INVESTIGATION OF CHEST X-RAY IMAGES BASED ON MEDICAL KNOWLEDGE AND BALANCED HISTOGRAMS

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ABSTRACT

The primary checking for our health at hospital needs to include a chest x-ray as routine diagnosis because it effectively illustrates the lung diseases especially tuberculosis or lung cancer which are asymptomatic earlier. It is a convenient and quick process with a low cost in comparison with other studies. This paper presents an investigation of the radiographs of lung from the chest x-ray using on medical knowledge and balanced histogram. Selected images of lungs are depicted by the use of an active contour (e.g. snake algorithm) to find two regions of lungs (left and right). Then, such two regions of lungs are represented for two histograms which are profiles of two lung patterns. Such two histograms are compared for normal and abnormal lungs using a method of center of gravity (COG) to demonstrate the difference of both lung radiographs. If two histograms are balance, then the result is a normal case. However, if they are not balance, then it is an abnormal case. For the experimental results, the overall accuracy is at approximately 95% which there are 100 samples of patients for testing their lung images. All samples are previously checked from the medical doctors.

1. INTRODUCTION

Chest x-ray is a primary process to diagnose the abnormalities of chest field such as cancer, tuberculosis, emphysema, pneumonia, etc. It is easy to access and available at most of hospitals. The procedure is practical and convenient. The budget for the x-ray machine and apparatus is much cheaper than others such as computed tomographic scanner or magnetic resonance imager. The chest radiogram shows the structure and organs in thorax cavity effectively.

Nowadays, the clinicians will interpret the chest x-ray images. The radiologist will investigate the chest x-ray by placing it on fluorescent view box to see the details of image. The experience of radiologist enhances the chance to see abnormalities. Nevertheless, the contrast and resolution of radiographs cab be varied from one to another because of exposure factors adjustment by radiographers with different experience, or the physiological variation of patients. As a consequence, after processing the radiographs shows unclear details. The radiologist has to change from fluorescent technique to the light with higher intensity for better vision. At this process, the study requires the expertise and timing of clinician to find the abnormalities of thorax. The problem of most clinicians at large hospitals is that there are many patients for each day. Therefore, they have to wait for x-ray interpretation before referring the patients to consult the specialists. This effect will delay the treatment of patients from the clinicians.

There have been many related researches which can be categorized into three groups; to border the lung field, to improve the quality of image, and to analyze the outcome. All of them have utilized the data from chest x-ray and CT scan by different methods. The first group [1] is to find a border of lungs from CT scanogram by analyzing histogram, investigating [2] the highest peak among them and using active contour technique. The second group is the quality improvement of chest x-ray to enhance the details of images [3]. The last group is to a border of lungs from the X-ray images which are collected for the statistical data to analyze the abnormalities of lungs excluding mediastinum [4]. However, the disadvantage is the large amount of database to keep files for comparison. The analyzing and grouping chest x-ray to find abnormalities of lungs by considering vector coefficient [5] are the principle to be developed but not to indicate that the image is abnormal. It is an only method for checking the vector coefficient and improving the details of image.

The image improvement by neural network [6] is to receive input of gray level of chest x-ray and to improve the quality of image using wavelet filtering for viewing the high-low frequency of image, showing clearer bone and vessel structure by this technique. The clinician could have more resolutions of image but could not directly justify whether the image is abnormal. The specialist must finally diagnose the pathology. The disadvantage of primary diagnosis for lung cancer by searching for a small spot on CT image is time spent for the large numbers of CT scanograms spent [7]. From previous researches, there
have been many efforts to find abnormalities from chest radiograph and CT scanogram requiring processes and time. But there is none using the histogram from chest x-ray to determine the patterns of normal and abnormal lungs. No researches have presented how to resolve the problem of delay in treatment by specialist, to be the convenience in patient screening and decrease the workload of x-ray interpretation of the clinicians.

In this paper, an investigation of chest X-ray images is presented through the use of medical knowledge and balanced histograms. The selected images of lungs are depicted by the use of an active contour (e.g. snake algorithm) to find two regions of lungs (left and right). Then, such two regions of lungs are represented for two histograms which are profiles of two lung patterns. Such two histograms are compared for normal and abnormal lungs using a method of center of gravity (COG) to demonstrate the difference of both lung radiographs. If two histograms are balance, then the result is a normal case. However, if they are not balance, then it is an abnormal case.

2. MEDICAL KNOWLEDGE OF LUNGS

2.1. Physical Characteristics

The uppermost border is above clavicle and adjacent to upper rib. The lateral border is close to rib with no space in between. The lowest part is close to diaphragm. Right diaphragm is placed a little bit higher than left diaphragm. The heart is slightly skew to the left but it may be to the right in some cases [8].

2.2. Characteristics of Normal Lungs

Generally, the lung is white color with fine lines homogenously distributing all over. The white color is not flat and not too obvious. The image colors of X-ray lung are 1) dark including grey and 2) no clusters of white or whiter. The white lines set in irregular straight either horizontally or vertically. Therefore, there are same sizes and similar colors for both sides of two lungs. For example, Figures 1 (a) and (b) show chest X-ray images of both side for normal and abnormal lungs, respectively [8]. It can be seen from Fig. 1 (a) that we can exploit these knowledge to apply an investigation of the normal lungs using balanced histograms and image processing.

![Figure 1](a) normal lungs (b) abnormal lungs

3. PROPOSED METHODS

Figure 2 shows the process of proposed methods which start from set the edge by active contour, replacing X, Y value to position lung, converting image from RGB to gray level, transferring lung image into histogram value, and finally verification of lung. There are 5 steps as follows:

![Figure 2](Finding the edge of lungs

Representing X, Y value of image regions of the lungs

Converting RGB image to Gray level

The lung images for processing the histogram

Verification of Lung)

3.1. Finding the edge of lungs

Figure 3 sets the points lining the edge of lungs for locating x, y positions to calculate the lung position. After, the points are set, the deformity is done by active contour [9], [10] to set the border of lung areas. The active contour is performed to set x, y points using snake function. If the points are set in lung area manually, then the program automatically deforms them to set image’s border.

\[ E(x) = \frac{1}{2} \int \left[ \alpha |\dot{X}(s)|^2 + \beta |\ddot{X}(s)|^2 \right] + E_{ext}(x(s)) ds \]  

(1)

The parentheses are level of internal energy and Eext is external energy=entropy. X' (s) and X'' (s) are the energy for controlling the smoothness and flexibility of active contour lone on the parameters A and B respectively.

![Figure 3](The points lining the edge of lungs, and border using active contour.)
3.2. Representing X, Y value of image regions of the lungs

From step A, the x, y values are set to positions of both lungs images. For example, Figures 4 (a) and (b) show image regions of both lungs (left and right) for normal and abnormal cases, respectively.

![Image](image-url)

Figure 4 Image regions of both lungs (left and right) for (a) normal and (b) abnormal cases.

3.3. Converting RGB image to gray level

Normally, X-ray images of lung consist of three main colors i.e. red, green and blue. To find the histogram is the color images converted to gray-scale images. The equation can be defined as [11].

\[
Gray = (0.2989 \times R) + (0.5870 \times G) + (0.1140 \times B)
\]  

where Gray is the results of gray color, R is a red color, G is a green color and B is a blue color.

3.4. The lung images for processing the histogram

Figures 5 and 6 show the histogram values of both lung images for the normal and abnormal cases. This is the part of both lung images which are changed to gray image and transferred into histogram values.

![Image](image-url)

Figure 5 The histogram values of both lung images for the normal case.

![Image](image-url)

Figure 6 The histogram values of both lung images for the abnormal case.

3.5 Verification of Lung

In this section, we use a center of gravity (COG) for verifying lung images from the histogram. For the left-lung image, the equation can be defined as

\[
COGL = \frac{\sum_{i=0}^{255} (QIL_i \times i)}{\sum_{i=0}^{255} QIL_i}
\]  

where COGL is the center of gravity for the left-lung image, QIL is the intensity quantities of left-lung image at i which is the level intensity between 0-255. For the right-lung image, the equation can be defined as

\[
COGR = \frac{\sum_{i=0}^{255} (QIR_i \times i)}{\sum_{i=0}^{255} QIR_i}
\]  

where COGR is the center of gravity for the right-lung image, QIR is the intensity quantities of right-lung image at i which is the level intensity between 0-255. Therefore, the difference of equations (3) and (4) is the different result between the left and right of lung image in terms of absolute value which it can be defined as “Diff_COG”

\[
Diff_{COG} = \left[\left| COGL - COGR \right| \right] \leq Th \Rightarrow \text{Normal} \quad > Th \Rightarrow \text{Abnormal}
\]  

where Th is the threshold value for verifying the normal and abnormal lung of image. It can be seen from equation (5) that if the Diff_COG is lower than or equal the Th, then it will be the normal lung whilst if the Diff_COG is higher than the Th, then it will be the abnormal lung.

4. EXPERIMENTAL RESULTS AND FUTURE WORK

From the experiment to find the histogram of normal and abnormal lungs in 100 patients, there are 50 and 50 images for the cases of normal and abnormal lungs,
respectively. Table 1 shows the testing results for verifying lung images compared between the medical doctors and proposed methods. We uses the threshold value (Th) obtained from equation (5) which Diff_COG is equal to 21. The results show that there are no errors for verifying the case of normal lung because all values of Diff_COG are lower than or equal to 21. In the case of abnormal lung, there are 5 errors because these values of Diff_COG are not higher than 21. Such 5 errors are caused from unclear X-ray images taken from the capturing physicians. Therefore, the overall accuracy is at approximately 95%. We can set the pattern of normal and abnormal lungs only from the histogram that we primarily can indicate from chest x-ray whether there is abnormality.

Table 1 Testing results for verifying lung images compared between the expert and proposed methods.

<table>
<thead>
<tr>
<th>Methods</th>
<th>Normal lungs</th>
<th>Abnormal lungs</th>
<th>Error</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical Doctor</td>
<td>50</td>
<td>50</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Proposed</td>
<td>50</td>
<td>45</td>
<td>5</td>
<td>95</td>
</tr>
</tbody>
</table>

In this study, we not consider similar and opposite profiles of two histograms of the chest X-Ray images in the case of abnormal lungs because these images are not more for practically testing in this case. As a result, if the Diff_COG in equation (5) is a small value for verifying two histograms of lung images which may be similar and opposite profiles in the case of the abnormal lungs; therefore, the resulting answer is the normal lungs but it really will be the abnormal lungs. For future work, we will improve this flaw using a method for verifying the similar and opposite profiles of two histograms of lung images in the case of the abnormal lungs.

5. CONCLUSIONS

The detection of chest X-ray images has been presented through the use of balanced histograms. The selected images of lungs are depicted by the use of an active contour (e.g. snake algorithm) to find two regions of lungs (left and right). Then, such two regions of lungs are represented for two histograms which are profiles of two lung patterns (left and right). Such two histograms are compared for normal and abnormal lungs to demonstrate the difference of both lung radiographs. If two histograms are balance, then it is a normal case. However, if they are not balance, then it is an abnormal case. For the experimental results, the overall accuracy is at approximately 90% which there are 40 samples of patients for testing their lung images. All samples are previously checked from the medical doctors.

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7. REFERENCES