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Deep learning and probabilistic neural networks-based identification and classification of Pneumonia-related lung diseases

N. Vinothkumar [$]
Department of Computer Science and Engineering
Kumaraguru College of Technology
Coimbatore
Tamil Nadu
India

Ch. Madhava Rao [†]
Department of Computer Science and Engineering
Koneru Lakshmaiah Education Foundation
Vaddeswaram
Andhra Pradesh
India

Swati R. Nitnaware [§]
Department of Electronics Engineering
Yeshwantrao Chavan College of Engineering
Nagpur
Maharastra
India

M. Shakunthala [‡]
Department of Electronics and Communication Engineering
R.M.D. Engineering College
Kavaraipettai
Thiruvallur
Tamil Nadu
India

[$] *E-mail:* nvk.cpri@gmail.com
[†] *E-mail:* cmadhavarao@kluniversity.in
[§] *E-mail:* swatitidke02@gmail.com
[‡] *E-mail:* shakunthalamasi@gmail.com

K. V. Shahnaz [@]
Department of Electronics and Communication Engineering
Veltech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology
Chennai
Tamil Nadu
India

Nelli Sreevidya [#]
Department of Information Technology
Sreenidhi Institute of Science and Technology
Hyderabad
Telangana
India

L. Bhagyalakshmi *
Department of Electronics and Communication Engineering
Rajalakshmi Engineering College
Chennai
Tamil Nadu
India

Nitesh Kumar [^]
Department of Information Technology
L. N. Mishra College of Business Management
Muzaffarpur
Bihar
India

Abstract

In every part of the world, lung disease is a major issue. Early lung disease identification is crucial. A variety of deep learning techniques, such as convolutional neural networks (CNNs), Visual Geometry Group (VGG) networks, capsule networks, and traditional neural networks, are commonly employed for predicting lung diseases. Since the emergence of the novel COVID-19, extensive research has been conducted to explore its ability to make precise predictions. Given that many fatalities were attributed to severe chest congestion, Pneumonia an early-stage lung condition is likely closely associated with COVID-19

[@] *E-mail:* **shahnaznitc@gmail.com**
[#] *E-mail:* **sreevidya1509@gmail.com**
* *E-mail:* **Prof.Dr.L.Bhagyalakshmi@gmail.com (Corresponding Author)**
[^] *E-mail:* **rickyengineer@gmail.com**

(pneumonic condition). Medical professionals may find it difficult to differentiate COVID-19 from other lung diseases, such as Pneumonia.

Subject Classification: *92B20 Neural networks for/in biological studies.*

Keywords: *CNN, Novel COVID-19, Data source, Data gathering, Image quality enhancement, Adaptive, Precise region of interest (ROI) evaluation, Characteristic extraction, Disease prediction.*

1. Introduction

One's health is now at higher risk as a result of this. According to estimates, smoking and pollution, the two main causes of chronic obstructive pulmonary disease (COPD), killed over 3.4 million people in 2016, and asthma killed 400,000 people [1][2]. In order to aid in the early detection of lung problems, it is also critical to implement efficient diagnostic technology. Since late December 2019, those infected with the novel coronavirus disease known as COVID-19 have had severe lung damage and breathing difficulties [3]. [Pneumonia causes] Consequently, it is more important than ever to diagnose lung problems early. The study described in this paper can help doctors and other healthcare professionals by using the deep learning technique. By increasing the accuracy of disease detection, the approach that has been demonstrated here can also serve to lower the overall disease rate and safeguard a significant number of vulnerable individuals[3,4]. The link between machine learning systems and the prediction of diagnostic information from X-ray pictures has been the subject of numerous investigations by academics [5–7]. Given that computers are now in the hands of their managers and that the great majority of documents are accessible, it is past time to resolve this dilemma. One way that this solution can help lower the cost of medical treatment is by advancing computer science for use in health initiatives and medicine. When COVID-19 first appeared in November 2019, it posed a severe threat to human survival and swiftly expanded over the rest of the world. This hazard was initially identified in China. The World Health Organisation (WHO) continuously provides countries with the knowledge they require to defend against COVID-19 [10]. There was still no vaccine to defend against this hazard, despite the fact that various countries were working on its creation throughout the first six to eight months of the Covid-19 pandemic. Lastly, several nations have succeeded in creating a vaccination to prevent the The Covid-19 virus is currently in the testing or research phases of development. People infected with the COVID-19 virus often have moderate to mild symptoms, including fever, cough, and dyspnoea.

Pneumonitis is the term for this illness. This medical ailment is known as Pneumonia. It's possible that a large volume of fluid can build up in your lungs, which will make breathing challenging. You can have respiratory trouble if this happens.

2. Pre-Processing

Following the acquisition of the pictures, the picture will be evaluated for a further pre-processing step that will consider noise and background information. Before any processing can start, noise-cancelling techniques must be used to the image to eliminate this extraneous information. Four types of noise were detected in the skin photos: Poisson, Gaussian, Speckle, and Salt & Pepper. Following the completion of the pre-processing phase, the lesion was segmented in order to clearly define the skin region that was damaged. In order use fuzzy C-Means clustering and K-Means to divide the skin lesion area algorithms, the processed picture is subjected to a hybrid clustering method following modification [11]. The initial step of this procedure in the K-means approach is called segmentation. It is necessary to limit the cost junction at the cluster centres, and this cost varies randomly according to user input memberships. Based on the information displayed in Figure 9, the K-Means clustering technique is used in this suggested system initially, followed by fuzzy c means clustering, after the designated edges have been identified.

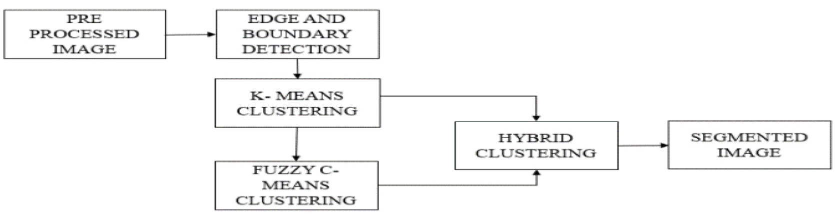

Figure 1

Segmentation with Hybrid Clustering Method[10]

Figure 1, which is available online, provides a detailed illustration of this K-Means clustering method[10].

2.1 *K-Means Clustering*

K-Means clustering consists of the steps listed below, which are explored in more detail below:

1. Start by creating centroids C, which will act as the random distribution's starting points.
2. equation 1=1 and the distribution of Xi.
3. It represented by the symbol Ci.
4. After then, the locations need to be changed while accounting for the threshold value TH. Figure 1, which is available online, provides a detailed illustration of this K-Means clustering method. Figure 2 shows input photographs that have been segmented using this method.

$$\left|\frac{c^t - c^{t-1}}{c^t}\right| < TH \tag{1}$$

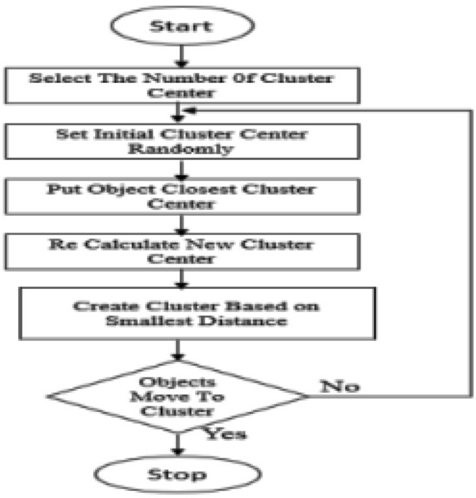

Figure 2

The K-Means Clustering Method[11]

Figure 2, shows input photographs that have been segmented using this method[11].

2.2 *Fuzzy C-Means clustering*

Fuzzified k-means segmentation method is very beneficial for medical picture analysis. It is widely used in the domains of photo segmentation and pattern recognition. The typical implementation of this method consists of the following phases.

$$u_k(x) = \frac{1}{d(center_k, x)} \tag{2}$$

Then, given a distribution larger than 1, the coefficient is a valid parameter. One is the outcome.

$$u_k(x) = \frac{1}{\sum_j \left(\frac{d(center_k, x}{d(center_j, x} \right)^{2/(m-1)}} \quad (3)$$

This works similarly to the K-means approach [14], where a cluster is significantly weighted more than other clusters when it is one metre closer. The clusters must be chosen at random in terms of their quantity [16–18]. The procedure must be carried out precisely as it is described in each of equations 2, and 3. The centre must be obtained using the preceding equation (3), and the coefficients must be computed using the canter value from (3) in equations 2 and 3.

3. Classification

The effective application of neural networks across a wide range of issue categories. Neural networks are interesting from a statistical standpoint because of the possibility that they could be applied to categorisation and prediction challenges. The PNN technique was created with the goal of simulating the brain architecture that exists at birth. For the classification operation to be effectively completed, the connections between the neurones are made in accordance with the predetermined design.

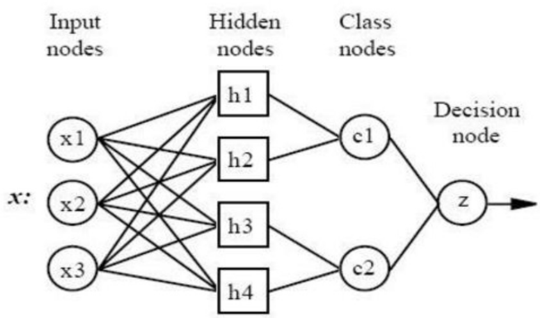

Figure 3

Layered architecture of PNN model[4]

Figure 3 shows the PNN design is made up of four separate, hidden layers, each of which, filter applications 4-pixel, the network's first convolutional 2D hidden layer reads the skin lesion pictures that measure 224 pixels by 224 pixels by 3

In the input dataset, which has hybrid features sorted according to weight distributions, the input layer aids in the mapping process? The PNN design is made up of four separate, hidden layers, each of which, filter applications 4-pixel, the network's first convolutional 2D hidden layer reads the skin lesion pictures that measure 224 pixels by 224 pixels by 3. Next are the layers for class node activation and decision normalisation. This was followed by the classification operation on the two hidden tiers of class nodes. Each of the two buried layer levels stores information independently regarding the normalcy and abnormalities of the skin cancer characteristics. It is separated into two classification stages: normal and abnormal, depending on the segmentation criteria. The output layer has these two levels mapped as labels. The weights of malignant and benign cancers in their second stage are stored in the hidden layer, while the abnormal cancer kinds are preserved in a different section. Once more, the hidden layer contains both of these. The output layer is likewise labelled with these benign and malignant weights in a similar manner. The categorisation step of the testing process tests the hybrid properties of the test image when it is used.

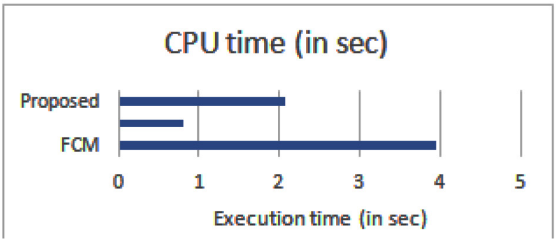

Figure 4

Evaluation of cpu running time effectiveness of multi-tissue detection [5]

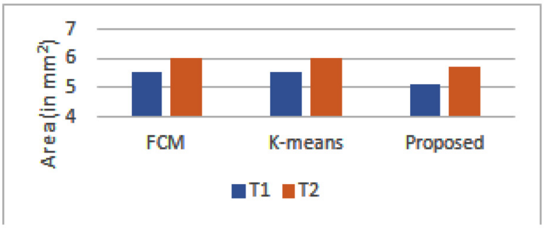

Figure 5

Estimated area of segmented tissues [6]

Figure 4 and Figure 5 show the link between machine learning systems and the prediction of diagnostic information from X-ray pictures has been the subject of numerous investigations by academics [5–7]. Given that computers are now in the hands of their managers and that the great majority of documents are accessible, it is past time to resolve this dilemma.

Figure 6

Images in input and segmentation [6]

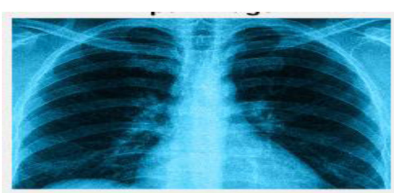

Figure 7

Input image [7]

Figure 8

Segmented and Disease Effected region [8]

In Figure 6, Figure 7 and Figure 8, Fuzzy C-Means clustering and K-Means to divide the skin lesion area.

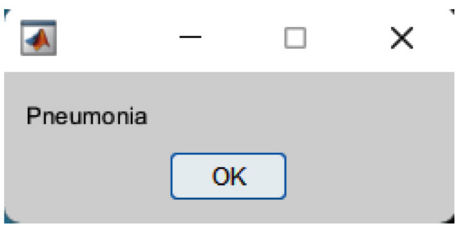

Figure 9

Disease Effect Identification [9]

Table 1

Processing Time of CPUs for Various Segmentation Methods[10]

S. No.	Segmentation algorithm	Computation time (Seconds)			
		Sample Image 1	Sample Image 2	Sample Image 3	Sample Image 4
1	Fuzzy C Means	11.2633	3.4008	2.8348	2.9282
2	K-Means	0.4156	0.5248	0.4572	0.3532
3	Proposed	0.2596	0.2440	0.2812	0.2898

In Figure 9, Fuzzy C-Means clustering and K-Means to divide the skin lesion area. The K-Means clustering technique is used in this suggested system initially, followed by fuzzy c means clustering, after the designated edges have been identified [9]. Processing Time of CPUs for Various Segmentation Methods is shown in Table 1.

4. Conclusion

In this body of work, we have presented a method for diagnosing lung disease from chest X-ray photographs in order to categorise cases of Pneumonia and Covid-19. Deep learning, machine learning, and soft computing techniques are all incorporated into the suggested framework. Our model is significantly different from the existing methods for detecting Covid-19 in that it only takes into account the lung-specific features after first taking into account a suitable picture improvement, normalisation, and ROI-based feature extraction. In other words, it is notably different in order to maximise classification performance and computing efficiency.

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