IFERP
ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 8, Issue 6, June 2021

Design and Implementation of Detection of Covid Using CT scan Images

[1] Ishwar Kharat, [2] Dr. Avinash S. Kapse
[1] Student, Department of Computer Science & Engineering, Anuradha Engineering College, Chikhli
[2] Head of Department & Assistant Professor, Department of Information Technology Anuradha Engineering College, Chikhli

Abstract: The diagnosis of any disease is like the light at the end of the tunnel. In the case of the COVID-19 pandemic, the importance of earlier diagnosis and detecting the disease is beyond measure. The initial focus must be on the data by which we need to efficiently train a model. This data will help Machine Learning (ML). or Deep Learning (DL) algorithms to diagnose COVID-19 cases. Due to the disadvantages of RT-PCR, researchers adopted an alternative method which is the use of Artificial Intelligence on chest CT or X-Ray images to diagnose COVID-19. Fundamentally, a chest CT image is an image taken using the computed tomography (CT) scan procedure where X-Ray images are captured from different angles and compiled to form a single image. Although a CT scan consumes less time to demonstrate, it is fairly expensive. As a result, many researchers adopted X-Ray images instead of CT images to develop a COVID-19 detection model. A chest X-Ray is a procedure of using X-Rays to generate images of the chest. Also, it is relatively economical and convenient to maintain.

Keywords: Detecting, Machine Learning, Deep Learning, X-Ray, Computed Tomography(CT)

I. INTRODUCTION

The flare-up of obscure serious pneumonia, first announced in December 2019 in Wuhan city of China, has transformed into a worldwide pandemic and a quickly arising emergency. An epic strain of Covid, like the intense SARS-CoV of 2002–2003, was answerable for the current pandemic (COVID-19). From now on, it was named Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2), there is no all around endorsed treatment convention is accessible other than indicative treatment, despite the fact that FDA as of late gave crisis use approval to Remdesivir. Deliberate exertion all around the world prepares into antibody improvement. Right now, FDA has endorsed Pfizer-BioNTech COVID-19 Vaccine and Moderna COVID-19 antibody for crisis use authorization.[1]

Following FDA endorsement, different nations have likewise affirmed the antibody for mass roll-out.Early determination is of prime significance for infection regulation and diminishing transmission by fast seclusion of patients and supporting basic treatment. Constant Reverse Transcriptase Polymerase Chain Reaction (rRT-PCR) has been the most generally executed SARS-CoV-2 symptomatic apparatus. An expanding inclination for point-of-care tests inclines the accessibility of a few other symptomatic devices and strategies. Place of care tests are for the most part refreshed advancements that incorporate both the fast and research facility free conclusion, which conceivably would meet the criticalness of the progressing circumstance. An as of late distributed survey paper on COVID-19 diagnostics by Yüce et al zeroed in on the standards of accessible atomic and serological symptomatic tests alongside clarifying Emergency Use Authorization-gave business test packs while another assessed the two standard of diagnostics – sub-atomic and serology in the light of just FDA endorsed units. Additionally, audit on the appropriate inspecting site or exclusively on the standards of diagnostics have likewise been distributed. Be that as it may, a far reaching audit covering all the accessible being used and expected advancements for SARS-CoV-2 recognition alongside their qualities and disadvantages just as reasonable examining locales is needed to fill the hole. Our present survey is expected to expand the missing piece relating to all the forward-thinking FDA-affirmed packs and examine the arising advancements with the possibilities as supporting indicative tools.[2][3]

II.LITERATURE REVIEW

Profound learning is a notable exploration territory in man-made consciousness. It furnishes promising outcomes with start to finish displaying without manual element designing in clinical picture characterization multi-name picture arrangement He et al., text classification Imtiaz et al. [17], cellular breakdown in the lungs identification Yamunadevi and Ranjani [50]

ECG arrangement Huang et al. [16], glaucoma analysis Ajesh et al. [1] Since the beginning of COVID-19, analysts COVID-19 cases for every one of the nations, left y-pivot shows absolute affirmed cases in million, and right y-hub shows complete number of passings in million Organization COVINet: a convolutional neural organization approach for foreseeing COVID-19 from chest X-beam begin zeroing in on antibody improvement, identification of SARSCoV-2 utilizing clinical pictures.

Salivary example location Bajaj et al. [2], factors influencing mortality of doctors and medical caretakers Jackson et al. what's more, clinical element examination Zhao et al. Exploration Li et al. presents a methodology which uses CNN on the chest CT for identifying COVID-19 patients.[15]

A profound learning model COVID-19 discovery neural organization (COVNet) is planned which removes visual highlights from chest CT. The CT tests for local area procured pneumonia and non-pneumonia CT tests are added in the dataset too to assess the proposed model. Results show that the model affectability and particularity are 114 of 127 (90%) and 294 of 307 (96%) for identifying COVID-19 patients.

Division is a significant and critical advance for AI based methodologies that plan to identify COVID-19 patients through imaging strategies. It delimits the tainted regions called districts of interest (ROIs) that can be utilized for additional handling and examination. Such countless explores works proposed profound learning-based methodologies for CT division for the evaluation and expectation of COVID-19.

The U-Net planned by Ronneberger et al. is a renowned strategy utilized in universally useful division. It has been received by numerous creators to portion COVID-19 patient's CT images.[39] For instance, creators in Zheng et al.used a pre-prepared UNet to fragment lung areas of CT pictures of the patients. An aggregate of 499 and 131 CT pictures are utilized for preparing and testing with the proposed DeCoVNet which is a feebly regulated profound learning model. The collector working trademark bend (PR AUC) esteem is 0.975 for the tried CT pictures and the affectability and particularity esteems are bigger than 0.9. [53] Essentially, creators in Gozes et al. use profound learning ways to deal with order COVID-19 and non-COVID-19 patients from CT pictures. Division of ROIs is finished utilizing UNet while the grouping of patients is accomplished through the Reset-50 2D profound convolutional neural organization [10]

Results are 0.996 AUC, 98.2% affectability and 92.2% particularity. Another comparable work that utilizes CT pictures to recognize COVID-19 and non-COVID-19 patients is Chen et al.[5]. The proposed profound learning approach utilizes CT pictures of 51 affirmed COVID-19 patients, and 55 control patients from different infections to prepare the model. Picture division is finished utilizing UNet++ and later a CNN is prepared for arrangement Zhou et al [54] . The proposed approach shows exactness equivalent to that of radiologists' and can impressively lessen the perusing season of the radiologists.

Creators in Jin et al. plan a framework that consequently investigates the highlights from CT pictures to recognize COVID-19 pneumonia highlights and help doctors in the arrangement of the patients [20]

A preparation dataset involving 1,136 CT pictures (723 positives for COVID-19) is utilized for this reason. The 3D U-Net++ is utilized for picture division while the characterization is performed utilizing ResNet He et al. The proposed approach accomplishes an affectability of 0.974 and an explicitness of 0.922 for the utilized dataset. The above-refered to explore works utilize profound learning models on the CT pictures for COVID-19 discovery. CT pictures are excellent 3D pictures accomplished from tomography. CT pictures are 3D pictures and contain many cuts. It requires a generous measure of time and computational assets to preprocess these pictures before we can put them to the preparation models [54]

Then again, X-beam pictures are more normal and simple to measure than those of CT pictures. Consequently different scientists proposed AI models that can work with X-beam pictures. Creators in Narin et al.introduces three unique models, i.e., ResNet50, InceptionV3, and Inception-ResNetV2 to order COVID-19 patients from X-beam pictures [33] The models are prepared on chest X-beam pictures of 50 COVID-19 patients and 50 typical individuals. The accomplished exactness is 98.0%, 97.0% and 87% for ResNet50, InceptionV3 and Inception-ResNetV2, separately. Oddity identification is utilized to improve COVID-19 characterization. Grouping is performed to isolate COVID-19 patients from pneumonia patients. Results show the affectability of 96.0%, the explicitness of 70.07%, and AUC of 0.952. Another profound learning model is worked out by creators in Wang and Wong for COVID-19 patient characterization. The model i.e., COVID-Net depends on a profound CNN and utilizations X-beam pictures of 1203 solid individuals, 931 bacterial pneumonia patients,660 patients with viral pneumonia, and 45 patients affirmed for

COVID-19. The testing exactness of COVID-19 is 83.50% [48] The investigations that use X-beam pictures to order COVID-19 patients and solid subjects train on a little dataset of 45 to 70 pictures Shi et al. (2020). With the predetermined number of X-beam pictures, the vigor and exactness of the proposed approach can't be resolved indisputably. Additionally, the outcomes can't be summed up with a more modest dataset. We, in this way, use Keras Image Data Generator class to expand pictures for expanding the quantity of X-beam pictures. Later we work out picture pre-handling strategy and an altered CNN model to build the forecast precision for COVID-19 patients.

III.ANALYSIS OF THE PROBLEM

COVID-19 has been declared as a pandemic that is, an epidemic spread across various countries and continents. 75% of the population all around the world is under the lockdown situation to overcome its widespread. Researchers are working hard to find a solution to diagnose the corona virus at an early stage and its cure. Though its fatality rate is low, still the chances of death are high for people with lower immunity especially elderly and infants. Hence, early detection of virus in their body is important. It is known as a droplet infection, spreads by the droplets of an infected person’s cough, sneeze or mouth. One of the major symptoms of COVID-19 is breathlessness and pain in the chest. The corona virus affects the lung region largely, causing an inflammation in the lungs and making it tougher for the person to breathe. The corona virus has been observed to attack the healthy cells present in the lungs and damages the alveoli (tiny air sacs) which transfers the oxygen to the blood vessels. These blood vessels carry the oxygen to the RBCs. RBC in turn; deliver the oxygen to all the internal organs in the body. But this functionality gets affected by the virus and the first response of the body is to destroy the virus and prevent its replication, but if the individual has weaker immunity then the body is unable to stop the virus and this aggravates the crisis.

Doctors can see signs of respiratory inflammation on a chest X-ray or CT-scan. On a chest CT image, they may see something they call “ground-class opacity” because it looks like a frosted image. The opaque spots in your lungs look like they start to connect each other in cases of severity. But these conclusions are not specific for COVID-19 (can be possible for flu as well). Considering that CT imaging could aid in screening and accelerating the speed of the diagnosis of COVID-19 especially with shortage of RT-PCR which is quite an expensive instrument that most of them cannot afford, we can say CT scans are useful but accuracy should be ensured.

To ensure accuracy, we train the convolution model using CT-scans of both COVID and non-COVID patients in our proposed work. Using this, it will support in the clinical decision making with considered accuracy rate.

IV.EXISTING WORK

Even though ***real-time reverse transcriptase polymerase chain reaction (RT-PCR)*** has been considered as the gold standard for SARS-CoV-2 diagnosis, the very limited supply and strict requirements for laboratory environment would greatly delay accurate diagnosis of suspected patients, which has posed unprecedented challenges to prevent the spread of the infection, particularly at the nucleus of the epidemic area. In contrast with it, ***chest computed tomography (CT)*** is a faster and easier method for clinical diagnosis of COVID-19 by combining the patient’s clinical symptoms and signs with their recent close contact, travel history, and laboratory findings, which can make it possible for quick diagnosis as early as possible in the clinical practice. It is also effectively helpful to isolate infected patients timely and control the epidemic. Chest CT is a key component of the diagnostic procedure for suspected patients and its CT manifestations have been emphasized in several recent reports.

Deep learning, as the core technology of the rising artificial intelligence (AI) in recent years, has been reported with significantly diagnostic accuracy in medical imaging for automatic detection of lung diseases. It surpassed human-level performance on the ImageNet image classification task with one million images for training in 2015, showed dermatologist-level performance on classifying skin lesions in 2017 and obtained very impressive results for lung cancer screening in 2019. However, most deep learning based methods for disease diagnosis requires to annotate the lesions, especially for disease detection in CT volumes. In the current, annotating lesions of COVID-19 costs a huge amount of efforts for radiologists, which is not acceptable when COVID-19 is spreading fastly and there are great shortages for radiologists.

Specifically, deep learning was applied to detect and differentiate bacterial and viral pneumonia in ***paediatric***

chest radiographs. Attempts have also been made to detect various imaging features of chest CT. In this report, we proposed a Deep Learning based Approach for Detection and Classification of COVID-19 on CT-scans using U-Net model and Convolutional Neural Network.

The proposed work is different from the existing work in such a way that we first perform the segmentation operation on the CT scans to filter out the lung region using the pre trained U-Net model. The output of this U-Net model is then fed into the Convolutional Neural Network for the training of the classification and detection process. U-Net model is very appropriate to run on a large dataset for processing and segmentation operation. Deep learning has been used for extracting COVID-19's graphical features from Computerized Tomography (CT) scans (images) using U-Net model in order to provide a clinical diagnosis ahead of the pathogenic test, thus saving critical time disease control.

The U-Net model accurately estimates and segments the shape and volume of the lung region. This segmented lung region from the CT scan is then fed to the CNN model. The study used a Convolution Neural Network (CNN) on 746 CT scans to train the model using the classification of the CT-scans of COVID and non-COVID patients, and then detect the infection in CT scans of COVID-19 patients. The training and validation accuracy of the model was recorded at around 91.5% and 70%, respectively.

V. PROPOSED APPROACH

The proposed work has great potential to be applied in clinical application for accurate and rapid COVID19 diagnosis, which is of great help for the front line medical staff and is also vital to control this epidemic worldwide. Accurate and fast diagnosis of infection results in treating a large number of patients in a short period of time. Manual read of a CT scan can take up to 15 minutes, the proposed model would be able to analyse the images in 10 seconds. It will support clinical decision making and improve workflow efficiency. We can say that it is at least 75% useful towards the human wellbeing during this time of crisis as it is rightly said, early detection leads to early treatment and cure resulting in less number of deaths.

The proposed framework uses X-beam pictures from the dataset. The design of the proposed approach is appeared in Fig. 1. The proposed approach includes two modules: picture preprocessing and CNN. These modules are depicted here in detail. Picture preprocessing The preprocessing targets eliminating the clamor in X-beam pictures to improve the preparation cycle of CNN. Overwhelmingly, input pictures are huge which expands the preparation time. The initial step is to lessen the size of the X-beams pictures. The size of X-beam pictures in the dataset is diverse for X-beam pictures. In the initial step, we diminish this size to 120 × 120 × 3. For edge identification, a worth based channel ([0,- 1,0],[-1,6,-1],[0,- 1,0]) is applied on the pictures. As the third step, Blue Green Red (BGR) picture is changed over to the luma segment, blue projection, and red projection (YUV).[4]

It decreases the goal of the U and V channels yet keeps Y at full goal. Since luminance is a higher priority than shading. Furthermore, decreasing U and V channels, the size of CNN can be diminished generously. The engineering of the proposed cnn Deep learning-based methodologies have shown unrivaled execution than those of conventional AI approaches.[5] Owing to their huge exactness, profound learning-based models has pulled in impressive consideration during ongoing days.

They have been applied in an enormous assortment of spaces like article discovery, scene acknowledgment, scene examination, and so on Convolutional neural organizations (CNN) have been explicitly used for PC vision errands. CNN includes countless convolutional, just as, pooling and completely associated layers, each layer playing out an alternate errand. For instance, the convolutional layer utilizes a fixed size channel called bit to separate neighborhood highlights from the information image.[6][7]

Another convolved picture is gotten each time a convolution is applied. Each convolved picture contains highlights that have been removed from the picture of the past advance. Let I(x, y) be a 2D information picture and let f(x, y) be the 2D portion applied for convolution, at that point the convolution is Nielsen (2015) pooling and completely associated layers. The pooling layer is utilized to sum up the nearby fixes of convolutional layers. It subsamples the convolutional layer to decrease the size of the element map.

The pooling layer figures the greatest and normal capacity over the convolutional layer and are called max pooling and normal pooling regarding the capacity they perform. Dispersing in the pixels of the picture is utilized with pooling and is called step. There is no actuation work in pooling layers; they utilize a corrected direct unit (ReLU)[8]

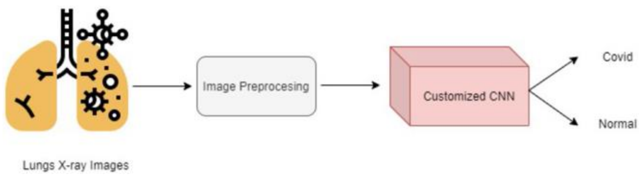

Figure 1. The flow of the proposed system

VI. RESULT

Fig. 2 Dataset availability of Normal and Covid

Data Exploration

```
In [60]:
#Loading the data about data
print ('Loading data about image')
pd.set_option('display.max_rows', 500)
covid_data = pd.read_csv('metadata.csv')
covid_data.head()

Loading data about image
```

Out[60]:

	Patientid	offset	sex	age	finding	survival	view	modality	date	location	filename	doi	
0	2	0.0	M	65.0	COVID-19	Y	PA	X-ray	2020	NaN	auntminnie-a-2020_01_28_23_51_6665_2020_01_28_...	10.1056/nejmc2001272	https://ww
1	2	3.0	M	65.0	COVID-19	Y	PA	X-ray	2020	NaN	auntminnie-b-2020_01_28_23_51_6665_2020_01_28_...	10.1056/nejmc2001272	https://ww
2	2	5.0	M	65.0	COVID-19	Y	PA	X-ray	2020	NaN	auntminnie-c-2020_01_28_23_51_6665_2020_01_28_...	10.1056/nejmc2001272	https://ww
3	2	6.0	M	65.0	COVID-19	Y	PA	X-ray	2020	NaN	auntminnie-d-2020_01_28_23_51_6665_2020_01_28_...	10.1056/nejmc2001272	https://ww
4	4	0.0	F	52.0	COVID-	NaN	PA	X-ray	2020	Changhua Christian Hospital	nejmc2001573_f1a.jpeg	10.1056/NEJMc2001573	https://ww

Fig.3 Data Exploration

Loading the image data

```
In [15]:
#List of files

path_list = list(paths.list_images('Dataset'))

X = []
Y = []


for path in path_list:
    # Set Class label
    y = path.split(os.path.sep)[-2]
    print(y)
    # Grayscale the image and reshape
    image = cv2.imread(path)
    image = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)
    image = cv2.resize(image, (512, 512))

    # update the data and labels lists, respectively
    X.append(image)
    Y.append(y)

# Normalize images

X = np.array(X) / 255.0
Y = np.array(Y)

print('Number of training images: ', len(X))
print('Number of training images: ', len(Y))
```

Fig. 4 Loading and Training the data

```
'NORMAL' 'NORMAL' 'NORMAL' 'NORMAL' 'NORMAL' 'NORMAL' 'NORMAL' 'NORMAL'
'NORMAL' 'NORMAL' 'NORMAL' 'NORMAL' 'NORMAL' 'NORMAL' 'NORMAL' 'NORMAL'
'NORMAL' 'NORMAL' 'NORMAL' 'NORMAL' 'NORMAL' 'NORMAL' 'NORMAL' 'NORMAL'
```

Splitting the data

```
In [24]:
# split training and test data

(X_train, x_test, Y_train, y_test) = train_test_split(X, Y,
    test_size=0.20, stratify=Y, random_state=2019)

(x_train, x_valid, y_train, y_valid) = train_test_split(X_train, Y_train,
    test_size=0.20, stratify=Y_train, random_state=2019)
```

Fig. 5 Splitting the data after training in terms of Normal and Covid

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)

Vol 8, Issue 6, June 2021

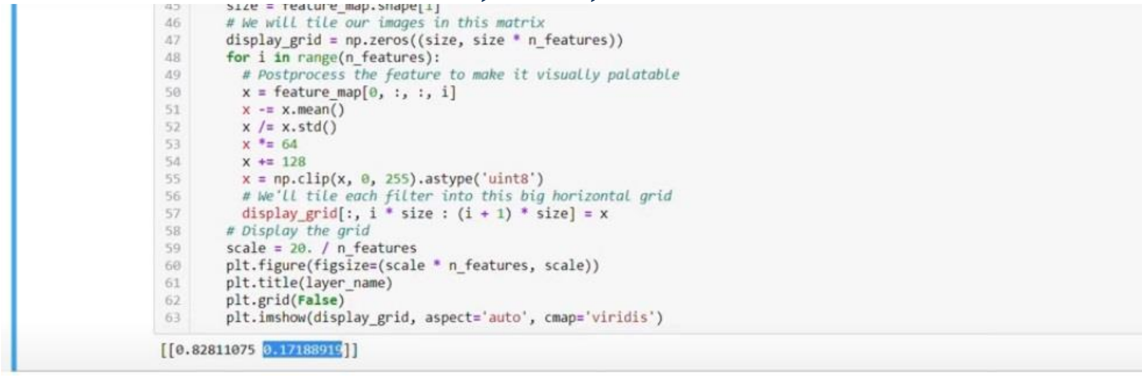

Fig. 6 Percentage of Affected Patient with input image

VII.ADVANTAGES

Convolutional Neural Network (CNN) has been fundamentally applied to extricate the highlights, and this exceptional trademark has been monstrously applied in clinical picture investigation that offers an incredible help in the headway of wellbeing local area research.[10][11]

• CNN is a kind of counterfeit neural organization which has various layers, and is master to handle the high volume of information with higher precision and less computational expense.

• The fundamental construction of CNN includes convolution, pooling, smoothing, and completely associated layers.[12]

VIII.DISADVANTAGES

- Large Database required for accuracy
- Time consuming
- Expensive techniques used

IX.CONCLUSION

Present overall situation causes to notice the way that research center finding is vital in general wellbeing reaction to control SARS-CoV-2 contamination which has been consistently underscored by the wellbeing specialists all throughout the planet. Different testing frameworks have been created, investigated to evaluate the test qualification for fruitful infectious prevention, yet a solitary fast, precise and savvy technique with sufficient affectability has been hard to find out with all advantages and disadvantages of every methodology. The current audit takes a gander at the symptomatic innovations that either have effectively been executed or are being worked on. Coronavirus demonstrative frameworks depend on four significant standards: Cell culture and microscopy, imaging frameworks, nucleic corrosive based location.

REFERENCES

[1] Ajesh F, Ravi R, G R, (2020) Early diagnosis of glaucoma using multifeature analysis and dbn based classification. J Ambient Intell Human Comput. https ://doi.org/10.107/s1265 2-020-01771 –z

[2] Bajaj N, Granwehr BP, Hanna EY, Chambers MS (2020) Salivary detection of sars-cov-2 (covid-19) and implications for oral healthcare providers. Head & Neck

[3] Bishop CM (2006) Pattern recognition and machine learning. springer, Berlin

[4] Chen F, Liu Z, Zhang F, Xiong R, Chen Y, Cheng X, Wang W, Ren J (2020a) First case of severe childhood novel coronavirus pneumonia in china. Zhonghua er ke za zhi Chinese Journal of Pediatrics 58:E005–E005

[5] Chen J, Wu L, Zhang J, Zhang L, Gong D, Zhao Y, Hu S, Wang Y, Hu X, Zheng B, et al. (2020b) Deep learning-based model for detecting 2019 novel coronavirus pneumonia on high-resolution computed tomography: a prospective study. medRxiv

[6] Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, Qiu Y, Wang J, Liu Y, Wei Y et al (2020c) Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. The Lancet 395(10223):507–513

[7] Dataset (2020) Covid data. https ://drive .googl e.com/uc?id=1coM7 x3378 f-Ou2l6 Pg2wl daOI7 Dntu1 a, online: accessed 22 April 2020

[8] Di Gennaro F, Pizzol D, Marotta C, Antunes M, Racalbuto V, Veronese N, Smith L (2020) Coronavirus diseases (covid-19) current status and future perspectives: a narrative review. Int J Environ Res Pub Health 17(8):2690

[9] Documentation K (2018) Imagedatagenerator class. https ://keras .io/ prepr ocess ing/image /#image datag enera tor-metho ds, online: accessed 28 April 2020

[10] Gozes O, Frid-Adar M, Greenspan H, Browning PD, Zhang H, Ji W, Bernheim A, Siegel E (2020) Rapid ai development cycle for the coronavirus (covid-19)

pandemic: Initial results for automated detection & patient monitoring using deep learning ct image analysis. arXiv preprint arXiv :20030 5037

[11] Hajian-Tilaki K (2013) Receiver operating characteristic (roc) curve analysis for medical diagnostic test evaluation. Caspian J Int Med 4(2):627

[12] He K, Zhang X, Ren S, Sun J (2016) Deep residual learning for image recognition. In: Proceedings of the IEEE conference on computer vision and pattern recognition, pp 770–778

[13] He T, Zhang L, Guo J, Yi Z (2020) Multilabel classification by exploiting data-driven pair-wise label dependence. Int J Intell Syst

[14] Hinton GE, Srivastava N, Krizhevsky A, Sutskever I, Salakhutdinov RR (2012) Improving neural networks by preventing coadaptation of feature detectors. arXiv preprint arXiv :12070 580

[15] Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, Zhang L, Fan G, Xu J, Gu X et al (2020a) Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. The Lancet 395(10223):497–506

[16] Huang JS, Chen BQ, Zeng NY, Cao XC, Li Y (2020b) Accurate classification of ecg arrhythmia using mowpt enhanced fast compression deep learning networks. J Ambient Intell Human Comput. https ://doi.org/10.1007/s1265 2-020-02110 -y

[17] Imtiaz Z, Umer M, Ahmad M, Ullah S, Choi GS, Mehmood A (2020) Duplicate questions pair detection using siamese malstm. IEEE Access 8:21932–21942

[18] Jackson D, Anders R, Padula WV, Daly J, Davidson PM (2020) Vulnerability of nurse and physicians with covid-19: Monitoring and surveillance needed. J Clin Nurs

[19] Jiménez-Valverde A (2012) Insights into the area under the receiver operating characteristic curve (auc) as a discrimination measure in species distribution modelling. Global Ecolo Biogeogr 21(4):498–507

[20] Jin S, Wang B, Xu H, Luo C, Wei L, Zhao W, Hou X, Ma W, Xu Z, Zheng Z, et al. (2020) Ai-assisted ct imaging analysis for covid- 19 screening: Building and deploying a medical ai system in four weeks. medRxiv

[21] Kaggle (2020) Covid-19 patients lungs x ray images 10000. https :// www.kaggl e.com/nabee lsaji d917/covid -19-x-ray-10000 –image s, online: accessed 20 April 2020

[22] Kanne JP (2020) Chest ct findings in 2019 novel coronavirus (2019-ncov) infections from wuhan, china: key points for the radiologist

[23] Kim H (2020) Outbreak of novel coronavirus (covid-19): What is the role of radiologists?

[24] Krizhevsky A, Sutskever I, Hinton G (2012) Imagenet classification with deep convolutional neural networks. Neural Inform Process Syst 25

[25] Krzanowski WJ, Hand DJ (2009) ROC curves for continuous data. Crc Press

[26] Lai CC, Shih TP, Ko WC, Tang HJ, Hsueh PR (2020) Severe acute respiratory syndrome coronavirus 2 (sars-cov-2) and corona virus disease-2019 (covid-19): the epidemic and the challenges. Int J Antimicrobial Agents p 105924

[27] Lalkhen AG, McCluskey A (2008) Clinical tests: sensitivity and specificity. Continuing Education in Anaesthesia Critical Care & Pain 8(6):221–223

[28] Lecun Y, Bottou L, Bengio Y, Haffner P (1998) Gradient-based learning applied to document recognition. Proc IEEE 86(11):2278–2324

[29] Li L, Qin L, Xu Z, Yin Y, Wang X, Kong B, Bai J, Lu Y, Fang Z, Song Q, et al. (2020) Artificial intelligence distinguishes covid- 19 from community acquired pneumonia on chest ct. Radiology p 200905

[30] Lippi G, Simundic AM, Plebani M (2020) Potential preanalytical and analytical vulnerabilities in the laboratory diagnosis of coronavirus disease 2019 (covid-19). Clin Chem Lab Med (CCLM) 1(ahead-of-print)

[31] Long T (2019) Research on application of athlete gesture tracking algorithms based on deep learning. Journal of Ambient Intelligence and Humanized Computing pp 1–9, https ://doi. org/10.1007/s1265 2-019-01575 –w

[32] Mining WID (2006) Data mining: concepts and techniques. Morgan Kaufinann 10:559–569

[33] Narin A, Kaya C, Pamuk Z (2020) Automatic detection of coronavirus disease (covid-19) using x-ray images and deep convolutional neural networks. arXiv preprint arXiv :20031 0849

[34] Nielsen MA (2015) Neural Netw Deep Learn, vol 25. Determination press, San Francisco

[35] Organization WH (2020) Coronavirus (covid-19). https ://covid 19.who.int/, online: accessed 27 April 2020

[36] Pan F, Ye T, Sun P, Gui S, Liang B, Li L, Zheng D,

Wang J, Hesketh RL, Yang L, et al. (2020) Time course of lung changes on chest ct during recovery from 2019 novel coronavirus (covid-19) pneumonia. Radiology p 200370
[37] Park S, Kwak N (2016) Analysis on the dropout effect in convolutional neural networks. In: Asian Conference on Computer Vision, Springer, pp 189–204
[38] Patterson J, Gibson A (2017) Deep learning: a practitioner's approach. "O'Reilly Media, Inc."
[39] Ronneberger O, Fischer P, Brox T (2015) U-net: Convolutional networks for biomedical image segmentation. In: International conference on medical image computing and computer-assisted intervention, Springer, pp 234–241
[40] Shi F, Wang J, Shi J, Wu Z, Wang Q, Tang Z, He K, Shi Y, Shen D (2020) Review of artificial intelligence techniques in imaging data acquisition, segmentation and diagnosis for covid-19. IEEE Rev Biomed Eng pp 1–1
[41] Shi F, Wang J, Shi J, Wu Z, Wang Q, Tang Z, He K, Shi Y, Shen D (2020) Review of artificial intelligence techniques in imaging data acquisition, segmentation and diagnosis for covid-19. IEEE Rev Biomed Eng
[42] Shorten C, Khoshgoftaar TM (2019) A survey on image data augmentation for deep learning. J Big Data 6:1–48
[43] Simonyan K, Zisserman A (2015) Very deep convolutional networks for large-scale image recognition. In: International conference on learning representations
[44] Singhal T (2020) A review of coronavirus disease-2019 (covid-19). Indian J Pediatrics pp 1–6
[45] Tu YF, Chien CS, Yarmishyn AA, Lin YY, Luo YH, Lin YT, Lai WY, Yang DM, Chou SJ, Yang YP et al (2020) A review of sarscov- 2 and the ongoing clinical trials. Int J Mol Sci 21(7):2657
[46] Umer M, Sadiq S, Ahmad M, Ullah S, Choi GS, Mehmood A (2020) A novel stacked cnn for malarial parasite detection in thin blood smear images. IEEE Access 8:93782–93792
[47] Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, Wang B, Xiang H, Cheng Z, Xiong Y et al (2020) Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. Jama 323(11):1061–1069
[48] Wang L, Wong A (2020) Covid-net: A tailored deep convolutional neural network design for detection of covid-19 cases from chest radiography images. arXiv preprint arXiv :20030 9871
[49] Wu C, Chen X, Cai Y, Zhou X, Xu S, Huang H, Zhang L, Zhou X, Du C, Zhang Y, et al. (2020) Risk factors associated with acute respiratory distress syndrome and death in patients with coronavirus disease 2019 pneumonia in wuhan, china. JAMA Int Med
[50] Yamunadevi M, Ranjani S (2020) Efficient segmentation of the lung carcinoma by adaptive fuzzyglcm (af-glcm) with deep learning based classification. J Ambient Intell Human Comput. https :// doi.org/10.1007/s1265 2-020-01874 -7
[51] Zhang J, Xie Y, Li Y, Shen C, Xia Y (2020) Covid-19 screening on chest x-ray images using deep learning based anomaly detection. arXiv preprint arXiv :20031 2338
[52] Zhao Y, Zhou J, Pan L, Zhang Y, Wang H, Wu W, He J, Chen J, Huang H (2020) Detection and analysis of clinical features of patients with different covid-19 types. J Med Virol
[53] Zheng C, Deng X, Fu Q, Zhou Q, Feng J, Ma H, Liu W, Wang X (2020) Deep learning-based detection for covid-19 from chest ct using weak label. medRxiv COVINet: a convolutional neural network approach for predicting COVID-19 from chest X-ray… 1 3
[54] Zhou Z, Siddiquee MMR, Tajbakhsh N, Liang J (2018) Unet++ A nested u-net architecture for medical image segmentation. In: Deep Learning in Medical Image Analysis and Multimodal Learning for Clinical Decision Support, Springer, pp 3–11
[55] Zhu Y, Ouyang Q, Mao Y (2017) A deep convolutional neural network approach to single-particle recognition in cryo-electron microscopy. BMC Bioinformatics 18(1):34