REVIEW PAPER OF THE CLASSIFICATION OF LUNG DISEASES INCLUDING COVID-19 USING CT AND X-RAY DATA BASE

MASTER THESIS

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Hajar Thyap M Alenezi

NEAR EAST UNIVERSITY

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Hajar Thyap M Alenezi

Supervisor
Prof. Dr Ayşe Günay KİBARER

Nicosia January, 2022

APPROVAL

We certify that we have read the thesis submitted by **Hajar Thyap M Alenezi** titled **"Review paper of the Classification of lung diseases including covid-19 using CT and X-ray data base**" and that in our combined opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Educational Sciences.

Examining Committee	Name-Surname	Signature
Head of the Committee:	Prof. Dr Ayşe Günay KİBARER	
Committee Member*:	Assoc. Prof. Dr. Sertan Serte	…..……
Committee Member:	Assoc. Prof. Dr. Boran ŞEKEROĞLU	….……

Approved by the Head of the Department

25/01/2022

Prof. Dr Ayşe Günay KİBARER
Head of Department

Approved by the Institute of Graduate Studies

...../...../20...

Prof. Dr. Kemal Hüsnü Can Başer
Head of the Institute

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I hereby declare that all information, documents, analysis and results in this thesis have been collected and presented according to the academic rules and ethical guidelines of Institute of Graduate Studies, Near East University. I also declare that as required by these rules and conduct, I have fully cited and referenced information and data that are not original to this study.

Hajar Thyap M Alenezi

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Hajar Thyap M Alenezi

ABSTRACT

Review Paper Of The Classification Of Lung Diseases Including Covid-19 Using CT And X-Ray Data Base

Hajar Thyap M Alenezi

MA/PhD, Department of Biomedical Engineering

01 **(Month),** 2022 **(Year),** 33 **(number) pages**

In 2018, the American Institute for cancer research reported Lung disease to be a global threat, for over 14 million cases around the globe. Other conditions that affect the lungs, include, asthma, Chronic obstructive pulmonary diseases, and also influenzas like influenza, tuberculosis, lung cancer, pneumonia and a many other breathing problems. Respiratory failure can be caused by several lung illnesses. Without any doubt, smoking tobacco is one of the major global causes of lung cancer. Inhaling secondhand smoke can also increase the risk of contracting the disease. Furthermore, inhaling of substances such as asbestos, exposure to marijuana, high concentration of polluted air, electronic cigarettes and exposure to talcum powder. Other means of getting lungs cancer includes, getting exposed to chemicals such as noxious from insecticides, fertilizer dust and chlorine gas. On the other hand, SARS-CoV-2 is another life-threatening pandemic that has recorded numerous mortalities around the globe.

In recent, many studies have emerged, disclosing the unique advances of modern techniques in treating and diagnosing COVID-19 using advanced biomedical methods such as applying x-ray, CT-scan, convolutional neural networks and in applying deep-learning models in the diagnosis and treatment of the disease. This study therefore, is aimed on analyzing different studies that used the deep-learning models, CT-scan and x-ray classifications in diagnosis lungs cancer and covid-19 based on different research approach. In our results, we searched for the relevant databases to get our recent data. In addition, simple classifications of lungs diseases and COVID-19 suing CT-scan and x-ray databases.

Key words: classification, covid-19, lung diseases, X-ray, CT scan.

ÖZET

Review Paper Of The Classification Of Lung Diseases Including Covid-19 Using CT And X-Ray Data Base

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Akciğer hastalığı, astım, KOAH, grip, pnömoni ve tüberküloz gibi enfeksiyonlar, akciğer kanseri ve çeşitli diğer solunum sorunları dahil olmak üzere akciğerleri etkileyen çok çeşitli koşulları kapsar. Solunum yetmezliğine çeşitli akciğer hastalıkları neden olabilir. Sigara içmek Amerika Birleşik Devletleri'nde akciğer kanserinin başlıca nedenidir. Pasif içiciliği solumak da hastalığa yakalanma riskini artırabilir. Asbest, radon gazı, hava kirliliği ve uranyum, berilyum, vinil klorür ve arsenik gibi kimyasallar, akciğer hastalığına bağlı diğer çevresel değişkenler arasındadır. Çin'de son zamanlarda keşfedilen akciğer hastalıklarına neden olabilen yeni virüs arasında COVID-19, Aralık 2019'da ortaya çıkan koronavirüs olan SARS-CoV-2'nin neden olduğu hastalıktır. Şiddetli olabilir ve dünya çapında milyonlarca ölüme de neden olmuştur. hastalıktan kurtulan bazılarında kalıcı sağlık sorunları olarak. Coronavirüsler viral bir tiptir. Bazıları hastalığa neden olan çok sayıda türü vardır. COVID-19, 2019 yılında keşfedilen bir koronavirüs olan SARS-CoV-2'nin neden olduğu bir solunum yolu hastalığı salgınıdır. Bu çalışmanın amacı, BT taraması ve X-ışını veri tabanı kullanarak COVID-19 dahil olmak üzere akciğer hastalıklarının basit bir sınıflandırmasını vermektir. . Bunun için normal zatürree olan bir hasta ve COVID-19 geliştiren başka bir hasta ile karşılaştırılmak üzere normal bir hasta BT ve röntgen görüntülerini veri tabanı olarak aldık.

Anahtar Kelimeler: sınıflandırma, covid-19, akciğer hastalıkları, röntgen, BT taraması.

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List of Abbreviations

AI:	Artificial intelligence.
AH-Net:	Anisotropic Hybrid Network.
AUC:	Area Under the Curve.
CAP:	Community-acquired pneumonia.
CNN:	Convolutional Neural Network.
COPD:	Chronic obstructive pulmonary disease.
CoV:	Coronavirus.
COVID-19:	Corona Virus Disease-2019.
CT:	Computed Tomography.
CXR:	Chest X-ray.
DeTraC:	Decompose, Move, and Compose.
DSC :	Dice Similarity Coefficient.
DWT:	Discrete Wavelet Transform.
E-D CNNs:	Encoder–Decoder Convolutional Neural Networks.
FPN:	Feature Pyramid Network.
GGO:	Ground-glass opacity.
GLCM:	Grey Level Cooccurrence Matrix.
GLRLM:	Grey Level Run Length Matrix.
GLSZM:	Grey Level Size Zone Matrix.
LSTM:	Long short-term memory.
LDP:	Local Directional Patterns.
MERS:	Middle East Respiratory Syndrome.
PI:	Percentage of Infection.
PPE:	Personal Protective Equipment.
RNN:	Recurrent Neural Network.
RT-PCR:	Real-Time reverse transcriptase-Polymerase Chain Reaction.
SARS-COV-2:	Severe acute respiratory syndrome coronavirus 2.

SVM:	Support Vector Machine.
SVMs:	Support Vector Methods.
U-Net :	Usual Contracting Network.

CHAPTER I

Introduction

The recent evolution of covid-19 globally has created an overwhelming trauma in virtually every sector of human life. The virus was confirmed pandemic on March, 2020; This made a conclusive revolutionary attack to curtail the menace disease. Interestingly, the world became more vicious in repelling the virus by using more advanced and novel approaches of updated standards to "destroy" the virus from the human race, Biomedical methods in partnership with advance engineering fields have recorded high pace in developing novel gadgets and in updating the old technology techniques to suite to fighting the covid-19[1]. For instance, drones were majorly considered in other fields such as in in the military. Therefore, this single initiative gave the privileges to be applied in medical fields to build it, specifically in serving patients contracted with the virus and applied in drug-delivery [2]. Similarly, in medical imaging became interested in the detection and diagnosis of the virus; This is considered as the first medical stage to proclaim the disease as virus, based on the morphological view and to differentiate with other similar symptomatic disease. Hence, medical equipment such as computed tomography and X-ray are used in the disease diagnosis and to differentiate the virus from other diseases such as the lung-infected diseases and pneumonia. In other relative view, the IOT, machine learning and deep learning are equally applied in the detection, diagnosis, treatment and prevention of the Covid-19 [3].

CT-scan is reported to detect a mutated variant of the of the virus than using the RT-|PCR; revealing the false results given by the RT-PCR. X-ray and the computed tomography play vital roles in the detection of disease. Therefore, they asses and test lung infections by isolating and treatment processes. A study conducted by Lu and colleagues revealed the brain pathological detection using the deep learning process. Over the years there has been reports of rapid increase in technology, especially applying it into medicine. Artificial intelligence and machine learning processes are considered pivotal in the detection of diseases and subsequent identifying the pathological effect in the human body [4].

The multiple fusion of artificial intelligence methods, model computation, and the process of mining of big data are now applied in fields like image processing, CAD. And computer

vision. Therefore, the application of image is widely based on large data that involves the image guidance and diagnosis of diseases in medicine [5]. Another example is the application of convolutional neural networks in the targeting of diseases and in image processing. This plays a positive role in lung nodules diagnoses and in disease classification, such as in classifying of tumors. Furthermore, the application of Lung CT is regarded highly vital in the treatment of COVID-symptomatic pneumonia [6].

1 Aim of The Study:

The initial imaging process is vital detector of COVID-19 disease is the chest X ray. In the identification of COVID-19, CT's sensitivity was 97%, suggesting that CT analysis is an accurate, realistic, and rapid method used COVID-19 diagnosis, especially in epidemic areas where high sensitivity rapid detection is the priority. For that, deep learning procedure to classify different lung diseases including Covid-19 using X-ray and CT scan techniques with reliable data base is a very important step to help comparing lung diseases with Covid-19.

2 The Importance of The Thesis:

This work is very important now a day because of the pandemic of Covid-19, it will help to have a platform of informations that contribute in addition to other fields like radiology and pneumology department to classify lung diseases including covid-19 and find the impotency of this work related to biomedical engineering department which is a new study matching radiology specifically X-ray and CT scan result data base and biomedical engineering therapeutic methods.

3 General Objective:

The current work will focus on the methods to Classify lung diseases and covid-19 using CT, X-ray data bases.

4 Specific Objective:

The mean objective of this study is:

- Classify lung diseases including covid-19 using recent results of CT and X-ray data base.
- Dtasets of Ct scan and X-ray
- Deep learning methods

5 Thesis Outline:

The first chapter gave us the summary of the study with the aim and objectives well expressed. Similarly, in the second chapter, literature review related to lung diseases and Covid-19 using Ct and X-ray data base to classify deep learning data. Next is the elaborate and concise methods and materials applied in this study. Lastly, the result was discussed and extensively dissected.

The conclusion and summary of the study was done in chapter 5.

CHAPTER II

Literature Review

2 AI in Computed Tomography Segmentation

2.1 Lung Lesion Segmentation:

Segmentation of images involve the multiple division of an image into many sub-regions. In other words, the single image in the sub-region often seen with similar features of different images. In the imaging procedures, the process is kept out of interference; such as noise, movement and magnetic field offset; [7] This process is to maintain accuracy and high integrity in the results. Similarly, the CAD process involves four main phases, the feature extraction and selection, lung parenchymal segmentation, diagnosis and lesion detection. However, the image processing results and the segmentation of lung parenchyma are dependent upon based-on the classification. The flow process involved using the CAD system for lung medical imaging is represented in figure 1 [8].

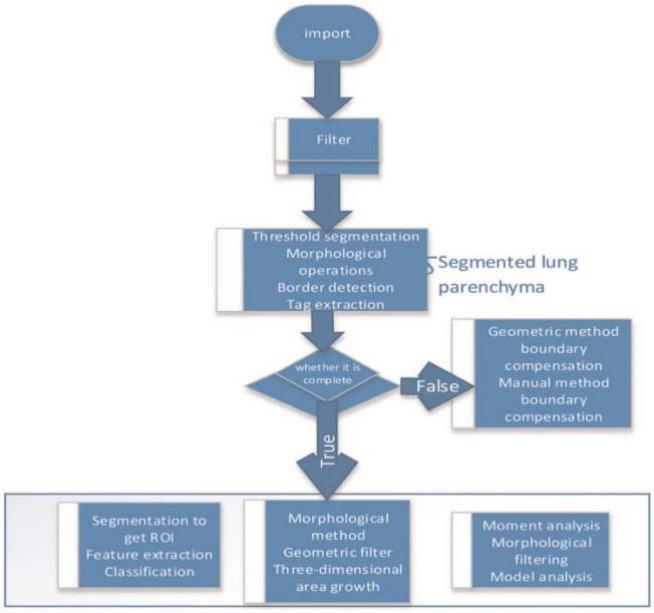


Figure 1: *Flow Process on the CAD System Applied in Lung Medical Imaging.*

The traditional procedures for the manual application by physicians to do tedious medical procedures is regarded as stressful and a times frustrating, that may involve time consuming. Therefore, deep-learning methods tend to exhibit high performance in segmentation in medical imaging. Deep learning has recorded high in solving issues related to imaging artifacts and in curing medical problems such as in muscle separation

and fluid in the organ lesion [9]. Furthermore, in Covid-19, the segmentation approach is applied in two processes, the lung disease and area processes. In thee lung-area methods, the lung area is forced to be separated into the lung lobes or the entire organ, applying the CT or X-rays as the first segmentation process in COVID-19 lesion. Relatively, in the case of lung lesions is separated from factors such as, movement of the organ, noise, and metal artifacts [10].

2.2 Segmentation Method:

Segmentation method is hugely involved in Covid-19 research with various studies used in the segmentation of Covid-19 lung images. U-Net is applied in this process as part of the medical imaging procedures [11]. Research have been greatly improved through U-Net in segmentation of images. In the training of segmentation networks, acquiring data is one of the tasking processes. In other studies, infected areas are identified through the simple diagnosis. However, if there's an insufficient training of data for segmentation, machine learning supervised methods will be applicable. As shown in table 1, the U-Net was applied in capturing of structures in medical images for the segmentation of the lesions in Covid-19 patients. This process requires sufficient data to be used [12].

process	**method**	**Organ target**	**application**	**Reference**
CT	U-Net	Lung lobes	Quantification	Qi et al
CT	U-Net	lung	Diagnosis	Zheng et al
CT	U-Net	Lung, Lesion	Diagnosis	Gozes et al
CT	U-Net ++	Lung, Lesion	Quantification	Shuo Jin et al
CT	Commercial software	Lesion	Quantification	Shen et al

Table1: *Application of AI in Covid-19*

2.3 Segmentation Application in Covid-19:

The first process used in the diagnosis of the covid-19 is the diagnosis of the lung to detect any lung infection. Medical practitioners such as clinicians first try to locate the area infected and to extract the results based-on the symptoms. Similarly, many studies have

applied machine learning-based segmentation of images in covid-19. Pneumonia and covid-19 are known to have similar symptoms when scanned using the Chest CT images. Therefore, a clear deep-learning process is used to attain accurate results and view the infection [13].

CHAPTER III

Methodology

3 Data Set Collection:

The data sets were collected using different databases online based-on the aim of the studies. Therefore, databases such as PubMed, ScienceDirect and Google scholar were searched using keywords such as deep learning, machine learning, medical imaging, covid-19 and CT\x-rays scan.

3.1 Data Pre-Processing:

3.1.1 Convolutional Neural Network (CNN):

In the deep learning techniques, it was applicable in this study to reveal the features of data through images and videos. The convolutional Neural Network (CNN) is applied in extracting the features, applying medical images that provides support. CNN is an artificial neural network with many layers and has the quality of processing high data with small costs. As represented in the figure 2, the CNN is shown on its application in detection of Covid-19 [14].

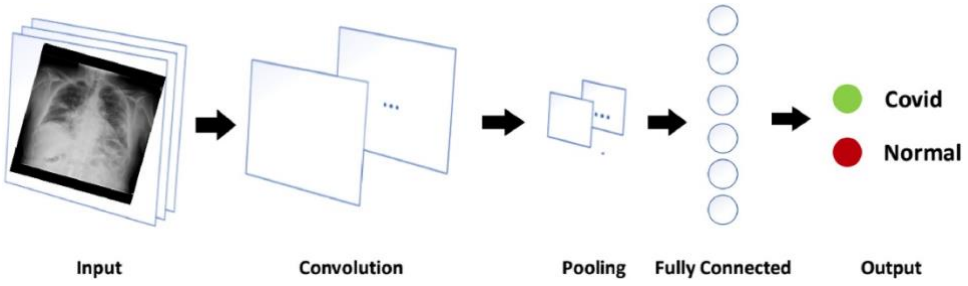
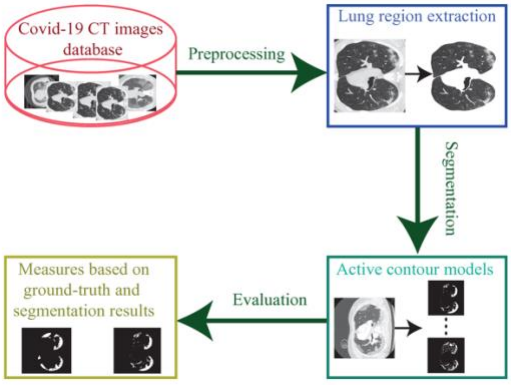


Figure 2: *Application of CNN in Covid-19*

3.1.2 Artificial Intelligence Application in Covid-19 Diagnosis:

The collaboration of AI and medical imaging in the diagnosis of covid-19 is important in having an accurate result. The application of medical imaging such as Chest CT uses many slices and a high quantity medical radiologist to diagnose accurately the covid-19 symptoms. As a result, many respiratory-related diseases are similar in morphology [15]. However, the application of Artificial Intelligence-assisted diagnosis tends to simplify the process by giving efficient and accurate study to differentiate the covid-19 with other disease such as pneumonia as shown in Figure 3.



[16]

Figure 3: *Application of AI in the Detection of Covid-19*

3.2 X-ray screening of Covid-19:

In the x-ray screening of corona virus 2019, the chest X-rays and CT images are both important in the detection and diagnosis of the covid-19. The chest x-rays are said to have limitations of lacking sensitivity as the CT images when viewing the chest abnormalities but the chest x-rays are considered cheap and portable and have tremendous benefits in the diagnosis of covid-19 [17]. The chest X-rays are revealed to have the abilities of distinguishing the virus from other etiology of lung diseases. The figure 4 shows the image illustration of a normal chest, pneumonia and covid-19 chest as shown in figure 4.

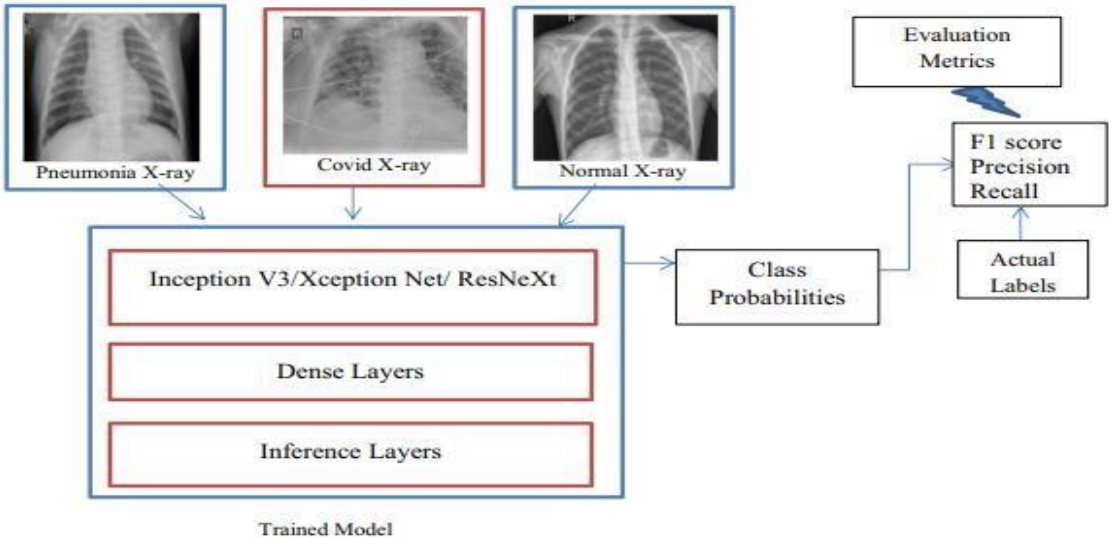


Figure 4: *Chest X-ray Dataset Model*

3.3 Deep learning in Covid-19:

In a survey study by Shorten et al 2021, explores the various applications of deep learning on its adventurous approaches in Covid-19 pandemic. Natural Language processing, epidemiology, computer vision and life sciences were the major focus of the research study. Similarly, the authors evaluated the current state of the effect of covid-19 and the novel deep learning methods to detect, diagnose, and treat the virus [19].

The widespread of Covid-19 has undoubtedly affect people livelihood and exposes the dangers portrayed by the disease with overwhelming effects of both positives and negatives. Deep learning has tremendously exhibited high rate of successes in its application on covid-19 patients. As shown in figure 5, the clear image of an infected chest with covid-19 and pneumonia.

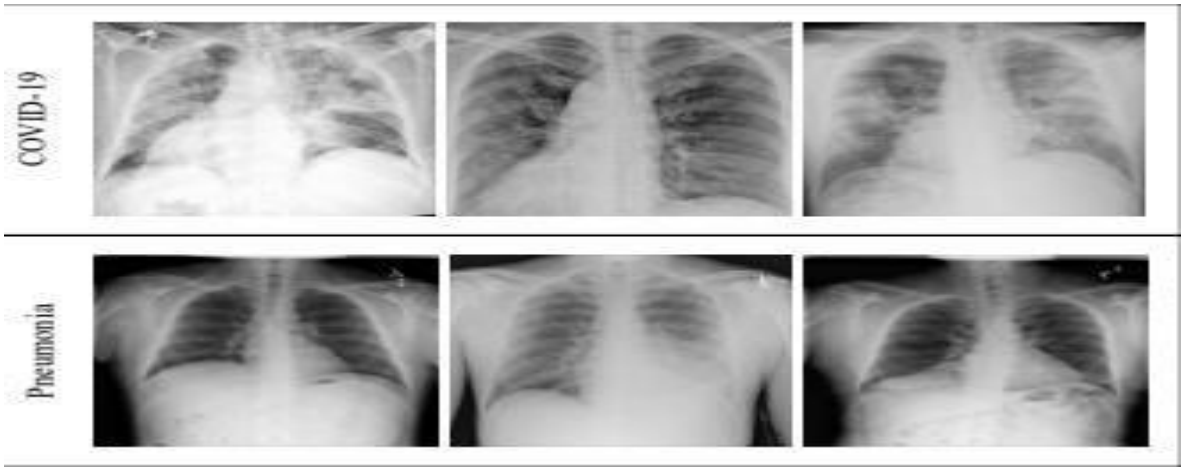


Figure 5: *Image Representation of Pneumonia and COVID-19*

Natural Language Processing:

In the application of Natural Language Processing (NLP) inputted data from text data is forwarded to the deep neural Networks. Smaller objects or components are mapped to be tokenized. This method, especially uses “Cat” to be mapped into a d-dimensional vector with a *d* serving as the hidden dimensions as applied in the deep neural networks. The Natural Language Process (NLP) has been of interest lately using the invention of the Neural Networks [21].

Computer Vision:

Computer vision is another factor that assists in the deep learning procedure. A report on Alex Net in 2012, shows its application on the convolutional Neural Network Optimization. This method of deep learning process, has significantly transformed the healthcare services through its application in Hospitals. The computer vision aids in therapy and in combating ICU-problems to improve surgical procedures. This process assists in processing images such as in detecting and monitoring of face masks and individuals observing social distance [22].

Medical Imaging:

Medical Imaging application is considered as another type of deep learning. This process is based on classification of Covid-19 and pneumonia related symptoms. With the increase number of existing datasets in classifying pneumonia using Chest radiographs, it is important in the detection of covid-19 [23].

Deep learning using X-ray images:

In the diagnosis of Covid-19, the lung is the major organ infected, due to this fact; the diagnosis is on the x-ray of the lungs. This procedure therefore, make it easier in the diagnosis of Covid-19, getting the data of the image using the deep learning approach. Furthermore, to detect pneumonia using the chest-rays, CNN algorithm is needed with the CNN layer of 121. These models are then trained using data sets containing above 90000 images with the frontal view of the lungs. The table 2 shows the table of reports on the pneumonia based on chest CT classification [24].

COVID-19 Pneumonia Imaging Classification	Rationale	CT Findings
Typical appearance	Commonly reported imaging features of greater specificity for COVID-19 pneumonia	Peripheral, bilateral, GGO with or without consolidation or visible intralobular lines ("crazy-paving") Multifocal GGO of rounded morphology with or without consolidation or visible intralobular lines ("crazy-paving") Reverse halo sign or other findings of organizing pneumonia (seen later in the disease)
Indeterminate appearance	Nonspecific imaging features of COVID-19 pneumonia	Absence of typical features AND presence of: Multifocal, diffuse, perihilar, or unilateral GGO with or without consolidation lacking a specific distribution and are nonrounded or nonperipheral Few, very small GGOs with a nonrounded and nonperipheral distribution
Atypical appearance	Uncommonly *or* not reported features of COVID-19 pneumonia	Absence of typical or indeterminate features AND presence of: Isolated lobar or segmental consolidation without GGOs Discrete small nodules (centrilobular, "tree-in-bud") Lung cavitation Smooth interlobular septal thickening with pleural effusion
Negative for pneumonia	No features of pneumonia	No CT features to suggest pneumonia

Table 2: *Pneumonia Reports Based-on the Chest CT Classification*

Classification of Covid-19 Chest X-rays:

In the classification of Covid-19 chest X-rays, the covid-19 disease is easily detected through a significant classification of models with accuracy in result features. Imaging is an important factor used in the classification of disease, such as in distinguishing Covid-19and other related diseases like pneumonia. Chest X-rays methods such as transformation are first performed to aid the process. After setting the algorithms in models, it is now evaluated based-on machine learning applications. Based on different studies, classification method is regarded more effective in the detection of Covid-19. As reported by Dongsheng Ji, the detection of the virus requires several phases, applying the x-ray imaging process. These are; scaling rotation, size adjustment and position

translation. As in figure 6, the collected data set is then distinguished into two which are the validation and training of sets [26].

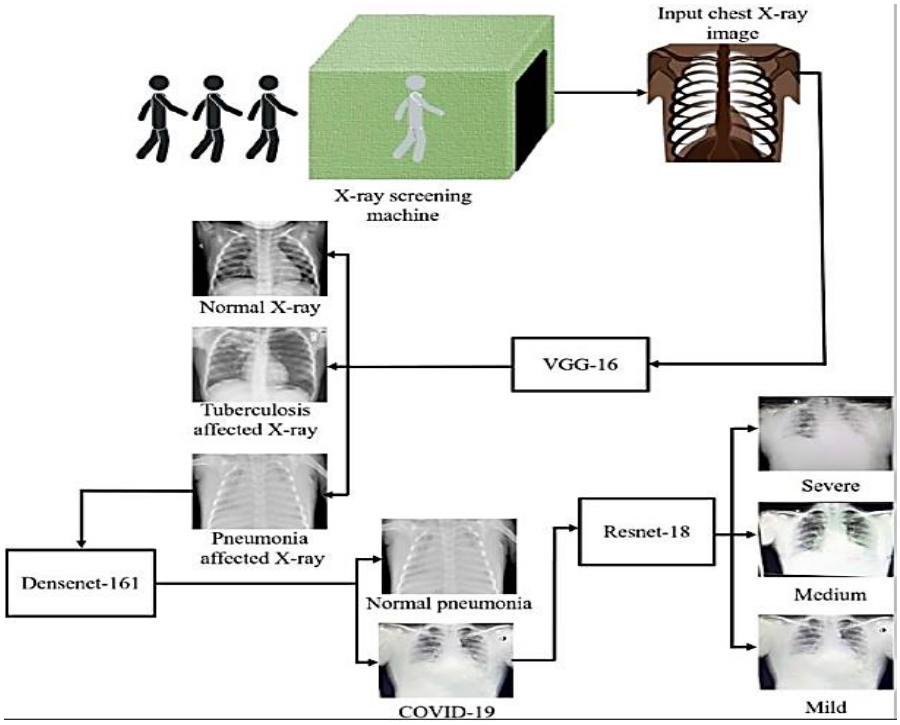


Figure 6: *Classification of Covid-19 Using Chest X-ray*

Transfer Learning:

This method of machine learning improves learning process from the knowledge acquired using learned and trained criteria to a model. The illustrations of the system in deep learning models depends on the required data of Covid-19 patients can be sourced online. Therefore, transfer learning assists in training of minor datasets to achieve the aim of a study [27].

Classification of Covid-19 CT Scans:

Computed tomography imaging is a major tool used in the clinical diagnosis of diseases. Thus, in the detection and diagnosis of covid-19, image is analyzed and recognized by the CT scan to determine the rate of infection and its spread in the body. Transfer learning and other neural networks are also applied in the detection of covid-19 as illustrated on figure 7 [28].

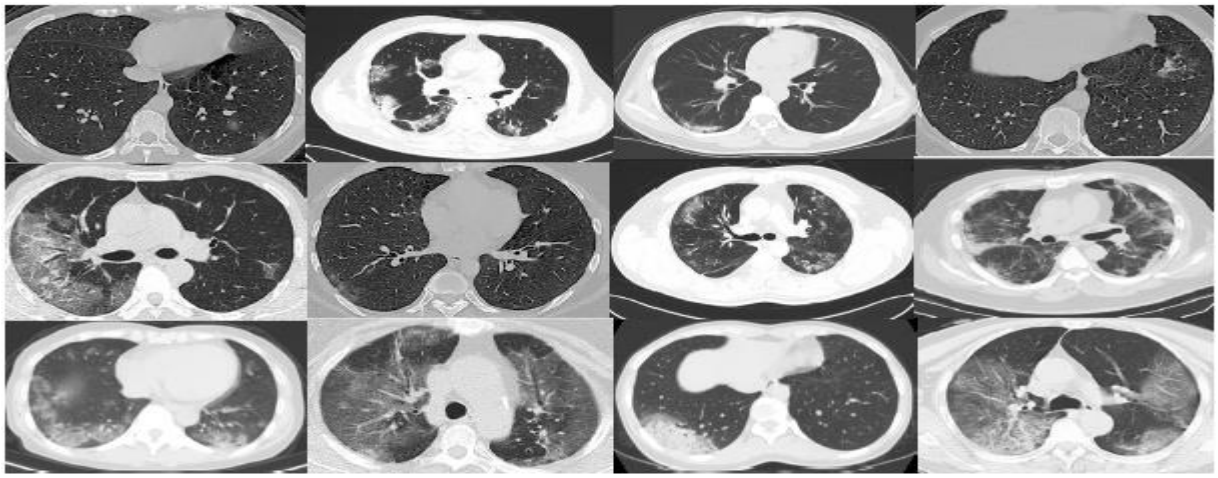


Figure 7: *Covid-19 Positive Image Under Chest CT Scan*

CHAPTER IV

Results and Discussion

The diagnosis of covid-19 has become crucial, that is why, there is so much interest in applying advanced techniques to contain the spread of the virus or in the detection and diagnosis of the disease. Several studies have concentrated in using the segmentation and lesions of patients CT images of lungs and in x-ray images and classify them in term of severity. They used multiple networks of segmentations to determine the perfect performances. In division, order, disease evaluation, and 3D perception, the proposed approach shows a cascaded model: the FPN having the DenseNet201 encoder revealed to be the best results of segmentation having 94.13% DSC value. For little lung regions, the proposed sore division pipeline can deliver better lung and injury covers. The system classified the severity of Covid-19 infections using PI, taking the networks of lung segmentation, as well as separation between different levels of infections with 98.3% of mild infections, 71.2% of moderated infections and 77.8% of severe infections.

To sum the quantification assisted by computer gives a reliable, easy and practical method to detect the Covid-19 infection as shown on table 2. Studies by Kouanou et al revealed that the support vector machine (SVM) is the best option when compared with other supervised machine learning technique.

Method	Accuracy(%)	F1-score(%)	AUC (%)
DenseNet169 on COVID-Seg	64.8	50.0	79.5
DenseNet169 on COVID-CT-349	79.5	76.0	90.1
DenseNet169 on Combination	74.5	70.1	89.8
JCS on COVID-Seg	72.4	77.5	**95.0**
JCS on Combination	**83.3**	**84.6**	94.8

Table 3: *Methodology Applied and the Performance*

CHAPTER V

Conclusion

In this review study we aimed to evaluate the different forms and methods of classification that is us in the detection of covid-19, which may classify lung diseases including Covid-19 and pneumonia with machine learning and deep leaning methods by using CT scan and X-ray imagine. The imagine technics are efficient by giving the diagnostic of the diseases because of the availability of data in a large scale. As a result, we are trying to develop the models to understanding more this method and use them for mobile devices apps. This can work only with a fast detection of covid-19 by genetic and imagine AI.

To support the development of AI systems for the detection and evaluation of COVID-19 patients using CT, we developed a currently accessible COVID-19 CT image database. The quality of this data is confirmed by radiologists with deep expertise in the care and prognosis of COVID-19 patients. Studies are also undertaken out to evaluate the dataset's value. As a future study we are in the search of developing more effective methods and technics of imagine to make the diagnostic and treatment easy to reach time so the patients will have a fast and focused healthcare in the right time.

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