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ENHANCEMENT OF CHEST X-RAY IMAGING USING IMAGE PROCESSING

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ABSTRACT - The good X-ray film is self-explanatory to explain the scenario of inside the organ. However, some other parts are also visible with it. The gold standard reading procedures are helpful in reading out the output film and making a plan for diagnosis and disease management. Besides these the experience is also helpful to make a decision to read out and plan accordingly. Advance imaging techniques are helpful for early detection of disease at initial stage. Early detection of disease increases the rate of survival. In the developing countries, advance techniques are beyond the reach of many patients especially in the rural setup. The expenditure of advance techniques is high, thus it puts financial burden on the government as well as the patient. Accurate outputs of primary investigation reduce the financial overburden with increase rate of survival. Primary and secondary protective efforts can reduce cardiovascular morbidity and mortality. However, it is currently unknown how well screening of chest X-ray can predict cardiovascular events.

Keywords - *Chest X-ray, Image processing, cardiovascular abnormality*

I. INTRODUCTION

Pulmonary disease is a considerable public health problem for which early intervention is critical to improve survival. Historically, lung abnormality has been non-invasively diagnosed with sputum tests and chest X-rays. With the development of computed tomography (CT), imaging has gained a depth component that chest X-ray lacks, giving clinicians and researchers a three-dimensional view of human anatomy. However, the chest imaging is still the first line investigation for assessment of lung abnormality. Chest X-ray is a diagnostic test that has been used as a screening test for several diseases such as pulmonary, cardiac abnormality, fracture in bones as well as abnormal tissue growth etc. Coronary Artery Disease (CAD) is fast expanding incidence across the world and mainly in smoker population. Identification of the persons at risk of CAD in the earlier stages reduces mortality rate [1]**.** Posterior-Anterior Chest X-ray images used in the detection of cardiomegaly [16], [17] and evaluation of Cardiothoracic Ratio (CTR) is regarded as an important method of cardiac size assessment [10]. CTR is the ratio of the Cardiac Diameter (CD) to the Thoracic Diameter (TD). It is a helpful way of presentation to notice cardiomegaly. The importance of this study is to estimate the CTR among healthy population, which could be useful to diagnose, monitor and treat medical disorders at early stages [3], [4].

Due to various factors such as raid change in lifestyle, exposure to radiations, stress, sleeping disorders etc, a healthy person becomes ill and comes in patient's category. During sickness immunity power is less so noninvasive procedures are preferred for diagnosis and disease management. Generally it is seen that X-ray is recommended to every next patient suffering from chest discomfort because a chest X-ray provides an outline depiction of the lungs and heart with minimal radiation. Non availability of experienced technician sometimes adversely affects the output film of X-ray in terms of exposure. Due to this overexposure or underexposure, repeat of X-ray is recommended which in turn gives unnecessary radiation to the patients. The proposed study can yield relevant disease information in patients without repeating test procedures.

Despite of its long history and popularity, analysis of X-ray images remain a challenging task due to variation and complexity of image. Several studies have been undertaken to improve X-ray analysis day by day [7], [13], [15].

The objective of this study is to determine whether enhanced imaging techniques can yield relevant disease information in patients without repeating test procedure.

II. REVIEW OF LITERATURE

Chest X-ray imaging is a primary investigation for patients with chest discomfort besides the advance imaging techniques. Accurate diagnosis of primary investigation is important for early detection of any

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pulmonary abnormality and support decision for treatment plan. The present study shows that assessment of chest imaging with image processing is better than conventional methods. Using enhanced chest X-ray image analysis tools, physicians and researchers can enhance their ability to study, diagnose, monitor and treat medical disorders [3].

The cardiothoracic ratio has been considered as a characteristic index of cardiac function. However, its value has been challenged because echocardiography, radionuclide imaging, angiography, computed tomography (CT), and magnetic resonance imaging can provide more accurate knowledge about cardiac function. Nevertheless, clinicians continue to use the CTR because a swift judgment is required under urgent circumstances, especially in the emergency department (ED) or intensive care unit (ICU) [16]. Daily follow-up of chest radiography is still suggested in the ICU. New enlightening facts favoring CTR also has also been reported [6], [10].

Lester Glover et al assessed the accuracy of radiographic parameters of left heart enlargement; quantitative biplane angiographic data was compared to chest X-ray data in 254 adults with various heart diseases. The cardiothoracic ratio furnished with 70% accuracy [8].

To describe the dimensions of heart, CTR is the most widespread and popular method. Increased CTR in CXR is associated with poor prognosis, which is indicatory of noteworthiness and necessity of early diagnosis. According to Monfared CXR may not have the same diagnostic preciseness as echocardiography that is easy accessibility and high specificity in diagnosis of cardiomegaly but is very advantageous and plays a cost-efficient role particularly in screening the enlarged heart size [7], [11], [14].

Bhuvaneswari et al classified the lung diseases by applying effective feature extraction through moment invariants, feature selection through genetic algorithm and the results are classified by the Naive bayes and decision tree classifiers [2].

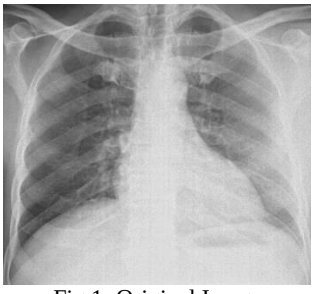
For monitoring and diagnosis of pulmonary abnormality Geraldo proposed a methodology introducing a tool for tracking the lung disease by X-ray screening [5].

Despite the availability of advance techniques early stage emphysema is very difficult to detect in early stages by using conventional radiographic imaging without contrast agents. According to Dong L et al, the changes of micro-structure in lung tissue especially in small airways and alveoli is strongly dependent on USAXS information, which plays an important role in early diagnosis of pulmonary emphysema [9].

Noori el al used three images of one patient after various stages of treatment to calculate the geometrical cancer features and found that conventional chest X-ray alone is not a sufficient for early detection of cancer cells due to complexity of these cells. During capturing of X-ray images noise was added to the image. For removing this irrelevant noise median filter was used and this improved the quality of the image [12].

III. METHODOLOGY

This study was carried out on 50 adult subjects attending hospital and chest X-ray was taken of each of the subject. Cardiothoracic ratio was measured with and without enhanced chest X-ray imaging in posterior anterior view of each subject. It was found that for the analysis of CXR (Chest X-ray) the good visualization is helpful in diagnosing the abnormality in early stage. The manual analysis is dependent on shadow, margins and border lines available in chest X-ray. Posterior chest X-ray images are also used in the detection of cardiomegaly and evaluation of cardiothoracic ratio is regarded as an important method of cardiac size assessment.
CTR is the ratio of the transverse cardiac diameter and the transverse chest diameter, where the transverse cardiac diameter is the horizontal distance between the most rightward and leftward borders of the heart seen on a posterior-anterior (PA) chest radiograph and the transverse chest diameter measured from the inside rib margin at the widest point above the costophrenic angles on a PA chest film. When cardiothoracic ratio becomes greater than 50%, it is considered to be abnormal [4]. Cardiomegaly was appraised on the basis of either an increased cardiothoracic ratio or an increased left heart dimension [6]. The mathematical measurement of CTR is more accurate and less time consuming with enhanced image due to clear visualization of the margins, shadow and borders. That's why image enhancement is necessary before applying the CTR by manual method.


Fig 1: Original Image

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For this purpose, convert the obtained image to gray scale image to reduce the processing time and to produce a faster algorithm.

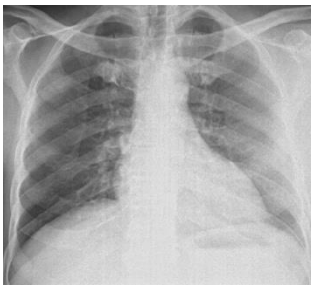


Fig 2: Gray Scale Image

Then, apply spatial domain technique of image enhancement that includes direct manipulation of image pixels. This study deliberates on Histogram Equalization, which adjusts image intensities to enhanced contrast, thus helping the radiologists as well as physicians to visualize more information in less time. It improves the vision in X-ray films. But, maintaining the details of the image is also a difficult task. Median filter helps to do this solves this problem. It not only preserves the edges but also removes the salt and pepper noise from the image, even after the change in the values of pixel intensities.

In median filter, the value of the output pixel is determined by the median of the neighboring pixel values rather than mean. It replaces the center value in the kernel with calculating median of all pixels around the kernel. This filter is therefore better able to remove the outlier as it has advantage of keeping the sharpness of the image.



Fig 3: Enhanced Image after filtering

The mathematical measurement of CTR is more accurate in less timing with enhanced image due to clear visualization of the margins, shadow and borders.

IV. CONCLUSION

Posterior-anterior chest X-ray image view contains a lot of primary information about the disease. The cardiac size and that proportioning the diameter to the thoracic diameter is established as cardiothoracic ratio. That ratio is 0.5 or higher is careful to abnormal. Examining a particular region of interest in an image, set by processing the information in the region provides a diagnosis of the region. That suspected region in chest X-ray require careful examination by doctor and can give alarm for particular cases which need urgent attention. Chest X-ray is an easy and economical screening test for any patient even in the rural setup, it can be considered as a groundwork evaluation to the size of the heart, but the advance imaging techniques remain more accurate. The enhancement of the X-ray image provides good quality visualization of the image that is very helpful in diagnosing the abnormality in early stage. Also, with enhanced images the mathematical measurement of CTR is more accurate and less time consuming as it increases the visualization clarity of the margins, shadow and borders. That's why image enhancement is necessary before applying the CTR by manual method. Image processing techniques not only increase the contrast of the image but also enhance the image by removing the noise from the image which saves the time of radiologist and physicians to visualize more information.

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