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A PULMONARY LOBE BASED COVID DISEASE PREDICTION USING DEEP LEARNING TECHNIQUES

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ABSTRACT

Corona virus disease 2019 (COVID-19) is an infectious disease triggered by severe acute respiratory syndrome corona virus 2 (SARS-CoV-2). Since the disease has spread all over the globe in enormous numbers and is declared a pandemic. Although radiological imaging is not recommended for diagnostics as the patient arrives in the clinic, a chest X-ray is often useful to monitor treatment outcomes and co morbidities in seriously ill patients. The detection of COVID-19 from chest X-ray and its differentiation from lung diseases with identical opacities is a puzzling task that relies on the availability of expert radiologists. Recently, several researchers have reported the use of AI-based tools in solving image classification problems in healthcare, based on training with X-ray images, CT scans, and histopathology images. Deep learning is an extremely powerful tool for learning complex, cognitive problems, and the frequency of their use and evaluation in different problems is increasing. In the present study, we have made use of a deep learning algorithm using the convolutional neural network (CNN) that can efficiently detect COVID-19 from CT-scan images. And also implement Multi-class CNN to identify the multiple lung diseases such as Pneumonia, tuberculosis. Experimental results shows that the proposed system provide improved accuracy in disease prediction and also provide the diagnosis information about analysed diseases.

Keywords: *COVID prediction, pulmonary lobe, image processing, Convolutional neural network, deep learning.*

1. INTRODUCTION

1.1 DEEP LEARNING

Deep learning is an Artificial Intelligence function that imitates the workings of the human brain in processing data and creating patterns for use in decision making. Deep learning is a subset of machine learning in artificial intelligence that has networks capable of learning unsupervised from data that is unstructured or unlabelled. Also known as deep neural learning or deep neural network. Deep learning is an AI function that mimics the workings of the human brain in processing data for use in detecting objects, recognizing speech, translating languages, and making decisions. Deep learning AI is able to learn without human supervision, drawing from data that is both unstructured and unlabelled. Deep learning, a form of machine learning, can be used to help detect fraud or money laundering, among other functions. Deep learning has evolved hand-in-hand with the digital era, which has brought about an explosion of data in all forms and from every region of the world. One of the most common AI techniques used for processing big data is machine learning, a self-adaptive algorithm that gets increasingly better analysis and patterns with experience or with newly added data. Artificial Neural Networks (ANNs) were inspired by information processing and distributed communication nodes in biological systems. ANNs have various differences from biological brains. Specifically, neural networks tend to be static and symbolic, while the biological brain of most living organisms is dynamic (plastic) and analogue.

1.2 DEEP LEARNING IN IMAGE PROCESSING

Image processing is processing of images using mathematical operations by using any form of signal processing for which

the input is an image, a series of images, or a video, such as a photograph or video frame; the output of image processing may be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it. Closely related to image processing are computer graphics and computer vision. Computer vision, on the other hand, is often considered high-level image processing out of which a machine/computer/software intends to decipher the physical contents of an image or a sequence of images (e.g., videos or 3D full-body magnetic resonance scans). Graphic software programs, which can be broadly grouped into vector graphics editors, raster graphics editors, and 3D modellers, are the primary tools with which a user may manipulate, enhance, and transform images. Many image editing programs are also used to render or create computer art from scratch. Once the image is selected, it may be copied and pasted into another section of the same file, or into a separate file. The selection may also be saved in what is known as an alpha channel. A popular way to create a composite image is to use transparent layers. The background image is used as the bottom layer, and the image with parts to be added are placed in a layer above that. Using an image layer mask, all but the parts to be merged are hidden from the layer, giving the impression that these parts have been added to the background layer. Performing a merge in this manner preserves all of the pixel data on both layers to more easily enable future changes in the new merged image.

1.3 STEPS OF IMAGE PROCESSING

1.3.1 Image Acquisition

This is the first step or process of the fundamental steps of digital image processing. Image acquisition could be as simple as being given an image that is already in digital form. Generally, the image acquisition stage involves pre-processing, such as scaling etc.

1.3.2 Colour Image Processing

Colour image processing is an area that has been gaining its importance because of the significant increase in the use of digital images over the Internet. This may include colour modelling and processing in a digital domain etc.

1.3.3 Compression

Compression deals with techniques for reducing the storage required to save an image or the bandwidth to transmit it. Particularly in the uses of internet it is very much necessary to compress data.

1.3.4 Morphological Processing

Morphological processing deals with tools for extracting image components that are useful in the representation and description of shape.

1.4 Segmentation

Segmentation procedures partition an image into its constituent parts or objects. In general, autonomous segmentation is one of the most difficult tasks in digital image processing. A rugged segmentation procedure brings the process a long way toward successful solution of imaging problems that require objects to be identified individually. Segmentation is a classifier which helps to fragment each character from a word present in a given image or page. The objective of the segmentation is to extract each character from the text present in the image. After performing Segmentation, the characters of the string will be separated and it will be used for further processing.

1.4.1 Colour based image segmentation:

Colour segmentation may be more accurate because of more information at the pixel level comparing to gray scale images. The standard Red-Green-Blue (RGB) colour representation has strongly interrelated colour components. Choosing a proper colour space is a very important issue for colour image segmentation process. Generally L*A*B* and HSV are the two frequently chosen colour spaces. For measuring their performance, we consider the parameters: mse and psnr. It is found that HSV colour space is performing better than L*A*B*.

1.4.2 Texture based segmentation:

Image segmentation methods can be subdivided into region based vs. edge-based methods. In order to identify possibilities for acquisition of scene information by digital images an analysis of the principle features of these images is required. In this regard, textures are the only possibility to derive information from imagery, besides the grey or color values and structural features and texture-based segmentation seems to be an adequate approach, because of the panchromatic images.

1.4.3 Shape based segmentation:

First, we extract a shape space consisting of a mean shape and principal components by using PCA (Principal Component Analysis) from a training set. Second, we obtain the eigenvectors of Laplacian matrix derived from an affine matrix. Third, we project the segmentation generated from the eigenvectors onto the shape space to obtain a parametric shape model. Finally, we update the shape model. After several iterations of modifying the affine matrix and updating shape model, the final convergent result will segment the object from the image successfully.

1.5 Feature Extraction

In pattern recognition and in image processing, feature extraction is a special form of dimensional reduction. Transforming the input data into the set of features is called feature extraction. If the features extracted are carefully chosen it is expected that the features set will extract the relevant information from the input data in order to perform the desired task using this reduced representation instead of the full size input. The meaning of the word “feature” is in general highly application dependent. A feature is result of some calculations performed on the input data stream. Extracted feature is then matched with the stored feature data to complete the object recognition task accurately. There are so many techniques developed for feature extraction, to make the shape based object recognition easier as well as accurate.

1.5.1 Colour histograms:

For the given colour image the colour histogram is obtained by discretizing the image colours and counting the number of times each discrete colour occurs in the image array. The histograms are invariant to the rotation and translation and change only slowly under change of angle of view, change in scale, and occlusion. Because histograms change slowly with view, a three dimensional object can be represented by a small number of histograms. In the colour histogram method colour histogram of the sample object is used for the retrieval of the similar object image. The drawback of this method is it is more sensitive to the colour and intensity of the light source and colour of the input object image.

1.5.2 Edge Pixel Neighbourhood Information (EPNI):

In EPNI method the neighbourhood edge pixels are found out that structure of those pixels will be used to make an extended feature vector. This feature vector is used for matching process for the image retrieval. This method is scale and translation invariant, but not rotation invariant.

1.5.3 Histograms of Edge Directions (HED)

In computer vision and image retrieval process edge image matching is widely used for the comparison process. In images with the similar colour information and in the absence of the colour information this histogram of the edge directions is the significant tool for image retrieval. The edge is extracted using the Canny edge operator for this feature extraction and corresponding edge directions are, subsequently, quantized into 72 bins of 50 each [2]. HED is also useful for shape representation.

1.5.4 Edge Histogram Descriptor (EHD)

Edge Histogram Descriptor is the histogram generated using the edge pixels. The edge distribution is a good texture signature and also useful for image to image matching. This approach is not rotation invariant. The MPEG-7 standard defines the edge histogram descriptor (EHD) in its texture part. The distribution of edges is useful for image to image matching. But this descriptor is not effective for the rotation invariance.

1.5.5 Angular radial partitioning (ARP)

In ARP method, the images in the stored database are converted to grayscale and edge detection is performed. To achieve the scale invariance property, the edge image will be partitioned by the surrounding circles and the intersection points of the

edge and surrounding circle are found and angles will be measured for feature extraction process which will be used for the comparison process in image retrieval process. The algorithm uses the surrounding circle of edge of an object and also make the n number of radial partition for that edge of the object image i.e. after making the surrounding circle equidistant circles will be made to extract the features for achieving scale invariance.

1.5.6 Neural Network classification:

Image processing using artificial neuronal networks (ANN) has been successfully used in date reduction, segmentation and recognition are the processes used in managing images with ANN. An image can be represented as a matrix, each element of the matrix containing colour information for a pixel. The matrix is used as input data into the neuronal network. The small dimensions of the images, to easily and quickly help learning, establish the size of the vector and the number of input vectors. The transfer function used is a sigmoidal function. Depending on the type of data that is the matrix, the images are divided into images of intensity scale and indexed and vector images. Scalar image intensity is an image where each pixel value is considered a measure of luminous intensity. The MLP and many other neural networks learn using an algorithm called back propagation. With back propagation, the input data is repeatedly presented to the neural network. With each presentation the output of the neural network is compared to the desired output and an error is computed. This error is then fed back (back propagated) to the neural network and used to adjust the weights such that the error decreases with each iteration and the neural model gets closer and closer to producing the desired output.

II. LITERATURE SURVEY

A robust research effort is currently under way to develop a vaccine against Covid-19.10 We anticipate that the first candidates will enter phase 1 trials by early spring. Therapy currently consists of supportive care while a variety of investigational approaches are being explored. Among these are the antiviral medication lopinavir–ritonavir, interferon-1β, the RNA polymerase inhibitor remdesivir, chloro quine, and a variety of traditional Chinese medicine products. Once available, intravenous hyper immune globulin from recovered persons and monoclonal antibodies may be attractive candidates to study in early intervention. Critical to moving the field forward, even in the context of an outbreak, is ensuring that investigational products are evaluated in scientifically and ethically sound studies. Every outbreak provides an opportunity to gain important information, some of which is associated with a limited window of opportunity.

This finding of a delay in the progression to serious disease may be telling us something important about the pathogenesis of this new virus and may provide a unique window of opportunity for intervention. The Covid-19 outbreak is a stark reminder of the ongoing challenge of emerging and reemerging infectious pathogens and the need for contend surveillance, prompt diagnosis, and robust research to understand the basic biology of new organisms and our susceptibilities to them, as well as to develop effective countermeasures.

This study has several limitations. First, only 99 patients with confirmed 2019-nCoV were included; Virus particles spread through the respiratory mucosa and infect other cells, induce a cytokine storm in the body, generate a series of immune responses, and cause changes in peripheral white blood cells and immune cells such as lymphocytes. Some patients progressed rapidly with ARDS and septic shock, which was eventually followed by multiple organ failure.

Use of intravenous immunoglobulin is recommended to enhance the ability of anti-infection for severely ill patients and steroids (methylprednisolone 1–2 mg/kg per day) are recommended for patients with ARDS, for as short a duration of treatment as possible. Damage to T lymphocytes might be an important factor leading to exacerbations of patients. The low absolute value of lymphocytes could be used as a reference index in the diagnosis of new coronavirus infections in the clinic.

The study has some notable limitations. First, some cases had incomplete documentation of the exposure history and laboratory testing, given the variation in the structure of electronic databases among different participating sites and the urgent timeline for data extraction. Some cases were diagnosed in outpatient settings where medical information was briefly documented and incomplete laboratory testing was performed, along with a shortage of infra - structure and training of medical staff in non - specialty hospitals. Second, we could estimate the incubation period in only 291 of the study patients who had documented information. The uncertainty of the exact dates (recall bias) might have inevitably affected our assessment. Third, because many patients remained in the hospital and the outcomes were unknown at the time of data cut-off, we censored the data regarding their clinical outcomes as of the time of our analysis. Fourth, we no doubt missed patients who were asymptomatic or had mild cases and who were treated at home, so our study cohort may represent the more severe end of Covid-19. Fifth many patients did not undergo sputum bacteriologic or fungal assessment on admission because, in some hospitals, medical resources were overwhelmed. Sixth, data generation was clinically driven and not systematic. Covid-19 has spread rapidly since it was first identified in Wuhan and has been shown to have a wide spectrum of severity. Some patients with Covid-19 do not have fever or radiologic abnormalities on initial presentation, which has complicated the diagnosis.

. III. EXISTING SYSTEM

3.1 OVERVIEW

Imaging plays a vital role in the diagnosis of lung cancer, with the most common modalities including chest radiography, CT, PET, magnetic resonance imaging (MRI), and radionuclide bone scanning, but in this work, we primarily used CT images for analysis. X-Ray imaging will show most lung tumours, but CT is used because it is more sensitive in finding tumour size and the presence of lymph node metastases. Efficient lung segmentation technique helps to raise the accuracy and higher decision confidence value of any lung abnormality identification system. Computer-aided diagnosis may serve as a second reader by analysing nodules, lesions or tumour and providing a malignancy estimate using computer vision and machine learning techniques. CAD may address some of the issues in diagnosis characterization, such as the increasing demand on radiologist's time caused by the increasing data volume, radiologist fatigue or distraction, and differences in radiologists' experience.

Computers are playing an increasingly large role in radiology. In conventional radiography, X-ray images were recorded on screen-film systems, while today's radiologists view digital radiographs on display monitors. Computers have been vital in the development of medical imaging technology – without computerized reconstruction, CT and MRI imaging would not be possible. The next role for computers may be in the interpretation of images. A CAD system comprises segmentation, feature extraction, feature selection, and classification components.

We aim to develop an effective CAD system that will assist radiologists in setting the right diagnosis. CAD systems for medical images typically involve the steps of segmentation the image, extraction of various region of interest and classification of that area. Various algorithms from different authors can be found for medical image segmentation such as thresholding, region growing. These methods may be effective for specific types of disease; segmentation of lungs is always a challenging problem due to changes in pathology in the parenchyma area.

3.2 LIMITATIONS

- Segmentation accuracy is less
- Provide high number of false positives
- Computational complexity is high
- Fault tolerance can be occurred

IV. PROPOSED SYSTEM

4.1 OVERVIEW

The coronavirus disease 2019 (COVID-19) pandemic has caused health concerns worldwide since December 2019. From the beginning of infection, patients will progress through different symptom stages, such as fever, dyspnea or even death. Identifying disease progression and predicting patient outcome at an early stage helps target treatment and resource allocation. However, there is no clear COVID-19 stage definition, and few studies have addressed characterizing COVID-19 progression, making the need for this study evident. Lung abnormality is one of the common diseases in humans of all age group and this disease may arise due to various reasons.

Recently, the lung infection due to SARS-CoV-2 has affected a larger human community globally, and due to its rapidity, the World-Health-Organisation (WHO) declared it as pandemic disease. The COVID-19 disease has adverse effects on the respiratory system, and the infection severity can be detected using a chosen imaging modality. The field of medical imaging introduced CAD (Computer-Aided Diagnostic) systems which help medical specialist to identify and categories the problem. The lesions are produced with different body parts which cause the cancer. Such lesions are referred to as nodule if they causes cancer, otherwise non-nodule. In the design of a CAD system, the main task is to segment the volume of particular body part, like lungs volume should be separated from the complete image so that we can keep our focus on the object of interests. The next task is to separate the objects in lungs volume which are not part of lungs. These objects are unwanted lesions. These unwanted lesions are potential nodules. The next step is to classify the potential nodules into nodules and non-nodule. Rapid and accurate detection of COVID-19 coronavirus is necessity of time to prevent and control of this pandemic by timely quarantine and medical treatment in absence of any vaccine.

Daily increase in cases of COVID-19 patient’s worldwide and limited number of available detection kits pose difficulty in identifying the presence of disease. Therefore, at this point of time, necessity arises to look for other alternatives. Among already existing, widely available and low-cost resources, X-ray is frequently used imaging modality and on the other hand, deep learning techniques have achieved state-of-the-art performances in computer-aided medical diagnosis. Therefore, an alternative diagnostic tool to detect COVID-19 cases utilizing available resources and advanced deep learning techniques is

proposed in this work. The proposed method is implemented in four phases, viz., data augmentation, pre-processing, stage-I and stage-II deep network model designing. Deep network implementation in two stages is designed to differentiate COVID-19 induced pneumonia from healthy cases, bacterial and other virus induced pneumonia on X-ray images of chest.

We employed MIL, a deep learning method, using quantitative CT data to accurately predict the disease severity of COVID-19. By utilizing an inexpensive and widely available test, our model can be used to identify patients at high risk of disease progression in the early phase of the disease, which has important practical implications for conducting early intervention, preventing disease progression, and reducing mortality. We recommend that confirmed COVID-19 patients should undergo CT screening as soon as they are admitted to the hospital, so that physicians can use our model to determine the risk of severe disease. If the result indicates a potential worsening of the condition of the patient, closer monitoring and early intervention should be considered before the disease severity increases. We hope that this model would be of some help to clinicians to better manage patients and contribute to combatting COVID-19. In proposed methodology, we can train the medical images related to lung diseases in terms of CT scan images. In testing side, input the CT scan image, apply pre-processing to eliminate the noises in image using median filter algorithm. And extract the features using contour model. Finally classify the multiple lung diseases using CNN algorithm and to provide diagnosis details with improved accuracy rate.

4.2 ADVANTAGES

- Provide better segmentation results
- Multiple features are read and processed
- Overcome computational problems
- Remove the outliers from lung segmented images.

V. SYSTEM IMPLEMENTATION

5.1 Modules

- Data collection
- Image enhancement
- Contour extraction
- Tissues classification
- Diagnosis details

5.2 Modules Descriptions

5.2.1 Data Collection

Computed Tomography (CT) is taken into account in concert of the simplest strategies to diagnose the pneumonic nodules. It uses x-rays to get structural and practical info concerning the physical body. However, the CT image quality is influenced lots by the radiation dose. The standard of image will increase with the many quantity of radiation dose, however within the same time, this will increase the amount of x-rays being absorbed by the lungs. To forestall the physical body from all reasonably risk, radiologist's area unit obligated to cut back the radiation dose that affects the standard of image and is answerable for noises in respiratory organ CT pictures. In this architecture contains four phases such as pre-processing, segmentation, features extraction and classification.

5.2.2 Image Enhancement

Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise (but see discussion below), also having applications in signal processing. Median filtering is a nonlinear method used to remove noise from images. It is widely used as it is very effective at removing noise while preserving edges. It is particularly effective at removing 'salt and pepper' type noise. The median filter works by moving through the image pixel by pixel, replacing each value with the median value of neighbouring pixels. The pattern of neighbours is called the "window", which slides, pixel by pixel over the entire image pixel, over the entire image. The median is calculated by first sorting all the pixel values from the window into numerical order, and then replacing the pixel being considered with the middle (median) pixel value.

5.2.3 Contour Extraction

Feature learning comprises a set of algorithms to transform labelled or unlabelled data to a new space, where it can capture the parameters and patterns of variation by disentangling the hidden features. Features are learned through supervised and unsupervised learning scheme. Numerous unlabelled data is available in each domain, e.g. images, text data, speech, which contain several patterns of variation that can easily be collected for feature extraction, e.g. from pre-processed image. The task of feature extraction from unlabelled data is known as unsupervised feature learning. In linear sparse coding, the goal is to find a decomposition in which the hidden components are sparse, meaning that they have probability densities which are highly peaked at zero and have heavy tails. This basically means that any given input vector can be well represented using only a few significantly non-zero hidden coefficients.

5.2.4 Tissue Classification

The classification is the final step of the system. After analysing the structure, each section individually evaluated for the probability of true positives. Lung diseases are classified using Convolutional neural network algorithm. CNNs represent feed-forward neural networks which encompass diverse combos of the convolutional layers, max pooling layers, and completely related layers and Take advantage of spatially neighbourhood correlation by way of way of imposing a nearby connectivity pattern among neurons of adjacent layers. Convolutional layers alternate with max pooling layers mimicking the individual of complex and clean cells in mammalian seen cortex.

A CNN includes one or extra pairs of convolution and max pooling layers and ultimately ends with completely related neural networks. The hierarchical structure of CNNs is steadily proved to be the most efficient and successful manner to analyze visible representations. The CNN varies in how the convolutional and max pooling layers are realized and how the nets are trained.

5.2.5 Diagnosis Details

Covid-19 is a rapidly spreading viral disease that infects not only humans, but animals are also infected because of this disease. The daily life of human beings, their health, and the economy of a country are affected due to this deadly viral disease. Covid-19 is a common spreading disease, and till now, not a single country can prepare a vaccine for COVID-19. A clinical study of COVID-19 infected patients has shown that these types of patients are mostly infected from a lung infection after coming in contact with this disease. Chest x-ray (i.e., radiography) and chest CT are a more effective imaging technique for diagnosing lunge related problems. Still, a substantial chest x-ray is a lower cost process in comparison to chest CT. In this module, we can identify the COVID and other diseases. And also provide prescription for affected diseases.

VI. INPUT AND OUTPUT DESIGN

6.1 Input Design

The Input design is the main feature of the system. Input design determines the format and validations criteria for data entering the system. Inputs originate with end-users; human factors play a significant role in input design. The input design is designed to control the input, to avoid delay, errors in data, to avoid extra steps, to keep the process simple. The design of input focuses on controlling the amount of input required, controlling the errors, avoiding delay, avoiding extra steps and keeping the process simple. The input is designed in such a way so that it provides security and ease of use with retaining the privacy. The following are the general principles, which are considered in designing inputs are,

- Enter only variable data
- Do not input data that can be calculated
- List of values
- Sequence entry

6.2 Output Design

Designing the output is more important than working up with few layout charts and reports. The outputs are designed based on the issue encountered. It will also take care of who will receive the output, what for it is produced how much details are needed, when it is needed and by what method. The outputs designed in this system are easy to use and useful for their jobs. The outputs are simple to read interpret. The outputs obtained from this system are designed by using a few guidelines, which are given below. The information should be clear and accurate, yet concise and restricted to relevant data. Reports should have titles, the data and descriptive heading for columns of data, numbered pages and so on.

Performance Analysis

The proposed system implemented in Python framework and the performance of the system can be evaluated using accuracy metrics.

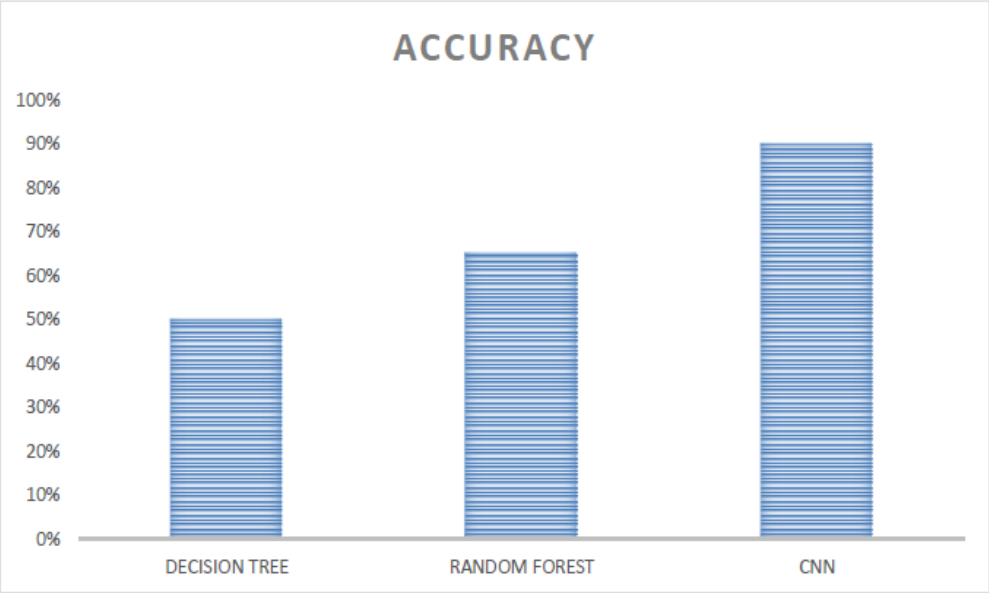

Figure 1: Performance Analysis

The proposed system provide improved accuracy than the existing algorithms and CNN algorithm predict the diseases with improved accuracy rate.

7. CONCLUSION

The confirmatory diagnosis of COVID-19 is mainly dependent on clinical symptoms, epidemiological history, nucleic acid detection, immune identification technology, etc. All the methods mentioned above have some limitations such as time required, costs, equipment dependence, shortage of testing kits, availability of trained healthcare workers, inter operator variability's, especially in a pandemic like this, making them cumbersome diagnostic procedures. Timely diagnosis of the COVID-19 patients can enable help in the optimization of available resources, including trained human resources, for all the supportive measures required for confirmed patients. Automated AI-based intelligent chest X-ray classification has such untapped potential for this unmet need, as evident from recent researches. Rapid screening to diagnose such patients is also essential for controlling outbreaks. In conclusion, an AI system derived from heterogeneous multinational training data delivers acceptable performance metrics for the classification of chest CT for COVID-19 infection. We can conclude that the proposed system provided multiple lung disease classification using CNN algorithm. Our system implemented contour method to segment the lung lesions and with multi-class classification with multiple lung related diseases with improved accuracy rate.

8. FUTURE ENHANCEMENT

In the present time, the whole world is affected by Covid-19 disease, and the most important thing is no single country scientists can prepare a vaccine for the same. In future, we can extend the framework to implement various deep learning algorithms to improve the accuracy with various images.

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