LARYNGEAL TUMOR RECOGNITION AND CLASSIFICATION USING NEURAL NETWORKS

S. Karthikeyan  
Associate Professor, Dept of ECE,  
Sathyabama institute of Science and technology, Chennai.  
skarthi1879@gmail.com

P. Farhath  
U.G Student, Dept. of ECE,  
Sathyabama institute of Science and technology, Chennai

M. Vineesha  
U.G Student, Dept. of ECE,  
Sathyabama institute of Science and technology, Chennai

T. Ravi  
Associate Prof., Dept. of ECE,  
Sathyabama institute of Science and technology, Chennai.

Abstract: One of the highly challenging fields is Biomedical Image Processing. Image Processing involves many techniques used to detect and classify the tumor more efficiently than doctors. Manual classification is a time consuming and gives inaccurate results compared to automatic classification. Imaging methods like CT (Computer Tomography) scans, MRI (Magnetic Resonance Image), X-rays plays a major role in tumor detection and classification. Out of these MRI is widely used because it does not involve any radiation and also identifies even the smallest abnormalities present in throat. The whole process of detecting the laryngeal tumor from these scanned images can be categorised into four steps: Pre-processing, Segmentation, Feature Extraction and Classification. In proposed method, classification involves hybrid classifiers to improve accuracy.

Keywords: MRI (Magnetic resonance imaging), laryngeal Tumor, Segmentation, Feature extraction, Classification.

1. INTRODUCTION

In today’s world, cancer rate is increasing day by day. One of the most frequent types of cancer is laryngeal cancer. According to the estimation of American Cancer Society, about 13,150 new cases of laryngeal cancer may occur in 2018. Out of which 10,490 may occur in men and 2,660 in women. It is also estimated that 3,710 will die of laryngeal cancer [2]. Based on the location of larynx, the tumor is divided into many stages. If the tumor is not detected in earlier stage, it may spread to nearby lymph nodes or to distant parts [2]. Also, there will be many treatment options available if the tumor is detected sooner. Based on type of tissue and location of tumor, it can be categorised into two types: Benign (non-cancerous) and Malignant (cancerous). Cancerous tumors are again divided into primary and secondary tumors. Primary tumors occur due to uncontrolled growth of cells within in the laryngeal whereas secondary tumors occur due to uncontrolled growth of cells which spreads from...
other parts of the body to laryngeal [9]. Manual detection and classification of laryngeal tumor is time consuming and challenging task because of its location, size and appearance of tumor in laryngeal [3]. Image Processing and artificial neural network techniques were used for automatic classification of tumor which helps to give right treatment. Tumor can be detected using various imaging tests like MRI (Magnetic Resonance Imaging), MRS (Magnetic Resonance Spectroscopy), CT (Computer Tomography) and Barium swallow [3]. Among all, MRI is the most frequently used imaging test to detect the laryngeal tumor. Because it provides a detailed location and shape of the tumor in throat without involving any radiation. Generally, MRI images contain noise. This noise has to be removed in order to enhance the image quality[4].

This process is classified into two types:

1. Spatial Domain
2. Frequency Domain

Spatial domain acts directly on the intensity values of the image. The techniques involved in spatial domain are Histogram equalisation, Threshold Method, Filtering techniques.( maximum, minimum, average, adaptive, gabor filter etc..) It is also used for gray level transformations. Frequency domain is another process which directly acts on the transform coefficients of images. It is less complex and ease of viewing. Image smoothing can be done here. One of the main problem in tumor detection is segmentation. It is a process which splits an image into multiple set of pixels. Each pixel is assigned a label in which pixels having same labels are grouped together and also share certain characteristics in common. The segmented image contains the boundary of the objects and also gives features of tumor region like area, eccentricity, orientation, bounding box. The image segmentation mainly depends upon different techniques like region based methods, threshold, cluster, edge, pixels. After segmentation, features are extracted from that image. Feature Extraction is the process of extracting desired features of an image which can be used for further processing.

Normally, it can be classified into two types:

1. Texture feature extraction
2. shape feature extraction

Techniques like DWT (discrete wavelet transform), counter based methods, GLCM (Gray Level Co-occurrence matrix) and Region based are used to extract features. Classification of tumor depends upon the feature extraction[4]. Classification of tumor into normal and abnormal (Benign & Malignant) depends upon the classifiers. Some of the algorithms used are Artificial Neural Networks, Support vector machine, Adaboost Classifier, Convolutional Neural Network (CNN)[3].

The other part of the paper explains: Proposed system (discussed in section 2), its simulation results (discussed in section 3) and conclusion of the work in section 4.

2. EXISTING SYSTEM

In the existing system, the process of detection of tumor is explained as in the below Fig (1):
Normally, in MRI images while converting optical signals into electrical signals and then into digital signals, noise is introduced. This noise has to removed using pre-processing since it changes the intensity values of the pixels. Pre-processing is a process to remove noise and enhance the image quality by using different filtering techniques. In pre-processing, MRI image is given as input and is converted into grayscale image. Image binarization is applied to convert gray scale image into black and white image. Later, image is segmented which splits the image into different parts. The features like contrast, correlation, clustering, energy, entropy ratio, kurtosis factor are extracted from MRI image. These texture features are used for training. While testing, the same features are extracted from the testing image and is compared with trained feature values. SVM (Support Vector Machine) is used for this purpose. The working principle of SVM can be easily understood by the following Figure (2). Training of SVM classifier is very easy. It is used to classify the tumor into normal or abnormal. Using these training features, the hyper plane is calculated which is used to differentiate the two classes. This classifier gives unique solution by using kernel functions which is used for non linear separation. But selecting the kernel function is tedious task. Also, SVM are not much effective if the boundaries are not known exactly. After classifying, the segmented tumor is displayed using K means algorithm. This clustering permits each member to be part of many clusters. But it is difficult to predict k-value. Also, it is not effective when the clusters are of different size and density.

3. PROPOSED APPROACH
In the proposed system, the process of detection of laryngeal tumor can be categorised into 4 steps:
• Pre-processing
• Feature Extraction
• Post-processing
• Classification

The block diagram of proposed system is shown in figure (1).
3.1. Pre-processing:

Firstly, MRI image is taken as input which is shown in Figure (2). But noise is introduced while converting optical signals into electrical signals and then into digital signals. This noise is removed in the process of pre-processing. Firstly, input image is resized and then converted into gray scale image as image may be colored.

![Input MRI image](image)

Fig.4. Input MRI image

This converts the 3D pixel value of an image into 1D pixel value thereby reducing the complexity. The mathematical parameters of the image are extracted and the image is segmented using canny edge detection.

![Filtered image](image)

Fig.5. Filtered image

3.2. Feature Extraction:

Texture is one of the most important characteristics used to identify the region of interest. This texture features of the image are extracted using GLCM (Gray Level Co-occurrence Matrix). It also calculates how often a pixel with gray scale intensity value i occurs either vertically, horizontally or diagonally with neighboring pixels of value j. The following features are extracted from GLCM:

1. Energy: It detects disorders in textures i.e., it calculates the uniformity of the texture.

\[
\text{Energy} = \sum p(i, j)^2 .
\]

2. Contrast: Contrast is the difference between highest and lowest values of contiguous set of pixels.

\[
\text{Contrast} = \sum |i - j| p(i, j) .
\]

3. Homogeneity: It returns a value that calculates the closeness in distribution of elements in GLCM to that of GLCM diagonal. It varies from 0 to 1.

\[
\text{Homogeneity} = \sum p(i, j) .
\]
4. **Correlation:** It returns the measure of how much a pixel is correlated to its neighbour over the complete image. It varies from -1 to +1.

### 3.3. Post-processing:

The pre-processing of an image may be distorted with noise and texture. Morphological operations can be used to eliminate these distortions and enhance the result. These operations process the image based on their shape. It depends upon the relative ordering of the pixels rather than the intensity value of the pixels. Here processing is done by using a small shape called structuring element which is positioned at different locations of the image and is compared with neighbourhood pixels. The two basic operations used are Dilation and Erosion. Pixel values are added to the boundary of objects in dilation and is removed in case of erosion. The image obtained after morphological operation is shown in Fig(4).

![Morphological image](image)

Fig. 6. Morphological image

Here, erosion operator is applied which shrinks the foreground by assigning minimum pixel values of neighbourhood pixel values in input image. Later, dilation operator is given which expands the foreground by assigning maximum pixel values of neighbourhood pixels values in input image. The following figure (5) shows the flow of proposed method:

### 3.4. Classification:

CNN (Convolutional Neural Network), KSONN (Kohonen’s Neural Network), ANN (Artificial Neural Network) are used for this purpose. Using these hybrid classifiers, disadvantage of each classifier is overcome with other classifiers. CNN is commonly used to identify the objects. These neural networks learn directly from the image data without manual feature extraction. They have hundreds of layers which learn to detect the features of image by applying filters at different resolutions. The output of image is given as input to the next layer. It is convenient as it learns without much training dataset and complexity. Next to it, KSONN (Kohenen’s self-organising neural networks) is applied. It is ideal for obtaining low dimensional view of high dimensional data. It applies competitive learning to a set of input data opposing error correction learning like other neural networks. It is best for accomplishing functions on unknown data to describe hidden structures in it. At last, ANN is applied to classify the tumor into benign or malignant. In this way, it provides accurate results when compared to single neural networks which has accuracy more than 90%.
4. SIMULATION RESULTS

The following table (1) shows the values obtained for different features extracted from different MRI images:

| Parameters  | MRI 1   | MRI 2    | MRI 3    | MRI 4    |
|-------------|---------|----------|----------|----------|
| Correlation | 0.88575 | 0.8911   | 1.8103   | 0.9052   |
| Energy      | 0.20295 | 0.21665  | 0.20435  | 0.20435  |
| Contrast    | 0.84765 | 1.0863   | 0.96945  | 0.96925  |
| Homogeneity | 0.81595 | 0.8278   | 0.81545  | 0.81545  |
| PSNR        | 97.4983 | 97.7757  | 98.0473  | 97.7365  |
| MSE         | 95.6417 | 95.9192  | 96.1907  | 95.8799  |
| Accuracy    | 97.7483 | 98.0257  | 98.0473  | 97.9865  |

Table-1. Values of the features extracted from GLCM
The figure (8) displayed below shows the image obtained after performing pre-processing techniques:

![Fig. 8. Images obtained after pre-processing](image)

The figure (9) displayed below shows the image obtained after performing post-processing techniques:

![Fig. 9. Images obtained after post-processing](image)

The figure (10) displayed below shows the values obtained from the extracted parameters:

![Fig. 10. Values of extracted parameters](image)

5. CONCLUSION

In proposed system, our goal is to automatically and statistically diagnose the type of tumor in the throat by using MR images. Region of interest, filtration and segmentation techniques were utilized to be the base of the information to get the statistical data for each case. It has been proven that a simple, harmless and accurate statistical technique can efficiently distinguish between the malignant and benign tumor (TCa). The huge advantage of this approach is that there will be no need to make any further tests or examinations on the patient after making the MRI. The diagnosis system achieves accuracy over 97.95% in differentiation between the different tumor types on various
qualities of MR images. The results of the experiments and application of the proposed method may also be applied.

REFERENCES

[1] Gopi K, Selvakumar J, “Lung tumor area recognition and classification using EK-means clustering and SVM”, IEEE-International Conference on Nextgen Electronic technologies, 2017.

[2] “Laryngeal Tumor Statistics”- Cancer.org. [Online]. Available: https://www.cancer.org./cancer/laryngeal-and-hypopharyngeal- cancer/about/key-statistics.html.

[3] Larisha Rayen, B., Monica, B., Karthikeyan, S., Sivakumar, V.G., " Multi-band circularly polarized antenna for 2.4/5.3/5.8 ghz WLAN and 3.5 ghz WI-MAX applications", Journal of Advanced Research in Dynamical and Control Systems, 2017, vol. No:16, PP: 1311-1322.

[4] Manikandan, R., Karthikeyan, S., Balaji, S.R., Vasudevan, V., Shalini, S. " An internal startup circuit for pacemakers using body temperature", International Journal of Pure and Applied Mathematics, Volume 117 No. 21, december 2017, PP:155-162.

[5] Karthikeyan, S., Venkata Nagi Reddy, M., Mazeed Ahamed, M., Sivakumar, V.G., "A novel approach to cost-aware energy based routing protocol for wireless sensor networks", International Journal of Pure and Applied Mathematics, Volume 117 No. 21 2017, PP: 107-112.

[6] Rajesh C. Patil, Bhalchandra A.S, "Brain Tumour Extraction from MRI Images Using MATLAB” International Journal of Electronics, Communication & Soft Computing Science and Engineering ISSN:2277- 9477, vol. 2, no. 1, April 2012.

[7] Daizy Deb, Bahnishika Dutta and Sudipta Roy, “A noble approach for noise removal from brain image using Region Filling,” 2014 IEEE International Conference on Advanced Communications Control and Computing Technologies, 2014.

[8] Dubey R, M. Hannandlu, and S. Vasikarla, “Evaluation of Three Methods for MRI Brain Tumor Segmentation,” 2011 Eighth International Conference on Information Technology: New Generations, 2011.

[9] Hadeel Abdullah N, Mustafa A. Habtr,” Brain tumor extraction approach in MRI images based on soft computing techniques ”,IEEE- International Conference on Intelligent networks and Intelligent systems,2015.

[10] Albert Mayan,J,Surya,B,Pranoy Prabhakar,Princekumar,"Department–Student Library Using Twig Pattern Query Processing Over Admin-User Login Privilege”, Pak. J. Biotechnol. Vol. 13 , Pp. 489 -493,(2016).

[11] Ravindra Sonavane, Poonam Sonar,” Classification and segmentation of brain tumor using Adaboost classifier”,IEEE- International Conference on Global Trends in Signal Processing, Information Computing and Communication,2016.

[12] Kanwarpreet Kaur, Gurjot Kaur, Jaspreet Kaur, "Detection of brain tumor using NNE approach",IEEE-International Conference On Recent Trends In Electronics Information Communication Technology,2016.

[13] Murthy T.S.D and Sadashivappa G, “Brain tumor segmentation using thresholding, morphological operations and extraction of features of tumor,” 2014 International Conference on Advances in Electronics Computers and Communications, 2014.

[14] Sathies Kumar T, Rashmi,K etal,” Brain tumor detection using SVM classifier”,IEEE-International Conference on Sensing, Signal Processing and Security,2017.

[15] Selvakumar J, Lakshmi A and Arivoli T, “Brain Tumor Segmentation and Its AreaCalculation in Brain MR Images using K-Mean Clustering and Fuzzy C-Mean Algorithm” IEEE-International
Conference On Advances In Engineering, Science And Management (ICAESM-2012) March 30, 31, 2012.

[15]Nandhini J.; Shabatini K., Karthikeyan S., "Wireless colour sensing arm robot”, International Conference on Robotics, Automation, Control and Embedded Systems (RACE) Year: 2015 Pages: 1 – 6.

[16]Gopika. S. Kumar, S. Karthikeyan and N. Ambily, “A Metaphorical Scrutiny in Banishing Salt and Pepper Noise”, BIOSCIENCES BIOTECHNOLOGY RESEARCH ASIA, December 2014 Vol. 11(3).

[17]G. Karudaiyar, S.Karthikeyan and B. Sainath, “Encryption and Decryption Scheme by Using Finite State Machine”, BIOSCIENCES BIOTECHNOLOGY RESEARCH ASIA, December 2014 Vol. 11(3), 1867-1872.

[18]S.Karthikeyan, S.Jayashri, “Energy Utilization Strategies using Novel Approach in Wireless Sensor Networks”, International Conference on Software Engineering and Mobile Application Modelling and Development, Dec 2012, pp: 1-5.

[19]S.Karthikeyan, S.Jayashri, “Energy Efficient System for Heterogeneous Wireless sensor Networks”, European Journal of Scientific Research, Volume 72, No 4 march 2012, PP: 599-607. ISSN: 1450-216X.

[20]S.Karthikeyan, S.Shannugapriya and S.Jayashri, "Sub-head Transmission of Heterogeneous Data by Cloned Agent to Android Mobile”, Research Journal of Applied Sciences, Engineering and Technology, 8(1): pp.24-34, 2014

[21]S.Pavithra, S.Karthikeyan, V.J.K. KishorSonti, S.Jayashri, “Competent Realization of Co-operative spectrum sensing in cognitive radio systems”, International journal of Engineering systems modeling and simulation, inder science publishers, Vol.7, No. 2, pp. 103-110 2015.

[22] Mayan J.A, Arifa S, Pavithra R,"Semantic based multi lexical ranking technique for an effective search in protected cloud,2016 International Conference on Control, Instrumentation, Communication and Computational Technologies (ICICCCT), Kuma

[23] K. Bharathi, S.Karthikeyan, “A Novel Implementation of Image Segmentation for Extracting Abnormal Images in Medical Image Applications”, Indian Journal of Science and Technology, Vol. 8 (S8), 333–340, April 2015.

[24] S.Karthikeyan, Merin Mary Koshy and V.G.Sivakumar, "Smart & automated robotic circular car parking using GSM", International Journal of Pure and Applied Mathematics Volume 117 No. 21 2017, PP: 81-86.

[25] Hari Krishna, K., Swamy, Y., Siva Kumar, V.G., Karthikeyan, S. "Integration of two way communication using gesture control hand movement and voice based text”, Journal of Advanced Research in Dynamical and Control Systems, 2017, vol. No:17 , PP: 1124-1135

[26] Meenakshi. R, Pooja Suppaiah , Siva kumar V.G, Karthikeyan, S,"COST EFFECTIVE REAL TIME HOME ENERGY MONITORING AND MANAGEMENT SYSTEM” Journal of Advanced Research in Dynamical and Control Systems, 2017, vol. No:17 , PP: 1103-1111

[27] Albert Mayan J, R. Julian Menezes, M. Breezely George, "Designing a Customized Testing Tool for Windows Phones Utilizing Background Agents”, International Conference on Soft Computing Systems (ICSCS), Advances in Intelligent Systems and Computing , vol.398, Springer, pp.33-46.

[28] Aashik JPM , Ajith M ,Mr.V.G.Sivakumar,Mr.S. Karthiickeyan, ” AN INTERNET OF THINGS APPROACH FOR MOTION DETECTION AND CONTROLLING HOME APPLIANCES USING RASPBERRYPI WITHOUT CLOUD SERVER”, Journal of Advanced Research in Dynamical and Control Systems, 2017, vol. No:17 , PP: 1112-1123
[29] T. V. N. Surendra Gopi, Illuru Phani Kumar, Dr. S. Karthikeyan, Dr. V. G. Sivakumar "A Novel Method Of Dynamic Mobile Data Collection Scheme By Fuzzy Logic", Journal of Advanced Research in Dynamical and Control Systems, 2017, vol. No:17, PP: 1136-1149
[30] Kumar, M. K., Surya, J., Kumar, V. G. S., Karthikeyan, S. "Online prediction of driver distraction based on brain waves activity patterns", International Journal of Pure and Applied Mathematics, Volume 117 No. 21 2017, PP: 139-146.