AI Techniques in Imaging Data, Detecting & Monitoring Symptoms of COVID-19

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Abstract— **Coronavirus 2019 (COVID-19) has developed into a pandemic with severe clinical symptoms, including death. A major epidemic, such as COVID-19, poses significant challenges to the global health system. It causes damage to vulnerable people and poses a serious threat to global communities. In 2019, the most common result of coronavirus infection is a lung infection or pneumonia (COVID-19). Photographic imaging, such as X-rays and CT scans, positron emission tomography-CT (PET / CT), lung ultrasonography, and MRI, are vital to this global debate. Newly developed Artificial intelligence (AI) technology enhances the capabilities of digital cameras. This test will look at allowing technologies and programs to deal with the COID-19 epidemic.**

Keywords- Artificial Intelligence, Covid-19, Imaging, Telemedicine, Monitoring, Wearable devices

I. Introduction

Coronavirus 2019 infection (COVID-19), caused by SARS-CoV-2, has spread to more than 210 countries worldwide. More than 7.6 million people have been infected, and more than 427,000 have died from the virus. COVID-19 patients often show fever, respiratory symptoms, pneumonia, low white blood cell count (WBC), and low lymphocyte count. Even if the results of RT-PCR from a suspected patient do not have, SARS-CoV-2 infection will not be completely eliminated.

The COVID-19 epidemic has introduced significant barriers to global health care systems. It has the potential to quickly replenish health care systems, reducing their ability to provide services. Studies from epidemics in China, Italy, and the United States reveal that they may limit the effectiveness of a health care system.

Follow-up CT scans are frequently conducted on COVID-19 patients to monitor disease progression or improvement. Quantitative follow-up can also help radiologists recognise imaging features. This section focuses on CT manifestations at various phases, as well as the quantitative CT metric changes related to these stages.

The rest of the paper is structured as follows: Section 3 provides a comprehensive evaluation of wearable equipment and invisible sensor technology that can monitor the early symptoms of COVID-19 and other prevalent health problems. It also introduces a telehealth framework for diagnostic and diagnostic tests, as well as the most important research areas of the future. Section 4 examines the most relevant COVID-19 study based on the medical model until March 31, 2020. In the following sections, we will first describe the smart imaging systems before summarizing them. Section 5 provides a comprehensive evaluation of the role of photography in the identification and management of COVID-19 and is now required, Following the conclusion of Section 6.

II. An overview of wearable devices & telehealth in COVID-19

A. Wearable Technology for Health Monitoring COVID-19

Wearable items can play an important role in early warning of COVID-19 infections by combining important symptoms with clinical signs, diagnosing people who may be diagnosed, and experiencing any sudden decline in people who are isolated, living alone, or in the clinic. a downpour unit, especially those that do not have symptoms, and remotely monitor non-COVID-19 patients in order to prioritize the use and distribution of resources and to reduce infection

Other problems, such as heart damage, can develop in people who do not have lower heart disease. Therefore, it is important to check for respiratory, and cardiovascular monitoring, and other symptoms such as fever and cough to diagnose and diagnose any suspicious situations.

(i) Wearable Devices for Respiratory Assessment

SARS-CoV-2 directs the respiratory tract by attaching its extra nail-containing proteins to angiotensin-converting enzyme 2 (ACE2) receptors in healthy cells. The lungs may become inflamed, leading to dyspnea and rapidly growing ARDS. It can cause pneumonia, an infection of the alveoli within the lungs.

Wearable devices can allow for routine and continuous testing and monitoring of the patient's respiratory functions or parameters such as SpO2, RR, and lung sounds.

- ***Oxygen Saturation***: Photoplethysmography, which analyses variations in light absorption, is used in pulse oximetry devices. Devices can be either reflective or transmissive in nature and can be worn in a number of positions on the body. Yokota et al.

used organic photodetectors to demonstrate a polymer LED-based pulse oximeter.

Figure 1: Commercially available wearable pulse oximeters

- *Respiratory Rate:* (RR) is an essential indicator of tracking the course of the disease. It is the first, measurable indicator of physical conditions such as hypoxia and hypercapnia. It has also been shown to be a powerful predictor of difficult events such as cardiac arrest.
- *Lung Sounds:* Respiratory rate (RR) is an essential metric for assessing illness progression. It is a detectable early indication of physiological problems including hypoxia and hypercapnia. It has also been demonstrated to be an excellent predictor of acute events such as cardiac arrest.

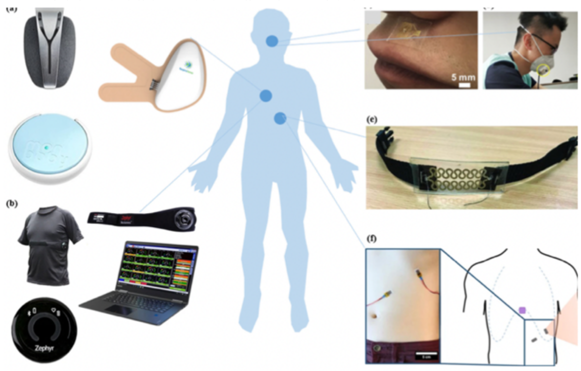

Figure 2: Wearable RR monitor product

(ii) Wearable Devices for Cardiovascular Evaluation

Cardiovascular comorbidities are a well-known risk factor for SARS-CoV-19, and CVD is one of the most common diseases in the world, especially among the elderly. Monitoring of cardiovascular indicators can help diagnose patients at high risk of SARS CoV-2 and may provide early warning of any heart failure

- *Electrocardiogram for Monitoring CVD and COVID-19 Patients*: The electrocardiogram (ECG) is a standard diagnostic procedure for assessing the electrical and muscular function of the heart. ECG abnormalities.

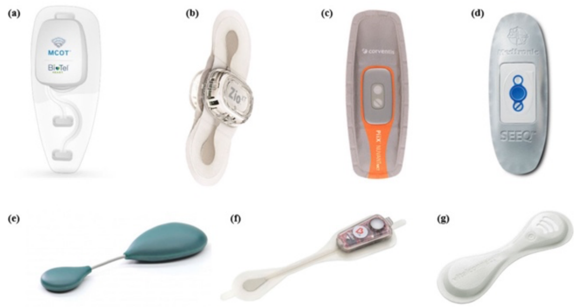

Figure 3: Commercial ECG patches used in clinical trials and in COVID- 19

- *Continuous Blood Pressure Monitoring:* A wristwatch, a sleeping pillow, or even a skin-like patch can be used to monitor your blood pressure continuously. The accuracy of many apps is still poor, particularly when used to track pharmacological effects. The technique for gathering energy from the human body should be enhanced and integrated with BP monitoring devices.

(iii) Wearable Devices for Clinical Symptom Monitoring

The most common clinical manifestations of COVID-19 are fever (90% or more), cough (approximately 75%), and dyspnea (up to 50%). These three symptoms are also important clinical indicators used to diagnose suspected individuals, as well as epidemiologic risks.

- Temperature: The wearable temperature monitor can detect a rise in body temperature before normal monitoring. The wearable nerves can be attached to the skin or worn on a specific area of the body. Han et al. studied the method of dual temperature fluctuations and developed wearable thermometry with a measurement error of less than 0.1 ° C.
- Cough Monitoring: Continuous cough monitoring assists inCOVID-19screeningandclinical diagnosis. Cough signals are frequently collected utilising oral or mechanical sensors able to detect the coughing motion or vibration. Imran et al. developed an app that identifies coughing based on 2-second cough audio and a combination of deep learning and classic machine learning approaches.

(iv) Unobtrusive Sensing for Physiological and Symptomatic Monitoring of COVID-19

Invisible sensory technology may enable the unaffected form to collect health information for one or more users for use at home or in public places. Sensors of this type may be concentrated in objects such as beds, toilets, and weight scales. It is a non-communicative way of measuring important signals in public places (e.g., airports).

One of the most obscure technologies used in the COVID-19 epidemic hot infrared camera is used to identify any patients with the flu at a hospital door or in public places such as airports. Video hearing is one of the most common ways to monitor important signals that no one can touch.

The nerves may be used to monitor vital signs in real-time in patients with minimally invasive health care facilities. They can also be used in the large screening of patients who may be infected in public places such as airports, which is important in reducing the spread of COVID-19.

(v) Multi-Parameter Physiological Monitoring Using Wearable and Unobtrusive sensors for Covid-19

BSN may be established to enable continuous monitoring and analysis of parameters of many organisms such as SpO2, RR, ECG, HR, BP, and other health data. Wireless BSNs, when connected to the hospital information system with mHealth technology, allow medical professionals to monitor remotely the patient's condition.

This section will look at mHealth wear-based technologies and telemedicine that allow you to monitor health everywhere. These technologies have the potential to improve and enhance health care systems while also improving the well-being of people affected by COVID-19.

B. Mobile Health and Telemedicine Technology For Tracking, Monitoring, Diagnosing and treating COVID-19

The rapid spread of COVID-19 has placed an enormous strain on healthcare systems. To address this catastrophe, we require an immediate digital transformation of the analogue healthcare system. Telemedicine and eHealth can help to address the problem by causing a paradigm change in health care.

(i) Mobile Health Monitoring of COVID-19

mHealth is a public health platform that is accessible via mobile devices. It may be used to monitor, diagnose, and treat a wide range of physiological and medical problems. Individuals with suspected or proven COVID-19, as well as those in need of other conventional clinical services, can receive aid and treatment.

- *Contact Tracing Technology:* A contact tracking system that builds a library of nearby links and quickly informs well-to-do contacts can help contain the epidemic. Yasaka et al. have developed a peer-to-peer contact tracking tool that uses an anonymous interaction network to track contacts.
- *Remote Physiological Monitoring:* Mobile sensors or monitors that may be used for remote health monitoring include smartwatches, pulse oximeters, and thermometers. During the pandemic, mobile ECG was one of the most often used health monitors for remotely monitoring patients' arrhythmia problems.

III. DIVERS METHOD FOR TREATING AND TRACKING COVID-19

A. Telemedicine Technology for COVID-19

Telemedicine is the use of communication to help treat illness. It can help with outpatient treatment, monitor critically ill patients in the ICU, and keep records of individuals who have been discharged from the hospital. In this section, we will look very closely at three applications of tele medication in the care of COVID-19 patients.

- Tele-imaging: Medical imaging is critical in the monitoring and diagnosis of illnesses. Tele- imaging can improve picture quality while lowering radiation exposure and speeding up patient throughput. During the COVID-19 pandemic in Wuhan, distant CT scans were sent to the West China Hospital in Sichuan Province using 5G connectivity.
- Tele-ICU: A tele-ICU is a fully integrated ICU platform that enables real-time electronic communication of health information between the central and satellite units. Off-site physicians can keep an eye on the patient's condition and consult with bedside staff about diagnostic and treatment options. Remote care delivery is preferable in order to reduce the presence of personnel at the bedside.
- Tele-Rehabilitation: The provision of treatment via a communication technology that connects patients with a centralised healthcare professional team is known as pulmonary telerehabilitation. Prompt pulmonary rehabilitation can enhance COVID-19 patients' respiratory function and quality of life. Rehabilitation therapies should be performed on a regular basis as part of standard therapeutic care.
- Other Telemedicine Technologies: Telemedicine can help improve the practice of long-distance health care. The COVID-19 test can be made available to the general public by locating test sites in easily accessible locations. The results may be linked to forums such as social networking and phone tracking systems, which can help prevent the transmission of the virus.
- Telerobotic: COVID-19 testing may be accessible to the general public by installing testing booths in publicly accessible locales. The results might be connected to platforms such as contract monitoring and tele triage systems. Despite all of these advantages, great attention should be paid to the potential hazards of telerobotic.

B. AI Empowered Contactless Imaging Workflows

Because of the high risk of infection in the workplace, health workers are at high risk. Photographers and specialists are given priority so that any possible contact with the virus is avoided. Additionally personal protective equipment, one must consider areas dedicated to photography and processes, which are important in reducing risks and saving lives.

- *Conventional Imaging Workflow:* X-rays and computed tomography (CT) scans are commonly used in the evaluation and diagnosis of COVID-19. Communication between specialists and patients is inevitable in normal images. This draws professionals closer to patients, which increases the risk of infection. To minimize interaction, a touch-free and automatic recording method are required.

- *AI Empowered Imaging Workflow:* During the COVID-19 epidemic, these devices aid in the implementation of a contactless scanning methodology. With AI-powered visual sensors, a typical scanning parameter may be approximated. Scan range may be determined by recognising the subject's anatomical joints in the pictures. Artificial intelligence (AI) can deduce critical facts about the digital human body. Based on dynamic multi-modal inference, it can learn a model that can be used across numerous such applications. AI may also infer other crucial factors, such as ISO-centering.
- ***Applications in COVID-19:*** Several critical routines were built during the COVID-19 epidemic, including improved patient access and flexible installation. An automated scanning process based on a mobile CT platform is a prominent example. The mobile platform is self-contained and includes an AI-powered pre-scan and diagnosis system.

C. AI aided Image Segmentation

Photographic classification is an important phase in image processing and analysis to evaluate and measure COVID-19. It describes areas of interest (ROIs), including the lungs, lobes, bronchopulmonary segments, and infected or malignant

- Segmentation of Lung Regions and Lesions: The search for COVID-19 applications can be split into two types. Lung-focused techniques require the separation of ulcers (or metal objects moving in the lungs) in the lungs. Because sores or bumps may be small and have a wide variety of forms and textures, locating them is necessary.
- *Segmentation Methods:* In COVID programs, U-Net is a frequently used method of distinguishing lung areas and lung ulcers. It uses a fully flexible network with symmetric signal coding and recording methods. Shortcut links connect layers of the same level in two ways. A number of U-Net variants have been developed, which bring the acceptable results of separation into COVID-19 systems. Newly developed attention spans can learn the most discriminating part of network traits. This procedure is necessary to separate the lesions and lung lumps in medical imaging. Training an effective partition network requires a large amount of labelled data. Adequate training data for the separation of COVID-19 images are generally not available because diagnostics are time-consuming. The human-in-the-loop method incorporates the input of radiologists into network training.
- *Applications in COVID-19:* COVID-19 segmentation can be utilised in a variety of applications. In a multi-centre investigation, Li et al. employ U-Net for lung segmentation. Image segmentation is also used for quantification in a variety of medical applications.

D. AI-Assisted Differential Diagnosis of COVID-19

In epidemic regions, patients who may have had COVID-19 require prompt diagnosis and treatment. Medical imaging, particularly CT images, contains hundreds of pieces that take radiologists a long time to diagnose. The second table highlights the most current modern works on this topic.

(i) X-ray Based Screening of COVID-19

For patients with COVID-19, the standard first-line imaging modality is X-ray. According to a recent study, X-rays are normal in early or mild illnesses. The findings of the experiments reveal that Bayesian inference improves detection accuracy from 85.7% to 92.9%. Narin et al. offer three deep learning models for detecting COVID-19 infection in X-ray pictures. When compared to InceptionV3 and Inception-ResNetV2, the ResNet50 model obtains the greatest classification performance with 98.0% accuracy.

The photos are mostly from two internet databases, each of which has just 70 photographs of COVID- 19 patients. This little dataset is insufficient to assess the robustness of the approaches. Furthermore, the severity of the individuals is unknown; future research might focus on early diagnosis.

(ii) CT-based Screening and Severity Assessment of COVID-19

Radiological patterns in COVID-19 chest CT scans have been documented and summarised in four phases. GGO might be seen unilaterally or bilaterally subpleural in the lower lobes. These radiological patterns serve as critical evidence for CT-based categorization and severity evaluation.

a. Classification of COVID-19 from non-COVID-19

A number of investigations are being conducted to distinguish COVID-19 patients from non-COID- 19 participants (that include common pneumonia subjects and non-pneumonia subjects). With the aid of AI findings, radiologists' reading time is reduced by 65 %.

b. Classification of COVID-19 from Other Pneumonia

Pneumonia, particularly viral pneumo- nia, exhibits radiological features similar to COVID-19. On manually delineated area patches, proposes a 2D CNN model. The model is trained using chest CT scans from 99 individuals. Song et al. employ 2D slices with lung regions segmented by OpenCV. Each 3D chest CT image yields 15 slices of complete lungs. For pneumonia categorization, the model gets results with an accuracy of 86.0% (COVID-19).

The picture is segmented into the left/right lung, 5 lung lobes, and 18 pulmonary segments using a 3D VB-Net. The experimental findings suggest that distinguishing COVID-19 has a sensitivity of 90.7%, a specificity of 83.3 %, and an accuracy of 87.9%

c. Severity Assessment of COVID-19

A number of studies for CT-based COVID-19 diagnosis have been proposed, with generally encouraging findings. Screening research might aid in early detection, reducing radiologists' diagnostic uncertainty. Furthermore, the prediction of severity is critical since it might aid in the calculation of ICU events or clinical treatment planning decisions.

IV. IMAGING MODALITIES IN DIAGNOSIS OF COVID-19

Medical imaging can be used in addition to RT-PCR testing to help diagnose COVID-19. COVID-19 individuals have typical imaging features, particularly CT characteristics. In the sections that follow, we will discuss the use of CT and other imaging modalities in the diagnosis of COVID-19.

A. CT Characteristics in Diagnosis of COVID-19

(i) CT Characteristics of typical COVID-19

This diagram shows the typical CT features of four COVID-19 patients. GGO, nodules, pleural changes such as pleural rupture or pleural thickening, and other abnormalities such as linear blindness with a crazy compression pattern are examples of this.

The most common detection of COVID-19 in the CT chest is GGO, which appears to be a growing pulmonary embolism with the preservation of bronchial and vascular boundaries. In the middle stage of the disease, GGO often develops into multifocal consolidative opacities and septal thickening.

Another commonly found radiologic chest CT scan is patchy shadowing of two countries. CU scans for ICU patients often reveal multiple lobular and subcutaneous regions of incorporation. People with COVID-19 often have multiple sores and a crazy paved pattern.

(ii) CT Characteristics in Asymptomatic COVID-19

Screening for people with invisible or abnormal presentations is an important aspect of managing COVID-19. CT can also be used to diagnose patients with no atypical symptoms and signs. To diagnose these people with no symptoms of COVID-19, a combination of CT imaging of the chest, RT-PCR, and complete follow-up should be performed. Hu et al. found that seven people with normal CT results and no symptoms were significantly younger than the others.

(iii) Use of CT Characteristics for Discriminating COVID-19 pneumonia from other pneumonia

The use of CT findings to identify COVID-19 pneumonia from other types of pneumonia has garnered a lot of interest. Patients with the syndrome are more likely to experience peripheral distribution, vascular thickening, and the reverse halo sign. They had a lower risk of central- peripheral distribution, pleural effusion, and lymphadenopathy.

(iv) Other Imaging Techniques

Additionally to chest CT, additional imaging modalities, such as positron emission tomography - CT (PET / CT), lung ultrasonography, and magnetic resonance imaging, are used to add chest CT to the diagnosis of COVID-19 (MRI). A brief overview of these photography methods is provided in the following sections.

- **PET/CT***:* CT findings of differentiating COVID-19 pneumonia from pneumonia have received considerable attention. Patients suffering from this condition are more prone to the peripheral circulation, vascular congestion, and the opposite halo mark. They are less likely to have central-peripheral, pleural effusion, or lymphadenopathy.
- **Lung Ultrasound:** Lung ultrasonography (LUS) enables low-risk individuals to be screened at home and suspected cases to be diagnosed. LUS can lower the risk of infection among affected patients and health care professionals. LUS might be used by obstetricians and gynaecologists to do lung examinations.
- **MRI:** MRI is a radiation-free imaging tool that is extremely effective for analysing soft tissues. However, owing of the longer scanning time and higher cost when compared to CT and LUS, it is not commonly utilised for COVID-19 diagnosis. Nonetheless, a non-invasive MRI may be useful in assessing COVID-19 in children and pregnant women. SARS-CoV-2 is mostly identified in the lungs, but three minimally invasive autopsies demonstrated that the virus also affects the heart, arteries, liver, kidney, and other organs. Because of its better performance in imaging structural and functional information of many soft organs, MRI might be used to assess the vulnerability of various organs.

(v) AI-Based Image Analysis of COVID-19

Self-diagnosis in CT images necessitates a significant amount of manual work and time. Computer-assisted diagnostic techniques have been developed using in-depth research or machine learning technologies. The software was tested on 1,136 instances (723 COID-19 positives) from five hospitals.

An in-depth study approach based on an in-depth study may accelerate the identification of COVID- 19. The proposed in-depth study model achieved 94.98% accuracy, with an AUC of 97.91%, and 95.06% sensitivity among 1,255 independent experimental conditions.

Zheng et al. used UNet to divide the lung area before splitting it again using 3DResNet. There were 3,506 patients in the trial (468 with COVID-19, 1,551 with Community-Acquired Pneumonia (CAP), and 1,303 with non-pneumonia). Recent research has shown that AI demonstrates efficacy in the rapid diagnosis of COVID-19. With the help of AI, doctors can be separated from patients to avoid infection. Using AI and CT imaging does not add up to the cost of healthcare professionals.

V. Conclusion

We concluded that Intelligent medical imaging was important in combating COVID-19. This study explains how Artificial Intelligence (AI) can deliver safe, accurate, and efficient solutions. To demonstrate the effectiveness of a powerful AI medical image, two imaging modes are used, X-ray and CT. Screening of suspected and symptomatic patients allows for immediate diagnosis and treatment. Remote monitoring and treatment may reduce communication between medical staff and patients. The goal of this program is to create portable devices and platforms based on highly advanced, inexpensive, flexible, and flexible sensors. Identifying and resolving ethical concerns, privacy threats, and potential security threats through the use of wearable devices, invisible sensors, and telemedicine.

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