Denoising the CT Images for Oropharyngeal Cancer using Filtering Techniques

M. Sakku Vidhya[1]
[1]M.Phil Research Scholar, PG & Research Department of Computer Science, Sadakathullah Appa College,T irunelveli, Tamilnadu, India

Dr. S. Shajun Nisha[2]
[2]Assistant Professor & Head, PG & Research Department of Computer Science, Sadakathullah Appa College, Tirunelveli, Tamilnadu, India

Dr. M. Mohamed Sathik[3]
[3]Principal, Sadakathullah Appa College, Tirunelveli, Tamilnadu, India

***Abstract* – Oropharyngeal Cancer (OPC) is a type of oral cancer. Death rate for this Cancer is higher than the other types of oral cancer. Oropharyngeal Cancer Affects Oropharynx, Tonsils, Back Wall of The Tongue and Vallecula. In this work, various filtering methods are employed to remove the speckle noise from the CT image. CT images are widely used in detection of oropharyngeal cancer. Comparison of Anisotropic Diffusion Filter, Gaussian Filter and Adaptive Median Filter are used to remove the noise from CT image. The metrics used for analysis are PSNR, MSE, FOM, PR, SSIM. Its identified that Anisotropic Diffusion Filter provide best result.**

Key Words: Oropharyngeal Cancer, Image Processing, Anisotropic Diffusion Filter, Gaussian Filter, Adaptive Median Filter

1. INTRODUCTION

Cancer causes when cells in the body change and grow out of control. Human body is made up of tiny building blocks called cells. Cancer of the oral cavity is the eighth most common cancer among men. The average age of diagnosis is 62. About 25% of cases occur in people younger than 55. Cancer that develop in the head and neck region is called Oropharyngeal Cancer. Oropharyngeal cancers are formed by squamous cell carcinoma. The two types of oropharyngeal cancers are HPV-positive oropharyngeal cancer, which is caused by an oral human papillomavirus infection; and HPV- negative oropharyngeal cancer, which is linked to use of alcohol, tobacco, or both.[5]

The proposed work mainly focused on HPV-Negative Oropharyngeal Cancer. Oropharyngeal cancer (OPC) found in the tissue of the throat (oropharynx) that includes the base of the tongue, the tonsils, the soft palate, and the walls of the pharynx. Depending on the place in head and neck region the stages of oropharyngeal cancer can be identified. OPC stage can be identified by the presence of the tumor in variance places. In stage 0 the tumor is only in the lining of the oropharynx is called carcinoma in situ. In stage 1 the tumor is 2 cm or smaller. In stage 2 the tumor is larger that 2 cm but not longer that 4 cm. In stage 3 the tumour is larger than 4 cm or has grown to the epiglottis and the final stage can be sub-divided into 3 stages dpending on the size and place of the tumor. Stage 4(i), it has spread in the part of larynx, front part of the mouth, lower jaw and tongue. Stage 4(ii) spread in the area of behind the nose and stage 4(iii) spread to other parts of the body, such as lung, liver or bone.[6]

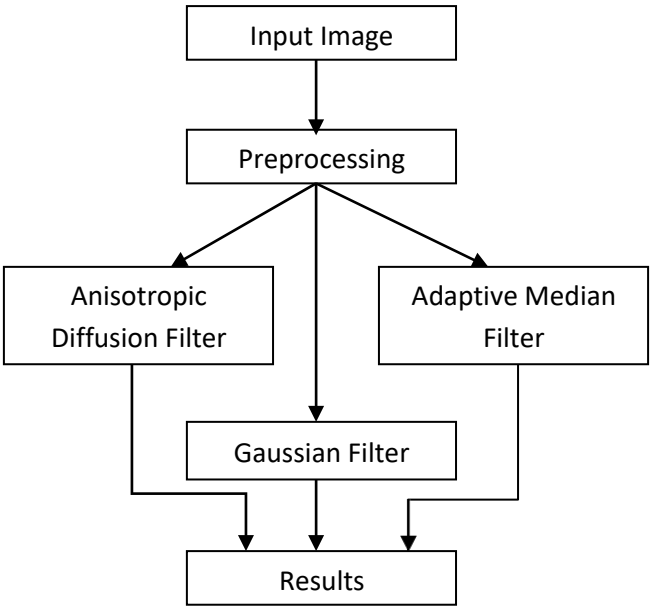
OPC can be treated with effective treatments and continuous monitoring. Over the years, medical image processing contributed much in medical applications The earliest one is CXR, electromagnetic radiation with short wavelength and high energy has been used. Another technique is CT, which uses X-Ray in imaging body organs and structure internally. Another imaging technique is MRI, which works on magnetic characteristics and provides detailed information about internal organs. It produces a number of parallel slices of organs in three dimensions. But the most important disadvantage of MRI is for manual analytics volume of data is being too large and so it is tedious to collect data. Also noise, intensity and low contrast will be its disadvantages. Images provided by X-Ray, CT (computed Tomography) serve as the basis for radiation therapy treatments. Most of the doctors prefer CT imaging and it is also being used for assessing parameters of the human body. To detect the oropharyngeal cancer using the modality of CT scan images.[8]

Image processing is an important phase for preprocessing an image. Due to noise and inconsistent, the filtering techniques are used to remove the noise in CT image namely Anisotropic Diffuison filter, Gaussian Filter and Adaptive Median Filter are used to remove the speckle noice in Ct image and also improve the quality of image. Performace of these methods are evaluated using the metrics like PSNR,MSE and Volu to find the results.

1.1 Motivation Justification

Various preprocessing methods are available, the purpose of using preprocessing is to remove the noise. To identify the best filtering techniques , Comparision of different filtering methods are used. Based on the performance evaluation metrics the result is justified.

1.3 Outline of the Paper



1.4 Organization of the Paper

The remaining section of the paper structured as follows Section II describes literature review, Section III comprises methodologies, Section IV includes Performance analysis and Section V discuss conclusions.

2. RELATED WORK

Zhalong Hu , Abeer Alsadoon, Paul Manoranjan, P.W.C. Prasad1, Salih Ali,
A. Elchouemic researchers objective was to improve the tumor diagnosis accuracy in the oral cancer with accurate results using anisotropic diffusion filter, Fuzzy C-Means and Support vector machine methods they detect the oral cancer stages.

C.R.Muzakkir Ahmed, M.Narayanan, S.Kalaivanan, K.Sathya Narayanan, A.K. Reshmy researchers objective was to detect the cancerous cells in the oral cavity and to classify the cancer affected position using firefly algorithm to detect the cancer tumor in the MRI image. And Expectation maximization (EM) algorithm to classify the cancer cells accurately the project is carried out using mat lab program.

Madhura V, Meghana Nagaraju, Namana J, Varshini S P , Rakshitha R researchers objective was to detect the oral cancer using machine learning as domain and uses Data Mining and data extraction for prediction techniques, classification rules for oral cancer prediction and uses association rules to perceive the relationship between the oral cancer attributes.

3.4 Adaptive Median Filter

Adaptive Median Filter performs spatial

$$PSNR = 20\log$$

Andrés M. Bur, Andrew Holcomb, Sara Goodwina, Janet Woodroof, Omar Karadaghy, Yelizaveta Shnayder, Kiran Kakaralaa, Jason Brant, Matthew Shew researches was To develop and validate an algorithm to predict occult nodal metastasis in clinically node negative oral cavity squamous cell carcinoma (OCSCC) using machine learning. To compare algorithm performance to a model based on tumor depth of invasion.

Vrushali N. Raut, Sachin D. Ruikar researchers was produce the effect of noise reduction filter on computed tomography (CT) images. Anisotropic diffusion is Selective and nonlinear filtering technique which filters an image within the object boundaries & not across the edge orientation. This technique is used to improve an image quality and allow the use of a low-dose CT protocol.

3. METHODOLOGY

3.1 Preprocessing

CT images are used to detect the OPC. The original CT image always included speckle noise for a range of reasons. These noise will affect the accuracy.

Preprocessing is an important step in image process.

3.2 Anisotropic Diffusion Filter

It is a technique aiming at reducing image noise without removing significant parts of the image content, typically edges, lines or other details that are important for the interpretation of the image. Each resulting image is a combination between the original image and a filter that depends on the local content of the original image. Anisotropic diffusion filter is also called Perona–Malik diffusion.[9]

3.3 Gaussian Filter

A Gaussian filter is a linear filter. It's usually used to blur the image or to reduce noise. The Gaussian filter alone will blur edges and reduce contrast.[10]
over every pixel in the image, repeating the process.[11]

4. EXPERIMENTAL RESULTS

4.1 Performance Metrics:

The performance metrics such as Peak signal to Noise Ratio (PSNR), Mean Squared Error (MSE), Figure of Merit (FOM), Performance Ratio (PR), and Structural Similarity Index (SSIM) are calculated to find which filtering techniques gives better result.

A. Peak Signal to Noise Ratio (PSNR): The term peak signal-to-noise ratio (PSNR) is an expression for the ratio between the maximum possible value (power) of a signal and the power of distorting noise that affects the quality of its representation.[12]

$$PSNR = 20\log_{10}\left[\frac{255}{MSE}\right]$$

processing to preserve detail and smooth non-impulsive noise. analyze the values of all the pixels in the neighborhood, and then replace the original pixel's value with one based on the analysis performed on the pixels in the neighborhood. The neighborhood then moves successively

Mean Square Error (MSE):

Mean Squared Error (MSE) of an estimator measures the average of the squares of the errors that is, the average squared difference between the estimated values and the actual value. The MSE is a measure of the quality of an estimator. it is always non-negative, and values closer to zero are better.

$$MSE = \frac{1}{m \times n} \sum_{i=1}^{m} \sum_{j=1}^{n} \left[I'(i,j) - I(i,j) \right]^2$$

M, N be the rows and columns of an image, I' and I are the original and detected output image respectively.

B. Figure of Merit (FOM):

Figure of Merit is used to analyse the efficiency of the technique implemented.[3]

$$FOM = \frac{1}{\max(N_\alpha, N_\beta)} \sum_{i=1}^{N} \left[\frac{1}{1 + d\alpha^2} \right]$$

Na is the detected edges, Nd is the Ideal edges is the distance; α is the penalty factor.

C. Performance Ratio (PR): Performance ratio is the measure of image quality. It can be calculated as[3]

$$PR = \frac{True\ Edge\ Pixel}{False\ edge\ pixels\ identified - edges}$$

D. Structural Similarity Index (SSIM): SSIM is used to compare luminance, contrast and structure of two different images. It can be treated as a similarity measure of two different images. SSIM of two images X and Y can be defined as

$$SSIM(X,Y) = \frac{(2\mu_x\mu_y + C_1) \times (2\sigma_{xy} + C_2)\ (\mu^2 + \mu^2 + C) \times (\sigma^2 + \sigma^2 + C_2)}{x \quad y \quad 1 \quad x \quad y}$$

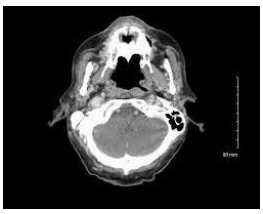
4.2 PERFORMANCE EVALUATION

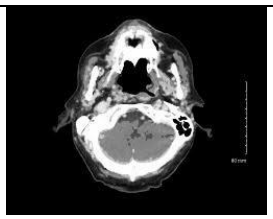
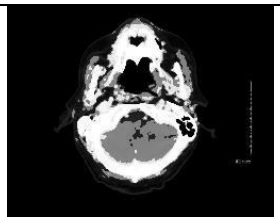
In this proposed work preprocessing techniques for OPC CT images were applied. Techniques such as Anisotropic diffusion filter, Gaussian filter and Adaptive median filter are applied and the quality of images are improved. The results of the images are tabulated in figure 1.

Table-1 : Values of PSNR,MSE,FOM,PR,SSIM

Image	PSNR	MSE	FOM	PR	SSIM
Anisotropic Diffusion Filter	1.290	10302.5	0.2149	14.8091	0.44784
Gaussian Filter	0.971	9294.9	0.1032	9.6280	0.43129
Adaptive Median Filter	1.553	10998.1	0.1296	11.2624	0.40711

Table-2: Result of images on applying filtering techniques

Input Image	

Anisotropic Diffusion Filter	
Gaussian Filter	
Adaptive Median Filter	

5. CONCLUSION

Filtering techniques such as Anisotropic diffusion filter, Gaussian filter and Adaptive median filter were used to remove speckle noise. After applying these techniques the image quality obtained and assessed with metrics. These metrics include Peak signal to Noise Ratio (PSNR), Mean Squared Error (MSE), Figure of Merit (FOM), Performance Ratio (PR), and Structural Similarity Index (SSIM). From the results Anisotropic diffusion filter succeeds because it has higher FOM, PR, SSIM.

REFERENCE

[1] [1] S. Shajun Nisha, and S. Kothar Mohideen "Wavelet Coefficients Thresholding Techniques for Denoising MRI Images" Indian Journal of Science and Technology, Vol 9(28),July 2016, ISSN (Print) : 0974-6846 ,ISSN (Online)

[2] : 0974-5645

[3] [2]J. AashikathulZuberiya, Dr. S. Shajun Nisha, Dr. M. Mohamed Sathik "Comparison of Preprocessing Methods for Diabetic RetinopathyDetection Using Fundus Images" International Research Journal of Engineering and Technology (IRJET) Volume: 06 Issue: 03 | Mar 2019, e-ISSN: 2395-0056, p-ISSN: 2395-0072

[4] M. Nagoor Meeral, Dr. S. Shajun Nisha, Dr. M. Mohamed Sathik "A COMPREHENSIVE ANALYSIS OF EDGE DETECTORS IN SD-OCT IMAGES FOR GLAUCOMA DIAGNOSIS" International Research Journal of Engineering and Technology (IRJET), Volume: 06 Issue: 03 | Mar 2019, e-ISSN: 2395-0056, p-ISSN: 2395-0072

[5] J.Aashikathul Zuberiya, M.Nagoor Meeral, Dr.S.Shajun Nisha" A Comprehensive Analysis of Edge Detectors in Fundus Images for Diabetic Retinopathy Diagnosis" SSRG International Journal of Computer Science and Engineering (SSRG-IJCSE)

[6] Special Issue ICRTETM March 2019, ISSN: 2348 – 8387 [5]https://en.wikipedia.org/wiki/Oropharyngeal_cancer [6]https://www.cancer.net/cancertypes/oral-and-oropharyngeal-cancer/stages-and- grades

A. Zhalong Hu , Abeer Alsadoon, Paul Manoranjan , P.W.C. Prasad, Salih Ali, Elchouemic "Early Stage Oral Cavity Cancer Detection: Anisotropic Pre- Processing and Fuzzy C-Means Segmentation" , 978-1-5386-4649- 6/18/$31.00 ©2018 IEEE R. Beaulah Jeyavathana, Dr.

[7] R.Balasubramanian, A. Anbarasa Pandian "A Survey: Analysis on Pre- processing and Segmentation Techniques for Medical Images", International Journal of Research and Scientific Innovation (IJRSI) | Volume III, Issue VI, June 2016 | ISSN 2321–2705

[8] https://en.wikipedia.org/wiki/Anisotropic_diffusion [10]https://en.wikipedia.org/wiki/Gaussian_filter [11]https://www.massey.ac.nz/~mjjohnso/notes/59731/presentations/Adaptive%20Median%20Filtering.doc [12]https://www.ni.com/enin/innovations

[9] /white-papers/11/peak-signal-to-noise ratio-as-an-image-quality-metric.html