

Design and Implementation of Efficient Information Retrieval Algorithm for Chest X-Ray Images

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Abstract: Separating the rib cages and lungs from other irrelevant structures in a given chest x-ray image is a major problem for the professionals of medical domain involved in chest x-rays. To provide an algorithm and automation solution for separating chest x-ray structures especially rib cages and lungs are the main focus of this thesis. An algorithm has been proposed using object recognition and template matching techniques of image processing domain. The results of the proposed solution have been verified for different chest x-ray images and it works with complete accuracy and efficiency. The proposed algorithm can be enhanced to accommodate the study of structures in chest x-ray image and report any inconsistencies. The Journal of American Science. 2009;5(4):43-48]. (ISSN 1545-1003)

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1. Introduction

Medical related systems have been developed in industry to facilitate humans. In the early days of computer systems, the development of such systems was confined to research laboratories. Since then many systems have been developed in the industry. Many of them have been very successful, which has created a demand for development of such systems. However, many others have been less successful, and have never been taken into operation. An important reason for this is that the art of developing the Medical was not well understood and the other factor is of cost effectiveness.

The chest X-rays in the medical science for investigation and diagnoses of disease is very important. The medical doctors are being misled due to irrelevant structures present in the X-rays. The focus of the thesis is to process chest x-ray images and differentiate its different parts. Main idea is separating the rib cages as they are of utmost importance. Rib cages are differentiated from lungs and any other data that may occur due to noise effectively and efficiently. An algorithm has been proposed which separate the rib cages from other structures in four steps. The final structure produced by the algorithm is more readable and understandable for not only the doctors but also for the common man.

The rest of the paper is organized as follows; related work is discussed in section 2, section 3 describes our proposed methodology, section 4 is about results and discussions, then comes conclusion and at the end future recommendations and references are provided.

2. Related Work

An algorithm for the automatic detection of rib borders in chest radiographs is presented (Zhanjun Yue et al., 1995). According to the algorithm it first determines the thoracic cage boundary to restrict the area of search for the ribs. It then finds approximate rib borders using knowledge-based Hough transform. Finally, the algorithm localizes the rib borders using an active contour mode

Automatic detection of abnormalities in chest radiographs using local texture analysis is also presented (Bram Van Ginneken et al., 2002). This is a fully automatic method to detect abnormalities in frontal chest radiographs which are aggregated into an overall abnormality score. Another algorithm for lung field segmentation in digital postero-anterio chest radiographs has been devised (Paola Campadelli and Elena Casiraghi). This is a lung field segmentation method, working on digital Postero-Anterior chest radiographs. The lung border is detected by

integrating the results obtained by two simple and classical edge detectors, thus exploiting their complementary advantages. The method makes no assumption regarding the chest position, size and orientation; it has been tested on a non-trivial set of real life cases, composed of 412 radiographs belonging to two different databases. An automatic segmentation of lung areas based on SNAKES and extraction of abnormal areas is also discussed (Yoshinori Itai et., al). It is a segmentation method for lung areas based on SNAKES without considering any manual operations. Furthermore, abnormal area including ground-glass opacity or lung cancer is classified by voxel density on the CT slice set. Experiment is performed employing nine thorax CT image sets and satisfactory results are obtained.

3. Proposed Methodology

3.1 Conversion of Image to gray-scale

The first step was to convert the image to gray scale. That's because, for the purposes of our processing, we only need to separate the solid regions of the rib cage from all other regions. For doing that, gray scale image is good enough. So by converting the image to gray scale, the processing time is reduced and a faster algorithm is produced. The proposed algorithm with reference to its implementation in MatLab works as under.

1:- The proposed algorithm will be given an image as input.

```
I = imread (image path);
```

2:- As this image is expected to be present in colored form. So it is necessary to convert it into gray scale for low memory consumption and efficient processing

```
I = rgb2gray(I);
```

3.2 Histogram equalization

The second step performs histogram equalization. This is performed in order to spread the gray scale intensities in the image over the whole possible range of gray scale intensities. This helps the solid regions in the ribs become more prominent than the rest of the image and hence be detected easily. The process is performed in the following steps

1:- Perform histogram equalization

This process differentiate intensities of structures those are present in the image

```
I = histeq(I);
imshow(I);
pixval on;
2:- Getting the size of Image:
[y x]=size(I);
```

3.3 Threshold

Threshold is performed to separate the region spanned by the boundary of the ribs from the outer region. The process is carried out in the following steps.

1:- Getting the size of Image:

```
[y x]= size(I);
```

2:- Finding threshold and extracting boundaries of rib cages

```
for r=1:y
    for c=1:x
        if I(r,c) > 150
            I(r,c) = 0;
        end
    end
end
imshow(I);
pixval on;
```

3.4 Edge Decton:

If the pixel values change abruptly, consider it as a transition from lung to rib and vice versa. Now we have lugs and rig canes structures and they are not interconnected. The edges of images of lungs and rib cages are detected in this step. Then follows the most important step i.e. detecting the edges of the ribs. Since the intensity of the data at the edges changes frequently, use of a simple threshold function sufficed. If intensity of image changed abruptly from a lower gray scale value to a higher gray scale value, the algorithm recognizes it as the start of the rib-cage region and includes all the following pixels as the rib-cage, until the intensity changes abruptly from higher to lower gray scale value, which is recognized as the end of the rib region

```
max= 4;
min=-4;
maxflag=0;
IA=I;
IA=double(IA);
for c=1:x
    for r=1:y-1
        ((IA(r+1,c)-IA(r,c))>max & maxflag ~= 1 )
            I(r,c)=0;
            maxflag=1;
```

```

        continue;
    end
    if ( (IA(r+1,c)-IA(r,c))
    < min & maxflag ~= 0 )
        maxflag=0;
        continue;
    end
    if maxflag==0
        IA(r,c)=0;
    end
end
end
IA=uint8(IA);
imshow(IA);
pixval on;

```

3.5 Local averages

It was recognized that gray scale intensity that represented solid region at one point in image represented a non solid region at some other point in the image. Hence the use of all previous techniques left some errors in the output. Finally, a step was used known as use of local averages. In this step, square blocks of some suitable size are used and moved over the whole image. In each block, average is taken

```

for ro=1:40:y-40
    for co=1:40:x-40
        for ri=ro:ro+39
            for ci=co:co+39
                sum=sum+I(ri,ci);
            end
        end
        average=sum / 1600;
        average =average + ( .6 * average );

        for ri=ro:ro+39
            for ci=co:co+39
                if I(ri,ci) == 0
                    continue;
                end
                if I(ri,ci) < average
                    I(ri,ci)=0;
                else
                    I(ri,ci)=255;
                end
            end
        end
    end
end
sum = 0;
end
end
I=uint8(I);
figure;
imshow(I);
pixval on;

```

<http://www.americanscience.org>

over intensities of all pixels. This average represents the threshold. In this block, all the pixels below this threshold are set to zero, and ones above it are recognized as solid ribcage data.

```

for r=1:y
    for c=1:x
        if ( IA(r,c) > 0 & IB(r,c) > 0)
            I(r,c)=I(r,c);
        else
            I(r,c)=0;
        end
    end
end
figure;
imshow(I);
pixval on;

```

3.6 Finding rib cages:

Move square blocks of empirical size over the image take average gray level in these block the ribs should be ones above the gray level

```

I=double(I);
sum=0;
average=0;

```

3.7 Removing noise pixels:

Check the neighbors of a white pixel if any of them is black, then the current pixel is one of the noise pixels

```

IC=I;

for r=2:y-1
    for c=2:x-1

        if IC(r,c)==255

            if ( IC(r,c+1)==0 | IC(r,c-1)==0 )
                I(r,c)=0;
            end

        end
    end
end
imshow(I);
pixval on;

```

3.8 Making Regions clearer:

Grow regions and delete those who are smaller than 4
counter=0;

```

for r=1:y
  for c=1:x
    if ( I(r,c) == 254 )
      continue;
    end
    if ( I(r,c) > 0)
      [I counter]=mark4(I, r, c, counter);
    end
    if ( counter > 0 && counter < 4)
      counter=0;
      [I counter]=mark_black4(I, r, c, counter);
    end
    counter=0; end
  end
end
figure; imshow(I); pixval on;

```

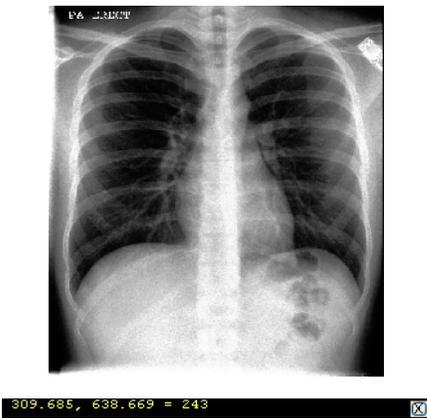


Figure 1: Original Image

This is the image on which I will apply my algorithm to find out rib cages from this image. It can be easily downloaded from Internet or can be obtained by scanning the real chest x-ray image. This image has rib cages, lungs and other structures due to noise. My algorithm will separate lung cages from this image. My ribs become more prominent than the rest of the image and hence are detected easily.

4. Results and Discussions

The above-mentioned procedure produces results that work for 80% images. The benefit of using this procedure is that its very simple and fast to implement and execute. It does not involve any complicated mathematical analysis etc. which are very typical in image processing applications. Hence, this algorithm is better than many others that perform the same job, because of its simplicity and low complexity and fast execution. Our proposed algorithm is explained using figures below.

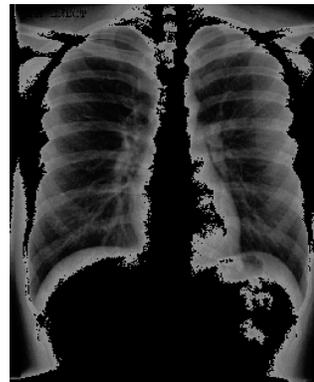
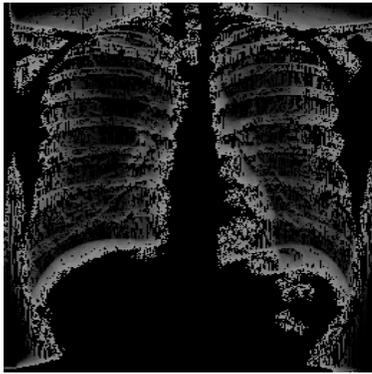


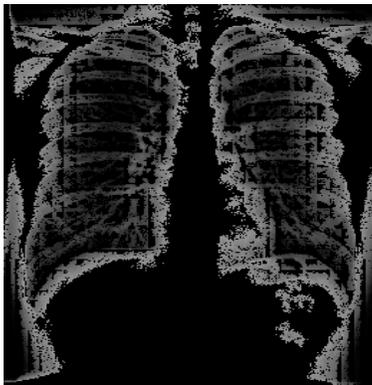
Figure 2: Performing Histogram Equalization

The gray scale intensities in the image are spread over the whole possible range of gray scale intensities. This helps the solid regions in the ribs become more prominent than the rest of the image and hence be detected easily



77.5, 216.946 = 0

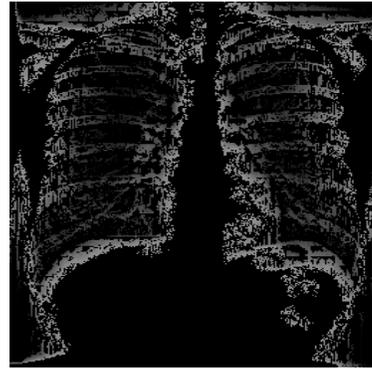
Figure 3: Applying Threshold
Threshold is performed to separate the region spanned by the boundary of the ribs from the outer region.



34.8538, 188.515 = 0

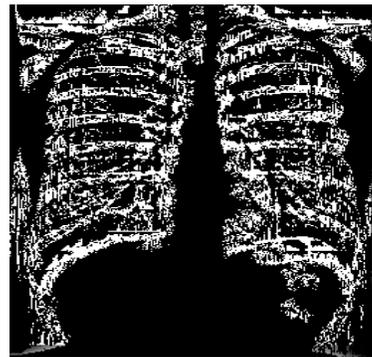
Figure 4: Getting transitions from lung to rib & vice versa

Detecting the edges of the ribs. If intensity of image changed abruptly from a lower gray scale value to a higher gray scale value, the algorithm recognizes it as the start of the rib-cage region and includes all the following pixels as the rib-cage, until the intensity changes abruptly from higher to lower gray scale value, which is recognized as the end of the rib region.



56.1769, 214.577 = 0

Figure 5: Getting the rib cages
Square blocks of some suitable size are used and moved over the whole image. In each block, average is taken over intensities of all pixels. This average represents the threshold. In this block, all the pixels below this threshold are set to zero, and ones above it are recognized as solid ribcage data.



56.1769, 214.577 = 0

Figure 6: Change color of pixels to white
The color of rib cages is set to white to enhance vision. It is clearer now as it can be seen in the figure.

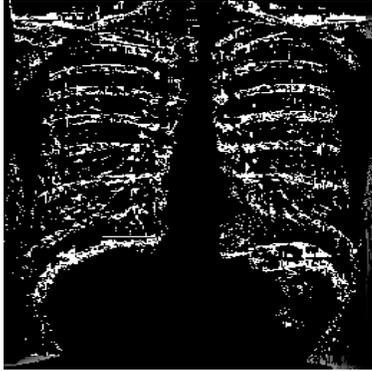


Figure 7: Finally finding the rib cages
The final shape of rib cages is much clearer now as can be seen in the figure. The final image depicts clearly the structure of rib cages and any inconsistencies that may be present in the rib cage structure.

5. Conclusion

Refined information retrieval in Chest x-ray images is the main focus of our research. We have developed a simple and efficient algorithm, which separates rib cages and lungs from other structures in chest, x-rays. The algorithm is based on much simpler concepts of image processing naming grey scale conversion, histogram equalization, finding threshold, edge detection, finding local averages, finding rib cages and finally removing irrelevant data.

6. Future Recommendations

The presented algorithm can be indulged to develop an online expert system for diagnosis of chest x-ray diseases. The system can be used to study structures in chest x-rays and report any inconsistencies. Expert system can study the structures and devise proper diagnosis for diseases and inconsistencies.

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