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Comparative Study of Systems Based on AI to Diagnostic of COVID-19

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ABSTRACT

The pandemic COVID-19 keep spreading all over the world after it first appeared in China in December 2019. COVID-19 became an international issue for the health service. The role of each individual in our society is important to fight against this pandemic, the exceptional effort and various measures have been done and took by the healthcare and government to minimize the spread of this disease. Despite all this effort made, the number of COVID-19 cases increase and put a lot of pressure on the healthcare system all over the world, this end leads to many cases of deaths. The diagnostic of this virus in the early stage will help to treat the infected patients and save their life. The use of new technologies especially Artificial Intelligence (AI) can help radiologists and physicians to make fast, early, and exact diagnoses of this disease. In this paper, we elaborate a comparative study of various implemented methods for the diagnostic of COVID-19 based on the AI. And especially we will focus on the systems that combine the AI methods and medical imaging such as X-ray and CT.

Key words: Classification, COVID-19, Medical images, Segmentation.

1. INTRODUCTION

In December 2019, a new virus has appeared in China exactly in the city of Wuhan in Hubei province. This virus started first to spread inside China then moved to affect other parts all over the world. The number of infected people increases day by day in every part of the world. On 30 January 2020, a Public Health Emergency of International Concern (PHEIC) has been declared by World Health Organization (WHO) [1]. On 11 February 2020, Novel coronavirus 2019 disease named COVID-19 by World Health Organization (WHO) and characterized this disease as a pandemic on 11 March 2020 [2]. The WHO reported 102,58 million confirmed cases and more than 2,222,647 deaths globally on 1 February 2021 [3].

The healthcare system is overloaded because of the fast spread of this pandemic, which causes many struggles and problems in taking care of every patient infected. Many countries are suffering from this problem such as Spain, Italy, the USA, and other countries. Morocco also suffered from the outbreak of this virus; the first case of coronavirus appeared in morocco on 2 March 2020 is announced by the Moroccan health minister. The last statistic reported in morocco (1 February 2021) we have been detected 471,157 confirmed cases of COVID-19 with 8,275 deaths [4].

The solution proposed to reduce the spread of this disease is the early identification of the patients infected with COVID-19. Reverse transcriptase quantitative polymerase chain (RT-qPCR) test is one of the methods used to diagnose infected patients [5]. Unfortunately, this method took up to two days to get the results. Another method of testing is based on medical imaging such as computed tomography (CT) imaging [6] and X-Ray imaging [7]. The mentioned methods of the test above are manual, time-consuming, and need the involvement of experts in the medical field. The healthcare service needs to control this health crisis worldwide and monitor it by using the support of new technologies such as Artificial Intelligent (AI). AI is one of the most technologies that can help to fight this pandemic by detecting and diagnostic infected patients in the early stage. Many researchers proposed methods based on AI to develop decision aided systems that help the physicians and radiologists to perform a fast and reliable identification and diagnosis of COVID-19 patient. In the article [8], the authors proposed a method to detect the coronavirus from chest X-ray images based on a GAN network with deep transfer learning. In another work [9], the researchers implemented a DRE-Net model based on ResNet-50 that use the chest CT scans. Jun C. and al. proposed a method based on deep learning to detect the affected part with COVID-19 from CT Images [10].

Due to many solutions proposed by researchers, comes the main of this work that proposes a comparative study for AI methods based on medical imaging used for the diagnosis of COVID-19. The rest of the paper is organized as follows: In section 2, we will present the modelization of the pandemic. Then the methods proposed by the researchers to diagnosis

this disease will be presented in section 3. Then, in section 4, the analyses and discussion about the mentioned methods in the previous section. And a conclusion in the last section.

2. PANDEMIC MODELLING COVID-19

The family of coronaviruses is spherical viruses with an envelope, 60-220 nm in diameter, with a partly hypothetical structure consisting of a helical nucleocapsid within a capsid of icosahedral structure, itself surrounded by a membrane envelope [11]. The name of this virus is based on its electron microscopy form (Fig. 1). All the viruses of corona do not contain the same structural proteins for a complete virion [12]. The new virus COVID-19 is different from the others type of coronavirus, it differs from the others in the S gene that encodes for the S protein which is responsible for the fixation and entry of the virus into the host cell. The envelope of the virus consists of the proteins S (spike), M and M' (membrane), and E (envelope). The nucleocapsid (NC), formed by the genomic RNA associated with the N protein, is contained in the capsid, which is itself surrounded by the envelope (Fig. 2).

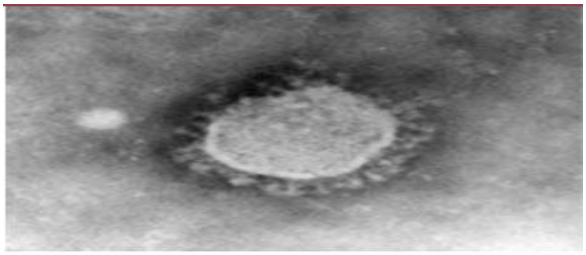

Figure 1: Coronavirus in electron microscopy

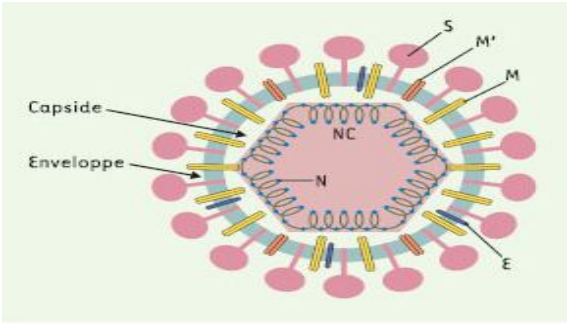

Figure 2: Schematic representation of a viral particle

This novel coronavirus disease is an infectious disease that appears as the common flu in some cases, it characterized by the fast spread, can affect especially the aged people and the persons that contain a critical disease such as cancer, diabetes, and others. The transmission of this pandemic done by direct contact or droplet between people and the period of incubation estimates between 2 and 14 days for the infection. The spread of this pandemic affected all the world and overloaded the health system even in the developed countries. Figures 3 and 4 show a weekly report of the distribution of the disease all over the world from 30 December 2019 through 1 February 2021 and table 1 present the affected and death cases by the WHO region [3].

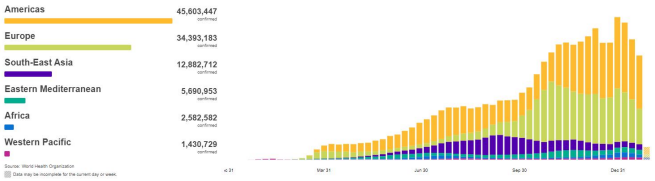

Figure 3: Weekly report of distribution of confirmed cases in the world from 30 December 2019 through 1 February 2021 by WHO

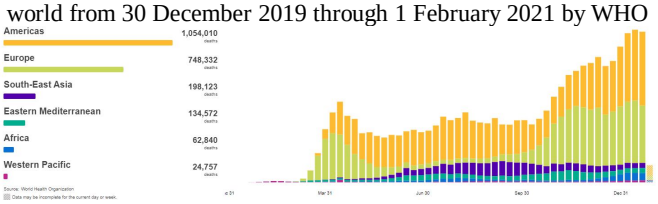

Figure 4: Weekly report of distribution of deaths in the world from 30 December 2019 through 1 February 2021 by WHO

Table 1: Statistics of COVID-19 by WHO region

Location	Confirmed	Deaths
Africa	2 462 083	57 902
Americas	43 456 970	999 894
Eastern-Mediterranean	5 507 360	130 886
Europe	32 032 536	706 238
South-East Asia	12 656 504	194 449
Western Pacific	1 347 894	23 307
Globally	**97 463 347**	**2 112 676**

Our country Morocco has encountered problems in the health care system like other countries. After the announcement of the first case infected by the Moroccan health authorities on 2 March 2020, the number of infected people increased day after day, 471,157 confirmed cases of COVID-19 with 8,275 deaths reported until 1 February 2021 (Fig. 4 and Fig. 5) [4].

Figure 5: Confirmed and Deaths cases of COVID-19 in Morocco (1 February 2021)

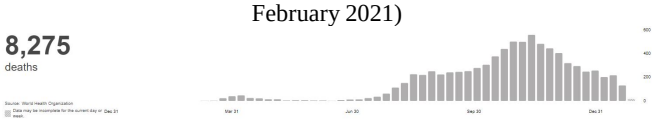

Figure 6: Deaths cases of COVID-19 in Morocco (1 February 2021)

The actual situation of the world needs the help of each individual which is important to fight against this disease. The community of mathematical epidemiologist is requested to propose models of outbreak dynamics. Those models are helping to estimate the future impact of COVID-19 on the population, measures required from the public health system, and the effectiveness of different quarantine measures [14][15]. Among the well-known models is the SIR model proposed by Kermack and McKendrick [16]. The goal of this model is to divide a population to analyze the spread of

COVID-19 to different compartments such as S (susceptible), R (recovered), C (Critical), E (exposed), D (dead), and I (infected). To create our model, we need to determine the probability and the rate from a case to another [17].

For probability:

- p(I→C) an infected patient becomes critically ill,
- p(I→C) an infected to be recovered,
- p(C→D) the critical patient dies,
- p(C→D) a critical patient to be recovered.

For the rate of number of days from:

- Infected to critical: 12 (→rate: 1/12),
- Critical to dead: 7.5 (→rate: 1/7.5),
- Critical to recovered: 6.5 (→rate: 1/6.5).

To treat the problem in its real situation, we need to add another constrain that's based on the number of beds available in the country studied and also to give the priority the critical patient to use these beds, so our SIR model will be as it is presented in figure 6:

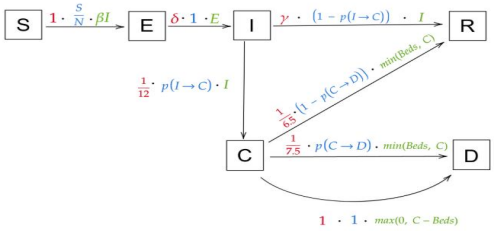

Figure 7: SIR model for COVID-19

And there are the functions that go with the presented SIR model:

$$\frac{dS}{dt} = -\beta(t) \cdot I \cdot \frac{S}{N} \quad (1)$$

$$\frac{dE}{dt} = \beta(t) \cdot I \cdot \frac{S}{N} - \delta \cdot E \quad (2)$$

$$\frac{dI}{dt} = \delta \cdot E - \frac{1}{12} \cdot p(I \to C) \cdot I - \gamma \cdot [1 - p(I \to C)] \cdot I \quad (3)$$

$$\frac{dC}{dt} = \frac{1}{12} \cdot p(I \to C) \cdot I - \frac{1}{7.5} \cdot p(C \to D) \cdot min(Beds(t), C) \quad (4)$$
$$- max(0, C - Beds(t)) - \frac{1}{6.5} \cdot (1 - p(C \to D)) \cdot min(Beds(t), C)$$

$$\frac{dR}{dt} = \gamma \cdot (1 - p(I \to C)) \cdot I + \frac{1}{6.5} \cdot (1 - p(C \to D)) \cdot min(Beds(t), C) \quad (5)$$

$$\frac{dD}{dt} = \frac{1}{7.5} \cdot p(C \to D) \cdot min(Beds(t), C) + max(0, C - Beds(t)) \quad (6)$$

With:

N: total population,
S(t): number of people susceptible on day t,
E(t): number of people exposed on day t,
I(t): number of people infected on day t,
R(t): number of people recovered on day t,
D(t): number of people dead on day t,
β: expected amount of people an infected person infects per day,
D: number of days an infected person has and can spread the disease,
γ: the proportion of infected recovering per day (γ = 1/D),
R□: the total number of people an infected person infects (R□ = β / γ),
δ: length of incubation period,
α: fatality rate,
ρ: rate at which people die (1/days from infected until death).

The SIR model is used to study the situation of this pandemic in the future, but there is another fact that can control and reduce this pandemic, which is the early identification. This early diagnosis will help the healthcare service to detect the infected patient for isolate them to not affect other person and to reduce the pressure from the health system. The use of new technologies such as AI will help to get early detection and to reduce the consuming time for the diagnosis. Many approaches have been proposed to help the world to solve this problem will be detailed in the next sections.

3. AI METHODS FOR COVID-19

The AI methods are very known for their power to solve many critical problems. COVID-19 is one of the most critical problems that facing all over the world since December 2019. Many solutions have been proposed to create a system to aid diagnosis using medical images to control this disease based on AI methods. Those methods are used to do the classification or the segmentation of medical images. CNN, ResNet, and RandomForest among the methods used to do the classification. Also, UNet and their variants are the segmentation methods that used to extract the infected part in the image.

3.1 Classification methods

Classification methods are used to separate the COVID and NON-COVID patient or to classify COVID-19 from other pneumonia based on medical images such as X-ray and CT scan. Among the classification methods most used by researchers are CNN, ResNet, and RandomForest.

A. Convolutional neural network

Convolutional neural network (ConvNet or CNN) is one of the deep learning methods very used in the field of computer vision like problems of detection and classification of objects in an image. The CNNs are also very successful in facial recognition, object detection, which is very much used in robots and automatic cars. Basically, anything that has to do with computer vision and images. Moreover, convNet can be used in all problems that have a matrix input. Note that the term "convolutional" comes from the matrix convolution operation used in signal processing. In the convNet, two new types of layers have been added to the network: the convolutional layer and the pooling layer. The convolutional layer consists to apply convolution filters to gradually extract characteristic information from the image and the pooling layer is used to reduce the spatial dimension in a ConvNet network.

Based on the convolutional neural network. In the article [20], the authors proposed an automatic detection of COVID-19 with CNN using transfer learning from X-ray images. the goal of using transfer learning in this work is to solve the problem of the small number of datasets for COVID-19 images, this factor controls the success of network training. The proposed system VGG19, MobileNet v2, Inception, Xception, and Inception ResNet v2 as models for transfer learning. Two different datasets have been tested. Firstly, 1427 X-ray medical images, 224, 700, and 504 images of confirmed Covid-19 disease, confirmed common bacterial pneumonia and normal conditions respectively. Secondly, a collection of 224, 714, and 504 images of confirmed Covid-19, pneumonia, and normal respectively. The best result attained 96.78% of accuracy with MobileNet v2.

M. J Horry and al [21] adopted a pre-trained model to detect COVID-19 from X-ray images. The goal of this study is to compare five pre-trained models for their limitation based on the COVID-19 images available to the public, to determine the most effective implementation of CNN. The pre-trained CNNs are Resnet50, Xception, VGG16/VGG19, and Inception. The experimental result was separated into two experiences. The first experience was to classify normal from pneumonia and COVID-19, in this case, the pre-trained models VGG16 and VGG19 attained the best result. In the second experience, the comparison was between pneumonia and COVID-19 and they obtained that the VGG19 is the most accurate model with 83%.

In order to accelerate the diagnosis to detect the COVID-19 patient, Linda Wang, Zhong Qiu Lin, and Alexander Wong introduce a COVID-Net [22]. X-ray images are used to detect COVID-19 based on a deep convolutional network model. The proposed COVID-Net is based on PEPX model which is a lightweight residual projection expansion projection extension, this design pattern composed of five steps, the first step is reducing the dimension of the input with 1*1 convolution. In the second step is a feature expanding to a higher dimension different to the input with 1*1 convolution. In order to minimize the complexity of computation, they are using Depth-Wise convolutional 3*3 in the third step to learning the special characteristics. Then, in step four they use convolutional 1*1 to reduce the dimension, and another 1*1 convolutional used to get a higher dimension to extend the dimension of the channel. In the end, they have compared the obtained result with the result of VGG19 and ResNet-50 and they got 93.3% for accuracy and 91%, 98.9% for sensitivity and PPV (Positive Predictive Value) respectively to detect the COVID-19 patient with COVID-Net.

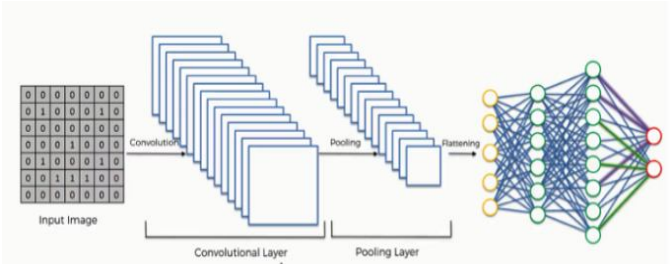

Figure 8: Convolutional neural network

B. Neural network

The proposed solution of making a convolutional neural network more robust and better was to add more layers to the network for extracting the important features. Earlier, it was something extraordinary, if someone could reach 30 layers, and increase or at least maintain the accuracy of the network. The augmentation of the network layers leads to problems of training and getting a lower accuracy. The issue of training was caused by the problem of vanishing gradient, where comes the role of Residual Networks which is a model of CNN. In 2015, the ResNet152 model won the ILSVRC Imagenet 2015 test with 152 layers and it became popular. The residual network characterized by a residual block that using identity or skip connection. The skip connection is to jump over the layers to avoid the problem of vanishing gradient, the layers could be 1, 2, or 3 and each layer contains a convolutional layer, batch normalization, and nonlinearities activation function ReLU. Normally, the residual block has two convolutional layers. Basically, those two layers are skipped then adding the input x to F(x) before the final ReLU activation function. We can add a 1*1 convolutional layer to adapt the dimension of x if it differs from the dimension of F(x) because of the convolutional operation.

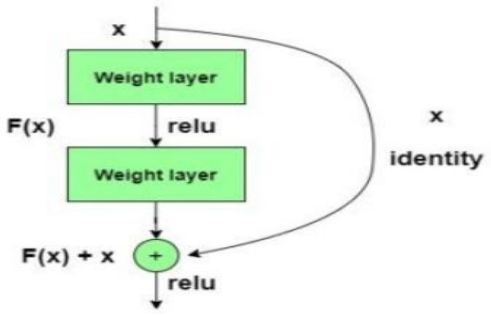

Figure 9: Residual block

Mohamed L., Florentin S., and Nour E. proposed a method to detect the coronavirus from chest X-ray images based on GAN network with deep transfer learning [8], the GAN network is used to generate more images for helping to get high accuracy, then they use three deep transfer models such as Googlenet, Alexnet, and Restnet18 to classify the image into four classes selected pneumonia bacterial, COVID-19, pneumonia virus and normal.

Song Y. and al implemented a DRE-Net model that uses chest CT scans from hospitals in China to identify patients

with COVID-19, this model is based on pre-trained ResNet-50 and Feature Pyramid Network (FPN) [9]. The proposed model used to separate between COVID-19, bacterial pneumonia, and normal patient. The highest accuracy was obtained with the implemented method after their comparison with others such as ResNet-50, VGG16, and DenseNet with 99% and 96% of sensitivity.

The deep transfer learning methods are used to create a system to detect the COVID-19 patient. In the article [23], Ali N., Ceren K., and Ziynet P. proposed an automatic system detection for diagnosis. This work is based on the comparison of three models of convolutional network InceptionV3, ResNet50, and Inception-ResNetV2. Those methods are used X-ray images to predict the COVID-19 patient. The pre-trained model ResNet50 obtained the higher performance among the other models with an accuracy of 98%.

C. Random forest

The random forest (RF) [27] is one of the most popular and powerful machines learning algorithms was presented by Breiman. It's performed to did the regression and the classification tasks. The name of this algorithm is based on the number of decision trees used in this method. RF consists of many algorithms to build multiple decision trees such as information gain [28], gini index approach [29], and others. The main idea of this algorithm is to create a forest with a number of decision trees. In general, if we have more trees in the forest the prediction will be more robust and the accuracy will be higher. Each tree in the forest gives as a classification, this classification called a vote to a selected class. The forest chooses the class that contains the most vote of all the trees in the forest and give it as a result of this algorithm.

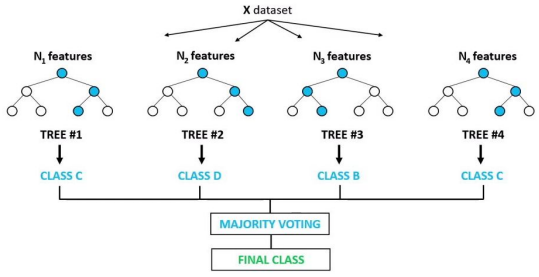

Figure 10: Random forest

The application of the random forest method touched many fields such as banks, medical, e-commerce, and others. In computer vision, the random forest is used for the classification of medical images to many diseases. Currently, COVID-19 is one of the most critical diseases. Many researchers are using the random forest method as a solution to classify the COVID-19 patient. In the article [25], a machine learning method has been proposed by F. Shi and al. to classify COVID-19 patients based on the CT scan images. The infection size-aware random forest (ISARF) approach suggested helping the doctors in making decisions. The ISARF method used to classify the CT images to COVID-19 or pneumonia patients. The process of this method stands on the determination of groups that contain the infected lesion with different sizes then classify each group with random forest using five-fold cross-validation. The experimental result in this article obtains 87% accuracy, 83% of specificity, and 90.7% of sensitivity. In another work [30], the authors presented a model of assessment severity automatic of COVID-19. This model is based on the random forest which is a machine learning method. The process of the proposed method begone with the analysis of the CT scan for the chest of COVID-19 patient with a uAI-Discover-NCP tool to features quantitative calculation. The uAI-Discover-NCP based on VB-net to do the segmentation of infected lesions in the lung from CT images. Then the classification with RF adapted to determine the severity of COVID-19, the RF model contain 500 trees decision and used three-fold for the validation of the result. The proposed method has been tested with a different number of quantitative features and obtained 0.875 of accuracy.

In another paper [31], the authors used a boosted random forest to predict the severity of the COVID-19 patient. This application is based on two methods, AdaBoost and the Random Forest classifier algorithm to classify the possibility of infected patients of recovery, death, or outcome from COVID-19. The proposed approach was based on many features such as age, gender, symptom, and others. The Boosted Random Forest algorithm obtain the best result compared with SVM, Gaussian NB, decision tree, and logistic regression in precision, recall, F1 score with 0.86, and accuracy for 94%. The tested data indicate that the age of infected patients between 20 and 70 years and the rate of deaths for males is bigger than the females.

D. U-Net Segmentation image method

The U-Net [26] method introduced by Olag Ronneberger et al. in 2015 and is dedicated to semantic segmentation for medical images. The name of this method is based on the shape of its architecture which looks like U. The output of the U-Net is a segmented image. The architecture of this method contains two paths. The first is the contracting or the encoder path (left side) which is used to do the factors extracting from the image with the down-sampling process, this process is based on two convolutional layers each one followed by ReLU function (rectified linear unit) and pooling operation. The second is expansive or decoder path (right side) consist of an up-sampling process which each based on the concatenation of the feature map cropped from the encoder path correspondingly and transposed convolution to do the localization.

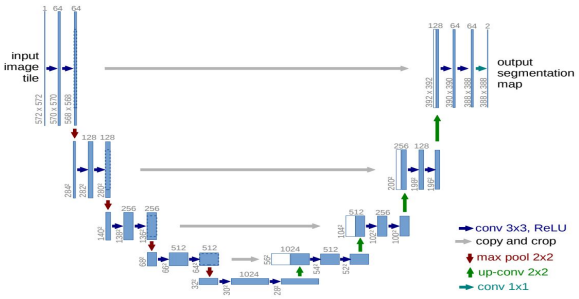

Figure 11: U-Net architecture

In the article [10], Jun C. and al. proposed a method based on deep learning to detect the COVID-19 from CT Images. This approach is based on UNET++ architecture which is powerful for the segmentation of the medical images, this method is used to extract the valid area from the image with minimizing the time. Chuangsheng Z., Xianbo D., and al proposed a computer-aided diagnosis system of COVID-19 [18]. This system is based on a pre-trained Unet method to segment the CT image then classifies it to positive or negative infection using a deep convolutional neural network. And they used a GPU to reduce the time of detection to 1.93 seconds for each CT patient. Fei S. and al [19] present a VB-Net based segmentation method to predict the COVID and NON- COVID patient. The goal of the proposed system is to extract the infected part from CT scan images. The training of the system was done with 249 images of COVID-19 patient and the validation with 300 images, those 300 CT scan images were contoured by two radiologists manually. After comparing the result of the automatic segmentation with the manual of radiologists, they got 91.6% ±10.0% for the coefficients of dice similarity and 0.3% of estimation error for percentage of infection (POI) for the hole dataset. In another work [24], the authors created a system combine segmentation and classification methods. The segmentation method UNet++ used to detect the part in the CT image that can be affected by the virus. And the classification method ResNet-50 employed to classify the detected lesions to COVID-19 or NON-COVID-19. The dataset of the test was obtained from five hospitals with 723 infected images with COVID-19 and 413 NON-COVID-19 images. This method showing a good result with 97.4% of sensitivity and 92.2% of specificity.

4. NUMERICAL RESULT AND DISCUSSION

The increase of COVID-19 cases is a big issue that facing all over the world. The diagnostic and the treatment are the essential things for each patient. Due to medical images, the radiologist can examine the patient using an X-ray and CT scan. The diagnostic based on CT scan takes a long time because contains a lot of slices, for that, the assistance of AI is mostly needed to do the segmentation and the classification.

4.1 Numerical result of classification

Classification is used in various COVID-19 applications. The classification could be used to separate COVID-19 patients from normal or COVID-19 from other pneumonia. DRE-Net model is proposed in [9], this model is based on ResNet-50 and used to separate between normal, COVID-19, and bacterial pneumonia patients. The images of the chest with CT scans are from hospitals in China. The test dataset contains 88 COVID-19 patients, 101 patients with bacterial pneumonia, and 86 of normal patients. This method gets 99% accuracy and 96% of sensitivity. In another work [23], the authors proposed a method based on a convolutional network, this method was based on three models of CNN ResNet50, InceptionV3, and Inception-ResNetV2. The classification between COVID-19 and the normal patient was based on a dataset of 100 X-ray images, 50 images for the normal patient which is obtained from Kaggle repository called “Chest X-Ray Images (Pneumonia)” and the other 50 images for COVID-19 patient obtained from an open-source GitHub. The comparison of the experimental results shows that the pre-trained model ResNet50 got the higher accuracy with 98%.

Ioannis and Tzani are using transfer learning to do the classification of a small dataset. The authors used two different datasets to compare different models of transfer learning such as and Inception ResNet v2, MobileNet v2, VGG19, Xception, and Inception. The first dataset contains 224 COVID-19 patients, 700 patients with bacterial pneumonia, and 504 normal patients. And the second dataset contains 224 COVID-19 patients, 714 patients with bacterial pneumonia, and 504 normal patients. The pre-trained model MobileNet v2 based on X-ray images obtained the best accuracy with 96.78%. The pre-trained model was used also in [21], the authors compare different models such as ResNet50, VGG16, VGG19, Xception, and inception based on two experiences. The first experience was to separate between normal, pneumonia, and COVID-19 patients, this last is based on a dataset of X-ray images that contains 200 normal patients, 100 patients with pneumonia, and 100 infected patients with COVID-19. For the first experience, VGG16 and VGG19 obtained the best accuracy. In the second experience, the VGG19 obtained the best accuracy with 83% for the classification between COVID-19 and pneumonia patients with 100 images for each case. Linda and al. [22] proposed the classification approach COVID-Net, this approach is based on PEPX to classify between normal, pneumonia, and COVID-19 patients based on COVIDx which is an open-access benchmark dataset that contains 13,975 CXR images across 13,870 patients. This method obtained 93.3% for accuracy, 91% for sensitivity, and 98.9% for PPV (Positive Predictive Value). Also, Feng and al. [25] proposed an approach based on machine learning methods such as a random forest. CT scan images are used to do the classification between COVID-19 and pneumonia. The

dataset contains 2685 images in total, 1658 images for confirmed COVID-19, and 1027 were CAP patients. The proposed method obtained 87% accuracy, 83% of specificity, and 90.7% of sensitivity.

Table 2: Summary of classification methods in COVID-19 applications

Article	Modality	Task	Method	Result
Ioannis D. A., al. [20]	X-ray	Classify: COVID-19, pneumonia and normal	CNN	Accuracy 96.78%
M. J Horry, al [21]	X-ray	Classify: COVID-19, pneumonia and normal	CNN	Accuracy 83%
Linda W., al [22]	X-ray	Classify: COVID-19, pneumonia and normal	CNN	Accuracy 93.3%
Song Y., al [9]	CT	Classify: COVID-19, pneumonia and normal	ResNet-50	sensitivity 96%
Ali N., al [23]	X-ray	Classify: COVID-19 and normal	ResNet-50	Accuracy 98%
Celestine I., al. [31]	Features	Severity assessment	RF	Accuracy 94%
F. Shi, al. [25]	CT	Classify: COVID-19 and pneumonia	RF	Accuracy 87%
Zhenyu T., al. [30]	CT	Severity assessment	RF	Accuracy 87.5%

4.2 Numerical result of segmentation

Various applications of COVID-19 diagnosis are based on segmentation methods with the goal to minimize the interval of search. In the article [10], the authors proposed an approach to detect COVID-19, this approach is based on the segmentation method UNet++ to extract the valid area from the CT scan image. Chuangsheng and al. [18] presented an application for diagnosis. This application combines a segmentation method UNet to extract the active part in the CT scan image, then the classification with a deep convolutional neural network to separate between COVID-19 and Non-COVID-19 patients. In another work [24], the authors also used the combination of classification and segmentation method. The method UNet++ for segmentation then ResNet50 to classify between the COVID-19 or NON-COVID-19. The training dataset contains 1136 in total, 723 images of COVID-19 and 413 on NON-COVID-19. The experimental results of this method are 97.4% of sensitivity and 92.2% of specificity.

VB-Net among the variance on UNet, in the article [19] the VB-Net is used to segment a CT scan image to extract the COVID lesion from the lung image. This method was trained with 249 COVID-19 images. And to validate the efficiency of the method, the authors used 300 CT scan images which segmented by two radiologists manually.

Table 3: Summary of application with segmentation methods in COVID-19

Article	Modality	Method	Application	Task
Jun C., al.[10]	CT	Unet++	Dignosis	Lung
Chuangsheng Z., al. [18]	CT	Unet	Dignosis	Lung/ Lesion
Fei S., al[19]	CT	VB-Net	Quantification	Lung segment
Shuo Jin, al [24]	CT	Unet++	Dignosis	Lung/ Lesion

4.3 Discussion

The interest and the implementation of AI have been increasing [32]. Especially with the appearance of this pandemic, many researchers deploying this technology in their works based on the medical images to find a solution and help radiologists in the diagnosis of the infected patient in their early stage.

At the onset of the disease, the researchers were suffering from the low number of collected data to build a robust system [33] because the hospitals were based on RT-PCR test to detect the COVID-19 patient. Contrary to the current situation, the doctors and radiologists adopted the technic of medical images to get a quick result at a low cost.

Examined a patient infected with COVID-19 based on X-Ray or CT scan images is a problem that could be solved with classification methods, those methods contain defined steps. First, we need to preprocess the input data which is a lung image. Then, extracted the features. And finally, performing the diagnosis by the classifier method based on the features. This classification is used to separate the COVID-19 from non-COVID-19 patients [23], also can be utilized to classify between a COVID-19 and other pneumonia [9,20,21,22,25]. Some common pneumonia contains identical radiological aspects with COVID-19 like viral pneumonia.

The classification methods are not the only solution that exists. Many researchers adopted the segmentation method to do the diagnosis [10,18,19]. U-Net and their variant such as U-Net++, VB-Net, and others among the segmentation methods. The goal of those methods is to minimize the search

area and create a powerful system to aid for diagnostic. Generally, the existing system for diagnosis is based on the U-Net for segmentation to extract the region of interest then diagnosis those small samples with CNN (ResNet).

There are many approaches proposed to fight against COVID-19, most of them are based on deep learning. Those approach facilities and help the radiology to make correct diagnostic. However, the medical images may have inexact, inaccurate, and incomplete labels which is a challenge to train a network. In addition, the imaging data needs to be labeled manually, but this operation is costly and time-consuming, which encourages researchers to use deep transfer learning [34] and self-supervised deep learning methods [35,36].

5. CONCLUSION

The early detection of COVID-19 is an important step for diagnosis a patient. This detection helped to avoid the spread of the various to another person. Artificial intelligence has an essential role to deal with this pandemic based on medical images. In our work, we presented many approaches that help to form a powerful system for getting efficient solutions to COVID-19. The mentioned systems aided for diagnosis in this paper are based on two modalities of imaging, X-Ray, and CT scan to improve the efficiency of AI. The imaging technic, not the only way that exists to diagnosis the patient, but for getting a better diagnosis and detection we need to combine this technic and the results of the laboratory.

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