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Application of Deep Learning and Machine Learning in diagnosing Coronavirus disease: A review

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Abstract—As of Feb 2022, the coronavirus instance in the world crossed 400 million and over 5.5 million deaths. The virus has spread to every continent. This review paper summarizes the current studies of deep learning and machine learning in diagnosing COVID. Currently, we use RT-PCR (reverse transcription-polymerase chain reaction) to diagnose viruses in the subjects, but researchers are finding alternative ways using the radiographic data. In this review paper, M. l. procedures are used to spot the SARS-CoV-2 by applying Radiography, Computed Tomography, ultrasound, etc. on the chest of suspects. Different techniques/algorithms used during the process are CapsCovNet, generative adversarial network, focal loss techniques, CNN, mask R-CNN, CBMIR, visualization techniques, adaptive few-shot learning, adversarial graph learning, etc.

Keywords—Coronavirus, CT-scan, Deep Learning, Machine Learning, SARS-Cov-2, Ultrasound, X-ray.

I. INTRODUCTION

This pandemic hit the whole very hard and impaired the economy of almost every country on this planet. Till now most countries suffered from its three waves. The best way to be safe is by following the guidelines like wearing masks in public places, staying at least one meter apart from others, etc. Currently used Covid testing kits are RT-PCR, and Rapid Antigen Detection Test (RADT) and research show that machine-learning techniques and models can be more effective in diagnosing COVID using data like chest X-ray, CT-scan, and ultrasound. Here this paper summarizes the current studies of AI in diagnosing SARS-CoV-2 using the above data.

Studies found Ct–scan data help find or predict COVID in subjects using the applications of deep learning and machine learning. T. A. et al. [1] worked on a type of Efficient Net to differentiate between positive and negative suspects. The study claims an accuracy of 0.90 and an Fl score of 0.90. P. Mann et a1. [2] used a combination of DenseNet121-MobileNet which acquired the Sensitivity of 99.74, Accuracy of 99.87, and Specificity of 100 percent, they also used the combination of ResNet50-VGG16. Polsinelli et al. [25] used light CNN and F1-score of 0.83 and 0.85, 0.817, 0.83. Z. et a1. [32] used D. N. N. (3d) to aid using radiographic data, which have 313 positive and 229 negative subjects.

Ultrasonography provides a fast alternative to RT-PCR. Research also understands the importance of Ultrasonic images in diagnosing COVID-19, as M. Karnes et al. [13] use an open-source ultrasonic dataset to distinguish between the COVID and pneumonia instances, and it is based on the visual classification algorithm. Also, B. Dan-Sebastian et al. [14] suggested how we can train the dataset effectively for diagnosing COVID-19. The method used in this process was Adversarial graph learning.

Apart from the Chest Ct-scan data, the chest X-ray data can also be useful in detecting or diagnosing COVID. T. Aara et al. [17] compare the models of Convolutional Neural and A. P. S. T Net. D. F. Eljamassi et al. [18] used SVM, KNN, and random forests with a rate of 98.14%, 88.89%, and 96 .29% respectively. Moreover, S. Tabik et al [19] built a database together with a hospital in Spain. S. Mohagheghi [20] used X-ray images to distinguish COVID from viral pneumonia using CNN and image retrieval algorithms.

We have divided the paper into seven sections as described below:

In section II we will discuss the application and usage of ML and DL in diagnosing COVID using CT-scan images, similarly, in section III we will discuss the same using X-ray images, again in section IV we discuss will the current studies of researchers on diagnosing COVID using ultrasound images. In section V we will discuss other applications in diagnosing and detecting COVID. Section VI is the conclusion of the review paper and our thoughts on the further scope of researchers. And section VII is about the scope of further research and studies.

II. DIAGNOSIS USING CT-SCAN DATA

A. Introduction

It is a contagious illness that first infects the lungs of the suspects. To identify the contaminated people, an R.T - P. C. R test is used. As we already know that it is a sluggish process, and these kits are out of stock to resolve this issue scientists and medical professionals found a way in which various radiographic approaches for recognition purposes.

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We apply the D. 1earning prototypes and systems. Many researchers gave a report consisting of a co-relation between the Computed tomographic scans and R.T - P. C. R test for confirmation of positive instances. Evidence proves that the diagnosis using the radiographic data is more responsive than the R.T - P. C. R test in the diagnosis. The study consists of more than 1000 issues and 59-percent were P.C.R +ve and 88-percent had CT Scan +ve results, that is enough to know the importance and role of C T samples in the diagnosis, that's why we've got discussed the scope of CT Scan [21].

J. et. e1.[22] developed the data base for the positive and negative instances. X. He. et. a1. [23] used self-supervised learning at the side of switch studying to acquire a score of F 1 of 85-percentage. S. W. et. a1. [24] put forward a D. L. N. prototype on Computed Tomographic samples and ensuing in a score of F 1 of 85-percentage. P. et. a1. [25] put forward a mild C. N. N. for diagnosing using chest samples on low-budget systems. They achieved recall precision, a score of F 1, and accuracy of 85, 81.7, and 83 percent respectively. A. et. al. [26] carried out 86-percent accuracies and ninety-three percent AUC ratings in the classification process. X. He. et. a1. [27] concluded that the DenseNet 3Dl2l had the score of F l and the highest accuracy of 88.l and 88.6 percent respectively. Z. et a1. [28] also put forward a weak1y supervised 3d D. N. L. to recognition of suspects using Compted Tomographic data. Records consisted of positive and negative samples as three hundred thirteen and two hundred twenty-nine respectively. Using the above model and system the author reported the accuracy precision-recall and accuracy of 84 and 90 percent respectively. M. et. a1. [29] gave a model in which they obtained a score of F 1 and an accuracy of eighty-seven percent each, in this they used a D. L. Capsule networks. K. M. et a1. 34] worked with networks like VGG-16, inception-V3, ResNet-50, DenseNet-121, DenseNet-201 and carried out a score of F 1, and accuracy of 86.7 and 88.34 percent respectively. M. et a1. [29] put forward a prototype that gives the output as slice*level when we give the input as volume level, during the process they acquired a score of F 1 of 8l.4 percent. A. K. M et a1. [30] put forward a D. F. a1gorithm which is supported with the Adaptive Feature Selection. For training the model, they used a data base that has COVID-positive and Pneumonia instances of approx. 1500 and 1000 instances respectively. During the application of the above prototype, they acquired a score of F 1, and an accuracy of 93.07 and 9l.79 percent respectively. In this, we take the help of EfficientNet architecture, and to guarantee the prediction in each fold they obtained a five fold cross validation approach. End experimental images are similar to those used by other researchers [23], [25], [26], [27], and [29]. The content is organized as follows Part-A which we have discussed above is about the introduction of recognition of suspects using the radiographic data, Part B presents the details and demonstrations of various algorithms used by other researchers during their research and Part C consists of a detailed dataset and procedure for classification via the Efficient net.

B. Algorithms used for diagnosis

As we discussed in the above part about the efficientNet architecture and performed a five fold cross validation strategy for the detection of COVID 19 using the chest CT Scan. Although there are various methods used to classify the images to predict and differentiate between the Negative and positive patients. They are:

- GAN (Generative Adversarial Networks) for generation of COVID 19 chest CT Scan
- The multimodal deep learning model

Generative Adversarial Networks (GANs) are used very often. Two models are trained at random by an adversarial process. A generator which is also known as the artist learns to develop or create images that look real as a result, while a discriminator which is also called the art critic learns to tell real images alone from fakes one.

The role of multimodal deep learning is to generate models that can process and refer to information using various methods. Even with the extensive development made for unimodal learning, it still can't cover all the aspects of human learning. Multimodal learning helps to know and analyse better when various reasons are gripped in the processing of information.

C. Dataset and Methodology

The dataset comprises only three hundred forty-nine computed tomography checkup samples composed of two hundred sixteen COVID victims & only three hundred ninety-six samples from non- COVID instances. [22]. The training dataset contains two hundred fifty-three COVID samples and two hundred ninety-one non COVID samples. As already mentioned, the dataset is very sparse, no other data set is used in this study. Rather, a five fold authentication technique is used. After processing, we can view these samples as different, which produces the best effects. Image rotation is most effective in indirect images and the transformation may affect the loss of other information, see figure 1.

The Efficient Net works best with the close modern functionality in the standard ImageNet database, efficient Net b4 is used as an in-depth study framework for this study.

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III. DIAGNOSIS USING X-RAY DATA

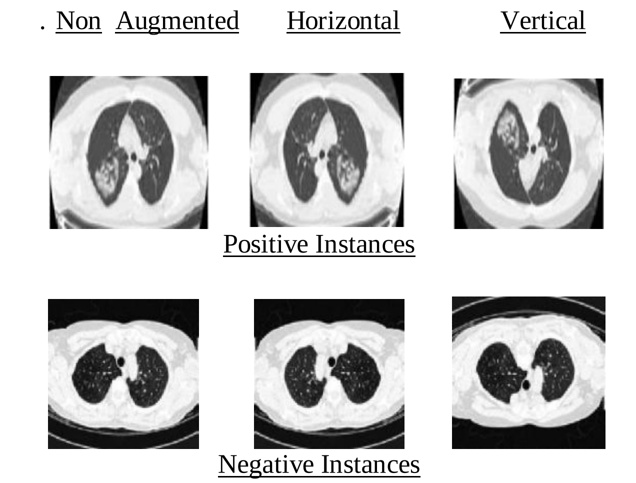

Figure-1

The use of image information has been listed as an aid in the rapid spotting of the positive suspects. Radiographic data provides a variety of symptoms concerning viral infection, but we have been given many samples, the highlights of the visual ones are difficult and may result in a greater effort to be done by the radiologists. Computer techniques and methods of a compilation of the machine were performed, it was found to be promising. S. Tabassum Aara et al. [17] introduce the test of a C. N. N. for the division of Coronavirus using a large set of data collected from positive and negative instances. Result shows that the use of calculation times various formats like:

- Root Mean Square Prop
- Stochastic Gradient Descent
- Adaptive Moment Estimation

S. Tabassum Aara et al. [17] made it clear that A. optimizer and A P S T Net receive the very good F 1 score: 98.20%, 98.45%, and 98.18%. It is a very deep structure, amazing inaccuracy, the balance between the sensitivity and features, as well F 1 score, achieved high division results. Due to COVID Pandemic, the economy and everyday life of people, as well as public health, was destroyed. COVID tests such as the Polymerase Chain Reaction i.e., PCR takes a very large amount of time, and it is also the main standard of diagnosis and treatment. D. F. Eljamassi et a1. [18] put forward that radiography with AI techniques can be useful in diagnosing the positive instances. There is a classification model used in which detection of the infection is done by the radiographic data. A data base is used that contains the above data of suspects suffering from pneumonia streptococcus, pneumococcus, and SARS also. The data set also contains computed tomographic data of positive and negative instances. For the image feature extraction, HOG also known as Histogram of Oriented Gradients is used. Classification of the images is done using SVM, Random Forest, K. N. N., and the classification rate is 98.14%, 96.29%, and 88.89% respectively. The results obtained may efficiently contribute to the detection of COVID.

S. Tabik et al. [19] proposed that COVID triage systems can be built using D. 1earning. But the problem is that currently, the databases present do not allow the creation of these types of systems because they are focused on severe cases. S. Tabik et a1. [19] proposed three points:

(I) It gave the proof and explanation about the sensitivities of new models.

(II) Gave stabilized and homogeneous data base that has insights into the severity of the instances working closely with the hospital.

(III) Suggested a smart data network technique for generalization improvement.

S. Mohagheghi et al. [20] proposed two methods, one for diagnosis using radiographic data and the second one for distinguishing viral pneumonia. Here deep neura1 networks are used and for distinguishing from viral pneumonia, the image retrieval approach is used. After training both, they find the Computed Tomographic involvement score. The accuracy achieved was 97% for the C. N. N. method and overall 87 percent.

W. Shi et al [10] suggest a model that distinguishes between pneumonia and COVID positive instances using an A. T. classification system, always reaches the student network from the teacher network. In the end, the analysis was performed on the radiographic data. D. A. Dharmawan et al. [11] introduced a deep neura1 network a1gorithm named COVID l9Net that is proved very helpful in the diagnosing process. Apart from the above-mentioned task, it is also effective in spotting conditions like Streptococcus, Acute Respiratory Distress Syndrome, Severe Acute Respiratory Syndrome, etc. Here average accuracy achieved is greater than 99 percent.

N. Hilmizen et al. [3] also concurred and admitted that Computed Tomography and Radiography can aid the confirmation of positive instances. Dataset used consisted of 2500 samples each for the Radiography (or X Rays) and Computed Tomography. The models used were VGG16, MobileNet, DenseNet12l, ResNet50, etc. for image recognition. The highest accuracy obtained was 98.93% percent. A. F. M. Saif et al. [5] proposed a parallel concatenated convolutional block-based capsule network. The model is created with the help of three datasets of which two are chest radiograph datasets and ultrasound images datasets. M. A. Al-Ansari et al. [4] proposed an R. D. L algorithm for the diagnosis of COVID. It is a C. A. D. system. This system achieved classification accuracy and detection accuracy of 97.4 and 96.31 percent respectively.

IV. DIAGNOSIS USING ULTRASOUND DATA

Ultrasonography is free from radiation and a very handy imaging model, apart from this Computed tomography and Magnetic Resonance Imaging are also used in critical instances. With access to Intensive Care Unit (I.C.U.) Ultra sonography has to potential to become an effective support in infirm zones. L. U. S. S. is used in clinics for

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deep analysis of swelling caused by pneumonia with considerable connection with huge lung sap, which can be considered as the commendable*clinical demonstration of SARS CoV 2. The collected images of LUS were automatically processed through these four steps by J. Chen et al. [16]:

- Curve converted to linear.
- P. L. recognition.
- Selection of (R O I) options.
- Feature removal, for extracting the features for the classification task.

The suggested automated L. U. S. S. model has the ability to relate to handy and vigorous ultra sound gears for analytic use in the different domains during the diagnosis of victims. The developed revolutionary D. L. prototype after proper training can be effective in*localization of indicators on ultra sound samples [16]. Hereby the prototype proposed has the potential computing capability for training. B. Dan-Sebastian [14] came up with automated diagnosis algorithms which are based on computed tomography and radiographic samples. V. et al. [31] used multi resolution signifiers using a variety of filters, for identifying various liver diseases using ultra*sound samples.

J. Zhang et al. [15] used a huge number of L U S images for building the data base. They observe that the feature were collected based on three stages of classes. They used EfficientNet because during the analysis the findings became very steady. It converges for 50 epochs, takes about 2.5 hours at most, and works nicely on a 3-layer dataset. Each image of the data*base with respect to the analytic features of the Pneumonia was interactively classified.

M. Karnes et al. [13] gave an algorithm that applies the transformations on the Gaussian Mixture Model of the latent manifold. Throughout the cycle, it helps in maintaining the mixture. This presented approach was unique because it did not require DNN training whereas it involved the linear modification of reference images and projects the Deep Neural Network (Mobile Net) features to the optimum level. This model took less than 15 seconds in training on a standard system. Less than 1 MB of memory was required by the generated disease state models. It gives an impulsive explanation of outcomes. S. et al. [32] provided a database consisting of one thousand two hundred and fifty-two computed tomography positive samples and one thousand two hundred and thirty negative samples. A. et al. [33] made public a database of fifty-nine positive samples. Goodfellow et al. [34] proposed to apply small perturbations on the input image, which give rise to more false outcomes. They suggest that we can increase the robustness of the prototype through the addition of adversarial data.

B. et al. [35] give the training structure that includes the goal of regularization, which has achieved the modern state of classifier for categorization of the data set with multi label.

V. OTHER APPLICATIONS

Apart from the above applications of ML and DL, there can be other utilities too, in this section we will discuss them: -
As we know the availability of the training dataset for training CNN or any other model is limited, so we cannot increase the accuracy of the models based on chest CT-scan data or other radiological data from a certain limit. So, to help in this issue and extend the current dataset P. Mann et al. [2] have developed a model based on Generative Adversarial Network. They showed how GAN can be useful in generating synthetical images for training other models used in the actual diagnosing of the COVID. They used deep convolutional GANs as their generative models. According to them, normally with limited datasets, the models have an accuracy between 85% to 90%, and CNN models are prone to overfitting when trained over small datasets. After using the extended datasets, the accuracy will improve substantially.

Because the dataset of COVID cases is limited, also many samples have other cases too. So, the problem of an imbalanced dataset arises, which affects the accuracy considerably. A. Y. A. Saeed et al. [6] proposed a technique that reduces the disparity in the data. According to them, the F1-score became 89 from 83 percent with the AlexNet-pre-trained model. The highest accuracy achieved was 89.41%, a recall of 92.6%, and a precision of 86.62%. Apart from AlexNet, two other CNN models were also used ResNet-18 and DenseNet12 but the score was given by AlexNet.

As the rates of daily COVID cases started to grow worldwide, the hospitals started to become overcrowded with people for medication or proper treatments. The efficient and autonomous operation required in that scenario, in other words, Smart hospitals are a must. K. H. A. et al. [7] suggest a model based on IoT. According to them, the accuracy rates can be improved by using three models namely, SVM, Random Forest, naive Bayes. The SVM model is superior in the above three (up to 95%). They stated, this will address the problem of overcrowding in hospitals, and ultimately decrease the mortality rate.

Besides AI and ML, [8] proposed a platform on human cases for the application of lung ultrasound. [9] suggest the CPN modeling tool perform artificial homecare applications.

VI. CONCLUSION

Machine learning and AI has the potential to become artificial humans or rather much more intellectual than humans that can not only solve and perform very complex tasks but can also flourish in monotonous and boring tasks from a human's point of view. In this paper, we compiled and organized the current studies and research on the applications of AI in diagnosing COVID. We have compiled research on diagnosis using chest CT-scan

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images/data, diagnosis using CXR images, and diagnosis using Ultrasound data. Apart from this, we have collected articles on other applications like models to create an artificial dataset for further processing, models to remove the imbalance in datasets to increase the accuracy, etc. We have compiled 35 research papers in this review paper to communicate current studies on the subject.

VII. SCOPE OF FURTHER RESEARCH

A. Y. A. Saeed et al. [6] suggest that we can apply the under sampling and oversampling techniques in further research for improve in the accuracy of the system. K. H. Abdulkareem et al. [7] concluded that they are planning to continue the research with other feature selection techniques and other datasets and models. The validation of reliable gold standards will be referenced in the future [16]. J. Zhang et al. [15] will extend the models, and this will help in improving the efficacy and accuracy. S. Mohagheghi et al. [20] suggest the future approach of using imaging modalities like CT images or a group of different models to obtain more accurate results.

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