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Image Processing Techniques on Radiological Images of Human Lungs Effected by COVID-19

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***Abstract*— The wide spread of COVID-19 all over the world inspires every human to know and visualize its effect on human body. As COVID-19 effects the human lungs here a number of radiological images of human lungs are analysed using an image processing technique called Threshold Segmentation. A significant difference is observed between healthy lung images and COVID-19 effected lung images.**

***Keywords*— COVID-19, Visualize, Lungs, Radiological images, Threshold Segmentation.**

I. Introduction

In December 2019, there was a cluster of pneumonia cases in China. Investigations found that it was caused due to a previously unknown virus, now named as the 2019 Novel Corona Virus. Corona Viruses are a large group of viruses. They consists of a core genetic material surrounded by an envelop of protein spikes. This gives it the appearance of a crown (Crown in Latin means Corona) and that's how these viruses get their name. The 2019 Novel Corona Virus(COVID-19) was first identified in the city of Wuhan in China in a group of people who were associated with seafood and live animal market[1],[2]. There are different types of Corona Viruses that cause respiratory and sometimes gastrointestinal symptoms. The respiratory symptoms are primarily manifested in the lungs. In this paper a number of radiological images of human lungs are analysed and the difference between healthy lung images and Corona Virus effected lung images are observed.

Identifying the effect on human lungs due to COVID-19 in a radiological image is difficult for a common man, which can only be observed by medical experts. So using some image processing techniques we can easily visualize the effect of COVID-19 on human lungs. In this paper a number of radiological images of human lungs are analysed using an image processing technique called Threshold Segmentation to identify the effect of COVID-19. Thresholding is the simplest method of segmenting images. Segmentation is a core part in image processing and computer vision applications such as medical image segmentation[22],fruit detection, yield estimation[23],[24], face recognition, disease recognition, handwriting recognition, traffic control system, video surveillances, etc. segmentation in medical field broadly classifies in two forms such as partial automatic [4],[5] and completely automatic [5] Chandra S, Bhat R, Singh H [6] proposed restoration and clustering based segmentation of brain tumour .This both segmentation methods produced better results compared to other segmentation methods in medical fields. And a brain tumour detection algorithm is developed using image processing techniques like morphology [22]. Image segmentation algorithms generally based on one of the two basic properties of intensity values, discontinuity and similarity. Discontinuity partitions an image based on the abrupt changes in the intensity, such as edges of an image. Where as similarity is based on partitioning an image into regions that are similar according to a set of predefined criteria[26],[27],[28].Thresholding, region growing, region splitting and merging are examples of methods in this category. Thresholding is the commonly used image enhancement technique used for segmenting an image into object and background[29],[30].

II. The Material

Thresholding is a commonly used image enhancement technique. The goal is to segment an image into object and background. A threshold value is computed. Pixel values above the threshold value are "object" and below are considered as "background" and eliminates unimportant shading variations. In thresholding the objects from their background are extracted using a threshold value T. Then any point (x, y) for which f(x, y)>T is called an object point, and f(x, y)<T is called a background point. The pivotal value that is used to decide whether any given pixel is to be black or white is the ‘threshold’ [3],[21]. If the threshold value is only dependent on the grey values then it is called “Global Thresholding”. If the threshold value is only dependent on the grey value and on some local property then it is “Local Thresholding”. If the thresholding value is dependent on the grey value , some local property and some spatial co-ordinates then it is called “Adaptive Thresholding”. There are two common adaptive thresholding algorithm concepts: (1) global thresholding, in which for each image, a different threshold is determined according to specific conditions for the entire image that is then transformed into a binary image; (2) local thresholding, in which the image is divided into sections and a different threshold is calculated for each section; the sections are then combined to a binary image. In this paper radiological images are examined, so to calculate threshold value Global Thresholding is used as the threshold value is depend on the grey values [7],[8],[9].

Thresholding is the most common method used. Thresholding converts an input image I to a binary image B[12]. There are many methods available to calculate the threshold of an image. Since most segmentation methods set a specific detection environment, they are unsuitable for ores in complex scenes. OTSU[14],[15] based on statistical measurement is a classic global threshold segmentation, having the advantages of speediness, stabilization and high universality [16],[17]. Hua et al. [18] obtained the aggregate size by using OTSU. Gajalakshmi et al. [20] advised that the grain boundaries of various metals were determined using OTSU and Canny edge detection techniques.

Global thresholding is used when the intensity distribution between the objects of background and foreground are extremely different. In this paper Otsu’s method is used for calculating the global threshold value. An optimal threshold (or set of thresholds) is selected by the discriminant criterion namely, by maximizing the discriminant measure q (or the measure of separability of the resultant classes in gray levels)[14],[15]. Here a global threshold T is computed from grayscale image. Otsu’s method chooses a threshold that minimizes the interclass variance of the threshold black and white pixels. The global threshold T is used to convert a grayscale image into a binary image .Here the gray value for a COVID-19 effected images are observed high when compared with the healthy lung images[7],[8],[9].

III. Method/Algorithm

Lung Segmentation Algorithm:
Step1: Read the image I
Step2: Pre-process the image I
Step3: Apply Otsu’s method on image
Step4: Get global threshold T from grayscale image I
Step5: Convert the image into binary image B
Step6: Display the original image next to binary image

As global thresholding depends on the extreme differentiation of the object background and foreground, at the point when the distinction between background and foreground items is extremely large, a solitary value of threshold can principally be utilized to differentiate both objects. Hence, in this kind of thresholding , the estimation of threshold T depends completely on the property of the pixel and the gray value of the image. For calculating such type of thresholding Otsu, entropy based thresholding strategies are used[21]. By implementing the proposed algorithm the estimation of threshold depends exclusively on the property of the pixel and the grey level value of the picture. In this paper Otsu method is used on four healthy lung images and four COVID-19 effected radiological lung images to calculate the threshold value. It is observed that the grey level value of COVID-19 effected lung images are found high when compared with healthy lung images. Here in Table I four radiological images of healthy lungs are taken and processed through the proposed algorithm. The resultant binary images along with the radiological images are shown. Here the lungs portion is visualized with black pixels and the rest of the image is replaced with white pixels and the gray values of all the images are shown ,which are found to be less when compared with the COVID-19 effected lung images shown in Table II

TABLE I
Showing the results after implementing the proposed method on the radiological images of healthy lungs

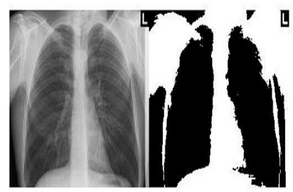
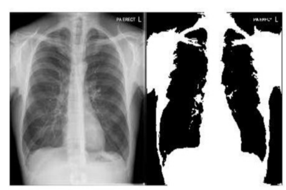
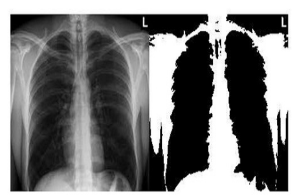
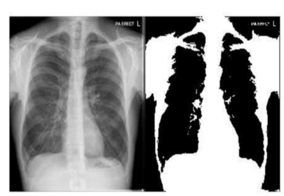
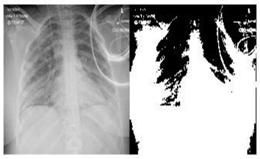
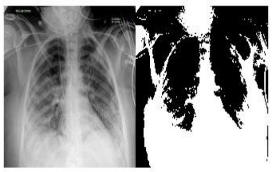
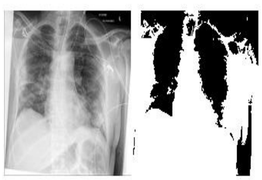
Image name	Healthy lung images along with binary images	Gray value
IMG1		0.3843
IMG2		0.4824
IMG3		0.3942
IMG4		0.4941

TABLE II
SHOWING THE RESULTS AFTER IMPLEMENTING THE PROPOSED METHOD ON RADIOLOGICAL IMAGES OF COVID-19 EFFECTED LUNGS

Image name	Covid-19 effected lung images along with binary images	Gray value
IMG5		0.5804
IMG6		0.5137
IMG7		0.5357
IMG8		0.5882

When we observe both the tables, the binary images in Table1(IMG1 to IMG4) are viewed with maximum reflection of the lungs with black pixels, but in Table2 (IMG5 to IMG8) maximum portion is converted to white pixels in binary images showing the COVID-19 effected part which can be easily visualized. Here we can clearly visualize the virus effect on lungs. The effected part is completely replaced with white pixels. This is done by calculating the global threshold value using Otsu's method . Depending on this threshold value pixels are converted to either white or black which gives us the binary image. In the binary image the effect of COVID-19 can be clearly visualized when compared with a gray image. In table II along with images its gray values are also displayed. These values are high when compared with the gray values in table I. This is because the gray portion in the original image is replaced with white pixels , so the gray value in COVID-19 effected lung images is high when compared with healthy lung images.

IV. RESULTS AND DISCUSSION

For better understanding of this method here two radiological images of lungs of a 72-year-old woman are considered, who has a cough and respiratory distress from one year(left image-IMG9)[6] and now she got effected with COVID-19(right image-IMG10)[6]. Here the yellow circle and ovoid indicate the typical subpleural peripheral opacities.

IMG9 IMG10

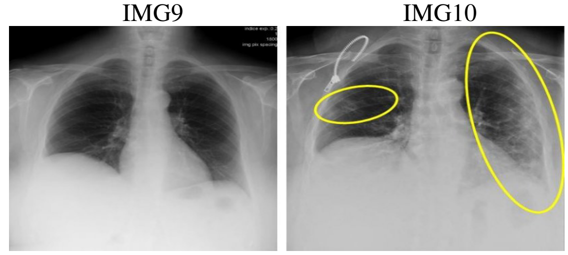


Fig1: Sample image before and after COVID-19 effect

When these images are processed through the proposed method, the lung images before and after COVID-19 effect along with its binary images are shown in IMG11 and IMG12 respectively.

IMG11

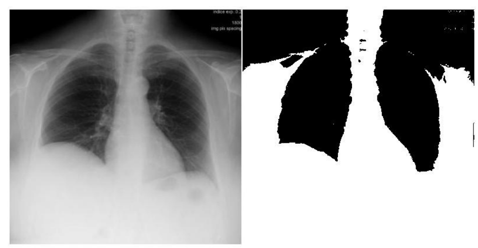


Fig2: Sample Healthy lung image after processing -Gray value(0.4824)

IMG12

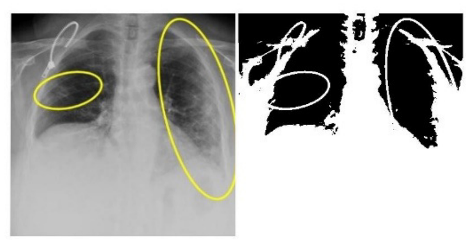


Fig3: Sample COVID-19 effected lung image after Processing-Gray value(0.5098)

By visualizing IMG11 and IMG12 even a common man can identify the effect of COVID-19 on lungs, which satisfies the objective. Here the grey level or grey value of these images are also observed. Grey value of COVID-19 effected lung image(IMG12)-0.5098 is found to be high when compared with that of healthy lung image(IMG11)-0.4824 and the virus effected part is clearly visualized in IMG12. This method is simple, easy to implement, quick in processing and a significant difference is observed between the input image and the image after processing.

V. CONCLUSIONS

This work is done to visualize the effect of COVID-19 virus on human lungs using image processing techniques. The technique is threshold segmentation, which is done using a global image thresholding by Otsu's method. The proposed method is experimented on a number of radiological images of human lungs for visualizing the COVID-19 effect . This method has given significant results

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