the total images correctly classified in the complete data set) as a function of the training function. From the results, SVM has the most optimal performance.

Table 2
Performance indices

	Accuracy of SVM	Accuracy of BPNN	Accuracy of L-M	Accuracy of GD
Sample1	95.13	94.12	90.54	92.24
Sample 2	95.67	92.05	93.67	94.67
Sample 3	95.42	93.27	92.43	95.50

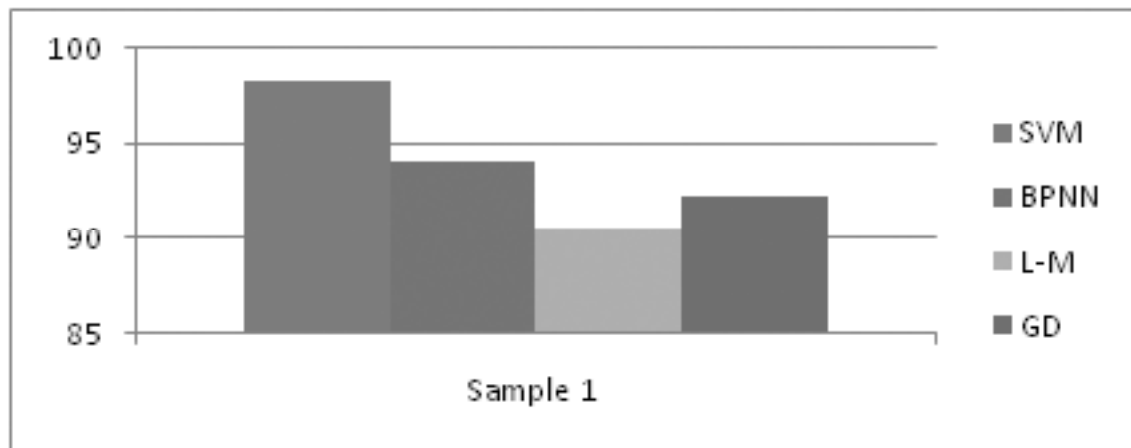


Figure 6: Comparison graph of SVM with neural classifiers

From the Table 2 and Fig. 6 it has been concluded that the accuracy are in high range when compared to L-M and BPNN classification, which reveals that proposed method works well for all the images. It has been noted that SVM takes less computation time when compared to ANFIS and BPNN classification.

4. CONCLUSION

Brain tumor diagnosing has becoming a vital one in medical field because which are caused by abnormal and uncontrolled growing of the cells inside the brain. Moreover treatment of a brain tumor basically depends on its size and location. Automatic classification of MRI brain image eliminates the manual errors and accuracy of the test drastically. In this work, SVM classification technique has been adopted MRI brain image classification. This automated intelligent system results in the improved accuracy rate and the error rate get minimized. Automation of MRI image classification based on SVM will be promising one which aids the physician to make the final decision without any hesitation. From the simulation results it is observed that SVM based classification has been efficient for the classification of the human brain into normal and abnormal. It also achieves high degree of accurate classification (i.e. more than 95%). From the outcomes it has been concluded that this technique seems to be rapid, easy to operate, non-invasive and cost effective.

References

- [1] Natarajan P, Krishnan.N, Natasha Sandeep Kenkre, Shraiya Nancy, Bhuvanesh Pratap Singh, "Tumor Detection using threshold operation in MRI Brain Images", IEEE International Conference on Computational Intelligence and Computing Research, 2012.
- [2] Dipali M. Joshi, N. K. Rana, V. M. Misra, "Classification of Brain Cancer Using Artificial Neural Network", IEEE International Conference on Electronic Computer Technology, ICECT, 2010.
- [3] Safaa E.Amin, M.A. Mageed, "Brain Tumor Diagnosis Systems Based on Artificial Neural Networks and Segmentation Using MRI", IEEE International Conference on Informatics and Systems, INFOS 2012.
- [4] Pankaj Sapra, Rupinderpal Singh, Shivani Khurana, "Brain Tumor Detection Using Neural Network", International Journal of Science and Modern Engineering, IJISME, ISSN: 2319-6386, Volume-1, Issue-9, August 2013.
- [5] Suchita Goswami, Lalit Kumar P. Bhaiya, "Brain Tumor Detection Using Unsupervised Learning based Neural Network", IEEE International Conference on Communication Systems and Network Technologies, 2013.
- [6] S. Rajeshwari, T. Sree Sharmila, "Efficient Quality Analysis of MRI Image Using Preprocessing Techniques", IEEE Conference on Information and Communication Technologies, ICT 2013.
- [7] V. Zeljkovic, C. Druzgalski, Y. Zhang, Z. Zhu, Z. Xu, D. Zhang, P. Mayorga, "Automatic Brain Tumor Detection and Segmentation in MR Images", ISBN: 978-1-4799-3555-0 IEEE Catalog Number: CFP1418G-ART, APRIL 7–12, 2014.
- [8] HariBabuNandpuru, Dr. S. S. Salankar, Prof. V. R. Bora, "MRI Brain Cancer Classification Using Support Vector Machine, IEEE Students' Conference on Electrical, Electronics and Computer Science, 2014.

- [9] Rohini Paul Joseph, C. Senthil Singh, M. Manikandan, "Brain tumor mri image segmentation and detection in image processing", *IJRET: International Journal of Research in Engineering and Technology*, eISSN: 2319-1163 | pISSN: 2321-7308, Mar-2014.
- [10] Demirkaya, O., 2002. Anisotropic diffusion filtering of PET attenuation data to improve emission images. *Phys. Med. Biol.*, 47: 271-278.
- [11] Andrzej & Michal, *Texture Analysis Methods – A Review*, Technical University of Lodz, Institute of Electronics, COST B11 report, Brussels 1998.
- [12] Haralick, R.M., K. Shanmugan, and I. Dinstein, Textural Features for Image Classification, *IEEE Transactions on Systems, Man, and Cybernetics*, Vol. SMC-3, pp. 610-621, 1973.
- [13] Liu & Wechsler, Gabor Feature Based Classification Using the Enhanced Fisher Linear Discriminant Model for Face Recognition, *IEEE Trans. Image Processing*, Vol. 11, pp. 467-476, 2002.
- [14] D. LU & Q. WENG, A survey of image classification methods and techniques for improving classification performance, *International Journal of Remote Sensing*, Vol. 28, No. 5, pp. 823–870, 2007.
- [15] Dr. R. J. Ramteke, Khachane Monali Y, "Automatic Medical Image Classification and Abnormality Detection Using K-Nearest Neighbour", *International Journal of Advanced Computer Research (ISSN (print): 2249-7277 ISSN (online): 2277-7970)*, Volume-2 Number-4 Issue-6 December-2012.
- [16] Priyanka, Balwinder Singh, "a review on brain tumor detection using segmentation", *International Journal of Computer Science and Mobile Computing (IJCSMC)*, ISSN 2320–088X, Vol. 2, Issue. 7, July 2013.
- [17] Huang, Y.L. and D.R. Chen, "Support vector machines in sonography: Application to decision making in the diagnosis of breast cancer". *J. Clin. Imag.*, 29: 179-184, 2005.
- [18] Jennifer Huang, Volker Blanz, and Bernd Heisele, "Face Recognition Using Component-Based SVM Classification and Morphable Models", *LNCS 2388*, pp. 334–341, 2002.
- [19] M. Veluchamy, K. Perumal and T. Ponuchamy, "Feature Extraction and Classification of Blood Cells Using Artificial Neural Network", *American Journal of Applied Sciences* 9(5), pp. 615-619.
- [20] Roopali R. Laddha, S.A.Ladhake, "A Review on Brain Tumor Detection Using Segmentation And Threshold Operations", (*IJCSIT*) *International Journal of Computer Science and Information Technologies*, Vol. 5 (1), 2014.
- [21] D.Ansari, J.Nilsson, R.Andersson, S.Regner, B.Tingstedt, B.Andersson, "Artificial neural networks predict survival from pancreatic cancer after radical surgery", *The American Journal of Surgery*, (205), 2013, pp. 1-7.
- [22] Martin T. Hagan and Mohammad B. Menhaj, "Training Feed forward Networks with the Marquardt Algorithm", *IEEE Trans. on Neural Networks*, Vol. 5, No. 6, November 1994.