Detection of Pneumonia Using Image Processing

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Abstract- Pneumonia causes the death of around 700,000 children every year and affects 7% of the global population. Finding ways to automate diagnostics from medical images, has continuously been one of the most interesting areas of software development. We will present an approach for detecting the presence of pneumonia clouds in chest X-rays (CXR) by using only Image processing techniques. For this, we have worked on 52 analog chest CXRs pertaining to Normal and Pneumonia infected patients. Histogram Equalization have been used for getting a clear view of lungs. To detect pneumonia clouds we have used Otsu thresholding which will segregate the healthy part of lung from the pneumonia infected cloudy regions. We are using connected components method to compute the number of labels of healthy lung region and affected lung region to classify them. The task has been performed using Python and OpenCV as they are free, open source tools and can be used by all, without any legality issues or cost implication.

Keywords- Medical image processing, lung extraction, Pneumonia cloud detection, lung segmentation, automated diagnosis, connected components.

I. INTRODUCTION

Pneumonia is the leading cause of death among children in developing countries. WHO estimates that one in three new born infant deaths is due to pneumonia. About half of these deaths can be prevented as they are caused by the bacteria for which an effective vaccine is available.

Chest X-ray (CXR), is an important tool for diagnosing pneumonia and many clinical decisions rely heavily on its radiological findings. Also it is relatively cheap compared to other imaging diagnostics and can be afforded by masses. Some work has been done on automated pneumonia detection through natural language processing and artificial neural network [1]. However, such tools require elaborate hardware and software setup.

When interpreting chest X-rays for Pneumonia, the radiologist will look for white spots in the lungs called infiltrates that identify an infection. However, such cloudy patterns would also be observed in TB Pneumonia and severe cases of bronchitis too. For conclusive diagnosis, further investigations such as complete blood count (CBC), Sputum test, and Chest computed tomography (CT) scan etc. may be needed. Therefore, we are only attempting to detect possibility of pneumonia from Chest X-rays, by looking for cloudy region in the same. Conclusive detection will depend on pathological tests.

X-ray imaging is preferred over CT imaging because CT imaging typically takes considerably more time than X-ray imaging, and sufficient high-quality CT scanners may not be available in many underdeveloped regions. In contrast, X-rays are the most common and widely available diagnostic imaging technique, playing a crucial role in clinical care and epidemiological studies. For the purpose of coding, we have used Python version 3.0 with the OpenCV libraries. We have also get dataset images from kaggle as mentioned in [2]. For this, we have worked on 52 analog chest CXRs pertaining to Normal and Pneumonia infected patients.

II. RELATED WORK

Detection of Pneumonia clouds in Chest X-ray using Image processing approach [3].

III. THE APPROACH

The approach used by us, is shown in Fig. 1. We shall describe each section in detail, explaining the steps and the algorithm.

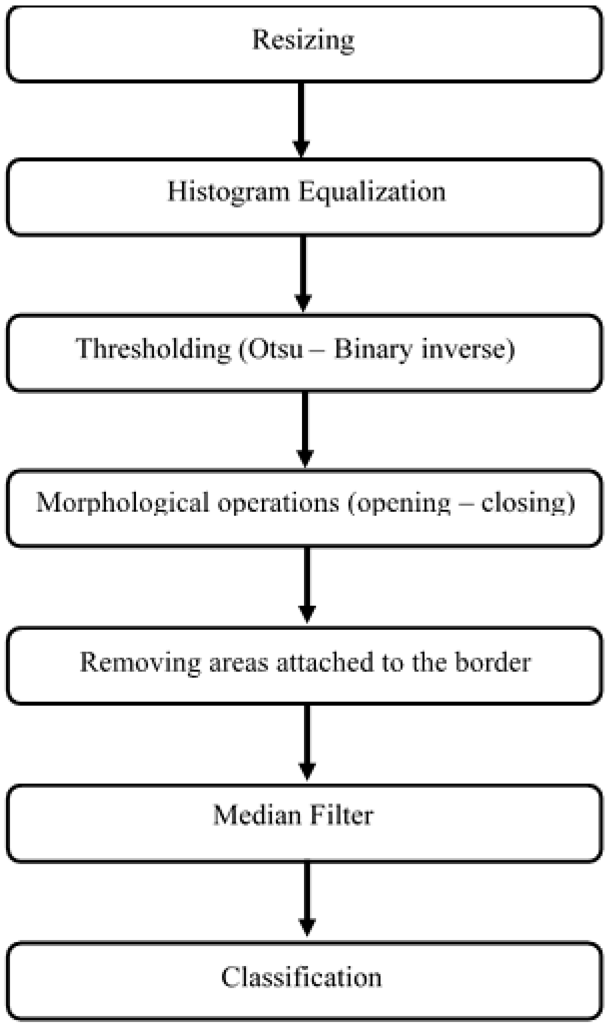

Fig.1. Block diagram for detection of pneumonia clouds

The task has been performed as follows. All images have been resized to optimal size for computational purposes. Then we have performed histogram equalisation on the same to enhance contrast of the images. Thereafter we have used threshold to segregate healthy part of lung region from the pneumonia affected part. Then we have used morphological operations to decrease the noise in the thresholded image such as removing small objects, filling holes, isolating objects and segmenting specific shapes. Then we have removed the areas attached to the borders to get the lungs area only. Then we have used median filter to remove noise in image. Finally, we classified the images by getting the number of labels in every image and used our method to classify them.

A. Resizing

The original images were having different size. We resized it to different values and compared the computational. we have randomly selected the 10 CXR images from our dataset and performed our methodology on the same 10 CXR images by changing their image size. The results are considered good, if they provide sufficient demarcation in the normal CXR images and pneumonia affected CXR images. we have selected an image size of 800x800 for further operations, as the computational time is lowest without compromising on the result quality. We resized all the images to 800x800, using the 'resize' function of OpenCV.

B. Histogram Equalization

Histogram equalization is done to adjust image intensities so as to enhance contrast. The enhanced contrast aids in detection of the clouds. We used the 'equalizeHist' function available in OpenCV.

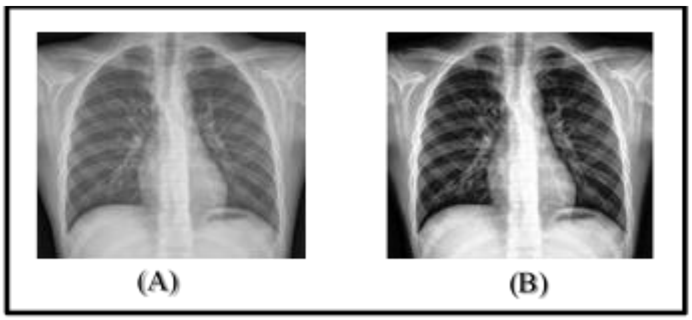

Fig. 2. (A) Image before histogram equalization (B) Image after histogram

C. Thresholding

Thresholding is done to segregate healthy part of lung region from the pneumonia affected part. For this purpose, we have used Otsu thresholding. The image after otsu thresholding gives us the binary image containing the dark region of image as black and remaining as white. But, we need the lungs with white color, so we have used binary inverse thresholding to inverse black and white.

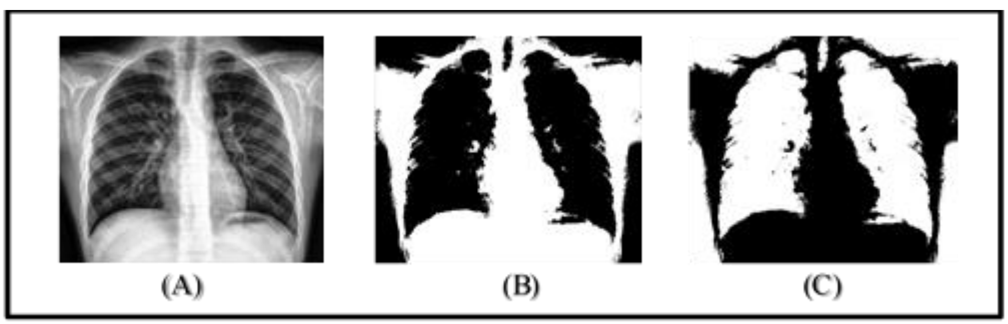

Fig. 3. (A) Image before Otsu thresholding (B) Image after Otsu thresholding (C) Image after Binary inverse thresholding

D. Morphological operations

Morphological operations have the same behavior of the filters, but it deals with binary image resulted from thresholded images. These operations work by scanning through the image and applying a filter to each pixel, we used different kernels and we discovered that kernel 7x7 give us the best image. We used two operations: First, Opening is one of the Morphological operations that acts to remove small objects and keeps the shape and size of the input image unchanged. opening is performed by applying erosion followed by dilation. Then, Closing is one of the morphological operations that acts to fill holes and keeps the shape and size of the input image unchanged. Closing is performed by applying dilation followed by erosion.

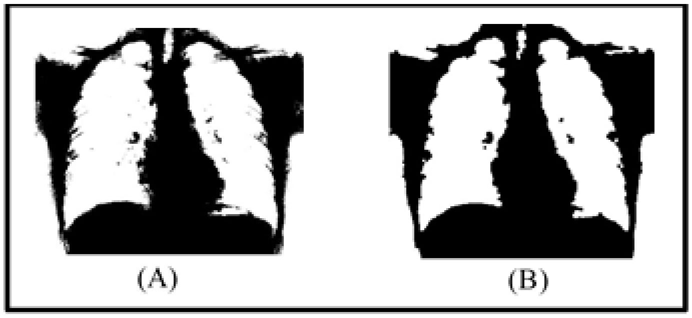

Fig. 4. (A) Image before morphological operations (B) Image after morphological operations

E. Removing areas attached to the border

We looked closely at the image after making morphological operations, we found that we need to remove the areas attached to the borders to get the lungs area only in white as foreground and the other in black as background. We have used ‘floodFill’ function available in openCV [4].

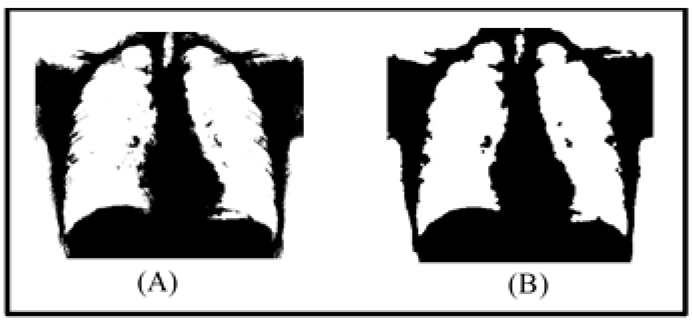

Fig. 5. (A) Image before morphological operations (B) Image after morphological operations

F. Median Filter

We need to remove noise from image, we used median filter to remove the noise. We used median filter with a different filter size, we discovered that filter size 21x21 give us the best result that we need. After we apply filter, the image become more clear and smoothing, then we multiply the result image with the original image ‘resized image’ to get a clear and realistic view of the lungs.

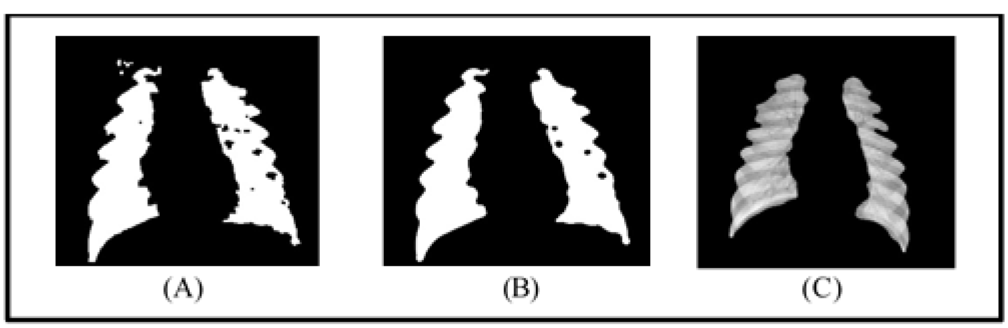

Fig. 6. (A) Image before median filter (B) Image after median filter (C) Image after multiplying

G. Classification

At the end, we need to classify the output image if it normal image or pneumonia affected. We tried many methods, but have discovered that the most accurate and effective method is to get the number of labels in an image, we get this by using ‘connectedComponents’ function available in openCV. After we get the number of labels for normal images, we discovered the labels of normal image in range between 3 and 6, but the labels of pneumonia are greater than 6, so if the number of labels are less than or equal 6 it is normal, otherwise it is pneumonia.

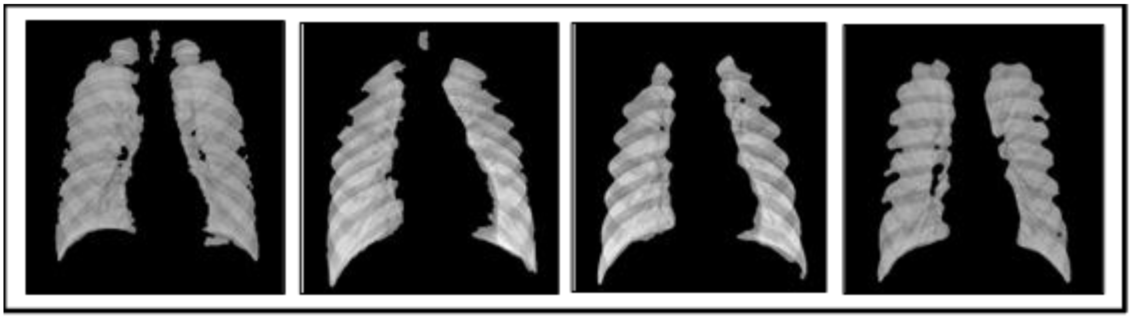

Fig. 7. Normal lung region

Fig. 8. Pneumonia affected lung region

IV. CONCLUSION

Computer assisted detection(CAD) of diseases from CXR are always very helpful at places where there is shortage of skilled radiologist. In some countries, they do not have experienced radiologists in rural areas, such tools can be of immense help by automatically screening people who need urgent medical care and further diagnosis. In this study, a main approach to chest X-ray classification has been used. The approach is: First, we got chest X-rays (CXR) images as input. Then, we performed Otsu thresholding and inversed it using binary inverse thresholding. Then, we did some morphological operations such as: opening and closing. Then, we removed the areas attached to the border to get the lung area only. Then, we applied median filter to remove noise. Finally, we classified the images using number of labels method to get images as normal or pneumonia affected. Also, we are now looking to discover new approach that are more efficient and accurate

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