مفهوم التصوير الطبي لتحليل كوفيد-١٩ القائم على الذكاء الاصطناعي : مراجعة

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الملخص :

بدء من ٢٤ حزيران من عام ٢٠٢٠ ، أصابت عدوى فيروس كورونا ٢٠١٩ (COVID-19) أكثر من ٩.٣ مليون شخص في جميع أنحاء العالم وتسببت في وفاة أكثر من ٠.٤٧ مليون شخص. تعد إجراءات التصوير التي يتم إجراؤها على الصدر ، مثل التصوير المقطعي المحوسب والأشعة السينية للصدر ، ضرورية للغاية لتشخيص وعلاج COVID-19 بسبب ارتفاع معدل العدوى لهذا المرض ، يتعرض اختصاصيو الأشعة إلى قدر كبير من الضغط. يتم الآن البحث في تقنيات تحليل التصوير التي تعتمد على الذكاء الاصطناعي في محاولة لمواجهة التحديات وتحسين دقة التشخيص. يركز هذا الاستطلاع على التقدم الحالي في تقنيات تحليل تصوير الصدر القائمة على الذكاء الاصطناعي لـCOVID-19 ، وهدف الورقة العلمية الأساس هو جمع تلك التقنيات. على وجه الخصوص ، من المهم أن نتذكر طرق تحليل التصوير لاثنين من أنواع الالتهاب الرئوي الفيروسي النموذجي لأن هذه الأساليب قد تكون بمثابة مرجع أثناء تحليل المرض على صور الصدر. التركيز على دور الذكاء الاصطناعي في جائحة كورونا ومراجعة مجموعة البيانات التي تم استعمالها من الأبحاث السابقة والبيانات ذات الصلة التي تم استعمالها بمزيد من التفصيل تطوير تشخيص وتقييم الأمراض بمساعدة الذكاء الاصطناعي ، وتوصل إلى استنتاج مفاده أن تقنيات الذكاء الاصطناعي مفيدة للغاية في هذا التطبيق.

الكلمات المفتاحية: فيروس كورونا، الطب، الذكاء الاصطناعي، مجموعة البيانات.

Medical imaging concept for AI-based COVID-19 analysis: Review

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Abstract

As of the 24th of June in the year 2020, the coronavirus infection 2019 (COVID-19) resulting in more than 0.47 million deaths and infected more than 9.3 million individuals over the planet. The diagnosis and treatment of COVID-19 both require imaging tests that are conducted on the chest, like chest Computed Tomography (CT)and computed tomography X-rays. Radiologists are under a considerable amount of pressure due to the high contagious potential of this disease. Imaging analysis methods that are based on Artificial Intelligence (AI) are currently the subject of research with the goal of improving diagnostic precision and addressing the obstacles. The collection of these AI-based chest imaging analysis techniques is the primary goal of this survey, which focuses on the most recent developments in AI-based strategies for analyzing chest images for COVID-19. Particularly, it is vital to recall the imaging analysis methods of two typical viral instances of pneumonia since these methods could serve as a reference while analyzing the disease on chest photos. This is why it is so important to remember the imaging analysis methods of two typical viral cases of pneumonia. Pay attention to the part that artificial intelligence played in the Corona epidemic and examine the dataset that was used from earlier studies as well as the data that was associated to it. Conduct a more comprehensive examination of the progression of AI-assisted disease diagnosis and evaluation, and reach the conclusion that AI approaches offer significant benefits in the context of this application.

Keywords: Coronavirus, medical, artificial intelligence, dataset.

1. Introduction

COVID-19 is typically diagnosed with an reverse-transcription polymerase chain reaction (RT-PCR) test, which stands for reverse transcription-polymerase chain reaction (Ciotti et al., 2020). It is able to identify the genetic material of the virus. RT-PCR testing, however, can be expensive and time-consuming, in regions where caseloads are heavy imaging in medicine, such as chest X-rays and computed tomography (CT) scans, can also be used to diagnose COVID-19. These imaging techniques can show characteristic lung findings, such as ground-glass opacities (areas of hazy opacity in the lungs) and consolidation (solidification of lung tissue). CT scans are more sensitive than chest X-rays in identifying COVID-19, but they are more widely available and can be used to screen for the disease in asymptomatic patients. CT scans are more sensitive for detecting COVID-19 but are also more expensive and expose patients to more radiation (Yang et al., 2020). Medical imaging can sometimes diagnose COVID-19 even when RT-PCR tests are negative. This is because RT-PCR tests can sometimes miss the virus, especially early in infection. Medical imaging is also helpful in monitoring the progression of COVID-19 and determining the illness's severity. For instance, CT scans can be used to monitor the extent of lung damage brought on by the virus and to identify those who are maybe experiencing an episode of acute respiratory distress syndrome (ARDS)(Daniel, 2020).

2. COVID-19 Diagnosis

Certain diagnostic approaches require the detection of RNA, it is the SARS-CoV-2 virus's genetic material., which is the causative agent of COVID-19. This virus is responsible for the development of the disease(Rai et al., 2021). The conclusion of detecting the virus is very dependable when the process is carried out with accuracy. However, these tests are not reliable enough to determine whether or not an individual has fully recovered from the infection. In addition to this, it is possible to receive a false negative result even though the patient does not have the virus in their system (Pascarella et al., 2020).The detection of virus-specific antibodies, which are an indication that the immune system of the body has been activated against the pathogen, is the goal of alternative diagnostic approaches. Because the production of antibodies takes a significant length of time, antibody testing is not a particularly reliable method of determining whether or not COVID-19 is present in the body during the first few days of an infection. In contrast to RNA tests, serological tests can assist determine whether or not an individual has been infected with the new Coronavirus in the past, even if the individual does not now possess the virus (Goudouris, 2021).COVID-19 has been demonstrated to be one of the most lethal diseases, which represents a significant threat to human civilization. When determining the COVID-19 diagnosis, several imaging modalities, like CT and the X-ray, are held in high esteem as being extremely effective. Computed tomography is used in conjunction with real-time RT-PCR testing and X-ray imaging of the chest. According to the results of the RT-PCR testing, the illness infection that can be recognized by chest CT scans possesses a sensitivity of 97% and an accuracy of 68%(Rai et al., 2021). Conventional techniques of diagnosing and analyzing CT/X-ray scans involve a significant amount of human labor and time, which results in a great amount of work for radiologists. Deep learning approaches within the realm of Artificial Intelligence (AI) have recently garnered a lot of attention from academics as a potential solution to the problems outlined above and an improvement in the accuracy of diagnostic procedures (Rashid et al., 2020). We will go over these different test formats as well as new methodologies. Diagnostic covid-19 was extended upon using a chest x-ray and a CT scan(Daniel, 2020).

- **PCR**

The polymerase chain reaction (PCR) test for COVID-19 is a molecular test that looks for genetic material (ribonucleic acid or RNA) of SARS-CoV-2, the virus that causes COVID-19, in an upper respiratory specimen. This test is utilized to identify minute quantities of genetic material in samples. (Zhu et al., 2020). Figure 1 show the polymerase chain reaction test for COVID-19.

Figure 1: PCR.

- **Saliva tests**

As an alternative to nasal and throat swabs, which some individuals find uncomfortable, saliva-based PCR assays are currently in the process of being developed. The results of these tests appear to be less sensitive than those obtained from conventional swabs (Czumbel et al., 2020). Figure 2 Indicates the type of saliva-based sequential examination

Figure 2: Saliva tests.

- **Rapid PCR tests**

In contrast to standard PCR methods, these tests can be conducted with minimal training using portable benchtop machines, and they offer results within a shorter timeframe of less than one hour. The objective of this initiative is to expedite the diagnosis of COVID-19 patients and facilitate their isolation. According to a recent study(Guglielmi, 2021). Figure 3 shows a new type of Covid test, which is rapid PCR tests that combine the accuracy of the PCR test with the rapid results of the rapid antigen test.

Figure 3: Rapid PCR Tests.

➢ **Pooled testing**

An alternative approach has been suggested in order to decrease the processing time for viral samples and increase the scope of nationwide testing. This technique has been utilized by the Red Cross to detect HIV, the Zika virus, and hepatitis in donated blood. Furthermore, its efficacy has been substantiated in relation to the SARS-CoV-2. Within laboratory environments, it is customary to analyze samples from multiple individuals collectively, as opposed to performing separate PCR assays on each sample(Mutesa et al., 2021). If the aggregated samples do not contain the SARS-CoV-2 virus, it can be reasonably deduced that each individual sample does not contain the virus as well. Upon receiving affirmative test results from the pooled sample, the source of the virus can be determined through additional testing on each individual specimen. Furthermore, the consolidation of samples offers a financially efficient method for reducing the costs associated with virus testing, as it reduces the total number of tests that require completion(Younis & Al-Tamimi, 2022).Figure 4 samples for proof-of-concept experiment on pooled testing of population screening

Figure 4: Pooled Testing.

- **Antibody tests**

Antibody tests aim to ascertain the previous exposure of individuals to SARS-CoV-2, rather than their current infection status, by the examination of B cell-mediated antibody production. The detection of these proteins within the bloodstream serves as an indication of prior contact with a viral agent and potentially signifies the potential establishment of future immunological defenses. The appearance of antibodies may be delayed and, in certain instances, their levels may decline with time(Fox et al., 2022). Consequently, a negative result from an antibody test does not definitively imply the absence of prior COVID-19 infection or the absence of any degree of immunity to the virus (Petherick, 2020). Figure 5 Illustration of a test result for the coronavirus Antibody tests.

Figure 5: Antibody Tests.

3. Medical Image Analysis and Its Types.

It is common practice for doctors and other primary care providers to base their decision to conduct a detailed medical imaging scan on the symptoms and possible diagnoses a patient present. Medical imaging technicians are responsible for capturing photographs of specific sections of a patient's body by applying the technical and anatomical expertise that they possess. These images then allow medical specialists to study the patient's body for indications of illness or disease. Medicine uses many imaging technologies, including medical imaging(Li et al., 2021). The following point is a type of Medical Image(McAuliffe et al., 2001)

- Common types of imaging include:
- X-rays.
- CT (computed tomography) scan.

- MRI (magnetic resonance imaging)
- ultrasound.
- Nuclear medicine imaging, including positron-emission tomography (PET)

Creating an image of the body's interior from an X-ray requires the passage of a beam of high-energy radiation through the patient's body. After passing through the lungs, the X-rays are taken in by the bones and tissues of the body. The regions of the lungs that are less dense, such as the air sacs, permit more X-rays to flow through, and as a result, they seem darker in the Image. People infected with COVID-19 are more likely to develop lung inflammation and fluid buildup due to the virus. On an X-ray, this can cause the lungs to have a denser appearance, which may be interpreted as ground-glass opacities or consolidation(Khaled & Al-Tamimi, 2021).

On the other hand, it is essential to remember that not everyone infected with COVID-19 will show detectable abnormalities on their X-rays .Depending on how far along the disease has progressed, X-rays may or may not provide an accurate diagnosis of COVID-19 (AL-Jibory, 2021).The following point describes the type:

- **X-ray**(Seibert & Boone, 2005): X-ray imaging has proven useful in facilitating the diagnosis of COVID-19. Pneumonia can show noticeable indicators, such as the presence of white spots in the lung area. Imaging is commonly used to monitor individuals with COVID-19 in hospital, with the aim of evaluating the effectiveness of therapeutic lung interventions. job. Medical professionals use skull X-rays, especially in urgent care cases involving individuals who have experienced trauma, a skull fracture, or cranial deformities. It is important to realize that exposure to X-rays is associated with some negative consequences. Especially pregnant women, as it has the potential to cause harm that can hinder the growth and development of the unborn child.

- **Computed Tomography (CT)**(Buzug, 2011): Computed tomography (CT) provides a higher level of information than traditional X-rays, allowing bones, muscles, organs and blood arteries to be seen. CT scans are performed using a CT scanner. CT scanning is a diagnostic imaging technique that uses X-rays and computerized techniques to create a cross-sectional image of the body. CT scans allow doctors to see deeper organs, tissues, and cancers they can evaluate the spatial orientation, size, and shape of the tumor. To improve the visibility of a CT scan, practitioners can inject a contrast agent intravenously.(Al-Khafaji & Al-Tamimi, 2022).
- **Magnetic resonance imaging (MRI)** Moonis et al., 2021): Magnetic resonance imaging (MRI) uses radiofrequency radiation and a strong magnetic field to create complex images of the body's internal systems. MRI scans are non-invasive, radiation-free and have an exceptionally high degree of accuracy, making them safe and useful for identifying many medical conditions. MRI can image the spine, brain, heart, lungs, abdomen, pelvis, and soft tissues such as the brain, muscles, and ligaments(Haider AbdAlkreem et al., 2024).Figure ٦ provides a synopsis of three distinct categories of medical images.

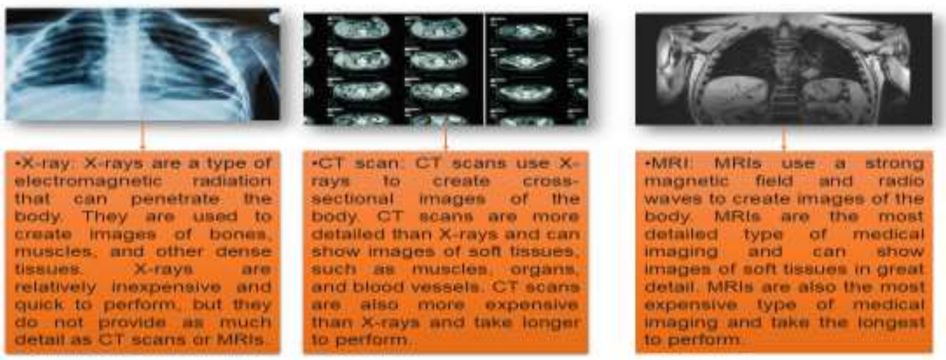

Figure ٦: Summarize Three Types of Medical Images.

٤. Previse Study

Researchers are trying to find good solutions for detecting, diagnosing, and monitoring the disease as well as developing drugs and vaccines for COVID-19. Although the available knowledge, resources, and systems are very limited with respect to curing the disease completely, researchers from various fields are approaching the problem of finding solutions as soon as possible(Boozari & Hosseinzadeh, 2021). The first step for solving any problem is to gather as much information as possible on the problem and information about existing approaches or solutions to the problem. Some researchers have been working on reviewing or summarizing the problem origin, applied methods, their advantages and limitations, available datasets, available tools, and applications of COVID-19 and presented them in survey/review papers(Clemens et al., 2022). Table 1, a few existing papers on COVID-19 approaches using image data were as follows:

Table 1: Papers Deep Learning-Based Methods for COVID-19 Medical Image

Ref.	Dataset/ image	Method used	Aim	Outcomes
Mohamed Loey et al. (Loey et al., 2020) 2020	chest X-rays images (COVID-19, normal, pneumonia bacterial, and pneumonia virus) / Total 307 for four	GAN with deep transfer learning technique (Alexnet, Googlenet, Restnet18) for coronavirus detection	Three deep transfer models are selected for investigation through as it contains a small number of layers on their architectures, this will result in reducing the	Binary classes accuracy (99.6%, 99.9%, 99.8%)

	different types of classes.		complexity, the consumed memory and the execution time	
Ardakani AA et al. (Ardakani et al., 2020) ٢٠٢٠	Computed tomography (CT) / 510 COVID 19 and 510 non COVID 19 patients and hence in total 1020 patients.	Ten well-know convolutional neural networks:- MobileNet-V2, AlexNet, SqueezeNet, Xception VGG16, GoogleNet VGG-19, , ResNet-50, ResNet-18, ResNet-101,	Coronavirus (COVID-19) infection was differentiated from atypical pneumonia or other viruses and computer-aided diagnosis (CAD) was made based on CT images. ResNet-101 can be considered a promising model for characterizing and diagnosing COVID-19 infection. It is not very expensive and can be used as an aid during CT imaging in radiology departments.	Auc=99.5 Precision=99.2 NPV=100, AUC= 99.4, Specificity= 99.02 Sensitivity=100
Ismael, Aras M et al. (Ismael &	the COVID-19 chest X-ray	deep-learning-based approaches, namely deep feature	the deep approaches to be quite efficient	ResNet50 model and SVM classifier with the Linear kernel function

Şengür, 2021) 2021	images – dataset / COVID-19: 180 Normal: 200	extraction, fine-tuning of pretrained convolutional neural networks (CNN), and end-to-end training of a developed CNN model, have been used in order to classify COVID-19 and normal (healthy) chest X-ray images. For deep feature extraction, pretrained deep CNN models (ResNet18, ResNet50, ResNet101, VGG16, and VGG19) were used. For classification of the deep features, the Support Vector Machines (SVM) classifier was used with various kernel functions, namely Linear,	when compared to the local texture descriptors in the detection of COVID-19	produced a 94.7% accuracy , the fine-tuned ResNet50 model was found to be 92.6%, the developed CNN model produced a 91.6%

		Quadratic, Cubic, and Gaussian.		
Aslan, Muhammet Fatih et al. (Aslan et al., 2021) 2021	chest CT X-ray images / COVID-19 219, Viral Pneumonia 1345, Normal : 1341	A hybrid technology based on deep learning to detect positive coronavirus (COVID-19) cases, with AlexNet architecture, BiLSTM	Lung segmentation (preprocessing) in CT images, which are given as input to these proposed architectures, is performed automatically with Artificial Neural Networks (ANN).	Accuracy CT = 98.14%, X-ray= 98.70%
Ameer Hamza et al. (Hamza et al., 2022) 2022	Three publicly datasets COVID-GAN and COVID-Net small chest x-ray ,COVID-19 radiographic (pneumonia, COVID-19, TB) / 6,000 images	Two pre-trained deep models, namely, EfficientNet-B0 and MobileNet-V2, are fine-tuned according to the target classes and then trained by employing Bayesian optimization (BO).	.A hybrid technology based on multi-filter fusion for contrast enhancement that increases both local and global information of the image. . Using Bayesian optimization in deep learning models to optimize hyperparameters which helps in better training for	Accuracy =99.4%

			given data. . Extract high-level features from both models and combine them through a novel segmentation-based serial fusion. . Grad-CAM imaging on the final classification, resulting in color visualization of COVID-19, pneumonia, and tuberculosis regions.	
Yashika Khurana et al. (Khurana & Soni, 2022) 2022	CT scan and chest X-ray images / 4000 CT and 4000 X-ray images	ResNet-50, EfficientNetB0, VGG-16 and a CNN	achieving high accuracy in CT and X-ray images extracted from two data sources aid physicians in determining the presence of virus in medical images, in addition to publishing 4 CNN architectures to	Accuracy ResNet-50 on CT scans = 98.9% ResNet-50 on X-rays =98.7%

			diagnose the presence of COVID-19.Comparing the performance models on CT scan and the X-ray images, evaluating the metrics of the different models and comparing the performance	
M. Maheswari et al. (Soundrapandiyan et al., 2023) 2023	for negative COVID-19, sample subsets of viral pneumonia, bacterial pneumonia, and normal images from the chest X-ray pneumonia dataset were used / The combined dataset had 5475 images.	deep learning architecture (ResNet50, VGG19, Xception, and DarkNet19) named WavStaCovNet-19	the input chest X-ray images in the wavelet image format and then gives them to the stacking model for distinct feature extraction. A customized loss function is applied in model for identifying COVID-19 positive X-ray images , In addition, model can also be applied for the detection of other pneumonia	accuracy = 94.24% on 4 classes (COVID-19, viral pneumonia, bacterial pneumonia, normal) accuracy = 96.10% on 3 classes (COVID-19, pneumonia, normal). , Time taken with DWT (in Seconds)=557.4

			that could affect the human body organs.	
Soumya Ranjan Nayak et al. (Nayak et al., 2023) 2023	chest X-ray images (normal, COVID-19, and pneumonia) / A total of 750 chest X-ray samples were collected from each category, so the total number was 2250 chest X-rays in all three categories.	CNN scheme includes the combination of three CBR blocks (convolutional batch normalization ReLu) with learnable parameters and one global average pooling (GP) layer and fully connected layer	To improve diagnosis, aimed to design and establish a unique lightweight deep learning-based approach to perform multi-class classification (normal, COVID-19, and pneumonia) and binary class classification (normal and COVID-19) on X-ray radiographs of chest.	accuracy =98.33%

٥. Future Pathways for Research

AI-driven machine learning and deep learning systems can also contribute to the fight against COVID-19 in the following ways.

i. Non-contact illness detection. Automated image analysis in CT and X-ray imaging will significantly reduce the possibility of disease transmissions from radiologists' patients during COVID-19 pandemics. AI-based ML and DL systems can be applied to camera facilities, X-ray and CT image detection, and patient posture.

ii. Online video consultations and diagnostics. Artificial Intelligence (AI) and Natural Language Processing (NLP) can be combined methods for developing robot systems and remote video diagnostic programs that will enable COVID-19 patient visits and initial group diagnoses

iii. creation of drugs and immunizations. AI-based ML and DL algorithms are useful for more than just locating potential medications and vaccines, but they can also be employed to simulate interactions between vaccines and drugs, proteins, and receptors, hence forecasting future responses to medications and vaccinations for individuals with different COVID-19 patients (Bai et al., 2020).

iv. tracking of patient contacts. An AI-powered ML and DL system can track and monitor the traits of those living nearby by building knowledge graphs and social networks, to COVID-19 patients, therefore being able to forecast and track the disease's possible spread with accuracy .

v. Robots with intelligence. Programs like public area sanitation and product delivery, providing patient care without requiring human assistance. The purpose of intelligent robots is to be employed This

vi. Future research based on artificial intelligence and the effectiveness of deep learning models and graphics features to differentiate between COVID-19 and other types of pneumonia should be demonstrated. This will help healthcare professionals identify the virus and correctly interpret any possible imaging findings related to the coronavirus (Bharati et al., 2021).

٦. Conclusion

Medical imaging is a valuable tool for diagnosing and monitoring COVID-19. It can be used to screen for the disease in asymptomatic patients, to diagnose patients who are have COVID-19, but RT-PCR results are negative, and to monitor the progression of the disease and assess the severity of illness. However, medical imaging is not a perfect diagnostic tool. It can sometimes miss COVID-19, especially early in the course of infection. Additionally, medical imaging can be expensive and expose patients to radiation. As a result, medical imaging is typically used in conjunction with other diagnostic tests, such as RT-PCR tests, to diagnose COVID-19. In some cases, medical imaging may be the only way to diagnose COVID-19, such as in places where RT-PCR testing is not easily accessible.

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