

Deep Learning applications for COVID-19: a brief review

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Abstract

Most aspects of human life have been affected by COVID-19 (coronavirus disease) since December 2019. The World Health Organization (WHO) has declared COVID-19 as a pandemic. One of the top praised techniques used in image-based healthcare applications is DL (Deep Learning). Thus, many studies have been suggested to develop devices with smart image-based diagnosis capability to detect COVID-19. In this paper, an elaborated summary is presented on the state-of-the-art studies associated with Deep Learning applications used in COVID-19 medical image processing to review the increased use of Deep Learning in COVID-19 studies.

Keywords: Deep Learning, Computer Vision, COVID-19.

Introduction

One of the greatest challenges in the 21st century is the COVID-19 disease. It was December 2019 when a new variety of coronavirus disease called COVID-19 (corona-virus disease 2019) was detected in Wuhan, PRC, the most prevalent symptoms of which were cough, fever, myalgia, and headache. As the World Health Organization suggests, molecular assays, including the RT-PCR, must be used to confirm the entire COVID-19 diagnoses [1,2]. In addition to medical imaging and RT-PCR, computed tomography (CT) has turned into a crucial technique to facilitate the management and diagnosis of COVID-19 patients. The radiologists' crucial duty is providing early treatment and diagnosis to recognize the infection with COVID-19 from other situations with the same symptoms at computed tomography [3,4]. In accordance with the changes occurred in COVID-19 radiography found in computed tomography images, artificial intelligence (AI) techniques can derive unique graphical characteristics of COVID-19 and present a clinical diagnosis before the pathogenic tests, and as a result, leading to saving crucial time for control of disease [5]. The artificial intelligence methods equipped with DL systems based on medical imaging have been developed to extract image characteristics, such as spatial relation and shape characteristics. DL techniques have been used to determine the nature of recognized diseases through computed tomography images [6,7,8]. Given the above facts, the present brief review study concentrates on improvement of image-based technological resolutions with special emphasis on deep learning. In summary, the present review study has been organized in three major sections, as a background on COVID-19, deep learning and a list of image-based deep learning techniques presented for COVID-19. One can summarize the major contributions of this study as below:

- This research makes a brief review on COVID-19 applications via the deep learning lens.
- We present a brief Computer Vision (CV) list of recent deep learning methods especially concentrated on COVID-19 studies.
- This research examines the prevailing constrains, their impacts and the resolutions to tackle these problems.

Methodology

Using the existing literature, this section presents a brief background on the principles of deep learning, COVID-19, and an analysis on adopting deep learning in medical images processing.

Computer Vision in medical imaging

Object localization, classification, and detection respectively refer to determining the location of available objects, the type of objects found in an image, and both location and type simultaneously. The quantity of publications employing computer vision approaches for static medical imagery has multiplied in recent years [16-18]. Some areas, such as pathology, radiology, dermatology, and ophthalmology, have received considerable attention due to the ascending access to highly structured images, and the visual pattern recognition capabilities required for diagnostic tasks in the above specialties [19]. The terms medical image analysis or medical imaging are employed to define a wide range of processes and techniques creating a general image of the interior parts of the body and specific tissues or organs as well. Generally, the disciplines covered by medical imaging include MRI (magnetic resonance imaging), ultrasound, X-ray radiography, thermography medical photography, endoscopy, etc. The medical image analysis is primarily aimed at increasing the efficiency of medical interventions and clinical examinations to have a look underneath bones and skin into the internal tissues and organs and figure out the origin of their problems. Firstly, medical imaging explores the inner workings of physiology and anatomy [20]. Secondly, the analysis of medical images contributes to diagnosis of the abnormalities and discovery of their impacts and causes.

Deep Learning

Artificial neural networks (ANN) and DL have received a great deal of momentum in today's scientific studies because they are capable of learning from the context. Given their capability of adapting to multiple types of data across various domains, these methods have become popular in different applications, including image recognition, self-driven cars, prediction and classification problems, object recognition, smart homes, etc. Deep learning mimics the human brain functions when filtering data for accurate decision makings [22]. Just like the human brain, a system is trained through deep learning so that it can filter out the inputs via various layers to contribute to data classification and prediction. The above layers act as layered filters employed in ANNs within the brain in which each layer functions as a feedback to the next layer. These feedback cycles are continued until obtaining the accurate output. By assigning weights to each layer, the accurate outputs are developed, and these weights are modified throughout training to reach the precise output. In deep learning, deep means the number of demanded layers for the data transformation [23].

In sum, given the above issues, one can conclude that the use of a deep learning framework to diagnose COVID-19 via medical images may result in designing computer-aided diagnosis instruments for COVID-19 in clinical conditions. The following section provides more details on the models proposed on the basis of deep learning presented in recent years.

Deep Learning Medical Image Analysis Techniques in COVID-19

Generating precise models that can localize, classify, and detect various objects in a single image has remained an essential challenge in computer vision [30]. Given the recent progressions in computer vision models and deep learning, it is easier to develop medical applications of image detection than ever before. Such models pave the way for localization and recognition of various objects in an image, extracting the features and learning to distinguish the object type instances [31]. The chest imaging has a crucial function in determining the extent of infection and follow-up necessities in COVID-19 disease diagnosis. The COVID-19 patients are typically distinguished due to the diffused or patchy asymmetric opaqueness of their airspace [32]. Also, the computed tomography images and the indicators reflect the bilateral lung involvement. While patients with serious symptoms in Intensive Care Unit show a consolidative pattern, the non-ICU ones have presented ground glass patterns in their reports. In contrast, the chest images in MERS and SARS diseases have presented unilateral indicators [33]. However, sometimes the chest images and primary X-ray have shown normalcy for the patients who had been already infected with the disease. This finding reflects the necessity of further validation via employing the deep learning-based techniques or physical tests. To acquire computed tomography images, an X-ray captures the images of a special part from various angles while rotating, which are saved in a computer and analyzed further to generate a new image eliminating the whole overlapping. Such images assist doctors in understanding the internal structures with improved clarity and having an idea of the structure, density, size, shape, and texture of them. Therefore, as a diagnostic method, CT scan is more effective compared to X-ray. The chest X-ray or computed tomography cannot distinguish the symptoms of COVID-19 from other symptoms associated with cold. The chest X-ray or CT often uncover the existence of an infection, which can also be resulted by any other diseases [33,34]. The conventional RT-PCR technique can detect the disease with high accuracy; however, it has longer detection time and requires reagents. Pandemic crises with their ever-growing population of patients are in dire need for faster disease detection via spending minimal resources. To satisfy this demand, deep learning algorithms functioning on the basis of image processing have a prominent role in discarding the incredible crowd of those undergoing the swab test and the relevant ones [35]. Figure 1 shows the images of X-ray and CT scan for COVID-19 patients.

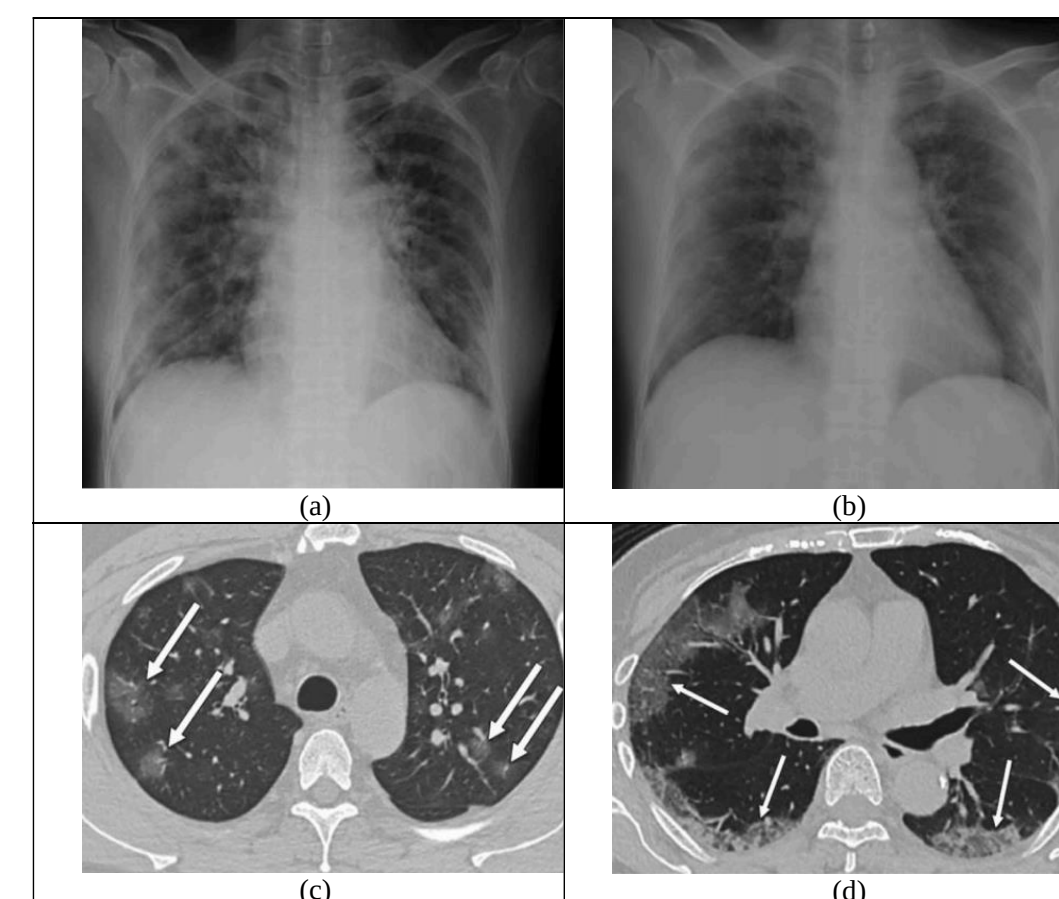


Fig. 1. (a) and (b) indicate X-ray images of COVID-19 patients, (c) and (d) indicate CT scan images of COVID-19 patients.

Discussion

After a critical review of the literature, it becomes clear that deep learning and medical image processing have a crucial role in fighting the COVID-19 pandemic by means of some promising applications such as coronavirus diagnosis. Table 2 summarizes this brief survey and the selected references. In fact, the use of deep learning in medical image analysis effectively supports prediction of disease in gigantic datasets acquired from accessible sources, including healthcare institutes and health organizations. The applications of deep learning concentrate on medical imaging emerged as a promising approach. The applications of deep learning are employed to analyze and process medical imaging data to assist doctors and radiologists in improving the diagnosis accuracy. Deep learning using medical images also has the capability of identifying the potential targets of a suitable COVID-19 vaccine. Numerous studies have been carried out on COVID-19 to underline the automated diagnosis of COVID-19 through deep learning systems via medical imaging datasets.

Conclusion

Thus, among numerous medical applications used for image processing, deep learning seems a suitable method presenting intelligent resolutions. The present brief review study summarizes the recent efforts on the COVID19 detection considering the deep learning. Regardless of promising results, the success in applying deep learning for processing COVID-19 medical images necessitates considerable effort, time and close cooperation between various parties from industry, academia, and government. Also, we have listed some issues and challenges related to current studies, and the differences between non-COVID-19 and COVID-19 symptoms. In accordance with the whole studies mentioned above, we assume that the use of image processing and deep learning techniques and also, various technologies including mobile communications, data science, and biomedicine can present effective solutions to overcome the COVID19 outbreak. Also, we wish that our study becomes a valuable reference and induces numerous novel studies on deep learning and processing of medical images in the battle against the COVID-19 virus outbreak.

References

To find the sources and references please read the full text. This research has a review of 59 references, which unfortunately could not be mentioned in the poster for us. Thank you for your attention.