

Classification of Brain Tumor from brain MRI Images using SVM

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Abstract: Brain tumor classification is an energetic analysis space in medical image process and pattern recognition. Tumor is associate abnormal mass of tissue within which some cells grow and multiply uncontrollably, apparently unregulated by the mechanisms that management traditional cells. The expansion of a growth takes up house inside the os and interferes with traditional brain activity. The detection of the growth is incredibly necessary in earlier stages. Automating this method could be a difficult task thanks to the high diversity within the look of growth tissues among totally different patients and in several cases similarity with the conventional tissues.

This paper depicts a unique framework for neoplasm classification supported gray level co-occurrence matrix(GLCM) applied mathematics options square measure extracted from the brain magnetic resonance imaging pictures, that signify the necessary texture options of growth tissue.

Index Terms— Brain, Magnetic resonance imaging, Support vector machine (SVM), LBPH, HOG, GLCM.

I. INTRODUCTION

Detection of a brain tumor from medical images has been a challenging task. The brain is one of the important organs of the human body as it coordinates each and every action of the human body. The human brain can be affected by many diseases like infections, strokes and tumors. A brain tumor is a cancerous or non-cancerous mass or growth of abnormal cells in the brain. It can be termed as the cells which don't die but grows in size and accumulates as a mass. A brain tumor is classified as a primary and secondary tumor. A tumor that starts in the brain is called Primary Brain a tumor. It can be either malignant (contain cancer cells) or benign (do not contain cancer cells). If a cancerous tumor which starts elsewhere in the body sends cells which end up growing in the brain, such tumor is called secondary or metastatic brain tumor. Image testing of a brain tumor is done using x-rays, strong magnets, or radioactive substances to create pictures of the brain. The brain tumors are generally diagnosed using different types of scans. Magnetic Resonance Imaging, Computer Tomography, Angiogram, Myelogram and Positron Emission Tomography are among the types of scans which are used most often to detect brain diseases. These pictures are so efficient that they can provide with primary information about the presence and location of a tumor.

WHY MRI SCANNED IMAGES ARE PREFERRED COMPARED TO OTHER IMAGING TECHNIQUES?

- MRI is non-invasive.
- MRI is cost effective.
- Good contrasts of the tumors that are present in the brain are provided.
- Acquisition time (Total body scan) of MRI is less compared to PET and X-Ray.
- MRI provides better details of bone structure and organs behind them like lungs behind ribs and brain beneath the skull.

II. RELATED WORK

KNN is the simple method which required low computational cost. An automatic medical image classification technique KNN classifier is used to classify the medical image into normal and abnormal image this concept Presented by R. J. Ramteke et al.[1] MRI image classification technique based on SVM classifier proposed by Khushboo Singh et al.[2].Advanced classification techniques based on Support Vector. Support vector machine is a supervised learning algorithm. In SVM, the classification is performed by quadratic programming.

An efficient brain tumor detection algorithm using watershed and threshold based segmentation implemented by A .Mustaqeem, et al [3]. This research was conducted to detect brain tumors using medical imaging techniques.

ANN is a mathematical problem which is inspired by the biological nervous system Priyanka et al.[4] proposed a urvey on the brain tumor detection algorithm and its location in the brain.Shweta Jain et al.[5] extract a feature using GLCM technique and extracted features were classified using the artificial neural network.

P.Vasuda and S.Satheesh [6] proposed a technique to detect tumors from MR images using fuzzy clustering technique. This algorithm uses fuzzy C-means but the major drawback of this algorithm is the computational time required.

Sindhushree. K.S, et al [7] have developed a brain tumor segmentation method and validated segmentation on two dimensional MRI data. Also, detected tumors are represented in three dimensional view. High pass filtering, histogram equalization, thresholding, morphological operations and segmentation using connected component labeling was carried out to detect tumor. The two dimensional extracted tumor images were reconstructed into three dimensional volumetric data and the volume of the tumor was also calculated

Gopal et al [8] proposed a smart system Brain Tumor Through MRI utilizing Image Processing Algorithm, for example, Fuzzy C Means Along with Intelligent Optimization Techniques", diary of IEEE 2010.

It is designed to diagnose brain tumor through MRI using image processing clustering algorithms such as fluffy C Means along with intelligent optimization tools, such as Genetic Algorithm (GA), and Particle Swarm Optimization (PSO). The average results classification error of GA is 0.078%. The average accuracy GA is 89.6%. PSO gives best classification accuracy and average error rate. In this the Average classification error of PSO is 0.059% and the accuracy is 92.8% and tumor detection is 98.87%. Therefore, we saw that average classification error is reduced when the number of sample is increased. This report has provided substantial evidence that for brain tumor segmentation of PSO algorithm performed well.

Badran et al [9], proposed an innovative system which can be used as a second decision for the surgeons and were based on adaptive thresholding. It determines whether an input MRI brain image represents a healthy brain or tumor brain as percentage it defines the tumor type; malignant or benign tumor.

HOG descriptors have been introduced by Dalal and Triggs in [10] and [11]. The main idea behind the histogram of oriented gradient is that the local appearance and shape of object in an image can be described by the intensity distribution of gradients or direction of the contours. The implementation of these descriptors can be obtained by dividing the image into small connected regions, called cells. Then, for each cell we compute a histogram of gradient directions or edge orientations for all pixels of the cell. The combination of these histograms is the descriptor.

The HOG descriptor has some key advantages. Since it operates on localized cells, the method maintains the invariance to geometric and photometric transformations. The method allows a more generic detection, requiring no prior information about the structure of the scene, with a processing time close to the real-time. In 2005, INRIA researchers propose a new technique based on the histograms of oriented gradient (HOG) [12].

Also in 2008, Mu & al. have successfully used local binary patterns (LBP), a type of features that had proven a good effectiveness especially when applied to face detection [13].

Brain tumor classification is very significant phase in the medical field. The images acquired from different modalities such as CT, MR that should be verified by the physician for the further treatment, but the manual classification of the MR images is the challenging and time consuming task [14]. Human observations may lead to misclassification and hence there is need of automatic or semiautomatic classification techniques to make the difference between different tumor types.

III. SYSTEM ARCHITECTURE

We have proposed segmentation of the brain MRI images for detection of tumors using K-Means clustering technique. A cluster can be defined as a group of pixels where all the pixels in certain group defined by similar relationship. Clustering is also unsupervised classification because the algorithm automatically classifies objects based on user given criteria. Here K-Means clustering algorithm for segmentation of the image is used for tumor detection from MRI scan.

The proposed system is as shown in figure:

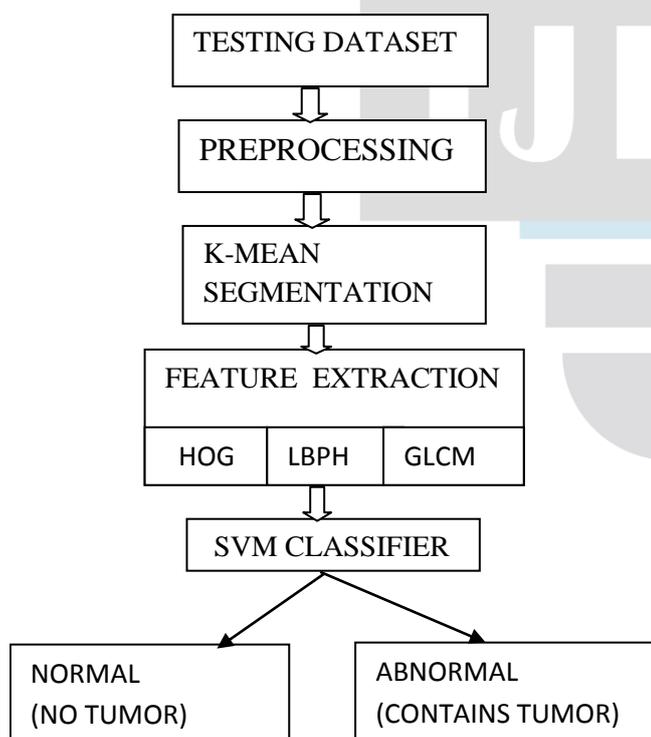


FIG: SYSTEM FOR BRAIN TUMOR DETECTION

IV. DESCRIPTION

MRI scans of the human brain forms the input images for our system where the grayscale MRI input images are given as the input. Noise present if any, will be removed using a filter. Image enhancement is done for better result. The pre-processed image is given for image segmentation using K-Means clustering algorithm.

Input Image

MRI scan is given as input to the system. MRI scan is preferred as it give the detail picture of nerves tissues and brain in different planes without obstacle and it gives better result than CT(computed tomography)scan.

MRI scanners use strong magnetic fields, electric field gradients, and radio waves to generate images of the organs in the body. MRI does not involve X-rays and the use of ionizing radiation, which distinguishes it from CT or CAT scans.

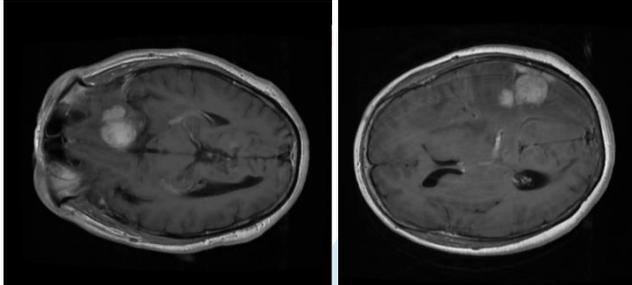


FIG: IMAGE 1

FIG: IMAGE2

Pre-processing stage

In this stage image is enhanced in the way that finer details are improved and noise is removed from the image. Most commonly used enhancement and noise reduction techniques are implemented that can give best possible results. Enhancement will result in more prominent edges and a sharpened image is obtained, noise will be reduced thus reducing the blurring effect from the image. Filtering is done to remove noise from the medical images because medical images are somewhat noisy. In proposed work we use filter to smoothing and removing noise from the image. In addition to enhancement, image segmentation will also be applied. This improved and enhanced image will help in detecting edges and improving the quality of the overall image. Edge detection will lead to finding the accurate position of tumor.

NORMALIZE In image processing, normalization is a process that changes the range of pixel intensity values. Applications include photographs with poor contrast due to glare, for example. Normalization is sometimes called contrast stretching or histogram stretching. In more general fields of data processing, such as digital signal processing, it is referred to as dynamic range expansion. The purpose of dynamic range expansion in the various applications is usually to bring the image, or other type of signal, into a range that is more familiar or normal to the senses, hence the term normalization. Often, the motivation is to achieve consistency in dynamic range for a set of data, signals, or images to avoid mental distraction or fatigue. For example, a newspaper will strive to make all of the images in an issue share a similar range of grayscale.

In our system image will be appear like in fig after normalization.

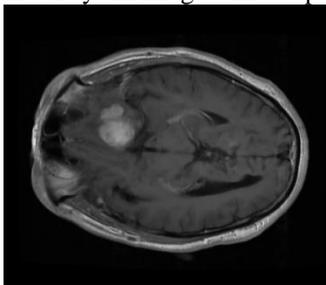


FIG: IMAGE 1 AFTER NORMALIZATION

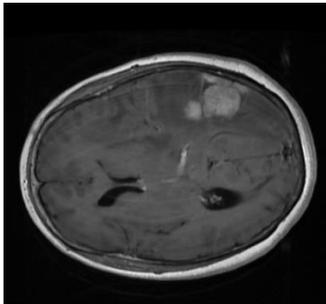


FIG: IMAGE 2 AFTER NORMALIZATION

CLAHE The first histogram equalization we just saw, considers the world distinction of the image. In many cases, it is no longer a desirable idea. For example, below picture suggests an enter picture and its result after global histogram equalization.



Image

It is genuine that the historical past distinction has improved after histogram equalization. But compare the face of statue in each images. We lost most of the data there due to over-brightness. It is because its histogram is now not limited to a specific vicinity as we saw in previous instances. So to clear up this problem, adaptive histogram equalization is used. In this, image is divided into small blocks called "tiles" (tileSize is 8x8 through default in OpenCV). Then each of these blocks are histogram equalized as usual. So in a small area, histogram would confine to a small vicinity (unless there is noise). If noise is there, it will be amplified. To keep away from this, contrast limiting is applied. If any histogram bin is above the special distinction restrict (by default 40 in OpenCV), those pixels are clipped and disbursed uniformly to different bins earlier than making use of histogram equalization. After equalization, to remove artifacts in tile borders, bilinear interpolation is applied.

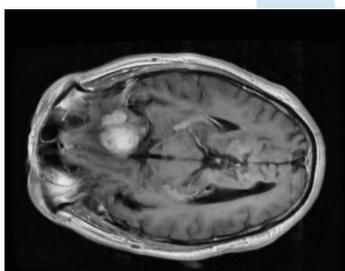


FIG: RESULTING IMAGE AFTER APPLYING CLAHE FOR IMAGE 1

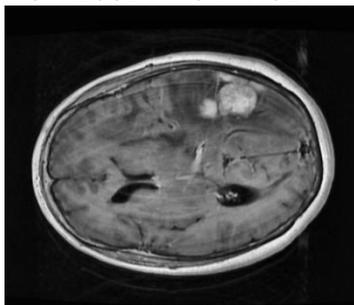


FIG: IMAGE 2 AFTER APPLYING CLAHE

ERODE OR DILATION:

Erosion shrinks or thins objects in a binary image. The manner and extent of shrinking is controlled by a structuring element. Erosion is a process of translating the structuring element throughout the domain of image. One of the simplest uses of erosion is for eliminating irrelevant details from binary image. Erosion is a morphological filtering operation in which image details smaller than structuring element are filtered from original image. The structuring element overlap only „1“ valued pixels of the input image (fore ground of image). The output image has a value of „1“ at each location of the origin of the structuring element. Dilation is an operation that grows or thickens objects in binary image. The manner and extent of shrinking is controlled by a structuring element. Dilation is a process of translating the structuring element throughout the domain of image. Let A is a set of original image and B is a set of structuring element. Mathematically dilation can be represented as This equation indicates that dilation A by B is the set of all displacements, z, such that B^z and A overlap by at least one element. It is processes that translate the origin of the structuring element throughout the domain of the image and check where it overlaps with „1“ valued pixels. Translation of structuring element in dilation is similar to that of convolution. One of the simplest applications of dilation is for bridging gaps.

OPENING AND CLOSING

In image processing applications, dilation and erosion are used in various combinations. The most common combination are opening and closing. Opening and closing contains series of dilations and/or erosions using same or different structuring element. Morphological opening remove completely regions of an object that cannot contain the structuring element, smooth object contours, break thin connections and remove thin protrusions. The Opening of set A by structuring element B is the erosion of A by B, followed by dilation of the result. Morphological closing tends to smooth the contours of object. It generally joint narrow break, fills gap smaller than structuring element.

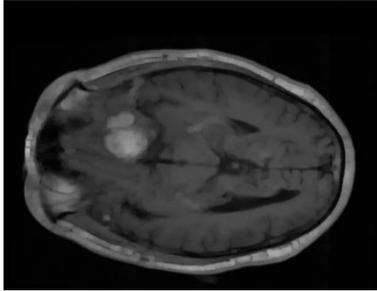


FIG: IMAGE 1 AFTER ERODE/DILATION

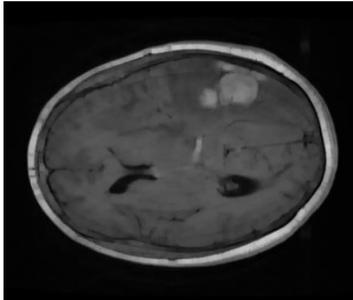


FIG: IMAGE 2 AFTER ERODE/DILATION

BILATERAL FILTERING:

A bilateral filter is a non-linear, edge-preserving, and noise-reducing smoothing filter for images. It replaces the intensity of each pixel with a weighted average of intensity values from nearby pixels. This weight can be based on a Gaussian distribution. Crucially, the weights depend not only on Euclidean distance of pixels, but also on the radiometric differences (e.g., range differences, such as color intensity, depth distance, etc.). This preserves sharp edges.

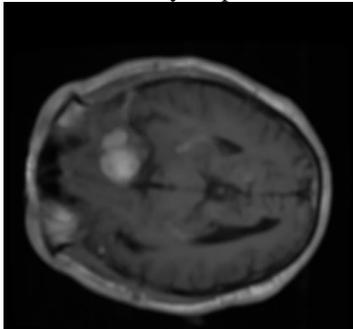


FIG: RESULTING IMAGE AFTER BILATERAL FILTERING FOR IMAGE 1

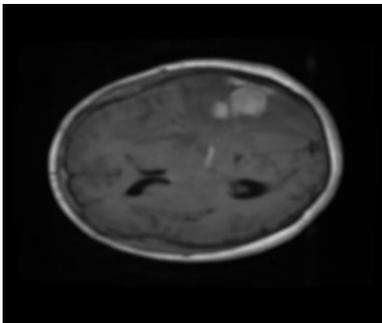


FIG: RESULTING IMAGE AFTER BILATERAL FILTERING FOR IMAGE 2

Segmentation using K-Mean clustering:

Segmentation is an essential process to extract information from complex medical images. The main objective of segmentation is to simplify or change the representation of an image into something that is more meaningful and easier to analyze and the pixels within the region are homogeneous with respect to a predefined criterion. Clustering is division of data into groups of alike objects. Each group consists of objects that are comparable between themselves and dissimilar to objects of other groups. In proposed system image is segmented into 8 segments and then feature are extracted.

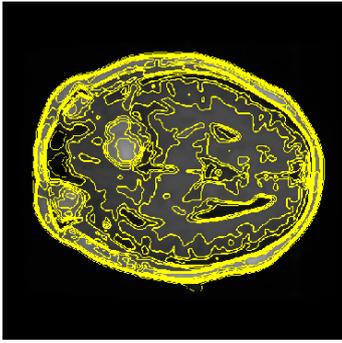


FIG: RESULTING IMAGE AFTER K-MEAN SEGMENTATION FOR IMAGE 1

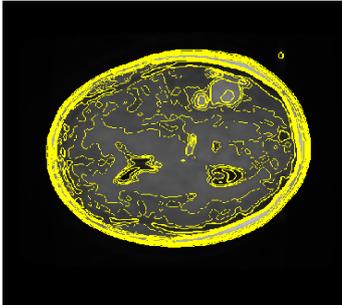


FIG: RESULTING IMAGE AFTER K-MEAN SEGMENTATION FOR IMAGE 2

FEATURE EXTRACTION

In this stage we need to retrieve the valuable information from the MRI images after pre-processing. It is the process of collecting higher-level information of an image such as shape, texture, color, and contrast. In fact, texture analysis is an important parameter of human visual observation and machine learning system. It is used effectively to improve the accuracy of diagnosis system by selecting important features.

In our proposed system HOG is used for extracting the shape feature. GLCM is used for texture feature. LBPH is used for intensity.



IMAGE 1	LBPH	GLCM	HOG
SEGMENT 0	4.73	1.4313	0.3354
SEGMENT 1	2.081	3.69877	0.2023
SEGMENT 2	4.6274	6.3866	5.1073
SEGMENT 3	4.2202	5.1181	0.3325
SEGMENT 4	3.8494	4.0315	5.5452
SEGMENT 5	3.1343	6.1242	0.2594
SEGMENT 6	3.0326	5.45104	0.4226
SEGMENT 7	4.0713	5.7701	5.1993

IMAGE 2	LBPH	GLCM	HOG
SEGMENT 0	2.62005	3.9199	0.26508
SEGMENT 1	0.0021	2.8476	0.36675
SEGMENT 2	2.99409	5.6581	0.33375
SEGMENT 3	5.23447	5.01175	0.29995
SEGMENT 4	0.73507	5.36768	5.1618
SEGMENT 5	3.2607	4.98351	4.09227
SEGMENT 6	4.30808	6.98567	3.95063
SEGMENT 7	4.92358	5.82898	6.54092

FIG: TABLES FOR IMAGE 1 AND IMAGE 2 FOR FEATURE EXTRACTION

CLASSIFICATION:

Support vector machine(SVM) is the linear learning algorithm used for classification. The process of classification forward through training and testing. Support vector machine (SVM) is the linear learning algorithm used for classification. SVM will classify the image into normal and abnormal.

SVM is a powerful supervised classifier and accurate learning technique that has been introduced in 1995. SVM has proven its efficiency over neural networks and RBF classifiers. SVM uses an optimum linear separating hyper plane to separate two set of data in feature space. This optimum hyper plane is produced by maximizing minimum margin between the two sets. Therefore the resulting hyper plane will only be dependent on border training patterns called support vectors.

SVM operates on two mathematical operations-

- Nonlinear mapping of an input vector into a high dimensional feature space that is hidden from both the input and output.
- Construction of an optimal hyper plane for separating the features .

SVM maps input vectors to a higher dimensional vector space where an optimal hyper plane is constructed .

The data with linear severability may be analyzed with a hyper plane, and the linearly non separable data are analyzed with kernel functions such as Gaussian RBF.

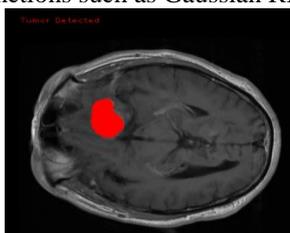


FIG: IMAGE SHOWING DETECTION OF TUMOR FOR IMAGE 1

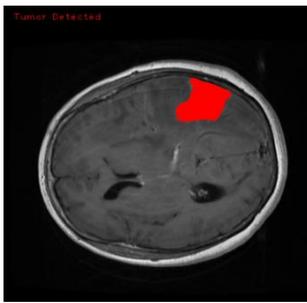


FIG: IMAGE 2 SHOWING TUMOR DETECTED

V. RESULT

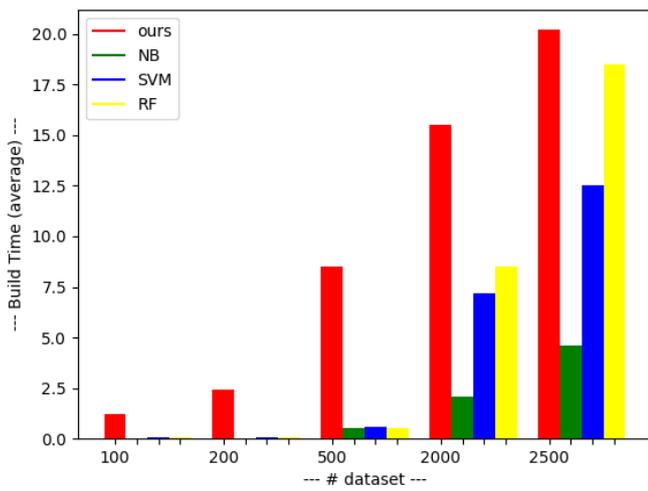


FIG: RESULT FOR BUILT IN TIME FOR TRAINING SAMPLES

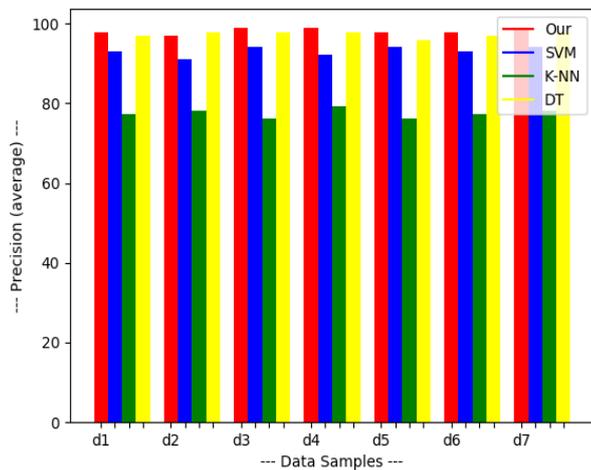


FIG: RESULT FOR ACCURACY

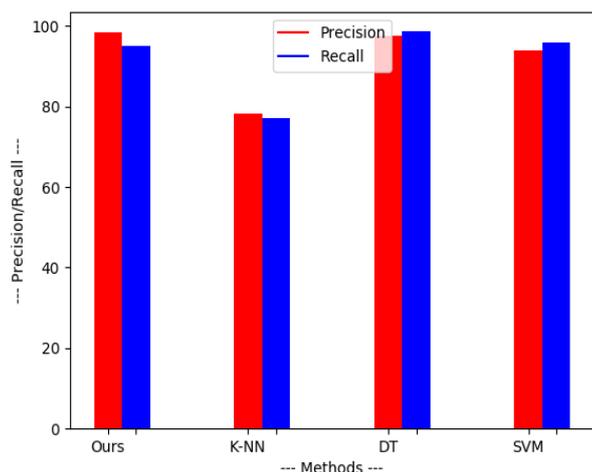


FIG: RESULT FOR OVERALL PERFORMANCE

VI. CONCLUSION

This paper proposes a work on brain tumor detection system based on kmean clustering and machine learning algorithms. The texture based features are extracted using Gray Level Co-occurrence Matrix (GLCM). The texture features of the image considered in this proposed work include energy, contrast, correlation, homogeneity. Along with texture based features intensity features also used with the help of LBPH (local binary pattern histogram).

For the classification purpose, support vector machine machine learning algorithm is used and the maximum accuracy 98.6% is achieved by considering around 250 training samples and 100 test samples of brain MR images.

This accuracy can probably be increased by considering a large data set and implementing other recursive pre-processing algorithmic steps.

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