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Computer Aided Detection of Nodule from Computed Tomography Images of Lung

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Abstract

Lung diseases must be identified and treated in its early stages, otherwise it will lead to a serious irreversible condition. Interstitial Lung Diseases, presence of lung nodules etc. are most common but very difficult in identifying in its preliminary stages. Identification of the diseases at an earlier stage helps a lot in fast recovery of the patient. Early stage detection can be achieved by combining various detection methods to find the presence of abnormality. Advantage is that anyone in the many existing imaging systems, identifies the occurrence of the abnormality in its earlier stage. So by using different imaging schemes it is possible to identify the disease. This can be tested with available data bases and existing results. The accuracy of the same can be evaluated to a certain extent. Here the paper tries to compare existing systems that are popular for the same and introduce a combinational system that may lead to an exponential growth in the applications of medical imaging techniques. The early detection and diagnosis of lung nodules can be done with the help of medical imaging systems.

Keywords: Computer aided diagnosis, nodule detection, feature extraction, lung nodule

1. Introduction

Lung diseases are very common and are very difficult to identify in its primary stages. The symptoms and the identification of the same take time. So the treatment gets delayed usually and at the time when the patient gets treated it gets late. This can be identified with the help of medical imaging techniques that are available in common. It is very difficult to identify the nodules in its primary stages, but with the help of computer aided systems it becomes very efficient. Here the paper deals with various imaging techniques available for the identification of lung nodules.

2. Detection using computer

Computer aided systems are available to verify the presence of lung nodules that are smaller in size. It is very difficult to identify the presence of small nodules from the medical image even if the practitioner is very expert. A CAD system, trained to identify the nodules is very efficient because it can segment the image into different segments. It can identify with the help of the artificial intelligence provided by the training. The features are selected and compared to identify the presence of the nodule.

3. Data acquisition

Medical images are required for training the system. The provided images are segmented and are used for training the network. The network trained for detecting the nodules are provided with the test images. The test images include real images with and without a nodule. The efficiency

of the nodule identification with the test images are measured. [Database under study: 1. LICD, 2. ELCAP, 3. LIDC, 4. LUNA 16]

4. Nodule segmentation

The image obtained may have unwanted regions, which are the regions other than lung. So the possibility of false identification is high. Hence with the help of lung segmentation it is possible to separate the area of interest, ie the lung. So the whole concentration will be under the area of investigation, by this the presence of false positive conditions can be reduced.

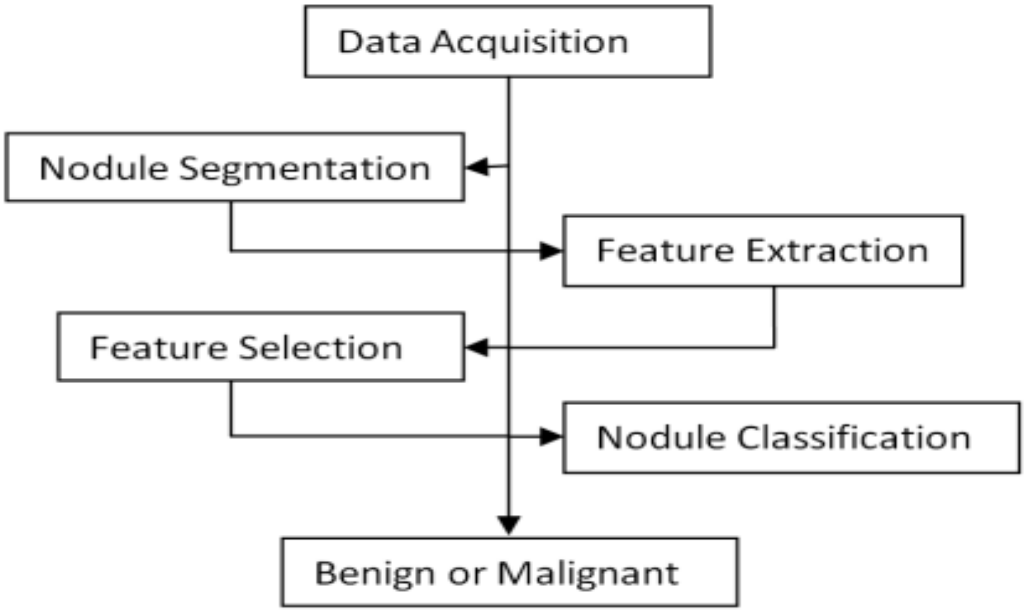

Fig.1: CAD system basic process steps

5. Feature extraction and selection

Feature selection plays an important role in the process of lung nodule detection. The main parameter will be the size. The size tells about the character of the nodule. Shape is another parameter. Shape helps to identify the presence of a nodule. It has an important role in the identification. Other parameters like texture and intensity also play an important role in the identification process. Various images are available such as 2D, 3D and so on. Best images with good features are selected and are used for training the system. False images will mislead the system, hence the images must be from an authentic source and the features are to be clearly verified. Then only it's possible to obtain a highly efficient and error free system.

6. Nodule classification

Classification is done based on the characteristics obtained by analysing various segments. The segments are obtained from the process of effective segmentation. The process of training is done only after the classification of available images. Various classifiers are available for the classification process. It separates the images with nodules, without nodules and invalid images etc. based on the existence of the segments. The size of the nodule matters here, where in many studies the nodules with greater sizes are not considered as they cannot be considered as lung nodules which are small in nature.Liu et al.[1-4] and Nishio et al. [3] comment on the same. Traditional methods can be employed for the process of classification. These methods are used in common and they do their job neatly. But the efficiency can be improved with the help of deep learning methods and by combining multiple methods for the same. Deep learning methods and combinational schemes provide better results. In deep learning the factor under consideration is time. It requires a lot of images for the training and the process is very much time consuming one. Hence each method possesses its own advantages and disadvantages. So its very difficult to say which one is the best in the current scenario. The two methods and existing works are tabulated here. [5-10].

Table 1

Author	Year	Traditional methodology employed
Chen et al. [4]	2018	Support Vector Machine (SVM)
Farag et al. [5]	2017	
Dhara et al. [6]	2016	
Akram et al. [7]	2016	
Costa et al. [8]	2018	GA and SVM
Gong et al. [9]	2018	SVM, naïve Bayes classifier and linear discriminant analysis
Kaya et al. [10]	2018	Cascaded classifiers and stacking methods
Naqi et al.[11]	2018	Geometric texture features descriptor (GTFD) and SVM
Filho et al. [12]	2017	GA and SVM
Sweetlin et al.	2017	Ant colony optimization

Table 2

Author	Year	Deep learning methodology employed
Filho et al. [17]	2018	Convolutional Neural Network (CNN)
Wang et al. [18]	2018	
Nishio et al. [3]	2018	
Tu et al. [19]	2017	
Liu et al. [20]	2018	Dense convolutional binary-tree network (DenseBTNet)
Wang et al. [18]	2018	Semi-supervised extreme learning machine (SS-ELM)
Zhang et al. [21]	2018	Spatial pyramid dilated network
Zhu et al. [22]	2018	Dual path networks (DPN) and gradient boosting machines (GBM)
Zhao et al. [1]	2018	Hybrid CNN based on LeNet and AlexNet
Jung et al. [23]	2018	CNN and ensemble models
Shen et al. [21]	2017	Multi-crop convolutional neural networks (MC-CNN)
Silva et al. [24]	2017	CNN and GA
Sun et al. [25]	2017	CNN, deep belief networks (DBN) and stacked denoising autoencoder (SDAE)

7. Study on selected works

Taxonomy based classification achieved by Costa et al. [8]. The same can be achieved with the help of CNN by Filho et al. [11-18]. Gong et al. [9] used pattern recognition schemes for the process of classification. Automatic system developed by Zhu et al. [19-26] was a good attempt for the same. Kaya et al. [10] used various modified schemes for the same purpose. Liu et al. [1] used dense net for the purpose of classification. Proposed a different approach for the classification of nodules by Wang et al. [18],Filho et al. [12]. Multichannel deep learning processes effectively help to identify the nodules. Comparison of three different types of the same is done by Sun et al. [25]. Wang et al. [26 proposed hybrid learning models that are very much effective. The same can be accomplished by framework settings and explained by Zhao et al. [1] Malignancy can be identified and 5 types of the same are classified by using LIDC-IDRI dataset Firmino et al. [14]. Shape, Margin and features are selected as features and are successfully extracted by Dhara et al. [6].

8. Discussion and Future work

The database must be collected from an authentic source. Many of the investigations lack efficiency

due to the issues related with the database. Traditional methods and deep learning methods provide their own efficiency, but combinatorial methods can provide higher degree of accuracy. Hence future works have to be concentrated on developing system that use multi modality and that provide highly efficient outputs.

Conclusions

The paper tries to compare the different methodologies used in the process of identification of lung nodules from lung images. Lung images are 3D or 2D in nature and are compared with various methods to identify the nodules present in them. Combining different methods helps to detect more effectively than conventional methods. Hence various combinations of detection schemes are to be done in parallel to obtain an efficient detection system.

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