

# Fusion of brain MRI and CT images and Classification of brain tumor using Machine Learning Algorithm



Jayasheela M, Gomathi E

**Abstract:** Brain tumor is the most common and destructive disease which reduces the life time of people. The earlier detection of brain tumor plays a most important role for better treatment of the patient. In this paper, a new technique for brain tumor classification using machine learning by fusion of MRI and CT images are proposed. Image fusion is a process of fusing two or more images (i.e. MRI and CT scan images) to obtain a new one which contains more accurate information of the brain than any of the individual source images. Initially fusion of MRI and CT scan images has been carried out using Stationary Wavelet Transform (SWT). Then watershed transform is applied for image segmentation and discriminative robust local binary pattern (DRLBP) is employed to extract the features exactly from the fused image. Classification of the tumor is done by Support Vector Machine (SVM) thereby reducing the generalization error and increasing the accuracy. The ultimate goal is to classify the tissues into normal and abnormal using machine learning algorithms. Image fusion process yields more accurate information of the brain than any of the individual source images.

**Keywords:** Image Fusion, SWT, Image Segmentation, DRLBP, GLCM, Tumor Classification

## I. INTRODUCTION

Medical imaging with the advancements in imaging era has become vital tool in medicine today. CT, XRA, MRA, MRI and other imaging methods are mostly used in medical practice as they provide detailed and complete history about the patient. Medical images with exact detailing of the features are needed in the automation of this diagnosis process. One of the important needs of medical imaging is detecting the brain tumor and classification of images of the affected patient obtained at various time. Due to the structure of the brain, detection of brain tumors and their classification are great challenge. There is high possibility of error and less accuracy as the tumor is classified based on various parameters such as location, shape, size, density and so on.

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The objective is achieved by Image fusion and recognition by Watershed algorithm. The scanned brain image is obtained by CT and MRI are fused together to obtain a more detailed image. The features of the fused image are then extracted to clearly find out the tumor and then it is classified as benign tumor and malignant tumor based on the complexity.

In Existing method, Image fusion done by Discrete Cosine transform (DCT) resulted in less accuracy, added noise and a blurred image. Therefore SWT is proposed for image fusion which produced a clear detailed image. Tumor segmentation method which is used earlier is not possible to extract the feature of vascular system exactly from each medical image modality. Further to improve the efficiency the discriminative robust local binary pattern (DRLBP) feature extraction is used. After the feature extraction the classification of the tumor is done by SVM thereby reducing the generalization error and increasing the accuracy.

## II. LITERATURE SURVEY

Du Tran et al [3] proposed an effectual method for spatiotemporal feature learning using deep 3-dimensional convolutional networks.

Swapnil et al [5] proposed an approach for brain tumor detection. K-means segmentation is achieved and SVM is employed to sustain the pattern. Bahadure et al [6] applied BWT and SVM techniques for brain tumor detection and classification. In this technique, 95% accuracy was obtained. Natarajan et al. [9] proposed brain tumor detection method in which preprocessing is done by using median filter, and segmentation of image is performed using threshold segmentation. Image subtraction technique is used to extract the tumor region.

Tushar Kant Mudgal et al [11] contributed a novel approach for the detection of brain Tumor detection. Also classification had done using the improved K-means clustering algorithm with mean shift segmentation for pre-processing MRI Scanned images. Detection is done using watershed transform and GLCM is used for feature extraction. For classification, improved version of GBM is used to get more accurate results. A detailed comparison with a large dataset between XG Boost models and other comparative machines and even hybrids using these extreme models offers great potential for research. The author Thejaswini P et al [12] had applied an adaptive kernel based fuzzy C-means clustering algorithm (ARKFCM) for segmentation of an image. A combination of Artificial Neural Network (ANN) and SVM were applied for detection and classification of brain tumor based on the extracted features.



These systems cannot be used for all types of MRI scanned images. Multiple dataset input will produce inaccurate results with this type of algorithm. Therefore in this paper, Image classification is done by machine learning algorithms for better performance of the system. DCT is time-variant and provides results with poor directionality.

In order to avoid this translation variation, an un-decimated approach called stationary wavelet transform (SWT) is utilized in the proposed system. In this paper watershed transform is utilized for image segmentation. The image after gradient magnitude consists of substantial pixel values along object boundaries and low pixel values in the remaining area. Watershed transform create the ridge lines along object boundaries [2]. This method mainly divides the process into two: first it is identifying main boundaries of the processed image, and then calculating the watershed of the gradient perceived [1][2]. Watershed transform is an efficient assessment tool for image segmentation [2].

Sanjit K. Mitra et al [8] combined wavelet transform of input images and then inverse wavelet transform is applied on the fused wavelet coefficients to get a new image. In this literature a maximum selection rule proposed for feature extraction based on area. This work is tested using synthetic tool with varying noise parameters.

### III. PROPOSED METHODOLOGY

In this paper, fusion of brain MRI & CT images and classification of brain tumor using machine learning algorithm is proposed. The proposed method described with following steps:

1. Image Fusion
2. Preprocessing
3. Segmentation using Water shed transform
4. Feature extraction
5. Using SVM Image classification will be done

#### A. Image fusion by SWT

The purpose of fusing more images is to remove repeated data from input images. Image fusion based on SWT transform is used in the proposed system. In this method the coefficients of low frequency components and coefficients of high frequency components are combined using fusion rule to get new fused value. In this proposed work measurement of activity level is done using fusion rule.

The activity level is window based spatial frequency (SF) is given by [9]

$$SF = \sqrt{RF^2 + CF^2}$$

where RF denotes row frequency and CF represents column frequency respectively and calculated as

$$RF = \sqrt{\frac{1}{M(N-1)N} \sum_{m=0}^{M-1} \sum_{n=0}^{N-2} (x(m, n+1) - x(m, n))^2}$$

$$CF = \sqrt{\frac{1}{M(N-1)N} \sum_{m=0}^{M-1} \sum_{n=0}^{N-2} (x(m+1, n) - x(m, n))^2}$$

When the activity level increases that indicates that amount of information in input image is more. During fusion, the input image which has highest level will contribute more in the fused image. The block diagram of Image fusion is shown in figure 1. Two images are fed into SWT. The SWT segregate the Low frequency and high frequency components along all directions respectively.

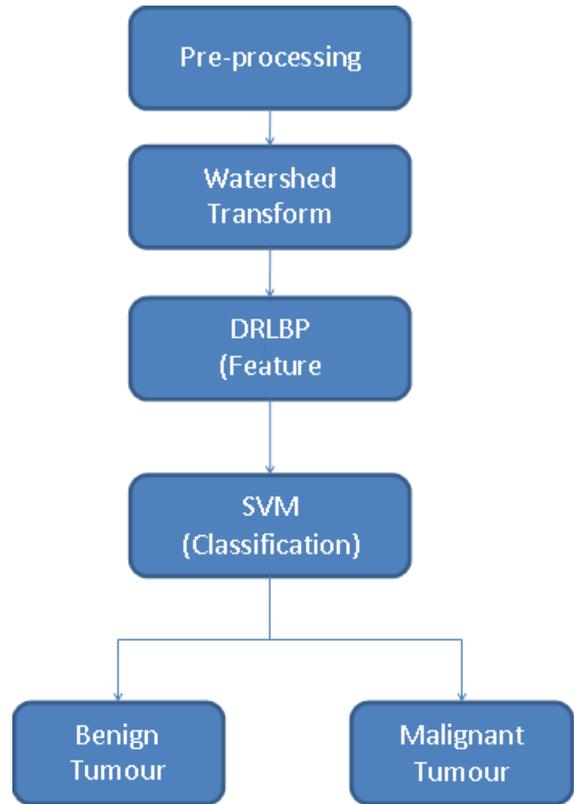


Figure 1: Flow Diagram of Proposed System

In SWT, the filter coefficients are up sampled by introducing zeros between them rather than down-sampling which is done in other transforms. The result contains four images in which three are detail and one is approximation. Even though the resolution is halved, all these image size are same as the original image. The de-composition of image is done in SWT domain. The process of moving or aligning one or more images to another image which is fixed is known as image registration. It is very useful in emphasizing the changes of image structures over time.

#### B. Segmentation by Watershed transform

The segmentation processes using gradient based watershed algorithm is as follows.

- Each nearest minimum is specified with a distinct label. A set S is initialized with the labeled nodes.
- Extract a node x from S of minimal altitude F, that is to say  $F(x) = \min\{F(y)|y \in S\}$ . Every non-labeled node y adjacent to x is denoted with a label of x, and y is inserted in S.
- Repeat Step 2 until S is empty.

#### C. Feature Extraction by DRLBP

LBP codes for both ULBP and LLBP are given below:

$$LBP_{x,y} = \sum_{b=0}^{B-1} s(p_b - P_c) 2^b$$

$$S(z) = \begin{cases} 1, & z \geq 0 \\ 0, & z < 0 \end{cases}$$

$$ULBP = \sum_{b=0}^{B-1} f(P_b - P_c) 2^b$$

$$LLBP = \sum_{b=0}^{B-1} f^1(P_b - P_c) 2^b$$

The dimensionality of the feature is reduced from 6561 bins to 512 bins. Using uniform LBP code representation, the number of bins is further reduced to 118 bins.

**D. Image Classification by Support Vector Machine**

Support Vector Machine is mainly used to classify the fused image into respective classes like benign and malignant tumors. Before classification, the input data set and label on it are taken respectively. So that next input image with the feature extraction value is obtained and is used for this classification. First support vector machine is used to plot all the obtained feature extraction values in a graphical format and then a linear line is drawn on it to classify the normal and abnormal conditions by finding the distance between each data with linear line and thus classified.

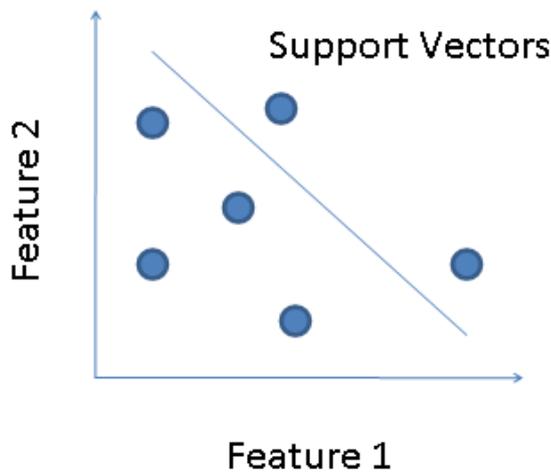


Figure 4: Support Vector Machine

**IV. RESULTS AND DISCUSSIONS**

The results of the proposed work are obtained by applying input brain images to the proposed flow diagram shown in Figure 1.

Using Matlab R2014, Monte Carlo simulations have been run to simulate the proposed system. For experimental analysis one CT scanned brain image and MRI scanned same brain image are taken and these 2 images are fused together in order to obtain new image. Fig 5c (1), shows that Image Fusion of MRI and CT scanned image by SWT.

Fig 5 c(2) shows that Image Fusion of MRI and CT scanned image by DCT.From the results it is proved that when the image fused by DCT (Existing) it is hard to extract the feature for classification because of less accuracy and noise. Fused Image using SWT is considered as an input to the water shed transform using gradient based approach. Then the features of brain image are extracted using DRLBP. The values of features extracted is fed into of SVM classifier to classify whether the given brain tumor is Benign or Malignant

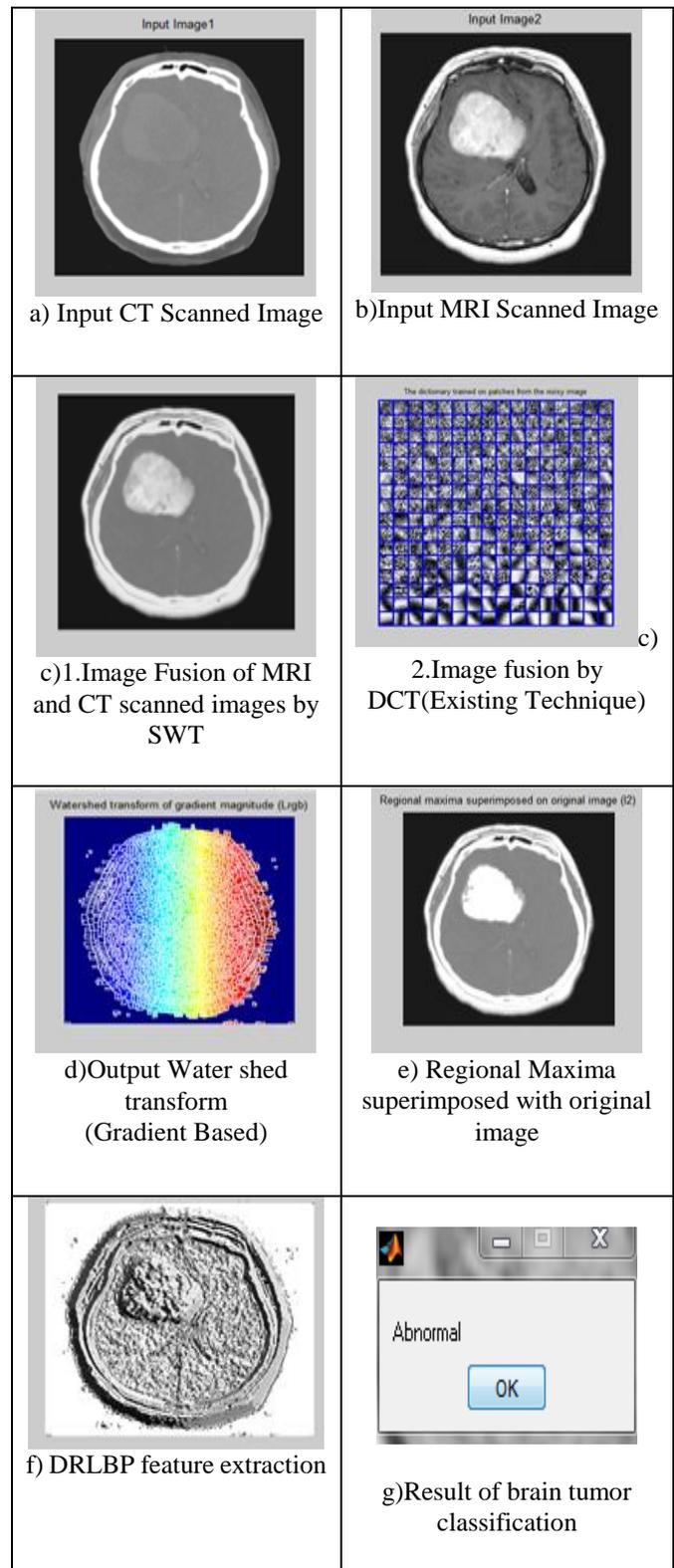


Figure 5: Fusion and Image classification using watershed transform

**A Performance Metrics**

**Accuracy**

Accuracy is a metric for evaluating classification models. The definition is as follows:

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

Where TP- True Positive, TN-True Negative, FP-False Positive, FN-False Negative

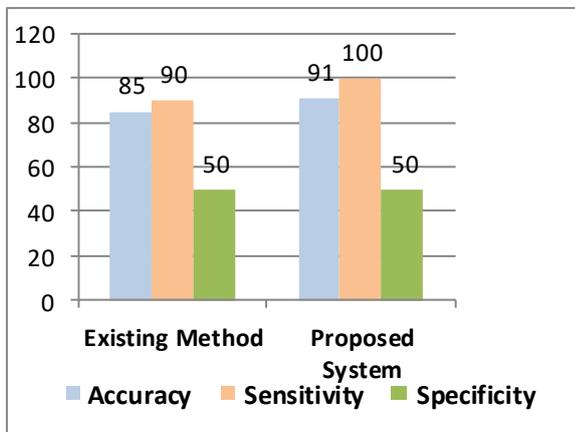
### Sensitivity (%)

Sensitivity or true positive rate measures the proportion of positive condition that is correctly identified .Sensitivity can be given by:

$$\text{sensitivity} = \frac{\text{Number of true positives}}{\text{Number of true positives} + \text{Number of false negatives}}$$

### Specificity

The Specificity is the measure of an image as the similarity between pairs of pixels values. For an image, assign a set S of N sentence descriptions  $\{s_1, \dots, s_N\}$ . Similarity is calculated between all possible pairs of sentences and averages the scores. Fig 6 deals the comparison performance metrics between existing and proposed system. From the figure 6 it is understood that the proposed system have better accuracy and sensitivity than that of the existing system



**Figure 6: Performance Metrics**

## V.CONCLUSION

The proposed technique was applied to brain MRI and CT images to classify brain tumor as normal or abnormal. Fusion of images are carried out using SWT to segregate the Low frequency and high frequency components and segmented using watershed transform. The features are extracted using DRLBP and SVM classifier was employed to classify whether the given brain tumor is Benign or Malignant. This proposed technique was compared with existing DCT method interms of accuracy, sensitivity and specificity. From the results it is concluded that accuracy and sensitivity are better when compared to existing system.

### ACRONYMS

CT	Computerized Tomography
GUI	Graphical User Interface
MRI	Magnetic Resonance Imaging
DCT	Discrete Cosine Transform
MRA	Magnetic Resonance Angiography
XRA	X-Ray Angiography
DIP	Digital Image Processing
LBP	Local Binary Pattern
PNN	Predictive Neural Networks
SWT	Stationary Wavelet Transform
LDP	Local Directional Pattern
HRCT	High-Resolution Computed Tomography

WT	Watershed Transform
MATLAB	Matrix laboratory
DRLBP	Discriminative Robust Local Binary Pattern

### REFERENCES

- Information Fusion for Human Action Recognition via Biset/Multiset Globality Locality Preserving Canonical Correlation Analysis, Nour El Din Elmadany, Student Member, IEEE, Yifeng He, Member, IEEE, and Ling Guan, Fellow, IEEE, 2018.
- Christoph Feichtenhofer, Axel Pinz, and AP Zisserman, "Convolutional two-stream network fusion for video action recognition," 2016.
- Du Tran, Lubomir Bourdev, Rob Fergus, Lorenzo Torresani, and Manohar Paluri, "Learning spatiotemporal features with 3d convolutional networks," in Computer Vision (ICCV), 2015 IEEE International Conference on. IEEE, 2015, pp. 4489–4497.
- Mohammadreza Zolfaghari, Gabriel Oliveira, Nima Sedaghat, and Thomas Brox, "Chained multi-stream networks exploiting pose, motion, and appearance for action classification and detection," in Computer Vision (ICCV), 2015 IEEE International Conference on. IEEE, 2015, pp. 4489–4497.
- Swapnil R Telrandhe, Amit Pimpalkar, Ankita Kendh "Detection of brain tumor for MRI images by using segmentation and SVM", World Conference on Futuristic Trends in Research and Innovation for Social Welfare, 2016.
- Bahadure NB, Ray AK, Thethi HP, "Image analysis for MRI based brain tumor detection and feature extraction using biologically inspired BWT and SVM", Int J Biomed Imaging 2017.
- Aranki, G. Kurillo, P. Yan, D.M. Liebovitz, and R. Bajcsy, "Continuous, real-time, telemonitoring of patients with chronic heart-failure: lessons learned from a pilot study," in International Conference on Body Area Networks (Bodynets), 2014.
- "Multi-sensor image fusion using the wavelet transform" HuiLiB.S. Manjunath and Sanjit K. Mitra, 1994
- Natarajan P, Krishnan.N, Natasha Sandeep Kenkre, Shriyai Nancy, Bhuvanesh Pratap Singh, "Tumor Detection using threshold operation in MRI Brain Images" , IEEE International Conference on Computational Intelligence and Computing Research, 2012
- Y. Nam, S. Rho, and J. Park, "Intelligent video surveillance system: 3-tier context-aware surveillance system with metadata," Multimedia Tools and Applications, vol. 57, pp. 315–334, 2012.
- Tushar Kant Mudgal, Siddhant Jain, Aditya Gupta, KunalGusain, "Automated system for Brain Tumour Detection and Classification using extreme Gradient Boosted Decision Trees", in International Conference on soft computing and its Engineering Applications, 2017.
- Thejaswini P, Bhavya Bhat, Kushal Prakash "Detection and Classification of Tumour in Brain MRI" , I.J. Engineering and Manufacturing, 1, 11-20, 2019.

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