Automatic Diagnosis Systems Using Image Processing- A systematic Study

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Abstract: **- There are different techniques for the diagnosis of diseases in Computed tomography (CT) images and microscopic Images etc. This paper provides a brief review of computerized aided automated diagnosis techniques which use Digital Image Processing, their benefits and the types of diseases diagnosed by these systems. However CAD system is having many problems, so new methods need to be introduced by combining the benefits of other classification techniques with CAD. In this paper, interest is on the discussion of the problem occurring at the time of computerized automated diagnosis, new approaches that can be introduced combining with the CAD to enhance its benefits and how actually it works i.e. different stages involved in computerized aided diagnoses are also summarized.**

***Keywords*— Computer Aided Diagnosis (CAD) System, Image Segmentation, Feature Extraction, Image processing techniques**

I. INTRODUCTION

Nowadays, CAD is one of the major research subjects in medical imaging which need to be explored further. Basically, Computer-aided diagnoses are processes which give a lot of information that help doctors in the understanding of medical images so that the accuracy and consistency of medical diagnosis could be ameliorated, and also the time taken in reading an image by traditional methods could be decreased [1][2].The Computer Aided Diagnosis (CAD) algorithms are very essential for early detection of many diseases and also help radiotherapists in their medical decision-making operations. The CAD algorithm is provided with functions that automatically analyses data acquired and provides patient and tissue diagnosis automatically to identify the suspected regions from images.

This algorithm consists of mainly two stages i.e An analysis stage and a diagnosis stage.

- In the analysis stage, diseased regions are extracted and examine the features of these regions with the help of image processing methods. In this a computer searches for features of disease.
- In the diagnosis stage, diagnosis rules are determined according the extracted features, and the diseased portion are identified according to defined diagnosis rules. In this a computer evaluates identified features to differentiate between malignant and benign diseased part.

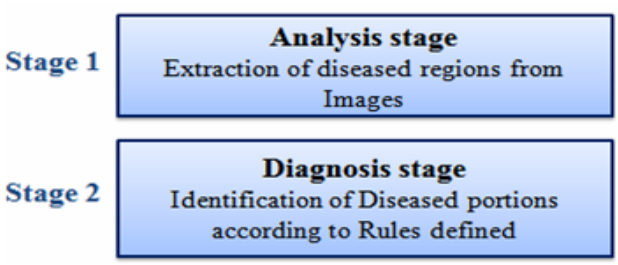

Fig. 1 Basic Stages in CAD

II. TYPES OF DISEASES DIAGNOSED IN CAD AND IMAGE PROCESSING

There are many types of diseases detected using Computerized aided diagnosis. Some are summarized below:-

- CAD applied to Brain Images: We can employ CAD for the detection of weakening of Brain Arteries [3][4]. It can successfully applied to classify localized necrosis resulting from obstruction of the blood supply which Improves sensitivity and reduces false Positive rate per Image[5][6].
- CAD applied to Retinal Images: Retinal fundus images can be analysed easily using CAD Systems and help in reducing the workload of oculists. It helps in the detection of Glaucoma [7].
- CAD applied to Lung Images: CAD algorithms are useful in detection lung cancer and pulmonary nodules which helps in differential diagnosis of lung diseases using computed tomography (CT) and microscopic images of chest [8-10]. To evaluation of complex imaging features in the chest and for improved performance and decision-making CAD is used [11].
- CAD applied to Breast Images: A CAD technique is used to detect Breast Cancer and thus reduces the False Positives [12]. It used for systems designed to help the doctors in the detection of visible findings and the early detection of breast cancer [13].
- CAD applied to Kidney Images: CAD helps in detection of kidney diseases and also in early detection of kidney stones which is based on

segmentation and categorization of kidney images with stone sizes [14].

- CAD applied to Heart Images: CAD is available for the automatic detection of significant coronary artery disease in patients [15]. Also CAD can be used to detect irregular heart sounds, caused by blood flowing through a unhealthy heart.

III. Generic Methodology Used in CAD

Radiotherapists develop symptomatic skill by looking at numerous images in their career and use that experience and cognition to analyse new medical images. Investigators use similar images as a symptomatic aid in the study of the disease. However, if the images are not alike to the unknown morbid tissue image then it would not be helpful for the radiotherapist in the medical diagnosis of the new Image. So, investigators [16-18] develop computerized automated schemes which automatically select similar images from a database on the basis of a some defined similarity factors to learn the relationship between subjective and objective characteristics of morbid tissues. So we use CAD System for automated diagnosis of medical Images. This section explains the main phases of CAD.

There are main Five phases included in the proposed computer aided diagnosis system for disease detection which are as follows:

- Extraction of abnormal region from computer tomography images, ultrasonic Images, magnetic Rasonance Images etc.
- Segmentation of diseased region using segmentation algorithms
- Feature extraction from the segmented region
- Formation of diagnosis rules from the extracted features.
- Classification of occurrence and non occurrence of disease in the body.

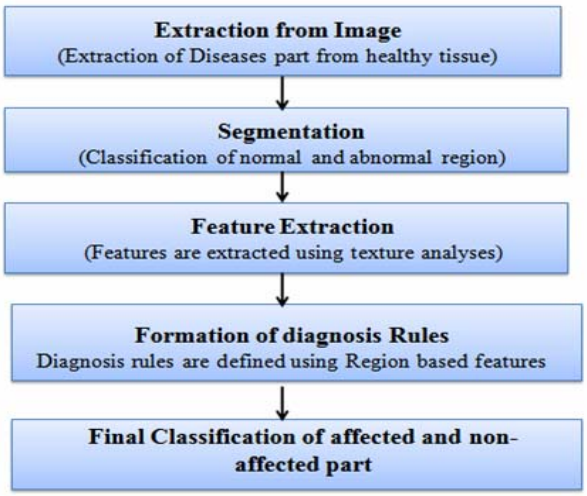

Fig. 2 Methodology of CAD

In CAD the experimentations are carried on the proposed computer-aided diagnosis schemes with the aid of real time tissue images. A good illustration is shown in M.GOMATHI, Dr.P.THANGARAJ paper [8]. The experimentation data consists of about 500 to 1000 tissue images and then images are passed to the proposed CAD algorithm. At last diagnosis patterns are then generated from those images by Feature Extraction and Regional Properties and these rules are passed to the classifiers for the learning process. After learning, a image is passed to the proposed CAD system. Then the proposed system will process through its processing steps and finally it will detect whether the supplied tissue image is with disease or of healthy person.

The steps are detailed below:-

Extraction: - It is the initial stage of the CAD [19][20] System. Various Image processing Techniques are applied for extraction of required portions from the CT Image leaving the non-required portions. So, ROI is extracted from the CT Scan Image.

Segmentation:- Segmentation is carried out to distinguish between normal and abnormal Areas in the tissues and so diseased and healthy tissues are separated based on regional descriptors.

Feature Extraction:- After the segmentation is performed on the CT Scan Image, the features can be obtained from it and the diagnosis rules can be designed to exactly detect the candidate region. This diagnosis rules can eliminate the fear of false detection of abnormal part and provides better diagnosis.

Formation of diagnosis Rules:- Diagnosis Rules are defined based on Regional properties and helps in detecting all abnormal regions more accurately and also helps in neglecting all the false positive diseased parts. Learning machine are passed with these rules and thus abnormal areas are easily detected from the Image.

Classification of affected and Non-affected Part:- After following all above steps the diseased and healthy potions can easily be separated.

IV. Benefits of CAD

Improving the quality of diagnosis

Suspected regions can easily be find out from medical Images thus improving the quality of diagnosis. It helps in detection of anatomical structures of concern, the categorization of lesions, the quantification of disease, risk assessment, and physiological evaluation of disease. It reduces time complexity and increase the diagnosis confidence of doctors. It also avoid that regions that are being overlooked by the diagnostician.

Increasing therapy success by early detection of Disease

One of the main reason for using CAD is that it helps in earlier diagnosis of disease; it is hoped that this would increase the survival rates.

Avoiding unnecessary biopsies
CAD avoid the risks associated with invasive procedures such as needle biopsies. Doctors can take advantage of information provided by images which are acquired from various medical imaging systems such as surface texture, object boundary extraction, neoplasm detection etc. to help them to improve their diagnosis. So unnecessary needle biopsies are avoided [21]

Reducing radiotherapist interpretation time
It also helps in reducing time involved in medical examination. So they can utilize their precious time in other works. This system improves the radiotherapist's productivity and reduce unnecessary reading fatigue [22,23].

Eliminates the need of repeated visits of patient to a doctor
A complete CAD system used to read formulations ,thus eliminates repeated visits for the patient to the doctor.CAD help doctors in better assessment of clinical parameters which reduces the chances of Error.

Improves the Accuracy of Diagnosis
Improved accuracy is also a strong reason for the usage of CAD Systems. ROSENBLATT [24] and GARLAND [25] has recently published papers in which accuracy of cancer diagnosis and accuracy of both diagnosis and diagnostic procedures respectively is explained. So, using CAD diagnosis accuracy can improved to a high level.

Improvement in the Reliability of Diagnosis
Human judgement is not so reliable. So it is one of the advantages of computers that they always use the same set of rules to a problem under all external conditions. Once they are programmed to use the standard procedures they always use it where human ability proves to be wrong.

V. Issues in CAD System

CAD is beneficial in many areas for the diagnosis of disease but its accuracy is questionable in some cases when diseases and patients change. Dataset is not limited to similar characteristics. Data can include different color Images and video, reflectance and florescence multi-spectral and hyper-spectral Imagery, tomography images. An Good Example is given in [26] that if a single helical CT is used in sorting of diseased and healthy portions, the diagnostic efficiency devolves because doctors have to read numerous images to get better results. So CAD is very beneficial in such cases.

But there are Several problems which has to be resolved to produce a successful Computer Aided Diagnosis system. Some problems are mentioned below:-

- Segmentation is the first problem to be considered which helps in generation of candidate region for observing affected area.
- The second problem is identification of affected region from all the candidate nodules.
- Sometimes the sensibility and specificity rates are often disappointingly less, and unsuccessful to accomplish the level of objective acceptance and utility [21].
- Also sometimes detection rate is not sufficient.
- The false positive rate is sometimes so eminent that it irritates and exhausts radiotherapists to the point of contradicting any potential increase in sensibility.

For instance, In [27] a study is carried out on 10 mm slice thickness CT data and reported only 38% sensitivity with 6 false positives per patient which is v high.
An another study is shown in [28] reports 72% sensitivity with 31 false positives per patient. Nodules of Diameters $\geqslant$ 5 mm is restricted in both studies.

VI. Conclusions

Consequently, the CAD systems for severe diseases like Idiopathic pulmonary fibrosis, brain tumours, breast cancers will become more essential for doctors in objective practice in the future.

This review paper outlines CAD algorithms from the basic to several new techniques which need be introduced so that the benefits of both can be combined because basic CAD is still lagging behind in various fields. It is still challenging and its accuracy has been an issue of concern. Therefore, if new techniques and an advanced methods like various classifiers are attached with CAD then it can give more better and accurate results.

Also, a number of researchers are investigating various kinds of novel CAD algorithms for detecting various diseases. CAD investigators attempt to develop very utile CAD systems, which can enhance automated diagnosis abilities to detect candidate region. The new methods introduced should be exemplified with experiments to show that that the new approach is highly efficacious and it outperforms existing system significantly and gives more effective results.

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