REVIEW OF AI BASED DIAGNOSIS OF COVID-19 EMPLOYING CT IMAGES

V. Rajesh¹, K. Khamarataj²
¹Professor, ²Research Scholar,
¹²Department of ECE, Koneru Lakshmaiah Education Foundation, Guntur, India-522502
Mail id: rajesh4444@kluniversity.in, kkhamarataj@gmail.com

ABSTRACT

On account of unforeseen epidemic of COVID-19, virus is spreading from one to another in proximity across the globe. To thwart the spread of virus the untimely diagnosis and isolation of the effected person is crucial for the alleged patients. Image processing technology fortified with AI techniques for automated diagnosis of COVID-19 helps radiologist’s clinical workflow and minimizes the chances of misdiagnosis. The present study presents the potential role of various convolutional neural network in classification, localization, and precise analysis in the effect of COVID-19 by employing images of CT scan. The study also presents various performance metrics for validating the diagnosing models and the use of AI imaging or portable point of care ultrasound (POCUS) that prevents the patients to move, minimizes the possible spread of virus and also prevent the patients to get exposed to ionizing radiation in CT scans.

I. INTRODUCTION

The occurrence of corona virus infection (COVID-19) since December 2019 is prevailing across various countries of the world, infecting all spans of life and causing acute respiratory distress and leading to multiple organ failures [1]. The disease is highly contagious, spreading from one to another in close proximity though droplets and other forms of physical contact. As of May 8, 2021 worldwide about 156,496,592 confirmed cases were reported and is still counting on every day. Thus, the early and efficient diagnosis of the disease has become crucial for timely treatment of the patients. The sensitivity of routine swab method of diagnosis for early detection of infection varies considerable between 42% to 71% with high rate of false negatives which turns out into true positive later on [2]. The numerous observations in the aspect clinical action and CT conclusions in the pathogens of respiratory viral are claimed for creatin issues regarding the influenza, respiratory syncytial virus (RSV), adenovirus, human parainfluenza virus (HPIV), and rhinovirus demonstrations for the disease in the pattern for the field of anairway-centric design to owe the illness for the thickness of wall at the area named “tree-in-bud” imperviousness including the bronchial partitionispissation. Thus, the adenovirus emerges with the multiscale focus of theamalgamation in the opacity associated to the ground-glass (GGO) which was solely observed by the ill persons or certain bacterial or fungal contaminations. On the contrary, it is believed from the recent studies made by Liu et al. regarding the comparison of HCT-chest in noting the characteristic behaviour of COVID-19 pneumonia to the various infection pneumonia, virus that caused the situation worst with the pneumonia like COVID-19 seems to be the category obilateral, multi-focal, peripheral,ground glass and integrative pulmonary opacities [3], and have sensitivity about 56% to 98% and is helpful in minimizing false negative throughout primary phases in the advancement of disease.

The most common community acquired pneumonia, influenza such types shares similar visual manifestations with COVID-19 through CT scans, thus making it difficult for radiologists/doctors to differentiate viral infection from the rest of pneumonia infections and is also a time consuming process.
Digital image processing technology performs a critical job as in the field of medical applications, technology supported with techniques like machine learning helps the radiologists/doctors in precise diagnosis of disease and decision making. The imaging-based diagnosis of the viral infection. In general, it contains three different stages, they are, image acquisition and de-noising, nodule segmentation, and disease diagnosis and prediction. The pre-scan preparation stage deals with individual patient associated to the protocols. The image acquisition stage involves with the CT images developed for a plan of single breath-hold. At the level of upper area of thoracic inlet, the angle for the costophrenic has scanned in the inferior region in optimizing the constraint established by the radiologist as per the shape of patient’s body. Based on the raw data attained, the reconstruction of CT images is redone and subsequently subsequent pre-processing, reading and diagnosis system for precise prediction of lung disease.

II. **AI BASED DIAGNOSIS**

Artificial intelligence based image diagnosis can provides accurate diagnosis of the infection levels and dealing to creatin range of cases and thus improving the clinical workflow. The present review presents the potential variants of AI in the medical imaging. A. Krizhevsky et al.[4] proposed AlexNetsuggested as the effective implementation with the case of deep convolutional neural network model for image object recognition procedures. Basically, five number of parallely associated layers of convolution network has been connected in reducing the size of the filter. And later the network is supported with three fully connected layers. So, initially, the main property for the AlexNet is certainly the decrement of the intermediate sample rate for the statements all the way through stride out convolutions and the layers of max-pooling scheme. K. Simonyan et al. [5] proposed VGG Net for object localization and classification tasks. In the proposed methodology, architecture built with the CNN was increased to kernels of large size has been replaced further to the multiple level of reduced kernels in order to obtain the accuracy for the advancements to be handled in the concerned concept of tasks related to computer vision missions. Variations to the VGG Net modifications found the format of extensive outcome in the extraction of features, and classification of further image processing in the field of medical applications. The model achieves 92.7% in localization and classification tasks. Zhao, J., Zhang et al., [6] proposed the task for classicisation employing the DenseNetplan. The inventors used learning system for further transfer and augmented data to enhance the task for classification. Many authors implemented DenseNet architecture instead of differentiating between non-covid cases covid-19, critically achieved the accuracy rate of 83.5% with F1-Score and values of AUROC remains 0.849 and 0.831, correspondingly. L. Li, L. Qin, Z. Xu et al., [7] has built up a three-dimensional profound learning model for identifying Covid infection (COVID-19) from chest CT pictures. The 3D profound learning structure for the discovery of COVID-19, alluded to COVNet can remove both 2D nearby and 3D worldwide agent highlights. The COVNet system comprises of a RestNet50 which takes arrangement of CT cuts and concentrates highlights for the comparing cuts. On a free testing informational index, the creators have accomplished high affectability (90% [95% CI: 83%, 94%] and high particularity of 96% in identifying COVID-19. Y.H. Wu et al., [8] the creators have built up a Joint Classification and Segmentation (JCS) framework for COVID-19 conclusion. In the model, the order model distinguishes if the speculated patient is COVID-19 positive and the division model concentrates injury areas in the CT pictures of COVID-19 patients. The proposed model has accomplished a 95.0% affectability and 93.0% explicitness on the arrangement test set of our COVID-CS dataset. Xuelin Qian. Mohanty et al., [9] proposed the system for deep
In medical image processing, the segmentation process remains the crucial part in order to detect the COVID-19 as per the HCT-chest scan images. The authors have implemented a 2D CNN for classification based on the spatial information to locate the abnormalities. The authors in their work have attained an overall performance with an accuracy rate of 95% for the error in false positive and negative of 2.8% and 4%, individually. However, oversensitive of model causes the occurrence of noise. Ko et al., [10] the authors developed a 2D deep learning network Fast-track COVID-19 classification network (FCONet), to diagnose COVID-19 based on a single chest CT image. FCONet was developed based on transfer learning using pre-trained deep learning models VGG16, ResNet-50, Inception-v3, or Xception as a backbone. The proposed model was validated on CT images of patients with COVID-19 pneumonia, other pneumonia, and non-pneumonia diseases. It was concluded that FCONet based on ResNet-50 outperformed other pre-trained models and achieved 96.97% of accuracy in the external validation data set of COVID-19 pneumonia images. Chen, Jun, et al. [11] the authors have developed a deep learning model based on U-Net++ and ResNet-50 as backbone of for diagnosis of COVID-19. The authors has also compared the findings of the proposed model with expert radiologists for consistency of the model. The system has achieved an accuracy of 96%, a sensitivity of 98%, a specificity of 94%, a PPV of 94.23% and an NPV of 97.92% on external dataset. Mei, Xueyan, et al., [12] the authors has suggested for the development of neural network involving the CNN theory to characterise the infected patients effected with COVID-19 as per the analysis made by the CT scanning. In the context, the later task will be associated with the application of various methods such as support vector machine (SVM), random forest and multilayer perceptron (MLP) classifiers to categorize patients effected with COVID-19 corresponding with the information gathered in the clinical aspect. Finally, they developed neural network model in combination with the data obtained from radiologists for prediction or estimation of COVID-19 prominence. However, the authors have reported small sample size and bias in the direction of patients with COVID-19 in the data trained as constraints of the AI model to differentiate COVID-19 from various other causes to the failure of respiratory. Roy, Subhankar, et al., [13] the authors has proposed lung ultrasonography (LUS) videos in the localization and classification of COVID-19 using U-Net architecture. In the proposed method the LSU video is converted into frames which are given as an input image to the U-Net architecture for frame-based pathological score for prediction.

### III. IMAGE SEGMENTATION WITH AI MODELS

In medical image processing, the segmentation process remains the crucial part in order to detect the infection occurred in lungs as well as lesion measurement triggering the analysis in quantitative region scoring off the effect due to COVID-19 cases. Segmentation is the process of outlining the region of interest for instance, lung, bronchopulmonary segments, lobes, and other contaminated provinces as well as lesions intended forth the reason of inspecting the features, discriminating the type and severity of the disease. Segmenting the region of interest in X-ray images is quite a difficult task due to the projection of ribs onto the tissue than in CT images. CT images delivers the 3D images with high resolution and quality that are appropriate to segment the region of interest. The lesions or nodules in the lungs being very insignificant structures, shapes, sizes, ad textures to allocate the nodules or patterns or lesions has stood as issue and concern in order to solve the challenging task. The methods involved for segmentation in the case of COVID-19 are generally classified based on 2 groupings; one is region of lung oriented and lung lesion-oriented practices. The objective of lung region-oriented practices steps up for the separation of regions in such as whole lung and lung lobes in the background works for the region of CT images [15-17], whereas lung lesion-oriented method dry for the separation of lesions from regions of lung into the lung lesions. The popular AI methods such as classical U-Net, U-Net++, VB-Net for segmentation has been used by many authors. This section summarizes the implementation of AI methods for segmentation. A two-stage pipeline has been proposed by Jin et al., for inspection of CT images in COVID-19, wherein the region of lung as a whole detecting for the segmentation process effectively for the case in networking of 3D class of U-Net++. The proposed segmentation architecture consists of deeply supervised encoder and decoder sub-networks which enabled more accurate segmentation. The 3D U-Net++ model obtained the highest dice coefficient of 0.754 and a sensitivity of 97.4% and specificity of 92.2%. Shan, et al. [15], the authors employed deep learning based “VB-Net” for segmenting the neural network-based detection of segmentation for COVID-19 region of infection occurred in the scan of CT images. By employing the 249 COVID19 affected patient’s information, the system has been trained for constructing the validation report of newly registered 300 COVID-19 cases. For the reason of training the CT images effected for the delineation the system trains further in the aspect of certain strategy outcome to human-in-the-loop (HITL) to support radiologists for automatic refining of annotation for the individual cases. The dice similarity coefficient for the recommended approach generated up to the standard deviation of 91.5%±10.5% amongst the segmentation.
done by manual or automatic process in which the error caused in mean POI is estimated around the range of 0.4% for the entire validation attained for the dataset provided with the region of lung. The progression for the longitudinal aspect of cases involved COVID-19 assessed by Cao et. al., for the analysis of deep learning technique combine to the voxel-level in segmentation of CT for the region of respiratory complexities. Later, comparison of the proposed technique with the manual process of segmentation made expertise is established for lungs and respiratory imperviousness. Huang et al. [17] perfumed a quantities assessment for the opacification of respiratory issues employing the AI techniques. The procedure contains 3 modules listed as follows (a) segmentation module for lung and lobes, (b) lung impenetrability segmentation module, and (c) quantitative analysis module to learn the multifaceted association amongst miscellaneous topographies removed from the CT scans of chest and sections of attention (lungs, lobes, and opacities) to be crucially analyzed for regulating the advancements in the COVID-19. Ying et al., [18] utilize 2D cuts including lung locales divided by OpenCV. 15 cuts of complete lungs are gotten from every 3D chest CT pictures, and each 2D cut is utilized as the contribution of the proposed profound learning-based CT determination framework. A pre-prepared ResNet-50 is utilized and the Feature Pyramid Network (FPN) is added to extricate the top-K subtleties from each picture. The model accomplished an exactness of 86.0% for pneumonia order (COVID-19 or bacterial pneumonia), and a precision of 94.0% for pneumonia finding (COVID-19 or sound). Li et al. [19], the authors develop a 3D deep learning framework for the detection of COVID-19. The proposed model reports 90% of sensitivity, 96% specificity, and 0.96 AUC in associating COVID-19 situations. Qi et al. [20]. The creators have proposed U-Net based calculation for programmed division of lung injury and removing the highlights of the CT for expectation of the seriousness. The models utilized two regulated learning calculations, strategic relapse (LR) and irregular timberland (RF), were utilized to fabricate the model and check the power of highlights. C. Zheng et al. [21], the creators have built up a directed profound learning-based framework utilizing 3D CT volumes to identify COVID-19. In the proposed philosophy the lung area was divided utilizing a pre-prepared UNet then the sectioned 3D lung district was taken care of into a 3D profound neural organization to foresee the likelihood of COVID-19 irresistible. The profound learning calculation acquired an exactness of 90.1%, a positive prescient worth of 84.0% and a high bad prescient worth of 98.2%. explained writing assessed portrays the need of an enormous amount of information for legitimate preparing of the models which in any case may prompt overfitting of the outcomes.

IV. METRICS FOR PERFORMANCE EVALUATION OF AI MODELS

To comprehend the performance of the proposed AI model algorithms, it is necessary to evaluate the techniques associated to various image classes for further support needed in classifying and localizing of the lesion/consolidations in CT image. Several authors have proposed various metrics in order to authorize the AI models efficiency on the image of CT scan for diagnosis. The metrics are as follows: sensitivity, accuracy, specificity, negative prediction value (NPV), positive prediction value (PPV), and error rate, Dice similarity coefficient, Area under ROC which are calculated as follows:

<table>
<thead>
<tr>
<th>Performance metrics</th>
<th>Formula</th>
<th>Preferred value</th>
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<tbody>
<tr>
<td>Accuracy</td>
<td>( \frac{T_p + T_N}{T} )</td>
<td>100%</td>
</tr>
<tr>
<td>Error rate</td>
<td>( \frac{P_N - F_N}{T} )</td>
<td>0</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>( \frac{T_p}{T_p + F_N} )</td>
<td>100%</td>
</tr>
<tr>
<td>Specificity</td>
<td>( \frac{T_N}{T_N + F_P} )</td>
<td>100%</td>
</tr>
<tr>
<td>Positive Prediction Value (PPV)</td>
<td>( \frac{T_p}{T_p + F_P} )</td>
<td>100%</td>
</tr>
<tr>
<td>Negative Prediction Value (NPV)</td>
<td>( \frac{T_N}{T_N + F_N} )</td>
<td>100%</td>
</tr>
</tbody>
</table>
Tₚ: Represents the true positive that defines the exact prediction quantity of total COVID-19 cases, Fₚ: Represents the false positive that defines the erroneously predicted quantity of total COVID-19 cases, Tₙ: Represents the true negative that defines the exact prediction of total non-COVID-19 cases, Fₙ: Represents the false negative that defines the mistakenly predicted quantity of total non-COVID-19 incidents; Tₚᵣ: True positive rate and when it is actually true, how often does it predict true; Pᵥ: positive predictive value and is when it predicts true, how often is it correct. To determine the ratio of overlapping amongst the region of infection segmented automatically and the reference corresponding to the same region can be done through the coefficient named the Dice similarity coefficient (DSC). Statistical methods such as correlation was also used to validate the observations made by radiologists and the AI models.

### V. DATABASE

For diagnostics of COVID-19 with the development of machine learning, the image data base is found the crucial procedure in enhancing the overall system performance. Based on the validated CT scans obtained from the constrained available data, the research impedes towards the expansion applying the techniques of AI. Numerous samples of images have been collected from the research articles by the author Zhao et al. [22] and further circulated a CT scan dataset widely. Based on the survey of various publications and websites, the author Cohen et al., [23] has created the image data collection of COVID-19 by constructing images of medical condition. With the mentioned website link, the number of cases that are registered for corona can be seen [https://coronacases.org] [29] which incorporates the images of 3D CT for the registered corona incidents. The segmentation of CT images from the effect of COVID-19 datasets contains representations of those registered incidents of COVID-19, all through which available on the stated website link http://medicalsegmentation.com [30]. A large data set is required for in-depth analysis for the progress of designed models in differentiating the potential stuck between the other pathological infective disorders and COVID-19.

### VI. CONCLUSIONS

Artificial intelligence based medical image diagnosis is gaining significance in diagnosing COVID-19 clinically. The comprehensive study reveals that the most of the pre-trained AI models using certain parameters and specifications and training strategies for the diagnosis of COVID-19 using various image modalities is not exhaustive and still requires a suitable learning networks and efficient training strategies with exhaustive data base for clinical validation and applications. The studies also reveals that the observations by the various models needs to be validated in conjunction with radiologists, additional examinations remainders the appropriate performance of the AI based diagnosis with high degree of confidence to relieve the burden on the radiologists. The studies also emphasis on the use of AI imaging or portable point of care ultrasound (POCUS) that prevents the patients to move, and minimizes the possible spread of virus and also prevent the patients to get exposed to ionizing radiation in CT scans.

### REFERENCES


