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CAD for Lung Cancer Detection: A Review

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Abstract— Lung cancer is the major cause of death in the world. Computer Tomography (CT) is the best imaging modality among various modalities for the detection of small pulmonary nodule. Computer-aided-diagnosis (CAD) system using images processing is used to extract the presence of lung cancer cell in CT image of patients. In order to increase radiologist's diagnosis performance and survival of patient, several CAD techniques have been implemented and developed to improve the detection of this disease. We have studied and reviewed several methods for detection and highlighted the limitation of the methods. Many results were tested over the real time databases of the images in consultation with a senior physician and radiologist. The images were collected of lung cancer CT images from Radio diagnosis department of Pt. J. N. M. Medical College, Raipur, India for research work.

Keywords— CAD, Computed tomography CT), lung cancer, medical image, diagnosis**.**

I. INTRODUCTION

Lung cancer is the most common among other cancer diseases in the world. This is fatal cancer also. Despite the modest improvements in treatments during the last few decades, the prognosis of lung cancer is still poor and the survival rate is 15% in the United States, 10% in Europe and 9% in developing countries. The survival of lung cancer is closely related to the stage at the time of diagnosis, ranging from 70% for limited, stage I disease to less than 5% for stage IV disease [1-3]. Lung cancer does not show symptoms early in the disease process and is diagnosed at a late stage in a clinical setting, when the probability of cure is rare. It is expected that screening can detect lung cancer at an early stage and reduce mortality. A number of clinical trials have been performed to prove this hypothesis. The development of multi-detector spiral computed tomography (CT) has benefitted in the detection of small pulmonary nodules, the interest in lung cancer screening rekindled. The results of several observational CT screening trials showed that CT is effective in the detection of early stage lung cancer, with a percentage of stage I lung cancers ranged from 68% to 96% of all detected. Despite its efficiency on early detection, lung cancer CT screening is still not being recommended by any public health department due to the inherent biases in cohort studies, including lead-time bias, length-time bias and over-diagnosis bias. It is believed that only a randomized controlled lung cancer screening trial can eliminate these biases to the highest degree and answer the question about mortality reduction by comparing lung-cancer mortality in the screening arm (with CT screening) and the control arm (without CT screening) [3-9].

Computer-aided diagnosis (CAD) system is mainly used for detection of lung cancer. Recently, the image processing algorithms are used widely in several clinical examinations to improve early detection and diagnosis of disease. This system generally first segments the area of interest (lung) and then analyzes the separately obtained area for nodule detection in order to diagnosis the disease. Here, image segmentation plays an important role in medical image diagnosis and interpretation [10-17]. The segmentation method is applied in order to detect the cancer nodules from the extracted lung image. After segmentation, rule based technique or some appropriate method is applied to classify the cancer nodules [17-28].

To improve accuracy of CAD based systems for lung cancer detection and localization, the present work attempts to develop a CAD system that involves robust segmentation methods applied over medical images of lung cancer and statistical parameters will be used for detection, classification and localization of abnormalities in medical images [25-30].

II. RELATED RESEARCH

Lingayat et al. (2013) proposed CAD system for feature extraction of lung nodule from the X-ray image. The system deals with the problem of developing a computer based system for the extraction of maximum features from the segmented suspicious area from the lung X-ray image and these properties can be used to classify lung tumor as benign or malignant from the X-ray image directly. The features help the CAD system to take correct decision in CAD system hard copy converted into soft and store for analysis and processing, then system classify the task. The benign tumor, area and perimeter value are large as compared to malignant tumor. But the irregularity index for benign is more. Irregularity index gives an idea about, how much the boundary of the nodule is irregular. Malignant tumor is more irregular that why irregularity index is near to zero. Solidity value for malignant is less because of its irregular surface. For benign tumor, mean, variance and standard deviation values are lower as compared to malignant tumor. Entropy value is higher for malignant tumor. Equivalent diameter show higher value in malignant tumor. In GLCM (grey level co occurrence matrix) properties, the average of contrast, correlation, energy and homogeneity values are calculated in different directions [2]. Sharma et al. (2011) implemented detection of lung cancer form the analysis of computed tomography images. The basic image processing techniques were applied such as Erosion, Median Filter, Dilation, Outlining, and Lung Border Extraction to the CT scan image in order to detect the lung region. The segmentation was used to detect the cancer nodules from the extracted lung image. After segmentation, rule based technique is applied to classify the cancer nodules. Finally, a set of diagnosis rules are generated from the extracted features. CAD was developed for finding the early lung cancer nodules using the lung CT images and classifies the nodules as Benign or Malignant. After the extraction step, the extracted lung regions are segmented using region growing segmentation algorithm. The accuracy of 80% was obtained approximately [3].

Archana et al. (2013) proposed Hidden Markov Model for early detection of lung cancer by analyzing chest computed tomography (CT) images. Most traditional medical diagnosis systems are founded on huge quantity of training data and takes long processing time. This method attempts to increase the diagnosis confidence and also reduce the time utility [4]. Aggarwal et al. (2013) demonstrated that the Computer aided detection system based on segmentation techniques applied on CT images gives better results. The results of a Pulmonary Nodule Detection System were obtained based on segmentation of CT images to of lungs further detect the location of the nodule and also discussed the steps involved in designing the proposed pulmonary Nodule detection system and the results obtained after applying these steps have also been discussed. This technique has its own different approaches available to be used by developers [5]. Ada et al. (2013) presented a hybrid technique based on feature extraction and Principal Component Analysis (PCA) for lung detection in CT scan images. The features which are extracted using principal component analysis and Histogram Equalization are used for preprocessing of the images. Low pre-processing technique is adopted based on histogram equalization. The system produces promising results for lung cancer detection [6]**.** Schaffer et al. (2012) presented an approach to first create a benchmark for recurrence prediction based only upon gender, age and TNM (Tumor, Node, Metastasis) features that uses several learning classifier induction methods and combines them into an ensemble using a recent extension of the general regression neural network. Future work aimed on discovering if gene signatures can be discovered that can improve this performance [7].

Magalhaes et al. (2012) suggested a methodology for automatic detection of lung nodules which consists of the acquisition of computerized tomography images of the lung. The structures are classified as either nodule or non-nodule, through shape and texture measurements together with support vector machine. The methodology ensures that nodules of reasonable size be found with 86% sensitivity and 91% specificity. This results in a mean accuracy of 91% for 10 experiments of training and testing in a sample of 48 nodules occurring in 29 exams [8]. Aggarwal et al. (2013) contributed towards development of lung nodule database with proven pathology using content based image retrieval (CBIR) and algorithms for detection and classification of nodules. A study and analysis of 246 patients was carried out for the detection of benign, malignant as well as metastasis nodules. The research work has been carried out using Lung Image Database Consortium (LIDC) database by National Cancer Institute (NCI), USA and achieved an average precision of 92.8% and mean average precision of 82% at recall 0.1 [10]. Parveen et al. (2013) suggested the method to segment the images to identify the focal areas in lung nodules. Threat Points Identification is used with region growing method for segmenting the suspicious region. Experiment is carried out using real time images to investigate our method. The segmented region can be used for further processing such as feature extraction and classification in future. Hence the proposed method is highly desirable in order to assist the radiologist in the detection of lung nodules and to increase the diagnostic accuracy [11].

Krewer et al. (2013) extracted texture and shape features from pulmonary nodules selected from the data set. Several classifiers including Decision Trees, Nearest Neighbor, and Support Vector Machines (SVM) were used for classifying malignant and benign pulmonary nodules. Wavelet features received the highest rank when using feature selection implying a larger contribution in the classification process. Considering the improvement in classification accuracy, the use of texture features appears to be a promising direction in computer-aided diagnosis of pulmonary nodules in LDCT [12]. Vivekanandan et al. (2011) presented an scheme to improve the efficiency of existing CAD systems by proposing a feature extraction model which is carried out in two phases. Experimental results demonstrate the proposed scheme can help radiologist to improve the diagnosis efficiency by calculating the quantity of tumor growth in each stage accurately. Grey Level Co-occurrence Matrix (GLCM) features can also be considered for ROI classifications to be even more accurate [13]. Assefa et al. (2013) worked to develop a CAD system to detect pulmonary lung nodules from Low Dose CT (LDCT) scan images using template matching algorithm integrated with multi-resolution feature analysis technique in order to enhance the false positive detection rate. 134 out of 165 nodules were correctly detected by our scheme. It was observed that lung vessels make up the majority of the false positive candidates, which results in a relatively high false positive rate. Additional multi resolution features are required in order to tackle the problem [17].

Bastawrous et al. (2006) proposed a novel Computer Aided Diagnosis (CAD) scheme for automatic detection of localized Ground Glass Opacity (GGO) nodules in chest Computed Tomography (CT) images. The scheme begins with a preprocessing stage to the cross sectional CT image to extract the lung region and enhance the intensity values of the nodular regions. Then filter the resulting image with Gabor filter followed by thresholding and labeling to assign the suspected regions and match them with some predefined reference Gaussian templates. The proposed scheme had an area under the ROC curve of 0.94, which proves its potential effectiveness in GGO nodule detection [20]. Chaudhary et al. (2012) attempted to solve the problem of time constraint in detecting the present of lung cancer regarding on the several diagnosing method used. In image processing procedures, process such as image pre-processing, segmentation and feature extraction have been discussed in detail. More accurate results could be achieved by using various enhancement and segmentation techniques [21]. Gomathi et al. (2010) presented a CAD system which can automatically detect the lung cancer nodules with reduction in false positive rates and different image processing techniques are applied initially in order to obtain the lung region from the CT scan chest images. The experimentation is conducted for the proposed technique by 1000 CT images collected from the reputed hospital [22]. Tariq et al. (2013) proposed a computerized system for lung nodule detection in CT scan images. The automated system consists of two stages i.e. lung segmentation and enhancement, feature extraction and classification. The segmentation process results in separating lung tissue from rest of the image, and only the lung tissues under examination are considered as candidate regions for detecting malignant nodules in lung portion. A feature vector for possible abnormal regions is calculated and Regions (foreground and background) are classified using neuro fuzzy classifier with fully automatic system that does not require any manual intervention and experimental results show the validity of our system [26].

III. PROBLEM IDENTIFICATION

Extensive literature survey reports the following problems in existing contributions:
a. Low contrast having more noise and accuracy up to 80%.
b. Can detect nodule size >=3 mm and a few features are used only.
c. More features such as area, perimeter and solidity can be added.
d. Average time needed to detect nodule is too high.
e. Difficult to detect area attached to the lung vessels.
f. Relatively high FP (false positive) rate.
g. Temporal comparison could further improve usefulness of CAD system.

IV. PROPOSED APPROACH

The CAD system for lung cancer detection is developed using the methodology as shown in flow diagram in Fig.1.

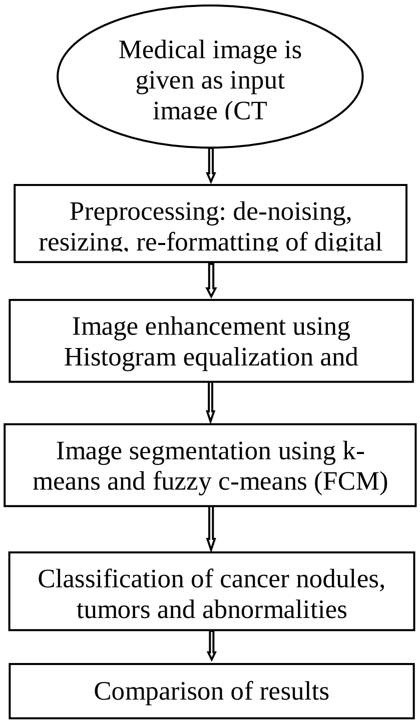

Fig. 1: Flow diagram of proposed CAD system

V. RESULT AND DISCUSSION

We have compared median and wiener filter techniques for lung cancer CT images database to find in terms of PSNR and MSE values. From Table 1 and Table 2, it can be seen that Wiener filter is better than median because the PSNR value is higher and MSE values are lower for all images.

Table 1: Comparison of PSNR (dB) for CT images

Image Database	Median Filter	Wiener Filter
cp1	30.24	37.03
cp2	17.53	33.39
cp4	28.87	34.55
cp9	25.69	31.83

Table 2: Comparison of MSE values for CT images

Image Database	Median Filter	Wiener Filter
cp1	5.36	1.9
cp2	32.33	3.19
cp4	4.34	2.43
cp9	4.01	1.81

VI. CONCLUSION

A reliable CAD system is proposed includes image preprocessing, image segmentation and classification as major components. PSNR (peak signal to noise ratio), MSE (mean square error), specificity, accuracy are used as CAD evaluation parameters. The implementation reports lung cancer detection that would help for early detection of cancer and creating awareness among the masses for early screening of the disease. The results were also validated with the comments of Physicians.

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REFERENCES

[1] Sheng Chen, Kenji Suzuki, "Computerized detection of lung nodules by means of virtual dual-energy radiography", IEEE Trans. on biomedical engineering, Vol. 60, No. 2, pp. 369-378, Feb. 2013.

[2] Nitin S. Lingayat, Manoj R. Tarambale," A Computer Based Feature Extraction of Lung Nodule in Chest X-Ray Image", International Journal of Bioscience, Biochemistry and Bioinformatics, Vol. 3, No. 6, pp. 624-629, Nov. 2013.

[3] Disha Sharma, Gagandeep Jindal, "Identifying Lung Cancer Using Image Processing Techniques", International conference on computational techniques and artificial intelligence (ICCTAI), pp. 115-120, 2011.

[4] Archana S, K.P. Kaliyamurthie and V.Khanaa, "CAD System for Lung Cancer Detection", International Journal Of Engineering And Computer Science", Vol. 2 , pp. 921-925, Apr.2013.

[5] Pareesha Aggarwal, Rishi Kumar, "Detection of ground glass nodules in human Lungs using Lungs CT Scans images", International Journal of Current Engineering and Technology, Vol.3, No.2, pp. 484-487, June 2013.

[6] Ada, Rajneet Kaur, "Feature Extraction and Principal Component Analysis for Lung Cancer Detection in CT scan Images", International Journal of Advanced Research in Computer Science and Software Engineering, Vol. 3, pp. 187-190, Mar.2013.

[7] J. David Schaffer, Jin Woo Park, Erin Barnes, Qiyi Lu, Xingye Qiao, Youping Deng Yan Li , Walker H. Land, "GRNN ensemble classifier for Lung Cancer prognosis using only demographic and TNM features", SciVerse Science Direct, pp. 450-455,2012.

[8] Stelmo Magalhaes BarrosNetto, Aristo´ fanes Correa Silva, Rodolfo Acatauassu Nunes and MarceloGattass, "Automatic segmentation of lung nodules with growing neural gas and support vector machine", Computers in Biology and Medicine, pp. 1110-1121,Sep 2012, journal homepage: www.elsevier.com/locate/cbm.

[9] Ying Wang,"Methods and validation of nodule measurement in a lung cancer screening", Ph.D thesis, University of Groningen, 2010.

[10] Preeti Aggarwal, Renu Vig and H K Sardana, "Semantic and Content-Based Medical Image Retrieval for Lung Cancer Diagnosis with the Inclusion of Expert Knowledge and Proven Pathology", Proceeding of IEEE second international conference on image infoemation processing(ICIIP), pp .346-351,2013.

[11] S.Shaik Parveen and C. Kavitha, "Detection of lung cancer nodules using automatic region growing method", 4th ICCCNT, Tiruchengode, India,Jul 2013.

[12] Henry Krewer, Benjamin Geiger Lawrence O. Hall, Dmitry B. Goldgof, Yuhua Gu, Melvyn Tockman and Robert J. Gillies, "Effect of Texture Features in Computer Aided Diagnosis of Pulmonary Nodules in Low-Dose Computed Tomography", IEEE International Conference on Systems, Man, and Cybernetics, pp. 3887-3891,2013.

[13] Vivekanandan D, Sunil Retmin Raj, "A Feature Extraction Model for Assessing the Growth of Lung Cancer in Computer Aided Diagnosis", IEEE-International Conference on Recent Trends in Information Technology, Anna University, Chennai, pp.953-958, Jun 2011.

[14] Fatma Taher, Rachid Sammouda, "Lung cancer detection by using Artificial neural network and fuzzy clustering methods", IEEE GCC conference and exhibition, Dubai, pp. 295-298, Feb. 2011.

[15]M. Gomathi, P. Thangaraj, "Automated CAD for Lung Nodule Detection using CT Scans", IEEE International Conference on Data Storage and Data Engineering, pp. 150-153, 2010.

[16]Muhammd Nauman Mughal, Waseem Ikram," Early Lung Cancer Detection by Classifying Chest CT Images: A Survey", INMIC , pp. 67-72,2004.

[17]Mickias Assefa, Ibrahima Faye, Aamir Saeed Malik and Muhammad Shoaib," Lung Nodule Detection Using Multi-Resolution Analysis", Proceedings of International Conference on Complex Medical Engineering, pp. 457-461,2013.

[18]S. Ashwin, J. Ramesh, S. Aravind Kumar and K. Gunavathi, "Efficien//t and Reliable Lung Nodule Detection using a Neural Network Based Computer Aided Diagnosis System", IEEE Proceeding International Conference on Emerging Trends in Electrical Engineering and Energy Management (ICETEEEM-2012),pp. 135-142,2012.

[19]Shinji Yamamoto, Hao Jiang, Mitsuomi Matsumoto ,Yukio Tateno, Takeshi Iinuma and Tom Matsumoto, "Image Processing for Computer-Aided Diagnosis of Lung Cancer by CT(LSCT)",7 pp 236-241,1996.

[20]Hany Ayad Bastawrous, Norihisa Nitta, Masaru Tsudagawa, "A New CAD System for Detecting Localized Ground Glass Opacity Nodules in Lung CT images Using Cross and Coronary Section Images", MeMeA - International Workshop on Medical Measurement and Applications Benevento, Italy, pp. 54-57, Apr, 2006.

[21] Anita chaudhary, Sonit Sukhraj Singh," Lung cancer detection on CT images using Image processing", International Conference on Computing Sciences, pp.142-146,2012.

[22]M. Gomathi, P. Thangaraj, "A Computer Aided Diagnosis System for Lung Cancer Detection using Support Vector Machine", American Journal of Applied Sciences, Vol. 7, pp. 1532-1538,2010.

[23]Ayman El-Baz, Garth M. Beache, Georgy Gimel'farb, Kenji Suzuki,Kazunori Okada, Ahmed Elnakib, Ahmed Soliman and Behnoush Abdollahi, "Computer-aided Diagnosis systems for Lung Cancer: Challenges and Methodologies Review Article", International Journal of Biomedical Imaging, pp. 1-46 ,2013.

[24]Fatma Taher and Rachid Sammouda," Morphology analysis of Sputm color images for early lung cancer diagnosis", 10th International Conference on Information Science, Signal Processing and their Applications, pp. 296-299, 2010.

[25]Yoshiyuki Abe, Kouzo Hanai, Makiko Nakano, Yasuyuki Ohkubo, Toshinori Hasizume, Toru Kakizaki, Masato Nakamura, Noboru Niki, Kenji Eguchi, Tadahiko Fujino and Noriyuki Moriyama, "A Computer-aided Diagnosis (CAD) System in Lung Cancer Screening with Computed Tomography", Anti cancer Research, Vol. 25, pp. 483-488, 2005.

[26]Anam Tariq , M. Usman Akram and M. Younus Javed, "Lung Nodule Detection in CT Images using Neuro Fuzzy Classifier", 4th International workshop on Computational Intelligence in Medical imaging, pp. 49-53,2013.

[27]Keizo Kanazawa, Mitsuru Kubo, Noboru Niki,Hitoshi Satoh, Hironobu Ohmatsu, Kenji Eguchi and Noriyuki Moriyama, "Computer Aided Diagnosis System for Lung Cancer Based on Helical CT Images", Proceeding of ICPR, 1996.

[28]Shingo Kakeda, Junji Moriya ,iromi Sato,Takatoshi Aoki,Hideyuki Watanabe,Hajime Nakata,Nobuhiro Oda,Shigehiko Katsuragawa,Keiji Yamamoto and Kunio Doi," Improved Detection of Lung nodules on Chest Radiographs Using a Commercial Computer- Aided Diagnosis System, AJR, pp. 505-510, 2004.

[29]G. R. Sinha and B.C. Patel,"Medical Image Processing: concepts and applications", Prentice Hall of India, 2014.

[30]Fan Li-nan and SUN Shen-shen, "Applied research on the automatic detection of lung nodules ROI based on Top-hatand Gabor filter", Third International Symposium on Information Processing", IEEE computer society, pp. 533-536, 2010.

[31]Bhagwati chran patel and G. R. sinha, "Comparative performance evolution of segmentation methods in breast cancer images" International Journal of Machine Intelligence,Vol. 3 (3),pp. 130-133,2011.

[32]Bhagwati charan patel and G. R. sinha " An adaptive K-means clusturing algorithm for breast image segmentation",International journal of computer application,Vol 10,pp. 35-38,Nov, 2010.

[33]Bhagwati charan patel, G. R. sinha " Energy and region based detection and segmentation of breast cancer mammographic image", International Journal of Image, Graphics and Signal Processing (IJIGSP), Vol 4,pp. 45-51,Jul 2012.