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Research Article

Development of Segmentation and Classification Algorithm for Lung Cancer Tumor Detection Using CT scan Images and Performance Analysis

M.Premchander [a], Dr. M. Venkateshwara Rao[b], Dr. T.V. Rajinikanth[c], M. Sowmya [d]

[a] Research Scholar, CSE Dept, Gitam University, Vishakapatanam, India
[b] Professor, IT Dept, Gitam University, Vishakapatanam, India.
[c] Professor CSE Dept, Sreenidhi Intitute of Science & Technology, Hyderabad, India
[d] Assitant Professor CSE Dept, Stanly College of Engineering and Technology for Women, Hyderabad, India.

Abstract

Lung cancer is one of the main causes of death in the world. The identification of lung cancer tumor at initial stage is of extreme importance, if it is intended to high mortality rate. Early detection and diagnosis of human beings. To identify lung cancer tumor, Computed Tomography (CT) scan images are broadly used to distinguish the disease, with the help of expert physicians. Time factor plays very important role in the diagnosis of the abnormal cells growth, as it is directly related to survival rate. In this paper, presented a fully automatic framework for lung cancer nodule detection from CT scan images. A Threshold based technique is proposed to identify and separate the candidate nodule from other structures. The main objective is noise removal operation, thresholding, gray scale imaging, histogram equalization, texture segmentation and morphological operation. The image processing techniques are mainly used for detection of lung cancer. Medical imaging is developing quickly due to evolutions in image processing techniques, as well as image analysis, recognition and image enhancement. The proposed method is evaluated using large lung database which is collected from lung Image Database Consortium (LIDC) using image processing toolbox in MATLAB. The Proposed method achieved excellent results compared with other existing segmentation methods .

Keywords: Lung cancer, segmentation, image enhancement, Threshold, image processing, Feature extraction. image processing

1. Introduction

Lung cancer is considered advance of anomalies cells. It is a dangerous disease. It grows fast abnormally and uncontrollably. The most nurture in NSCLC observed in 80% patients. 2.09 people died with this disease in 2018. A representative analysis being done using CAD diagnosis. 65% of the older people most frequently are effecting with this lung cancer. The uncontrolled growth of cells is formed as tumor. Some of the common symptoms are include cough, chest pain difficult in breath, change in speech, wheezing and weight loss. It is the most critical disease which starts in the lung. There are many known reasons of cancer more than 15.5 million cases are registered as on 1st January 2016 [1-2]. Lung cancer is spreading more approximately 1 in 14 in men, and 1 in 17 in women. Lung cancer killing 422 people per day [3-4]. Progress against cancer has been developed in these days, as compared to earlier days. Image acquisition and image interpretation are the two used to know the disease. Cancer deaths are 1.3 million per year. Lung cancer originates from lung tissues. Most of the lung cancer details are related to Non small lung cancer [5-6]. The main objective of this paper is to detect lung cancer, and it is considered as most dangerous cancer among all other types of cancers occurred in the

world wide. It is very difficult to identify in the early stage of the lung cancer. The major risk factor for normal people, is who will inhale the second hand smoke. Among all other types of cancers, lung cancer is having the high mortality rate. Lung cancer is very serious problem in the worldwide. As estimated lung cancer cases affected in female 75% and in male 85% which is mostly caused by smoking [7]. The effectives of canny edge detection depend on these parameters like i) Gaussian kernel width ii) lower threshold and iii) upper threshold. In the digital image processing, the canny edge detector more efficient than other edge details in detecting the edges in the image. Lung cancer detection has been a topic more serious disease. The need of robust and efficient algorithms and systems for detection of lung cancer tumor nodule [8-9].Research work has been done on lung cancer detection earlier using conventional and hybrid methods which may not be very efficient for particular systems. The present work is a new direction in detection of lung of lung cancer tumor detection. Our procedure involves, capturing the input image, preprocessing, segmenting each image and enhancing the affected area which is tumor in the lungs, which is retrieved using thresholding. It is proved that the performance of this technique is more strategy for lung cancer tumor detection and is very efficient.

Historical Perspective on Medical Imaging

The basic idea behind Image processing and medical images like, x-ray, MRI and computed tomography have been around for decades. The performance of image processing improved more after development of medical images. However performance was still inefficient, subsequently other classifiers are developed support vector machines and decision trees. Each of them has been applied to measure in the analysis CT images [10-11]. Ruchika karla et.al [12] described that to detect various type of tumor parameters like area, ,perimeter, and eccentricity in the CT scan images.

Contributions

- In the most CAD- based systems nodule detection, lung diseases are manually marked by the radiologists, which is more exhausting and time consuming task.
- In the proposed system CT scan images are used to detect lung cancer tumor, and also lungs are automatically segmented, without any user interruption.
- The proposed system uses the image processing approaches e.g., morphological operations, segmentation, histogram, and feature extraction which makes it implementable on simple systems.
- With in very short time radiologists may finalize with earlier CAD systems, very helpful and works efficiently and effectively.
- The proposed system achieved high sensitivity and accuracy exceeds the existing similar techniques. In an experimental evaluation carried out on a standard LIDC data.

The CT scan lung images are taken from cancer patients more than 200 for classification.[13-14]. These lung images are classified into SVM, KNN Deep Learning and CNN classifications. CT images of lungs normal and abnormal are shown in the figure 1and figure 2.

Figure 1. CT images of normal lung image in DICOM

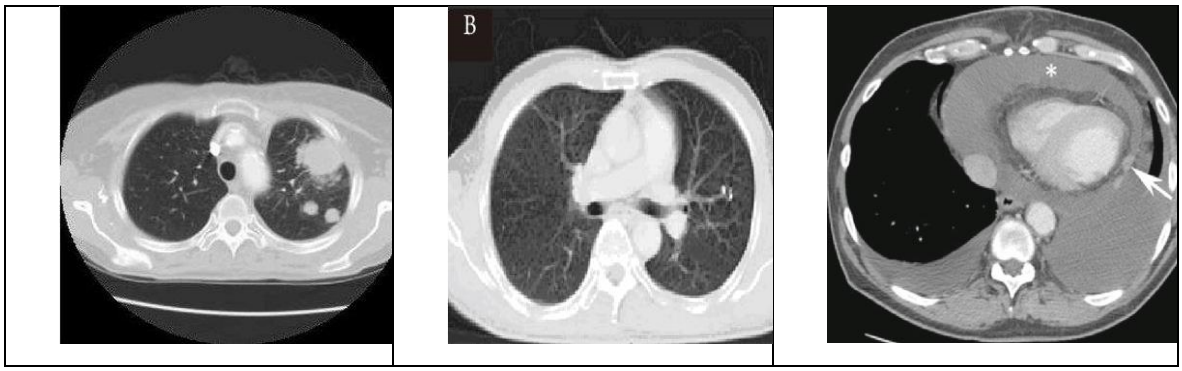

Figure. 2. CT images of lung cancer image in DICOM

Some of the lung cancer symptoms:

- A hoarse voice.
- Constant chest pain.
- Frequent lung infections.
- Coughing up blood.
- Weight loss with unknown cause.

2. Related Work

Goswami et. al [15] developed in their research work image enhancement implemented by histogram equalization and feature extraction stage. Segmentation of the lungs based on interactive Image Retrieval Algorithm, which is trained on available prior data. And also implemented a graph- cut segmentation technique which explains the structures of the lungs on pathological reports [16, 17, 18]. However, when the lung cancer patients are more, it is a challenging problem to radiologist to finalize the accurate results. We need to finalize the results in very short time. Due to this radiologists are misinterpret the results. In earlier studies CAD systems are very helpful that can detect lung cancer efficiently and effectively within in a short duration of time period. Rendon et al [19] described that present the tumor in the CT image and detecting various tumor parameters like area, perimeter and eccentricity are extracted from images. Huang et al [20] observed that detection of cancer cells using two methods segmentation such as thresholding and watershed are used to detect the cancer cells. Shrivastava et al [21] introduced that CT medical images image processing and finite elements under gradual stages of lung cancer. The optimum image features to represent lung nodule of a computer aided diagnosis system. CAD systems are mainly used in 1) Nodule detection and classification, 2) Discrimination of abnormality and 3) Nodule characterization and growth measurement [22-24].

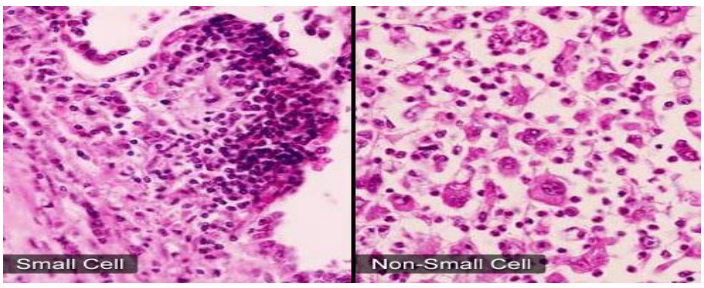

Figure 3 a) SCLC b) NSLC

Lung Cancer Screening of CAD overview for CT images

In this context, Computer Aides Diagnosis (CAD) has improved since 2000, and prevail the major challenged areas. Current CAD schemes include discrimination of lung tissue, nodule detection and classification [25-26]. Comparison among malignant and benign nodules as shown in figure 3, and growth measurement as well as estimation of malignancy [27].

3. Methodology

The methodology focuses to get more accurate results in the proposed method with enhancing the input image through the pre-processing stage as shown in figure 4. By using Gabor filter images are modified to enhance the image contrast [28-30]

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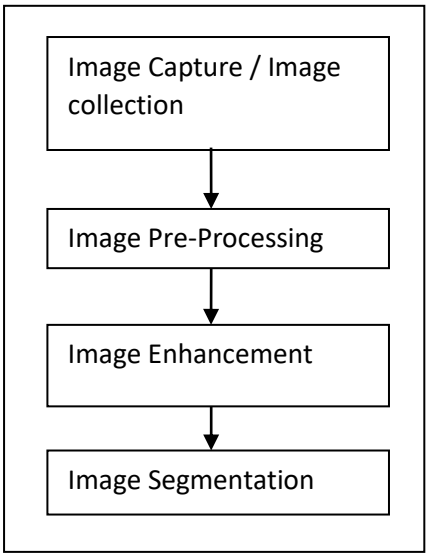

Figure 4. Lung Cancer Detection Methodology

A. IMAGE CAPTURE/ IMAGE COLLEGCTION.

Cancer and non-cancerous patient's lung images are collected from different hospitals and diagnosis centers. The Computed Tomography (CT) images are having 8 bit resolution and DICOM format. Preferably CT scan images are mostly used in medical imaging due to these images has low noise compared to MRI and X-ray images [31-32]. The collected images are requires pre-processing and Image enhancement steps for better interpretation.

B. IMAGE PROCESSING

Pre-processing is the basic step to transform the data into another format that will be processed more effectively and easily. It is essential to have a preprocessing stage for accurate image enhancement, noise removal, image thresholding and in morphological techniques. The objective of the pre processing stage is to remove any variations in the optical character recognition system.[33].

C. IMAGE ENHANCEMENT

Image enhancement is a process of improving the visibility of an image. Enhancement algorithms are used to obtain better quality of the image. Image enhancement algorithm is used for better quality image [34-35]. Image enhancement techniques are classified into two categories: a) Spatial domain method and b) Frequency domain Method. To increase the perception of the image, removing noise, sharpen the image, brightness and blurring from the image, increasing the contrast, are the image processing operations. The image enhancement technique can be performed, either in the frequency domain or in the spatial domain [36-38]. Spatial domain includes gray level transformations like image slicing, image negative and image thresholding. The histogram of the digital image produces the frequency of the gray levels. The shape of the feature is content based retrieval and used some image processing techniques for how to describe the shape of the object. [39-40]. Managing an efficient contrast image to improve the visual representation of medical images. CT images are collected from various clinical repositories. Medical images more usually used to diagnosis diseases medical images. Most of the medical images are degraded with noise and other artifacts usually in MRI, CT and PET images are used to recognize internal organs and the median filter used to remove the noise and smoothen the image. [41-42].

D. IMAGE SEGMENTATION

Image segmentation technique is an essential role in medical imaging. Image segmentation using medical images is the challenging task affecting with some limitations and artifacts, noise, weak boundaries, and similar intensities in different regions in the medical images.[43] The vast development in improving the technology in

detection of diseases in medical images. The images are more useful to detect various types of abnormal diseases, and also useful to implement new medical image processing algorithms. The edges contain more essential information in an image. Image segmentation is considered as a most effective technique to detect and extract the feature areas in the medical images. It extracts the images with the automatic process [44]. It divides the CT image in two areas with a specified description, such as tumor detection, body organs/tissues, border detection and mass detection. Partitioning of an image in to group of pixels is segmentation. Extract different features of an image in separation of an image. Segmenting of an image is a very challenging problem [45].

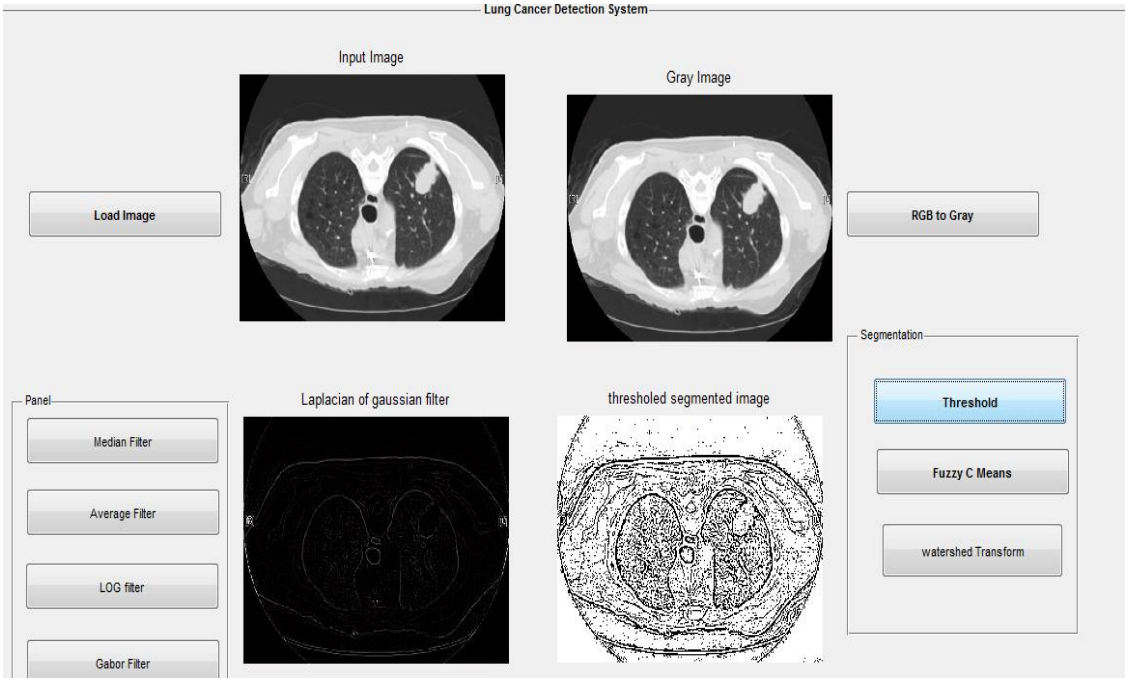

Fig: 5 Graphical User Interface of Lung Cancer Detection

4. Graphical User Interface

i)Median Filter

It is a non linear median filter, which forms with each pixel in the image, and it also checks with its neighbors to decide with its surroundings. This filter is more robust, and it is used better than mean filter, due to this it is having more sharp edgesas shown in the figure5.[46].

ii) Average Filter

Average filter is a linear filter which smoothes the image, and acts like low pass filter. The main purpose of the filter is that for any element of the image pixel of its neighborhood.

iii) Laplacian of Gaussain(LoG)

The Laplacian filter is used to find rapid change of the image and also it is a derivative filter which is sensitive to the noise.

iv) Gabor filter

The Gabor filter is using to segment the different objects. Gabor filters are reasonable model of how humans distinguish texture. This filter is approximately linear filter and also called band pass filter.

v) Thresholding

It is the simplest technique to partition the image. By using a single threshold value it transforms the color image or grayscale image into binary image. The binary image contains the input pixels values less than the threshold value and some input pixel values greater than threshold value. After the binary image map is labeled with non- zero (1) and zero (0).

vi) Watershed Transformation

Gray level image is represented as altitudes; the region with constant gray level constitutes the flat zone of an image. With this process we can find any other noise or irregularities in the image.

vii) Fuzzy C Means Algorithm

This algorithm gives appropriate results for overlapped data in the images. This algorithms works by assigning membership to data point for each cluster.

5. Feature Extraction

Feature extraction is the process of identifying the piece of information which is extracted from the feature extraction stage. In this feature extraction features like area, perimeter, eccentricity and intensity are extracted from the image. Shape measurements of tumor or any other artifacts appeared in the image are physical dimensional measures which characterize the presence of object, different types of segmentation techniques are described in table1. [47].

The following table1 shows that comparison between different types of segmentation techniques.

Segmentation method	**Description**	**Advantages**	**Disadvantages**
Thresholding Method	Depends on the peaks of histogram of the image to find threshold values.	Simple to method previous data not needed	Spatial details are not considered, mostly depends on peaks
Region Based	Image is divided into many similar parts	More immune for noise and used for similar criteria.	In terms of memory and time, it is expensive.
Clustering Based Method	Depends upon partitions into homogeneous clusters	Mostly Used to real problems where as fuzzy uses partial problems.	Difficult in finding membership function
Watershed Based Method	Depends on topological interpretations	Detected boundaries are continuous and results are stable	calculations of gradient are more complex
Artificial Neural Network Based Method	Based on decision making and learning of simulation process	No need to write complex programs	Wastage of time is more in training
Detection through Edges	Depends on edge discontinuity detection system	Good contrast	No more useful for more number of edges detected

6. Experimental Results

This study is to develop a new segmentation approach in image processing of the study of lung tumor compared with other studies. Different types of image processing techniques are used in this study. Primarily, the medical images are enhanced through some image processing techniques as shown in figure 6. Secondary process is the effected tumor image is segmented using segmentation technique which is called thresholding, by using this technique we observed different gray level s in the images as shown in the Figure 7 and 8. Finally, extraction of the tumor from the CT image as shown in the figure 9. [48]. By using some image segmentation techniques in order to extract the tumor as shown in the Figure10 and 11.

Figure.6. Original Gray scale image

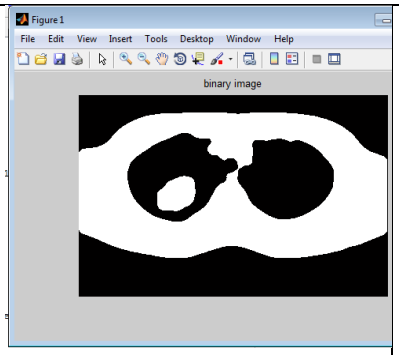

Figure7. Binary image

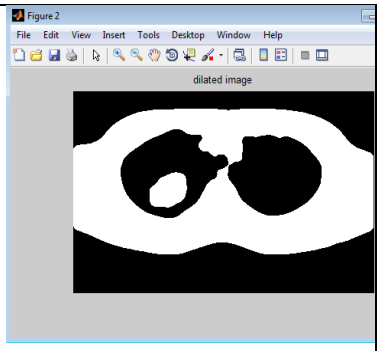

Figure.8. Dialated image

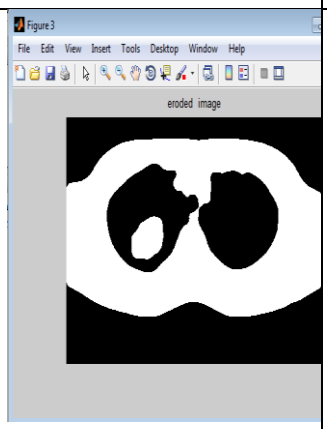

Figure9. Eroded image

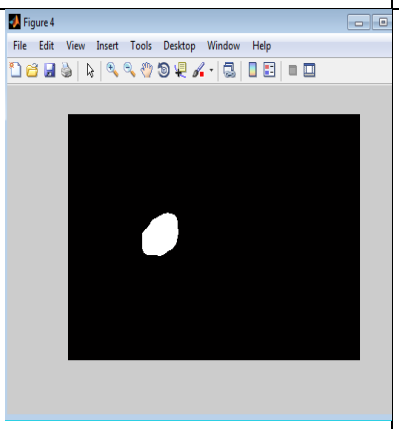

Figure. 10.Tumor Detection

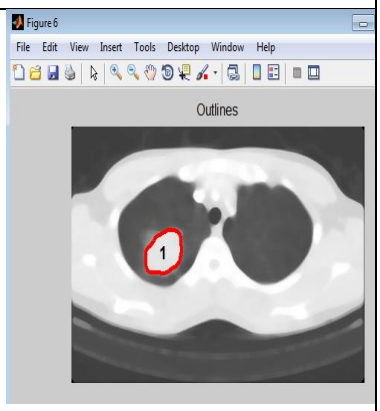

Figure.11. Outline of Tumor

DATA SET COMPARISON TEST

Table 2.

Patient	TRUE Acceptance Rate	FALSE Acceptance Rate	Success Rate
1	98.73	78	94
1[2]	91.86	8.4	80.625
2	95.23	7.14	82.625
2[2]	92.14	15.12	83.03
3	97.145	78	92
3[2]	93.42	29.34	86.62
4	96.56	77.25	94.12
4[2]	88.23	22.35	82.32

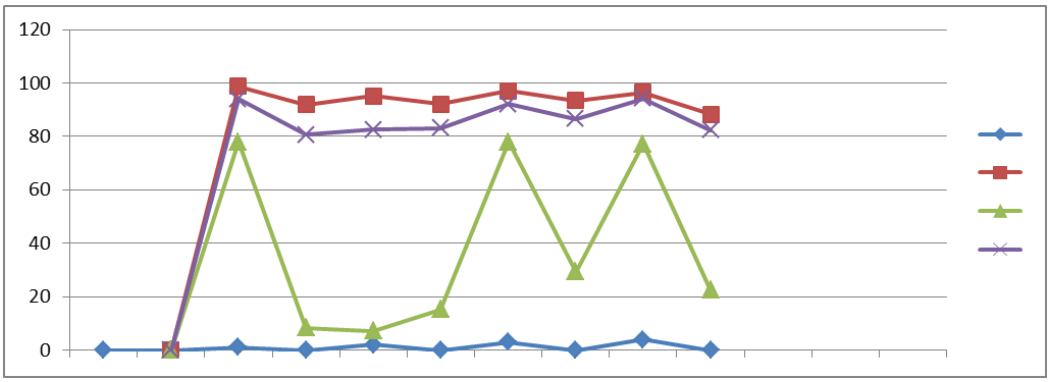

Figure 12. Dataset Comparison Test

Convolutional Neural Networks is about using Deep Learning with Computer Vision. It is a good way to intuition to know about a Neural Network Architecture and how to visual tasks e.g. video and image.

Convolutional Neural Network have allowed us to create Object Recognition, Facial Recognition, self driving cars and more. The new binarization technique has been presented is more efficient technique than threshold value binarization as shown in the figure 12.. Several medical image capture modalities are used to detect lung cancer tumor as shown in the table 2[49-50].

True positive(TP): These are positive tuples that are correctly labeled by the classifier. Let TP be the number of true positives.

True Nagative(TN) :These are negative tuples that are correctly labeled by the classifier. Let TN be the number of true negatives.

False possitve(FP): These values are negative tuples that were incorrectly labeled by as position. Let FP be the number of false positives.

False Negative (FN): These are positive tuples which are mislabeled as negative. Let FN be the number of false negatives.

True positive rate=TP(TP+FN)

True negative rate=TN(TN+FP)

Accuracy=(TP+TN)/(TP+FN+TN+FP)

Positive predicate value=TP/(TP+FP)

Negative predicate value=TP/(TN+FN)

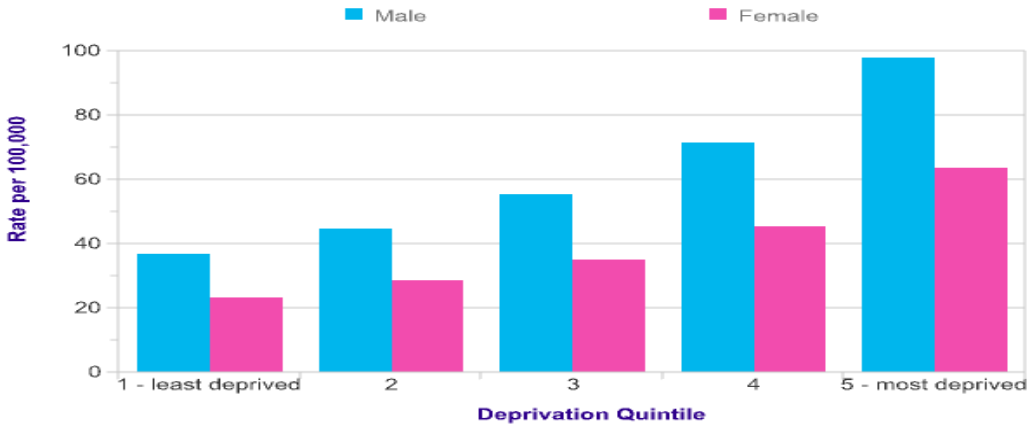

Figure.13 lung cancer graph

The above figure 13. Shows that the lung cancer graph of male and female.

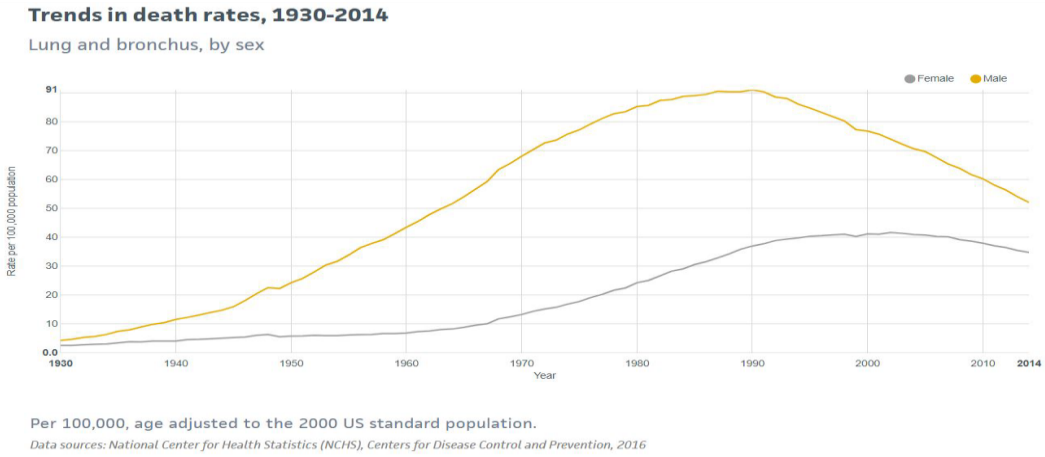

Figure 14 Death Rate Trend of Lung Cancer in the US

Convolutional Neural Networks is abo.ut using Deep Learning with Computer Vision. It is a good way to intuition to know about a Neural Network Architecture and how to visual tasks e.g. video and image as shown in the figure 14.

7. Conclusion

In this work, an efficient algorithm is developed for classify the cancer images. The early detection of lung cancer will increases the life span of the patient's. An image improvement technique is developing for earlier disease detection and stage of the cancer. The experimental results shown that the segmentation techniques used in this system. Various image segmentation methods are described and compared; all the methods are useful for many medical imaging applications. These techniques can be useful for object recognition and detection. The proposed method is efficient and capable of segmentation principles to be a region of interest foundation for feature extraction obtaining. Moreover, efficient feature selection is still a problem in medical Images and it can be addressed in future, in an effective manner to achieve better results The main detected feature for accurate images comparison is pixels percentage and mask labeling with more accuracy.

8. Ackowledgement

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References

[1] M. Premchander, Dr.T. V. Rajinikanth, and Dr. M . Venkateshwara Rao , "Robust and Automated Lung Cancer Detection Using Image Processing Techniques", International Journal of Advanced Research in Computer Science(ISSN No:0976-5697) Vol 9,No 5 Sep/Oct 2018.

[2] M. Premchander, Dr.T. V. Rajinikanth, and Dr. M . Venkateshwara Rao , "Detection of Lung Cancer in Medical Images Using Image Processing Techniques "International Journal of Emerging Technology and Advanced Engineering (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 7, Issue 7, July 2017).

[3] M. Premchander, Dr.T. V. Rajinikanth, and Dr. M . Venkateshwara Rao ,"Detection of Lung Cancer Using Digital Image Processing Techniques: A Comparative Study" International Journal of Medical Imaging, 2017; 5(5): 58-62,doi: 10.11648/j.ijmi.20170505.12, ISSN: 2330-8303 (Print); ISSN: 2330-832X (Online).

[4] K. Narsimlu, Dr. T.V Rajinikanth and Dr. Devendra Rao Guntupalli (2014), "A Comparative Study on Image Fusion Algorithms for Avionics Applications," International Journal of Advanced Engineering and Global Technology, volume 2, issue 4, pp. 616-621.

[5] Dr. T. V. Rajinikanth, Tarun Rao, N. Rajasekhar (2012), "An efficient approach for Weather forecasting using Support Vector Machines," International Conference on Intelligent Network and Computing (ICINC-2012), volume 47, issue 39, pp. 208-212.

[6] Dr. T. V. Rajinikanth, Tarun Rao (2014), "Supervised Classification of Remote Sensed Data using Support Vector Machine," International Research Journal Publisher, Global Journals Inc. (USA), volume 14, issue 14, pp. 71-76.

[7] Dr. T. V. Rajinikanth, Y. J. Nagendra Kumar (2014), "Managing Satellite Imagery Using Geo Processing Tools And Sensors - Mosaic Data Sets," Elsevier Publications, 1st International Conference on Rough Sets and Knowledge Technologies (ICRSKT-2014), pp. 52-59.

[8] J Kuruvilla and K.Gunavathi, "Lung cancer classification using neural networks for CT images", Computer Methods and Programs in Biomedicine, vol. 113, no. 1, pp. 202–209, 2014.

[9] Tarawneh MS. Lung cancer detection using image processing techniques. Leonardo Electronic Journal of Practices and Technologies. 2012.

[10] Gindi,A. M., Al Attiatalla, T. A., & Sami, M.M. "A Comparative Study for Comparing Two Feature Extraction Methods and Two Classifiers in Classification of Early stage Lung Cancer Diagnosis of chest x-ray images." Journal of American Science, 2014.

[11] Ajil MV, Sreeram S. Lung cancer detection from CT images using various image processing techniques. International Journal of Advance Research in Computer Science and Management Studies.2015 May; 3(5), 249–254.

[12] Ruchika Kalra A. Detection of lung cancer in CT images using mean shift algorithm. International Journal of Advanced Research in Computer Science and Software Engineering. 2012.

[13] Xiuhua,G., Tao, S., &Zhigang, L, "Prediction Models for Malignant Pulmonary Nodules Based-on Texture Features of CT Image." In Theory and Applications of CT Imaging and Analysis. 2011.

[14] Chaudhary A, Singh SS. Lung cancer detection on CT images by using image processing. International Conference on Computing Science, Phagwara. 2012.

[15] Goswami A. For image enhancement and segmentation by using evaluation of gabor filter parameters. International Journal of Advanced Technology and Engineering Research. 2012.

[16] Tao, S., &Zhigang, L, "Prediction Models for Malignant Pulmonary Nodules Based-on Texture Features of CT Image." In Theory and Applications of CT Imaging and Analysis. 2011.

[17] Roy, T Sirohi, N., &Patle, A. (2015) "Classification of lung image and nodule detection using fuzzy inference system." International Conference On Computing, Communication & Automation., 2015.

[18] Ignatious S, & Joseph, R. (2015) "Computer aided lung cancer detection system." 2015 Global Conference On Communication Technologies (GCCT).

[19] Rendon-Gonzalez, E., &Ponomaryov, V. (2016) "Automatic Lung nodule segmentation and classification in CT images based on SVM." 2016 9Th International Kharkiv Symposium On Physics And Engineering Of Microwaves, Millimeter And Submillimeter Waves (MSMW).

[20] Huang S, Ong SH, Foong KWC, Goh PS, Nowinski WL. Medical image segmentation using watershedsegmentation with texture merging. IEEE Engineering in medicine and biology Society Conference, Canada. 2008.

[21] Patela SVK, Shrivastavab P. Implementation of medical image enhancement technique using gabor filter. International Journal of Current Engineering and Technology. 2012.

[22] Tanaka K, Sakuma T. Geographical difference of chromosome aberrations between Japanese and American small cell lung Cancer cell lines. Indian Journal of Science and Technology. 2012. SPIE-AAPM-NCI Lung Nodule Classification.

[23] Challenge Dataset. The Cancer Imaging Archive; 2015.

[24] Hollings N., Shaw P. Diagnostic imaging of lung cancer. European Respiratory Journal. 2002.

[25] Li W., Nie S. D., Cheng J.Berlin, A fast automatic method of lung segmentation in CT images using mathematical morphology; pp. 2419–2422. (IFMBE Proceedings) Springer; 2007.

[26] Hu S., Hoffman E. A., Reinhardt J. M. Automatic lung segmentation for accurate quantitation of volumetric X-ray CT images. IEEE Transactions on Medical imaging, 2001.

[27] Shah S. Automatic cell images segmentation using a shape-classification model. IEICE Transactions on Information and Systems. 2007.

[28] Prasad M. N., Brown M. S., Ahmad S., et al. Automatic segmentation of lung parenchyma in the presence of diseases based on curvature of ribs. Academic Radiology. 2008.

[29] Wang J.,Q. Automated segmentation of lungs with severe interstitial lung disease in CT. Medical Physics. 2009.

[30] Sudha V, Jayashree P. Lung Nodule Detection in CT Images Using Thresholding and Morphological Operations. International Journal of Emerging Science and Engineering. 2012.

[31] Guo Y., Feng Y., Sun J., et al. Automatic lung tumor segmentation on PET/CT images using fuzzy markov random field model. Computational and Mathematical Methods in Medicine. 2014.

[32] Lam M., Disney T., Pham M., Raicu D., Furst J., Susomboon R. Content-based image retrieval for pulmonary computed tomography nodule images. Medical Imaging 2007: PACS and Imaging Informatics; March 2007.

[33] Dhara A. K., Chama C. K., Mukhopadhyay S., Khandelwal N. Content-based image retrieval system for differential diagnosis of lung cancer. Indian Journal of Medical Informatics, 2012.

[34] Liu C.-T., Tai P.-L., Chen A. Y.-J., Peng C.-H., Lee T., Wang J.-S. A content-based CT lung image retrieval system for assisting differential diagnosis images collection. Proceedings of the IEEE International Conference on Multimedia and Expo (ICME 2001), 2001.

[35] Nguyen worring HT, Van de Boomgaard R. Watersnakes: Energy-driven watershed segmentation. Pattern Analysis and Machine Intelligence, 2003.

[36] Patil S. A., Kuchanur M. B. Lung cancer classification using image processing. International Journal of Engineerin and Innovative Technology. 2012.

[37] A. patil and M. B Kuchanur, "Lung cancer classification using image processing", International Journal of Engineering and Innovative Technology, vol. 2, no. 3, 2012.

[38] J. Kuruvilla and K. Gunavathi, "Lung cancer classification using neural networks for CT images", Computer Methods and Programs in Biomedicine, vol. 113, no. 1, pp. 202–209, 2014.

[39] Lung Cancer Staging Essentials, available at http:// pubs.rsna.org/doi/full/10.1148/rg.305095166;

[40] S. Hu, E. A. Hoffman, J. M. Reinhardt, "Automatic lung segmentation for accurate quantitation of volumetric X-ray CT images," IEEE Trans. Med. Imaging 20 (6), 490–498 (2001).

[41] H. Arimura, S. Katsuragawa, K. Suzuki, F. Li, J. Shiraishi, S. Sone, and K. Doi, "Computerized scheme for automated detection of lung nodules in low-dose computed tomography images for lung cancer screening," Acad. Radiol. 11 (6), 617–629 (2004).

[42] T. Jia, D.-Z. Zhao, J.-Z. Yang, and X. Wang, "Automated detection of pulmonary nodules in HRCT images," in Proc. 2007 1st Int. Conf. on Bioinformatics and Biomedical Engineering (ICBBE 2007) (Wuhan, China, 2007), IEEE, pp. 833–836.

[43] L. Y. Tseng and L.-C. Huang, "An adaptive thresholding method for automatic lung segmentation in CT images," in Proc. IEEE AFRICON 2009 (Nairobi, Kenya, 2009), pp. 1–5.

[44] S. P. Tidke and V. A. Chakkarwar, "Classification of lung tumor using SVM," Int. J. Comput. Eng. Res. 2 (5), 1254–1257 (2012).

[45] A. S. Al-Fahoum, E. B. Jaber, and M. A. Al-Jarrah, "Automated detection of lung cancer using statistical and morphological image processing techniques," J. Biomed. Graphics Comput. 4 (2), 33–42 (2014).

[46] D. Sharma and G. Jindal, "Identifying lung cancer using image processing techniques," in Proc. Int. Conf. on Computational Techniques and Artificial Intelligence (ICCTAI'2011)(Pattaya, Thailand, 2011), pp. 115–120.

[47] N. Pandey and S. Nandy, "A novel approach of cancerous cells detection from Lungs CT scan images," Int. J. Adv. Res. Comput. Sci. Software Eng. 2 (8), 316–320 (2012).

[48] S. Shaik Parveen and C. Kavitha, "Detection of lung cancer nodules using automatic region growing method," in Proc. 2013 Fourth Int. Conf. on Computing, Communications and Networking Technologies (ICCCNT) (Tiruchengode, India, 2013), IEEE, pp. 1–6.

[49] K. Kancherla and S. Mukkamala, "Early lung cancer detection using nucleus segmentation based features," in Proc. 2013 IEEE Symposium on Computational Intelligence in Bioinformatics and Computational Biology (CIBCB) (Singapore, 2013), pp. 91–95.

[50] Ada and Rajneet Kaur, "Early detection and prediction of lung cancer survival using Neural Network Classifier," Int. J. Appl. Innovation Eng. Manage. 2 (6), 375–383 (2014)..

AUTHOR'S BIOGRAPHY

M. Premchander has been pursuing Ph.D degree in Computer Science and Engineering from GITAM UNIVERSITY, Visakhapatnam ,A.P, India ,as well as workingas Asst..Professor in CSE Departmentin at MNR College of Engineering and Technology, Hyderabad. As well as obtained M. Tech. in Computer Science and Engineering from Jawaharlal Nehru Technological University(JNTU), Anantapurum, AP,INDIA in 2011. Prior to his professional career, he obtained Bachelor of Technology (B.Tech) in Computer Science and Information Technology from Sri Datta Institute of Engineering and Science, Hyderabad, Affiliated to JNTUH, Hyderabad ,Telangana ,India in 2005. His current research interests inclued Image Processing and Data Warehousing &Mining for Medical Applications. His total teaching experience is 15 years. He guided around 30 projects at B.Tech .and 10projectsatM.Tech.level.He has conducted two national Conferences namely CONVIVALITY2K11,and CONVIVALITY2K12 at MEC, Hyderabad as Convener. He is a Member in IEEE.

Dr. M. Venkateshwara Rao has obtained his Ph.D degree in C.S.E branch. He is working as Associate Professor in the Department of Information Technology, in **Gitam Institute of Technology, GITAM UNIVERSITY, Visakhapatnam,** AP, India. He obtained his M.Sc(Electronics), M.Phil(OptoElectronics), and M.Tech(CST). His teaching and Industrial experience is 28years. Hiswritingshave appeared in numerous Professional conferences and Journals (International journals-5 National conferences-2.

Dr. T. V. RajiniKanth has obtained his **Ph.D. degree** in C.S.E. branch from Osmania University, Hyderabad in July,2008 and M. Tech.(C.S.E.) degree from Osmania University, Hyderabad in January, 2001. His specialization area in research is "Spatial Data mining". He obtained his PGDCS degree from HCU, Hyderabad in 1996. He received his M. Sc. (Applied mathematics) degree in the year 1989 from S.V. University, Tirupati as University Ranker. He is currently working as **professor in CSE, at SNIST, Hyderabad.** He worked as a Professor and Head, Department of IT, GRIET, Hyderabad from 2008 June to Oct 2013. Before that he worked as a Professor in CSE department, GRIET, Hyderabad since 2007 November. Prior to that, he worked as Asso. Prof. in VNRVJIET, Hyderabad where he joined in 1996. His total teaching experience is 23 years. His writings have appeared in numerous Professional conferences and Journals (International journals-29, national Journals-3, International conferences- 23, national conferences-1, Total =56).Under his guide ship 15 Ph.D. Research Scholars got awarded (5- JNTUH &5-ANU 5 from other University). He has received seminar grants from AICTE and DST organizations. Reviewer for many International Conferences like ICACM-2011, ICACM-2013, ICRSKT, ITQM, ICCCT etc., He has also received UGC Project Grant as a Principle Investigator and AICTE project grant as Co-Principle Investigator. He is a Review Committee Member \ Editorial Board member for 18 International Journals namely IJAEGT, IJAC, JDECS, IJEAT, IJAENT, etc., He was an author for few books i.e. Artificial Intelligence etc. His current research area interests include Image processing, Data Warehousing & Mining, Spatial data mining, web mining, Text mining and Robotic area etc. He is presently guiding (supervisor & co supervisor level) many Ph.D. scholars at various universities namely JNTUH, JNTUK, JNTUA and ANU. He was called for around 55 AICTE sponsored \ TEQIP workshops as resource person. He is Life Member in ISTE, CSI and a member in IEEE