IJCSC 0973-7391 Volume 8 • Issue 2 March 2017 - Sept 2017 pp. 42-47 available online at www.csjournals.com

Analysis of Brain MRI Tumor Detection and Classification using Hybrid Approach

[1]Varun Jain, [2]Sunila Godara

[1,2]Department of CSE, Guru Jambheshwar University of Science & Technology, Hisar, India

Abstract: Nowadays, brain tumor has been proved as a life threatening disease which cause even to death. Various classification techniques have been proposed for Classification of Brain MRI Tumor Images. In this paper brain tumor from MR Images with the help of hybrid approach. This hybrid approach includes discrete wavelet transform (DWT) for feature extraction, Genetic algorithm for diminishing the number of features and RBF Neural Network (RBFNN) for brain tumor classification. Images are downloaded from SICAS Medical Image Repository which classified images as benign or malign type. The proposed hybrid approach is implemented in MATLAB 2015a platform. The simulation analysis approach results shows that hybrid approach offers better performance by improving accuracy and minimizing the RMS error as compared to the state-of-the-art methods.

I. Introduction

Magnetic Resonance imaging (MRI) is an imaging procedure that delivers excellent pictures of the anatomical structures of the human body, particularly in the cerebrum, and gives rich data to clinical analysis and biomedical research. The indicative estimations of MRI are incredibly amplified by the computerized and precise characterization of the MRI pictures. MRI (Magnetic Resonance Imaging) has demonstrated out as an effective instrument in location of brain tumor with the assistance of MR Images. It is a non-intrusive strategy which delivers exceptionally point by point 2D and 3D pictures of the organ inside the brain toward each path. As the large amount of information given through MRI system, so it is illogical to build up a strategy which can characterize the pictures in typical or strange through human assessment. [2]

Brain Tumor is a bunch of abnormal cells developing in the brain. It might happen in any individual at any age and show up at any area and have wide assortments of shapes and sizes. They can be dealt with by radiotherapy or by chemotherapy. This turns out to be a severe problem which causes even death. Tumor is additionally classified in two: malignant and benignant. Benignant tumors have homogeneous structure and don't contain disease cells while malign have heterogeneous structure and contain malignancy cells. Benign tumors are either radio-logically or surgically crushed and have uncommon odds of become back. Malignant are life undermining tumor and can be dealt with by chemotherapy, radiotherapy or their blend. In order to deal with brain tumor, MRI is a useful technique which provides us all fine details of brain such that we can easily detect the area of tumor.

II. Literature Review

S. Chaplot et al. [2] proposed a novel strategy utilizing wavelets as contribution to neural system self-organizing maps and support vector machine for characterization of magnetic resonance (MR) pictures of the human brain. The proposed technique orders MR brain images as either normal or abnormal. They tried the proposed approach utilizing a dataset of 52 MR brain images. A rate of over 94% was accomplished utilizing self-organizing maps (SOM) and 98% from support vector machine strategy. Fundamental perception is that the classification rate is high for a support vector machine classifier contrasted with self-organizing map-based approach.

M. Maitra et al. [3] proposed new approach for mechanized diagnosis, for the classification of MRI images. Wavelet transform based strategies are valuable apparatus for removing recurrence space data from non-stationary signals. The proposed strategy is known to be an enhanced variant of orthogonal discrete wavelet transform (DWT) for highlight extraction, called Slantlet transform. For every 2-D MR picture, first process its intensity histogram and after that Slantlet transform is connected on this histogram flag. At that point an element vector is made by considering the sizes of Slantlet transform yields comparing to six spatial positions, picked by a particular rationale. The components which are extricated used to prepare a neural system based classifier. The fundamental reason for classifier is to arrange the pictures either as typical or unusual for Alzheimer's sickness. From this strategy, they accomplished the productivity of 100% in accurately characterizing the Alzheimer's malady.

Y. Zhang et al. [4] proposed a hybrid technique in light of forward neural network (FNN) to group MR brain images. The proposed strategy initially utilized the discrete wavelet transform in order to extract main features from MR Images and after that applied the principal component analysis technique to diminish feature space to a limit. The diminished components were sent to a forward neural network (FNN), where the parameters were upgraded utilizing an improved artificial bee colony algorithm (ABC) calculation in view of both fitness scaling and chaotic theory.. At that point, K-fold cross validation technique was utilized to maintain a strategic distance from over fitting. The outcomes demonstrate that SCABC can acquire the minimum mean MSE and 100% accuracy.
Janki Naik et al. [6] introduced a proposed method to classify the medical images for diagnosis. Steps involved in this system are: pre-processing, feature extraction, association rule mining and classification. They do some experiments for tumor detection in MRI images. Preprocessing has been done with the help of median filtering process. After that, essential features have been extracted with texture feature technique. Then mining of association rules is done from extracted feature using Decision Tree classification algorithm. They concluded that the proposed method improves the efficiency of classification of CT scan images than traditional methods.

Y. Zhang et al. [17] proposed a novel method for classify brain MRI images as either normal or abnormal by using SVM and DWT (Discrete Wavelet Transform) approach. PCA (Principal Component Analysis) approach also used to diminish the no. of features extracted by Wavelet Transform. These methods were applied on 160 MR Brain Images for detection of Alzheimer's disease with four different kernels and achieved maximum accuracy for GRB kernel of 9.38%.

III. Techniques Used

A. RBFNN(Radial Basis Function Neural Network)

A Radial Basis Function (RBF) neural network contains only one hidden layer and neurons in the hidden layer may vary depending upon a particular task. At this layer Gaussian transfer functions having outputs inversely proportional to the distance from the center of the neurons are used. The predicted target value of an item is same as other items, close to the predictor variables. Positions one or more neurons can be positioned by RBF network in the space described by the predictor variables. A dimension of this space is same as the number of predictor variables. The Euclidean distance is calculated from the point being evaluated to the center of each neuron, and a Radial Basis Kernel Function (RBF) is applied to this distance and weight for each neuron is calculated. Radius is used as one of the parameter so it is called Radial Basis Kernel Function (RBF) [10,14]. Figure 1 shows the architecture of RBFNN.

The radial-basis functions technique recommends designing of interpolation functions F of the subsequent form[14]:

$$F(\mathbf{x}) = \Sigma_{i=1}^{N} w_i \varphi(|| x - x_i ||)$$

Where $\varphi(|| x - xi ||)$ is a set of nonlinear radial-basis functions, xi are the centers of these functions, and ||.|| is the Euclidean norm.

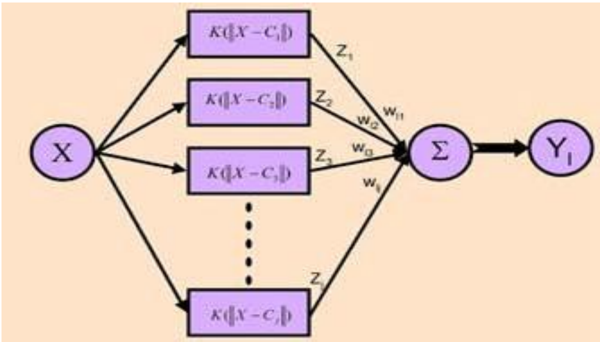


Fig1. RBFNN Architecture.

B. Principal Component Analysis (PCA)

After extracting features from the dimensional space, main concern is to deal to diminish the number of features. PCA is used as an effective tool in order to reduce the size of features by transforming the data set into patterns while retaining most of variations, i.e. without much loss of information. This system has three impacts: it orthogonalizes the segments of the info vectors so that uncorrelated with each other; it orders the subsequent orthogonal parts so that those with the biggest variety start things out, and dispenses with those segments contributing the slightest to the variety in the informational collection [17].

C. Discrete Wavelet Transform (DWT)

First, Discrete Fourier Transform is used as signal analysis tool which decompose a signal into different sinusoidal signals of different frequencies, i.e. from time domain to frequency domain signals. But it has disadvantage of rejecting the time information of signal [21]. To overcome this drawback, Discrete Wavelet Transform (DWT) is used which decompose the signal into mutually orthogonal wavelet functions. It preserves both time and frequency domain of the signal.

IV. Proposed Methodology

MRI Brain Images downloaded from Medical Image Repository are present in .mha format. To deal with .mha image files, READ MEDICAL DATA 3D is needed to attach with MATLAB tool. Then, it is converted to jpeg extension images. Then, DWT transformation is applied to extract the features from image. But the no. of features are so much large such that we have to reduce the features by applying Principal Component Analysis (PCA) technique. These are the phases introduced in the Preprocessing phase. After that, Kernel SVM classifier is built which is required for classifying images as normal or abnormal. Fig. 2 shows the flow chart of proposed work done.

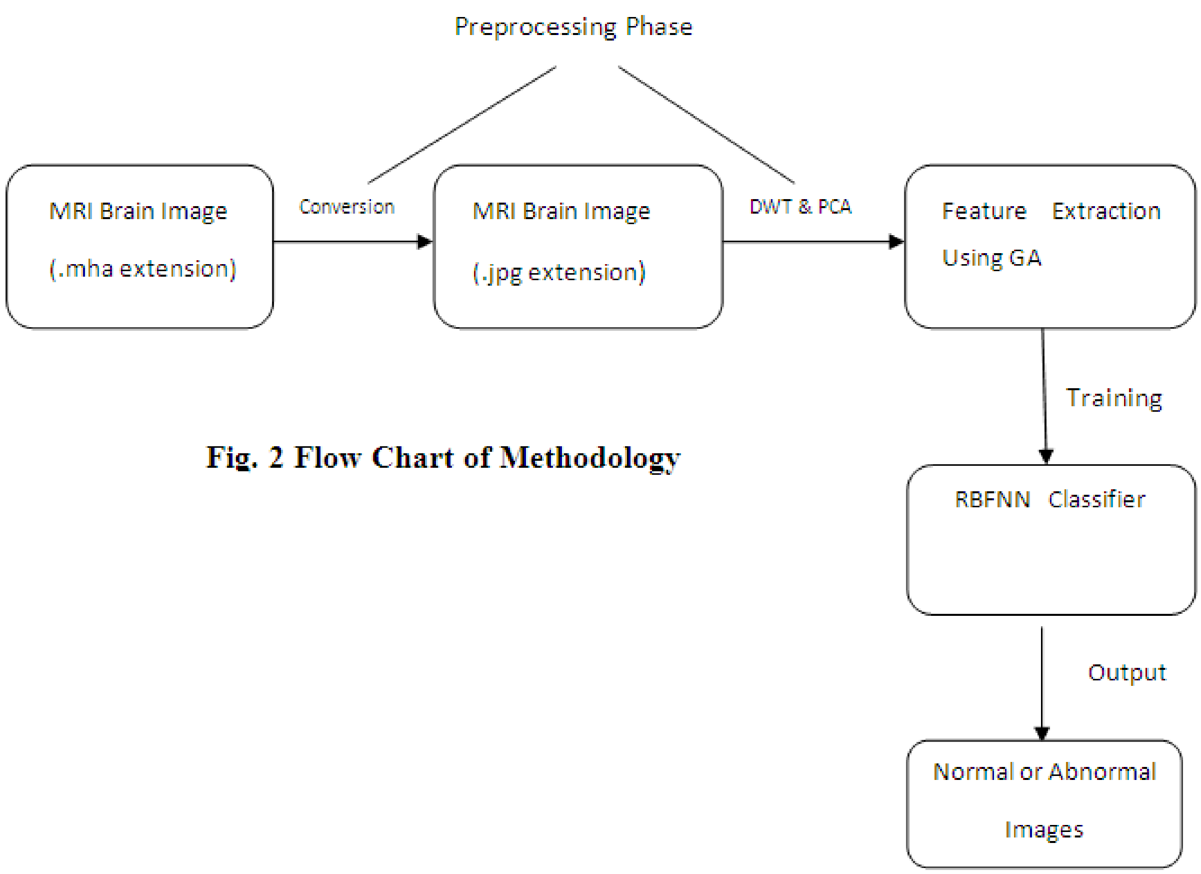


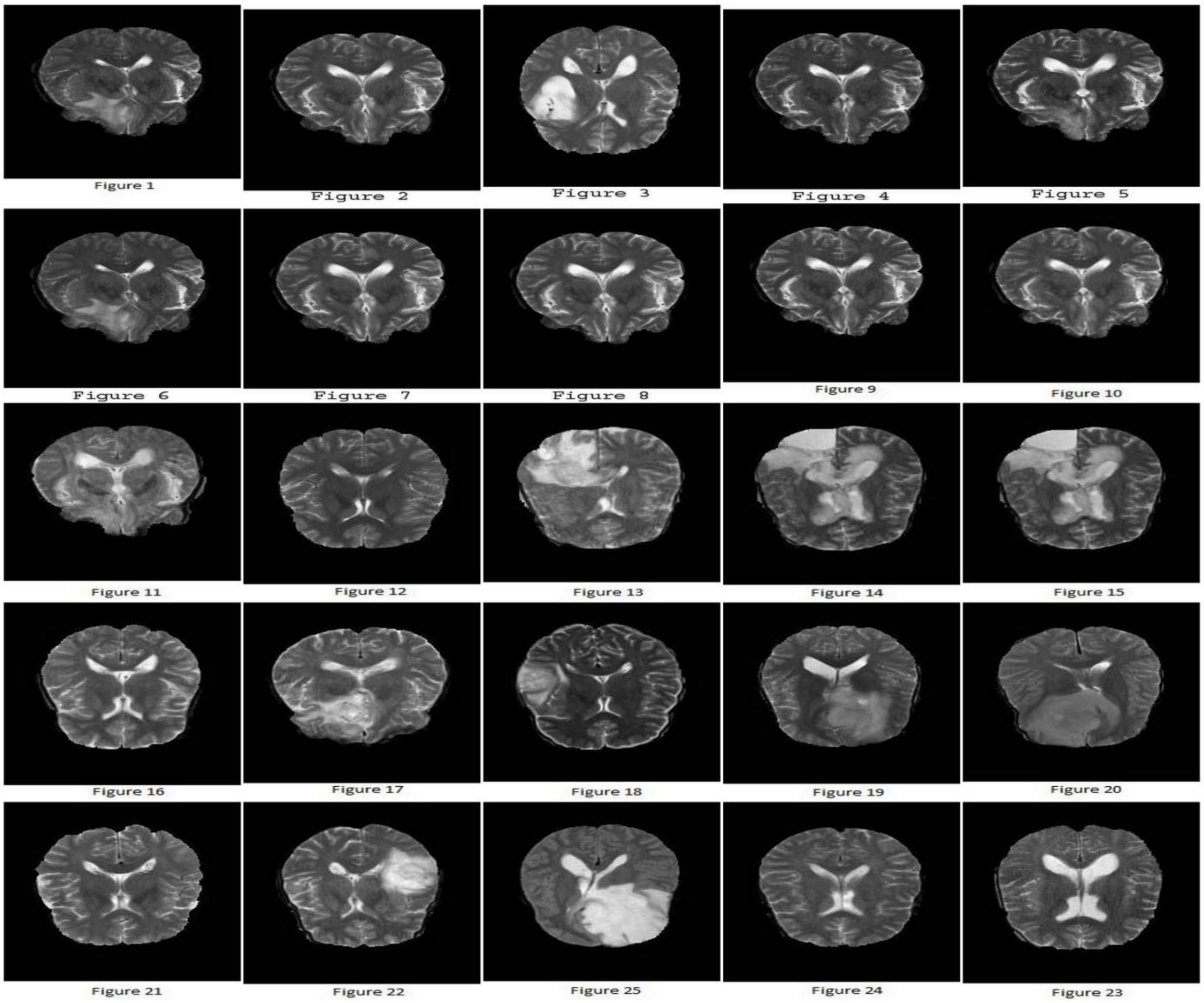
Fig. 2 Flow Chart of Methodology

V. Input Image Data Source

For analyzing the described technique, images dataset are obtained from SICAS Medical Image Repository. A data set of 25 MRI Brain Images (20 benign, 5 malign images) given in the picture1 which are the T2 weighed axial view of the brain images.

VI. Results

Table1 shows the picture wise result of the MR Images on the behalf of the following parameters: Type of tumor, Entropy, RMS, Smoothness, Kurtosis and Correlation. Type of tumor parameter has two values: benign and malign. Out of there 25 images, 20 are classified as benign and 5 are as malign. RMS represents root mean square error which computes RMS value of every row and column's input. From Table 1, RMS value is near to 0.1.

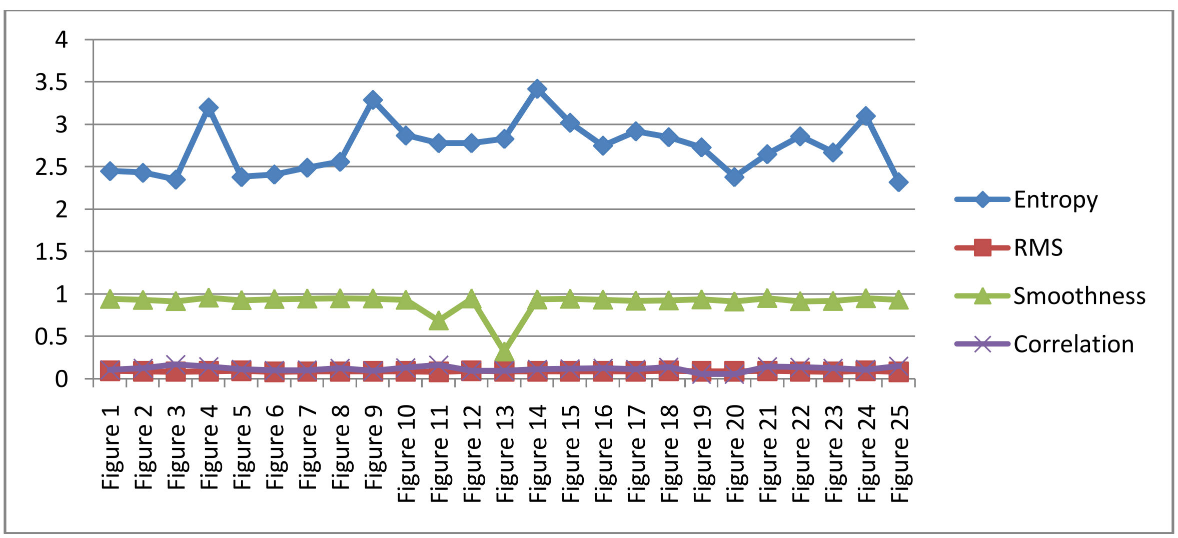


Picture1: Dataset of 25 Brain MR Images.

Smoothness describes as the measure of different grey level that can be utilized to build up descriptors of relative smoothness. For Figure 13 and Figure 11, its value is 0.322 and 0.60 which is very low. For other images, it is near to 1 which shows smoothness. Entropy defines the randomness which describes the text part of the input image, i.e. distribution variation within a image. Kurtosis shows the flatness of a distribution region to a normal region. Its value varies from 6 to 29. Correlation defines how a pixel correlate to its neighbor pixel. Its value varies from -1 to 1. For negative correlated image, it is -1 and for positive, 1. As observed from table, its value is approx. to 0.1.
Linear accuracy varies from 80% to 90%.

Table1: Parameter wise result of MR Images

MRI Image	Type of Tumor	RMS	Correlation	Linear Accuracy in %
Figure 1	Benign	0.1934	0.107	83.4
Figure 2	Benign	0.2892	0.123	87.2
Figure 3	Benign	0.1843	0.168	89.5
Figure 4	Malign	0.1865	0.142	88.7
Figure 5	Benign	0.2923	0.114	86.1
Figure 6	Benign	0.2814	0.102	81.2
Figure 7	Benign	0.2856	0.103	83.7
Figure 8	Benign	0.1855	0.126	90.2
Figure 9	Benign	0.1892	0.096	87.9
Figure 10	Benign	0.2885	0.131	84.2
Figure 11	Benign	0.2825	0.162	81.3
Figure 12	Benign	0.1925	0.092	87.2
Figure 13	Benign	0.2895	0.097	88.8
Figure 14	Malign	0.2882	0.114	89.1
Figure 15	Malign	0.2894	0.117	87.2.
Figure 16	Benign	0.1893	0.127	88.5
Figure 17	Benign	0.2892	0.114	88.9
Figure 18	Benign	0.1954	0.138	88.9
Figure 19	Benign	0.2903	0.060	81.7
Figure 20	Benign	0.1892	0.057	79.2
Figure 21	Malign	0.2925	0.146	87.2
Figure 22	Benign	0.1284	0.139	88.8
Figure 23	Benign	0.0855	0.123	87.2
Figure 24	Malign	0.1972	0.109	88.2
Figure 25	Benign	0.2866	0.149	88.9



Graph1: Graphical representation of Table 1

VII. Conclusion

The proposed hybrid approach was applied to brain MRI Images in order to classify brain tumor either as benignant or malignant. Automatic brain tumor detection approach reduces the manual labeling time and avoid the human error .This approach is a combination of DWT (Discrete Wavelet Transform) used for feature extraction, then PCA (Principal Component Analysis) for diminish the features and Support Vector Machine for classification of MR Images. In future, an enhancement can be further done for optimizing the accuracy and lower down the RMS error rate.

References

1. Fox, Michael D. and Raichle, Marcus E (2007). Spontaneous fluctuations in brain activity observed with functional magnetic resonance imaging. Nature Publishing Group, vol. 8.
2. Chaplot, S.; Patnaik, L.M.; Jagannathan, N.R. (2006). Classification of magnetic resonance brain images using wavelets as input to support vector machine and neural network, Biomed. Signal Process Control, 1, 86–92.
3. Maitra, M.: Chatterjee, A. (2011). A Slantlet transform based intelligent system for magnetic resonance brain image classification. Biomed. Signal Process Control, 1, 299–306.
4. Zhang, Y.; Wu, L.; Wang, S. (2011). Magnetic resonance brain image classification by an improve artificial bee colony algorithm. Progress Electromagnetic Resolution, 116, 65–79.
5. Zhang, Y.; Wu, L. (2012). An MR brain images classifier via principal component analysis and Kernel support vector machine. Progress Electromagnetic Res., 130, 369–388.
6. Naik, J.; Prof. Patel, Sagar (2013). Tumor Detection and Classification using Decision Tree in Brain MRI. IJEDR , ISSN:2321-9939.
7. Kumari, M.; Godara, S.(2011). Comparitive Study of Data Mining Classification Methods in Cardiovascular Disease Prediction. IJCST, Vol. 2, ISSN: 2229-4333.
8. Zhang, Y.; Lu, S.; Zhou, X. et al. (2016). Comparison of machine learning methods for stationary wavelet entropy-based multiple sclerosis detection: decision tree, k-nearest neighbors and support vector machine. Simulation, Vol. 92(9), 861–871.
9. Gonzalez, R.C. and Woods, R.E. (2009). Digital Image Processing, Third edition, Prentice-Hall.
10. Navneet, L. and et al. (2012). A Novel Machine Approach for Detecting the Brain Abnormalities From MRI Structural Images. PRIB, pp. 94-105.
11. Chau, M.; Shin, D. (2009). A Comparative Study of Medical Data Classification Methods Based on Decision Tree and Bagging Algorithms. Proceedings of IEEE International Conference on Dependable, Autonomic and Secure Computing, pp. 183-187.
12. Patil, S.; Kumaraswamy, Y. (2009). Intelligent and effective Heart Attack prediction system using data mining and artificial neural networks. European Journal of Scientific Research, Vol. 31, pp. 642- 656.
13. Han, J.; Kamber, M. Data Mining Concepts and Techniques. 2nd Edition, Morgan Kaufmann, San Francisco.
14. Palaniappan, S.; Awang, R. Intelligent Heart Disease Prediction System Using Data Mining Techniques. Proceedings of IEEE/ACS International Conference on Computer Systems and Applications 2008, pp. 108-115.
15. Godara, Sunila and Singh, Rishipal (2016). Evaluation of Predictive Machine Learning Techniques as Expert Systems in Medical Diagnosis. Indian Journal of Science and Technology, vol. 910.
16. Godara, Sunila and Verma, Amita (June 2013). Analysis of Various Clustering Algorithms. International Journal of Innovative Technology and Exploring Engineering (IJITEE), Volume-3, Issue-1.
17. Zhang, Y. and Wu, L. (2012). An MR Brain Images Classifier via Principal Component Analysis and Kernel Support Vector Machine. Progress in Electromagnetic Research, Vol.130, 369-388.
18. Kumari, Rosy (July 2013). SVM Classification an Approach on Detecting Abnormal in Brain MRI Images. IJERA, Vol. 3, Issue 4, pp.1686-1690.
19. Adeli, E.; Wu, G.; Saghafi, B.; An L.; Shi, F. and Shen, D (2017). Kernel-based Joint Feature Selection and Max-Margin Classification for Early Diagnosis of Parkinson's disease. Scientific Reports,7:1069, DOI:10.1038.
20. Jain, Varun; Godara, Sunila (June 2017). Comparative Study of Data Mining Classification Methods in Brain Tumor Disease Detection. IJCSC, Vol.8, Issue 2, pp.12-17.
21. Kour, Prabhjout (Jan. 2015). Image Processing Using Discrete Wavelet Transform. IIJEC, ISSN: 2321-5984, Vol.3, Issue 1.
22. Srivastva, Durgesh K.; Bhambhu, Lekha. Data Classification Using Support Vector Machine. Journal of Theory and Applied Information Technology.