Research Article

An Efficient Content-Based Medical Image Retrieval System For Clinical Decision Support In Brain Tumor Diagnosis

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Abstract -Accurate diagnosis is crucial for successful treatment of a brain tumor. Content Based Medical Image Retrieval (CBMIR) can assist radiologist in diagnosis by retrieving similar images from medical image database. Here a novelmethdology CBMIR for brain tumor is proposed. Magnetic Resonance imaging (MRI) is most commonly used for imaging the brain tumor. During the image acquisition there can be misalignment of MR images due to movement of patient and also low level semantics from MR image may not corresponds with high level semantics of brain tumor, for this two level CBMIR system used, which first classifies (using SVM and ANN) query image of brain tumor as cancerous and non-cancerous tumor using global feature (circularity, irregularity and texture feature) and then search for most similar images with identified class using local feature. This experiment has been performed on 294 brain MR images and result of classification is compare with precision rate, accuracy and recall rate.

Keywords —CBMIR, Brain MRI, Global Feature, LBP, ANN, SVM..

I.INTRODUCTION

In recent years, the level of diagnosis and treatment of brain tumors is constantly improving, and imaging techniques such as computed tomography (CT) and magnetic resonance imaging (MRI) are also widely used in brain tumor detection[1,2]. These techniques are very effective in examining patients with brain tumors, and the detection rate is also relatively high. MRI has become an important part of modern imaging medicine. According to relevant clinical research, MRI is better than CT in the diagnosis of intracranial brain tumors,which can reach 98% correct rate[3,4]. MRI Imaging Technology has many advantages: on the one hand, people are more concerned about radiation, but this Imaging Technology will not cause harm to the human body.

On the other hand, it can be imaged with multiple parameters, and this imaging approach can provide a wealth of useful information for diagnostic purposes, and it is also more convenient and effective for studying human metabolism and function. In addition, MRI imaging technology provides a wealth of anatomical information on human soft tissue.In medicine, MRI imaging technology is generally used for brain tumor segmentation and detection,and experts analyze the MR images to determine the existence and development of brain tumors [5,6].

In the recent years,CBIR systems have been developed to organize and utilize the valuable image sources effectively for various collections of images. Most of the recent CBIR systems in biomedicine are designed to classify and retrieve images according to the anatomical categories of their content. R. Guruvasuki and A. Josephine have proposed a CBMIR method using GLCM based texture features extraction and multi SVM based classification.

HaticeAkakin and Metin N. Gurcan have proposed CBIR system which uses a Multi-Tiered approach for retrieving images. In first tier they classified images using SVM in two main types and K- nearest neighbors are used in second tier for classified the subtypes of the two main types. Here the robustness of the method is increased due to these two classifiers[7,8,9,10]. The method is used only for multi-image query.Here they have not discussed the performance evolution of the retrieval process. Mohanpriya S. and Vadivel M. have proposed a new CBMIR system for classified and retrieves the images from the database. They also used two tiered approach for classified the MRI images.Here also the robustness is increased due to the two classifiers.The method is also for multi image query and cannot be used for single query.

HashemK.et.al.[11,12,13,14] have proposed the MRI image classification method and compare the classification results using two different classifiers, KNN and SVM. They classified the images in eight different classes and concluded that SVM gives better classification result than KNN.YudongZ.et.al.have proposed a hybrid method for image MRI image classification [15,16,17,18,19] .They extracted texture features using wavelet transform and classified MRI images using Back Propagation Neural Network.The result of their method is good.Chaplot S.et.al. have proposed the MRI image classification method for classified the images in normal and abnormal class and

compare the classification result using different classifiers.They also concluded that SVM classifier gives better result than ANN [20-28].

II. PROPOSED METHODOLOGY

Our proposed work presents a complete CBMIR system. There is main two part of this system one is to offline part to create a database and other is online part which we used to retrieve the similar image.

In the off-line phase, MR images are automatically segmented using k-means clustering technique to extract brain tumor from MR image. Tumors can be well discriminated by their shape and texture characteristics. These features are fed into SVM and ANN classifier and assign label to the image as cancerous or non-cancerous tumor. In second stage local feature such as Local Binary Pattern (LBP) is extracted are extracted from the brain tumor for discrimination between tumors within the class.

Similarly, in the online phase, the class label of the query image is identified using ANN classifier based on rotation invariant global shape and texture features of tumor. Using this label, the similarity comparison is only to images with similar class labels in the database. This reduced search time from the database. Then, the features of the query image are compared with database using Euclidian distance and retrieved most similar K images[29,30,31,32].

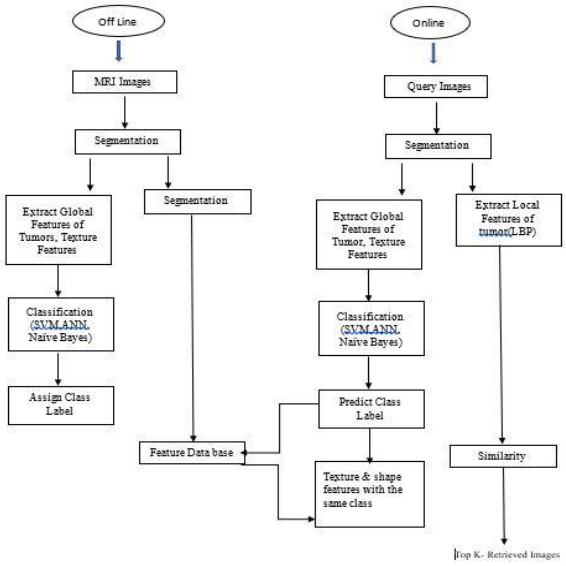


Fig 1 :Proposed Diagram For Content Based Medical Image Retrival System.

III. FEATURE EXTRACTION

Non-Cancerous tumor are more circular whereas cancerous are more irregular in shape so circularity and irregularity is main feature we extract from the tumor.

1) Shape Feature: Circularity and Irregularity ofTumor is measure as:Circularity (C) = $4\pi A/P^2$
Where, P is perimeter of tumor and A is area of tumor.

$$\text{Irregularity (I)} = 1/N \sum_{i=1}^{360} d_i$$

$$\text{di}=\sqrt{(x_i - x_c)^2 + (y_i - y_c)^2} \quad (1)$$

Where, (x_i, y_i) are boundary points and (x_c, y_c) is the region centroid. These features are rotation invariant.

2) Texture Feature: Tissue exhibit consistent and homogeneous texture. In this texture of the tumor are represented using first order statistics. So we can find following texture feature from tumor.

a) Skewness:

Skewness is a measure of the asymmetry of the data around the sample mean. If skewness is negative, the data arespread out more to the left of the mean than to the right.The skewness of a distribution is defined as

$$S=\frac{E(x-\mu)^3}{\sigma^3} \quad (2)$$

b) Kurtosis:
It is measure sharpness of the peak of a frequency distribution curve. It is same as skewness.

$$K=\frac{E(x-\mu)^4}{\sigma^4} \quad (3)$$

c) Entropy:
Entropy is a statistical measure of randomness or complexity that can be used to characterize the texture of the input image.Entropy is defined as

$$E=-sum(p*\log_2(p)) \quad (4)$$

d) Standard Deviation:
It is measure variation of pixel value from its mean.

$$S=\sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(Ai-\mu)^2}$$, μ is mean of Ai (5)

e) Coefficient of Variance:
The coefficient of variation is a measure of spread that describes the amount of variability relative to the mean. And it is defined as
CV = Standard deviation / Mean
From this we have got 9 dimensional feature vector using different global features techniques. We have computed this feature from the segmented tumor of brain MRI image. And then we have fed this extracted feature vector into three classifier namely SVM, ANN, Naïve Bayes.

Local Feature Extraction:
The Local Binary Pattern (LBP) operator is a gray invariant texture primitive, derived from a general definition of texture in a local neighborhood. Due to its discriminative power and computational simplicity, the LBP operator has become a highly popular approach in various computer vision applications, including visual inspection, image retrieval, remote sensing, biomedical image analysis, biometrics, motion analysis, environment modeling, and outdoor scene analysis, etc. LBP is formed by comparing gray value of center pixel (gc) with that of P neighborhood pixels in the local neighbour.

$$LBP=\sum_{i=0}^{p=1} s(g_i-g_c)2^i, s(x)=1, x>0 \quad (6)$$

$$0 x<0$$

Where, g_c and g_i are the gray value of the center pixel and neighbor pixel respectively. P is the total number ofNeighbors located in a radius R. LBP code computation is shown in Fig.2 with P = 8 and R = 1

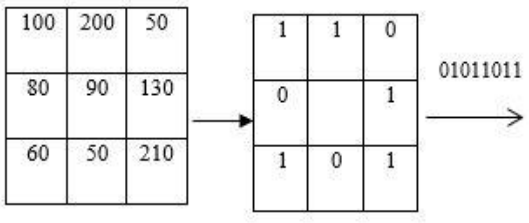


Fig2: LBP Code Computation

IV. CLASSIFICATION TECHNIQUES

Classification or Recognition process is for decision making, like this query image fit in which class or looks like. It means, in the phase of classification characters are identified and assign labeling. Performance of the classification depends on good feature extraction and selection. Various classification techniques are available and they all are ultimately based on image processing and artificial intelligence.

A. Support Vector Machine:

Support Vector Machine is a binary classifier, it finds the separation line which maximizes the distance between two classes. It is based on statistical learning theory and quadratic programming optimization. The linear SVM classifier can be represented as

$$P(x)=\sum \alpha_i x_i x+b \quad (7)$$

Here "x_i" represents support vectors, where "α_i" and "b" are calculated by solving the Quadratic Equation.

B. Artificial Neural Network:

The concept of ANN is derived from the working of biological neurons in the brain. It is having the capability to learn automatically from the examples. Generally it gives good performance with noisy data. It can also learn large databases efficiently. It can also be implemented to run in parallel. Due to all these characteristicsANN is a well-known classifier. Here we used Multilayer perceptron and Back propagation feed forward neural network in thisdomain [33,34,35].

C. Naive Bayes classifier:

Naive Bayes classifiers are linear classifiers that are known for being simple yet very efficient. The probabilistic model of naive Bayes classifiers is based on Bayes' theorem, and the adjective naive comes from the assumption that the features in a dataset are mutually independent.

It assume that the presence of the particular feature in the class is unrelated to presence of any other feature, it calculate posterior probability.

$$P\ (c/x) = \frac{p\left(\frac{x}{c}\right)p(c)}{p(x)}$$

Where, p(c) is prior probability of any class, p(x/c) is likelihood which is probability of predictor given class, p(x) is prior probability of predictor.

V. RESULT ANALYSIS:

The proposed method is implemented using MATLAB. Allthe experiments were performed on a personal computer with2.5Ghz Core i3 processor and 4GB of memory running underWindows 10 operating system. The experimental results wereevaluated with the help of the experienced radiologist.

A. Data Set:

The image database was built with 294 MR images of brain tumor.All images for experiment were collected from Vijaya Hospital,Visakhapatnam. and all images are of the size 256x256.

B. Results:

We have Extracted 9 dimensional feature vector for all 294 images using Global feature Extraction Techniques and fed it to the two different classifier SVM and ANN. Result of compression is as shown in TABLE 1 and performance of the system is measured with help of classification rate, precision and recall.

Classifier	Accuracy	Precision	Recall Rate
SVM	94.11%	91.86%	90.12%
ANN	85.62%	83.51%	81.24%
Naive Byes	74.50%	73.34%	76.50%

Table 1: Result of Classification

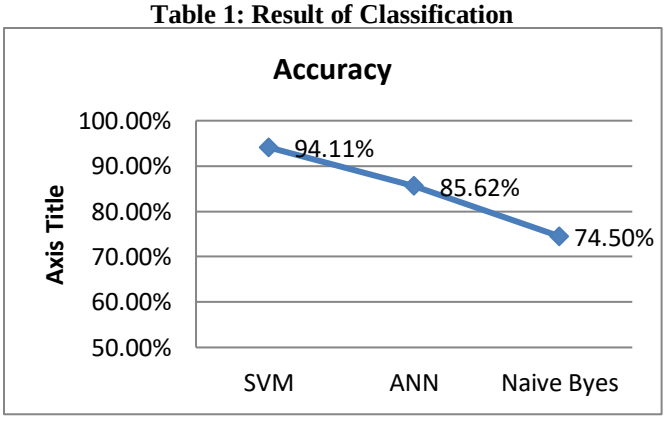


Fig1 : Comparison of Accuracy

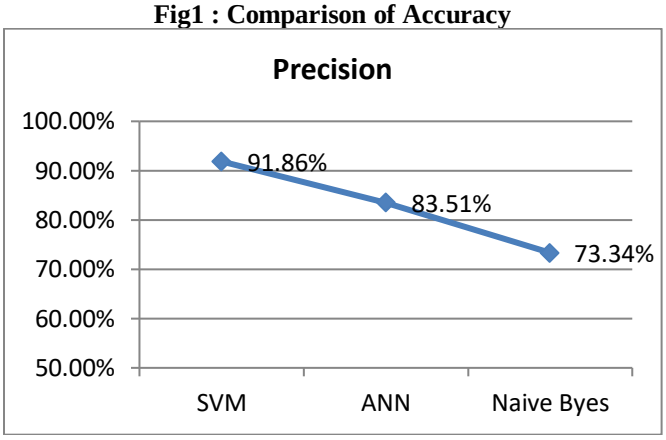


Fig 2: Comparison of Precision

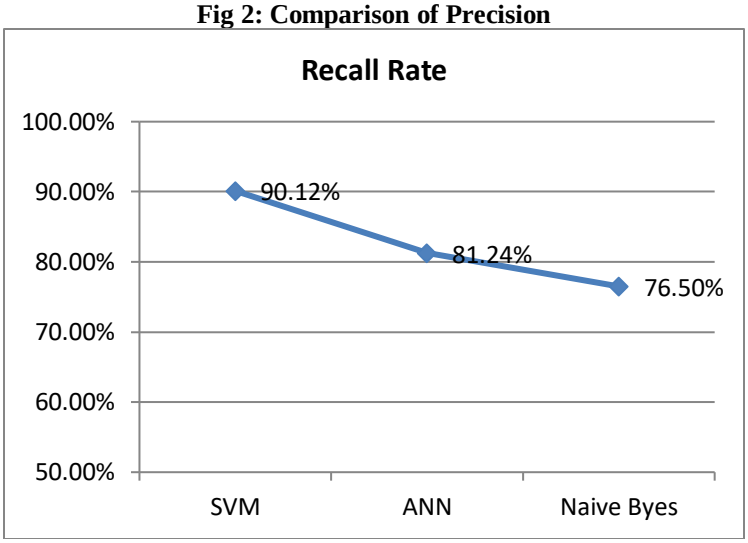


Fig 3 : Comparison of Recall Rate

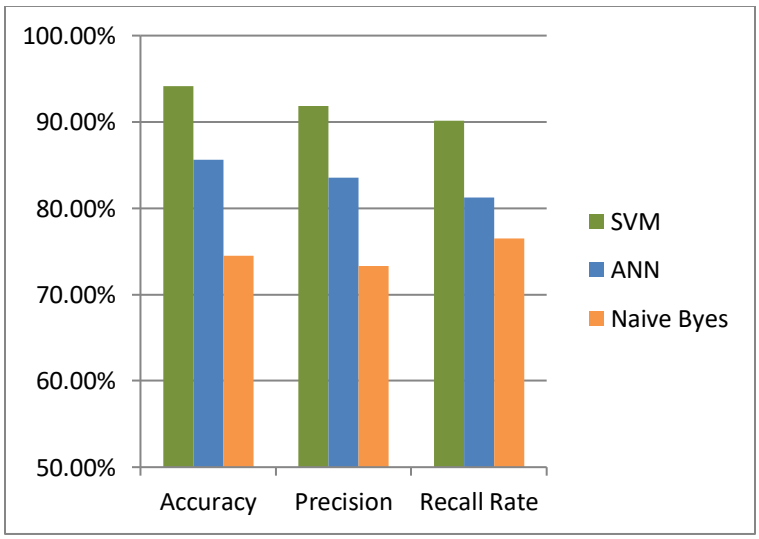


Fig 4: Graph of Classification

So, we have classified query image using ANN and Retrieved most similar images using LBP Feature and ED and get following result.

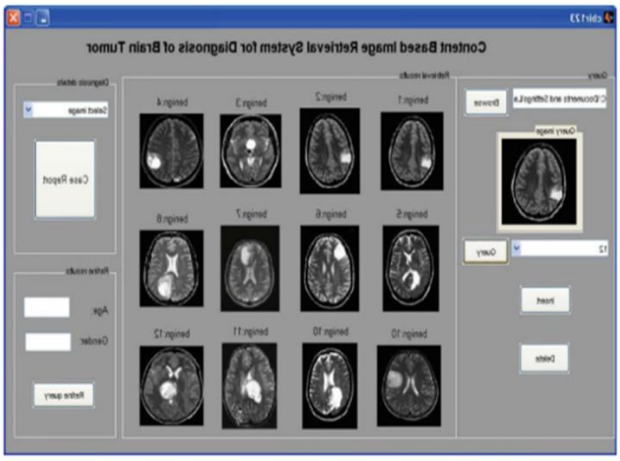


Fig 5: GUI for Content based Image retrieval of brain Tumor

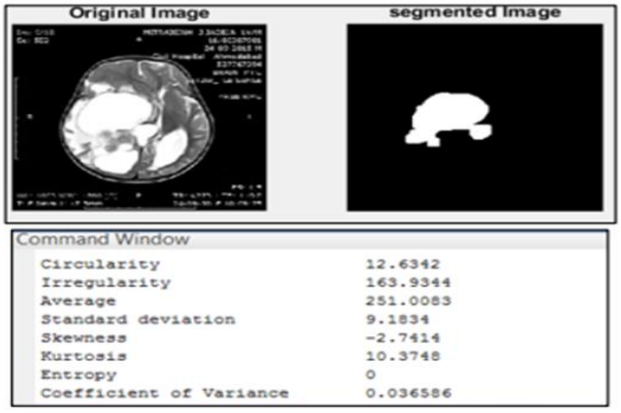
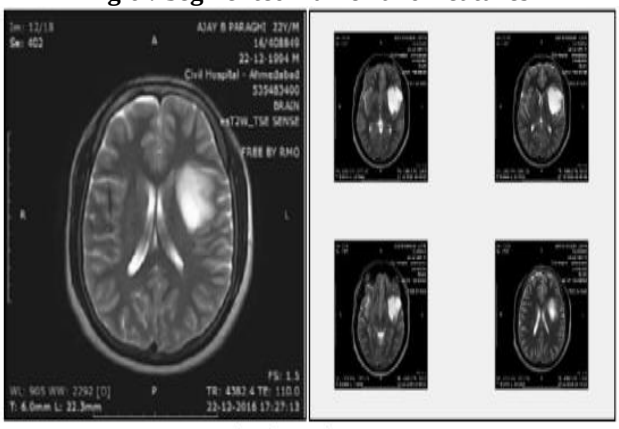


Fig 6 : Segmented Tumor and Features



Selected image has Cancer
Fig 7 : Output of Test image and Retrieved Images

VI. CONCLUSION

Several application of content based image retrieval but use of CBIR for medical image is one of the important applications. CBIR can assist the radiologist in diagnosis of brain tumor by retrieving similar images from medical image database. To get more accurate retrieving system main task is to generate good database of images from visual feature of images. We have extracted the features using Combination of Global Feature Extraction from Cancerous and Non-Cancerous MR Images and create the database and then fed these features to three different

classifiers namely SVM, ANN and Naive Bayes classifier for Classification of tumor in two classes. Then we have measured the accuracies of different classifiers and we have got highest accuracies 93.62% using ANN. Secondly we extract Local feature of query image and retrieved most similar four images by measuring the ED within the identified class.

REFERENCES

1. M. Li, L. Kuang, S. Xu and Z. Sha, "Brain Tumor Detection Based on Multimodal Information Fusion and Convolutional Neural Network," in IEEE Access, vol. 7, pp. 180134-180146, 2019.
2. S. N. Shivhare, S. Sharma, and N. Singh. An Efficient Brain Tumor Detection and Segmentation in MRI Using Parameter-Free Clustering in Machine Intelligence and Signal Analysis. Advances in Intelligent Systems and Computing 748, Springer Singapore. pp:485–495,2019.
3. Mansi Lather, ParvinderSingh,Investigating Brain Tumor Segmentation and Detection Techniques,Procedia Computer Science,Volume 167,2020, Pages 121-130,ISSN 1877-0509.
4. M. A. Kabir, "Early Stage Brain Tumor Detection on MRI Image Using a Hybrid Technique," 2020 IEEE Region 10 Symposium (TENSYMP), Dhaka, Bangladesh, 2020, pp. 1828-1831.
5. M. Gouskir, M. A. Zyad and M. Boutalline, "Automatic Analysis of Brain Tumor from Magnetic Resonance Images based on Geometric Median Shift," 2020 IEEE 6th International Conference on Optimization and Applications (ICOA), Beni Mellal, Morocco, 2020.
6. S. S and G. R. N, "Detection of Brain Tumor in Medical Imaging," 2020 6th International Conference on Advanced Computing and Communication Systems (ICACCS), Coimbatore, India, 2020,
7. D. Kar and S. Halder, "Early Detection of Brain Tumor by Using K-Means Clustering, Convolutional Neural Network and Support Vector Machine without any Imaging Test," 2019 International Conference on Information Technology (ICIT), Bhubaneswar, India, 2019, pp. 59-64.
8. Hazra, A. Dey, S. K. Gupta and M. A. Ansari, "Brain tumor detection based on segmentation using MATLAB," 2017 International Conference on Energy, Communication, Data Analytics and Soft Computing (ICECDS), Chennai, India, 2017, pp. 425-430.
9. S. Giraddi and S. V. Vaishnavi, "Detection of Brain Tumor using Image Classification," 2017 International Conference on Current Trends in Computer, Electrical, Electronics and Communication (CTCEEC), Mysore, India, 2017, pp. 640-644.
10. Deepa and A. Singh, "Review of brain tumor detection from MRI images," 2016 3rd International Conference on Computing for Sustainable Global Development (INDIACom), New Delhi, India, 2016, pp. 3997-4000.
11. Shah, Hemang J. (2014) "Detection of Tumor in MRI Images using Image Segmentation." International Journal of Advance Research in Computer Science and Management Studies 2(6): 53-56.
12. Kumbhar, Uday, Vishal Patil, and Shekhar Rudrakshi. (2013) “Enhancement of Medical Images Using Image Processing In MATLAB.” International Journal of Engineering Research & Technology 2 (4): 2359-2364.
13. P. Singh and M. Lather. (2018) “Brain Tumor Detection and Segmentation using Hybrid Approach of MRI , DWT and K-means.” In ICQNM 2018: The Twelfth International Conference on Quantum, Nano/Bio, and Micro Technologies: 7–12.
14. Jagan. (2019) “A Contemporary Framework and Novel Method for Segmentation of Brain MRI,” in Proceedings of the International Conference on ISMAC in Computational Vision and Bio-Engineering 2018 (ISMAC-CVB) 30: 739–747.
15. S. Pereira, A. Pinto, V. Alves, and C. A. Silva, ‘‘Brain tumor segmentation using convolutional neural networks in MRI images,’’ IEEE Trans. Med. Imag., vol. 35, no. 5, pp. 1240–1251, May 2016.
16. Ling CheiSiong, W Mimi Diyana W Zaki, Aini Hussain, Hamzaini Abdul Hamid, ”Image retrieval system for Medical application”- IEEE, ISCAIE, pp, 73-77,.2015.
17. M. Huang et al., ‘‘Content-based image retrieval using spatial layout information in brain tumor T1-weighted contrast-enhanced MR images,’’ PLoS ONE, vol. 9, no. 7, p. e102754, 2014.
18. M. A. Khan, I. U. Lali, and A. Rehman, ‘‘Brain Tumor detection and classification: A framework of marker–based watershed algorithm and multilevel priority features selection,’’ Microsc. Res. Technique, vol. 82, no. 6, pp. 909–922, 2019.
19. NooshinNabizadeh, Miroslav Kubat, Brain tumors detection and segmentation in MR images: Gabor wavelet vs. statistical features,Computers& Electrical Engineering, Volume 45,2015, Pages 286-301.
20. Stosic, Zorana, and PetarRutesic. (2018) “An Improved Canny Edge Detection Algorithm for Detecting

Brain Tumors in MRI Images."International Journal of Signal Processing 3: 11-15.
21. Priya and Vivek Singh Verma. (2017) "New Morphological Technique for Medical Image Segmentation." 3rd IEEE International Conference on "Computational Intelligence and Communication Technology" 1-5.
22. Shah, Hemang J. (2014) "Detection of Tumor in MRI Images using Image Segmentation." International Journal of Advance Research in Computer Science and Management Studies **2**(6): 53-56.
23. Cadena, Luis, Franklin Cadena, Nikolai Espinosa, Anna Korneeva, Alexey Kruglyakov, Alexander Legalov, Alexey Romanenko, and Alexander Zotin. (2017) "Brain's tumor image processing using shearlet transform." Proc. SPIE 10396, Applications of Digital Image Processing XL, 103961B.
24. S. Bauer et al., "A survey of MRI-based medical image analysis for brain tumor studies," Phys. Med. Biol., vol. 58, no. 13, pp. 97–129, 2013.
25. D. Zikic et al., "Segmentation of brain tumor tissues with convolutional neural networks," MICCAI Multimodal Brain Tumor Segmentation Challenge (BraTS), pp. 36–39, 2014.
26. Joseph RP, Singh CS, Manikandan M (2014) Brain tumor MRI image segmentation and detection in image processing. Int J Res Eng Technol 3, eISSN: 2319-1163, pISSN: 2321-7308.
27. Alfonse M, Salem M (2016) An automatic classification of brain tumors through MRI using support vector machine. Egypt Comput Sci J 40:11–21.
28. Bahadure NB, Ray AK, Thethi HP (2017) Image analysis for MRI based brain tumor detection and feature extraction using biologically inspired BWT and SVM. Int J Biomed Imaging 2017.
29. Sawakare S, Chaudhari D (2014) Classification of brain tumor using discrete wavelet transform, principal component analysis and probabilistic neural network. Int J Res Emerg Sci Technol 1(6), E-ISSN: 2349-761.
30. Demirhan A, Toru M, Guler I (2015) Segmentation of tumor and edema along with healthy tissues of brain using wavelets and neural networks. IEEE J Biomed Health Inform 19(4):1451–1458.
31. A Murali, K Hari Kishore, C P Rama Krishna, S Kumar, A Trinadha Rao "Integrating the Reconfigurable Devices using Slow-changing Key Technique to achieve High Performance "Proceedings- 7th IEEE International Advance Computing Conference, IACC 2017, 7976849 ISSN: 2473-3571, pp.530-534, July 2017.
32. Avinash Yadlapati, Kakarla Hari Kishore, "Constrained Level Validation of Serial Peripheral Interface Protocol", Proceedings of the First International Conference on SCI 2016, Volume 1, Smart Innovation, Systems and Technologies 77 (Publisher: Springer Nature Singapore Pvt. Ltd), ISSN No: 2190-3018, ISBN: 978-981-10-5544-7, Chapter No: 77, pp. 743-753, 25th December 2017.
33. NagaJyothi, Grande, and Sriadibhatla Sridevi. "High speed and low area decision feed-back equalizer with novel memory less distributed arithmetic filter." Multimedia Tools and Applications 78.23 (2019): 32679-32693.
34. NagaJyothi, Grande, and Sriadibhatla SriDevi. "Distributed arithmetic architectures for fir filters-a comparative review." 2017 International conference on wireless communications, signal processing and networking (WiSPNET). IEEE, 2017.
35. NagaJyothi, Grande, and Sriadibhatla Sridevi. "High speed low area OBC DA based decimation filter for hearing aids application." International Journal of Speech Technology 23.1 (2020): 111-121.