

Covid 19-Xray Image Segmentation Using Thresholding And K-Means Clustering

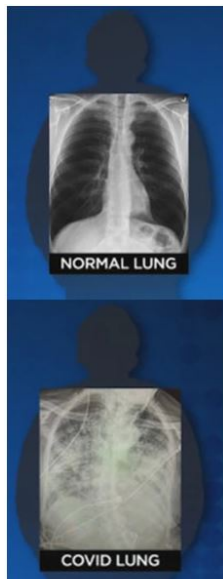
Medical Image Analysis

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Introduction

- The novel coronavirus disease 2019 (COVID-19) constitutes a public health emergency globally and causes severe inflammation in your lungs.
- Chest X-ray is among the most commonly used imaging modalities to identify COVID-19 infections and other various pulmonary diseases due to its low radiation, free of side effects, economic feasibility.
- Extraction of lung areas from the X-rays by accurately detecting lung boundaries is an important step, especially in determining whether the lung is normal or abnormal.



Primary goal

- This project proposes two unsupervised learning method for lung segmentation of COVID 19 patients based on thresholding and k means clustering.
- This computational procedures for image preparation can be used for further analysis by medical specialists.
- Three-stage computational procedure includes
 - **Pre processing** - X-ray images are typically low resolution, and the pixel intensity distribution can have wide verities due to patients age and configuration of X-ray capturing devise. Therefore, image pre processing will be carried out to improve the quality of the image and enhance significant areas.
 - **Noise elimination** - Noise elimination techniques are used to eliminate noise occurred in the pre processing steps and initial steps by preserving the details of image.
 - **Classification** - Proposed two classification methods local threshold method and k-means clustering method.

Method Based on K means Clustering

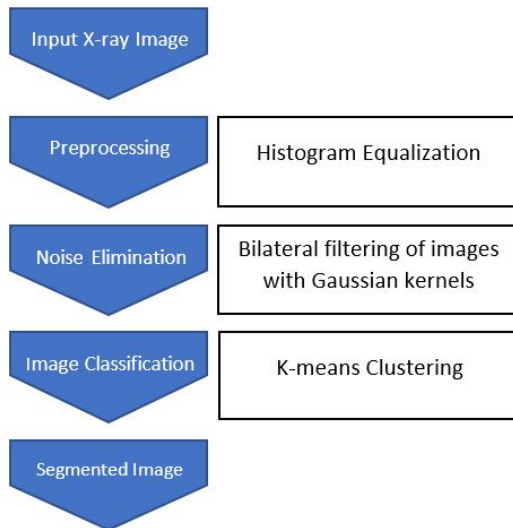
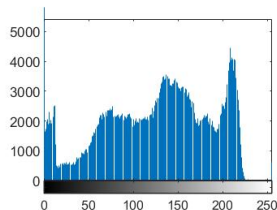


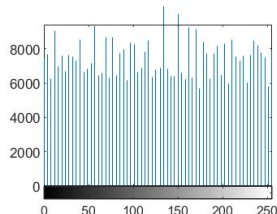
Image Preprocessing Using Histogram Equalization

- Histogram equalization is a method to adjust the contrast of an image by modifying the intensity distribution of the histogram.

Original image



After histogram equalization



Noise Elimination Using Bilateral filtering

Gaussian filtering

2-D convolution operator that is used to 'blur' images and remove detail and noise. The Gaussian outputs a 'weighted average' of each pixel's neighborhood, with the average weighted more towards the value of the central pixels.

Bilateral filtering

The bilateral filter is also defined as a weighted average of nearby pixels, in a manner very similar to Gaussian convolution. The difference is that the bilateral filter takes into account the difference in value with the neighbors to preserve edges while smoothing.

Image after histogram equalization



Degree of Smoothing: 943.9371



K Means Clustering For Image segmentation

The K-means algorithm clusters data by trying to separate pixels in 2 groups of equal variance, minimizing within-cluster sum-of-squares.

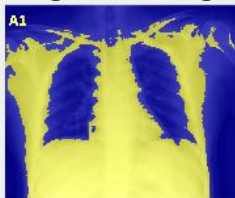
Algorithm

- Randomly assign objects to 2 nonempty initial partitions
- Compute the centroids of the clusters of current partitioning
- Assign each object to the cluster with nearest centroid
- Repeat step 2 and 3, Stop when the assignment does not change

Image after preprocessing



Segmented image



Segmented image



Convex Hull For Border Detection

- Convex hull (CH) is basically an important geometrical problem that could be solved computationally. The problem is all about constructing, developing, articulating, circumscribing or encompassing a given set of points in plane by a polygonal capsule called convex polygon.
- This algorithm search the border points, and help to determine an outline of the lung's boundaries.

Original image



Segmented image



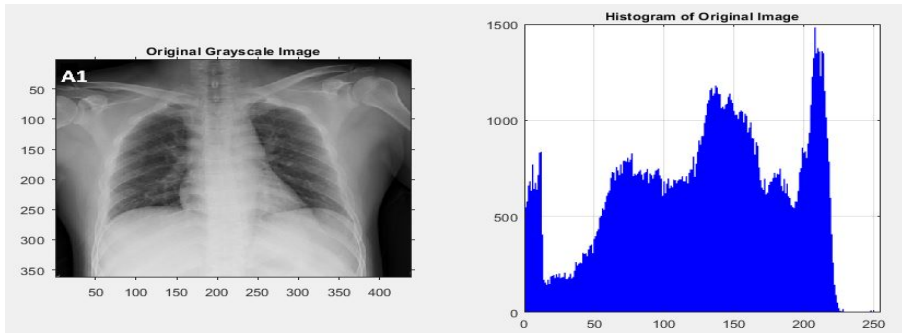
Final output



Method Based On Thresholding

Pre-processing

- Images are converted from RGB to gray scale.



Thresholding Using Otsu's Method (Contd.)

- Classify the pixel into two classes, C_1 and C_2 by a threshold at level T .
- The optimal T minimizes the within class variance σ_W^2 , or equivalently, maximize the between class variance σ_B^2 , where σ_W^2 and σ_B^2 defined as

$$\sigma_W^2 = w_1\sigma_1^2 + w_2\sigma_2^2$$

$$\sigma_B^2 = w_1(\mu_1 - \mu_L)^2 + w_2(\mu_2 - \mu_L)^2 = w_1w_2(\mu_2 - \mu_1)^2$$

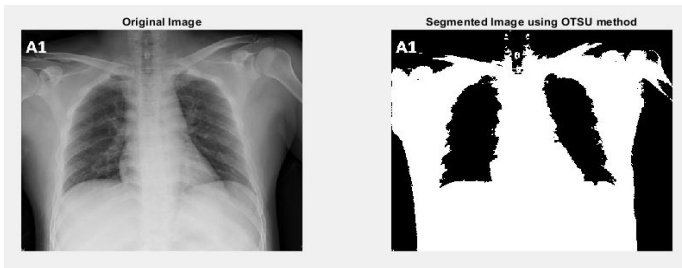
where σ_1^2 and σ_2^2 are class variances, μ_1 and μ_2 are class mean levels, and w_1 and w_2 are the probabilities of class occurrence.

Thresholding Using Otsu's Method (Contd.)

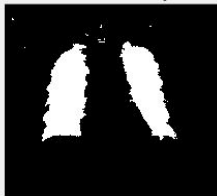
- If $J(x, y)$ be the thresholded version of the grey-level image $I(x, y)$ at threshold T ,

$$J(x, y) = \begin{cases} 1 & \text{if } I(x, y) > T \\ 0 & \text{if } I(x, y) \leq T \end{cases}$$

Thresholding Using Otsu's Method (Contd.)



Delete outer body



Morphological Operations



Smoothing



Discussion

- This project proposes two unsupervised learning method for lung segmentation of COVID 19 patients based on thresholding and k means clustering.
- Obtained segmented X-ray image will be helpful in the medical diagnosis by medical specialists
- Method is incapable of extracting lung region associated with heart from the X-ray image.

References

- [1] Aleksandr Zotin, Yousif Hamad, Konstantin Simonov, Mikhail Kurako (2019) "Lung boundary detection for chest X-ray images classification based on GLCM and probabilistic neural networks", *Procedia Computer Science*, Vol. 159, pp 1439-1448,
- [2] P. Pattrapisetwong and W. Chiracharit (2016) "Automatic lung segmentation in chest radiographs using shadow filter and local thresholding" , *IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology (CIBCB)*, pp. 1-6
- [3] Sylvain Paris, Pierre Kornprobst, Jack Tumblin and Frédo Durand (2009), "Bilateral Filtering: Theory and Applications", *Foundations and Trends® in Computer Graphics and Vision*: Vol. 4: No. 1, pp 1-73.

