**Hybrid Optimized Deep Learning-CNN Tool for COVID-19 Detection from Chest X-ray Images**

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***ABSTRACT:*** While RTPCR is by far the most effective way of COVID-19 detection. This method is very time consuming (taking hours to even days) and requires special kits that may not be available in remote regions of a country due to geological, social, and economic barriers. On the contrary, the rapid antigen test looks for the presence of antigens of the virus from a nasal swab but suffers from higher rate of false negatives. The serological test looks for the antibodies produced by the immune system against the virus from the blood sample of the patient. However, it only checks the IgM and IgG antibodies during or after recovery and does not help in early virus detection. CT scan and X-ray scans, both use invisible ranges of electro-magnetic spectrum to detect any kind of anomaly, used for early detects and have high clinical relevance. In this proposal, we will find out the new computer aided diagnosis for chest X-ray tests, that are economically affordable, and the results are relatively easy to use. Chest X-ray tests are easily available, have portable versions, and a low risk of radiation. On the other hand, CT scans have high risk of radiation, are expensive, need clinical expertise to handle and are non-portable. This makes the use of X-ray scans more convenient than CT scans.

***Keywords: Chest X-ray images, COVID-19, CNS, Deep Learning, Optimal feature selection, Meta- heuristic optimization***

**1. INTRODUCTION**

COVID-19 (coronavirus disease 2019) is an infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which is a strain of coronavirus and spread over 200 countries in the past year. The disease was officially announced as a pandemic by the World Health Organisation (WHO) on 11 March 2020.Meanwhile, COVID-19 has become a serious health threat for the entire world that causes respiratory problems, heart infections, and even death. This virus first reported in a human being in December 2019 in Wuhan, Chinarapidly crossed the continent borders due to intensive travelling among countries. COVID-19 has had an adverse impact on the world economy too. Research studies found out that the COVID-19 virus severely affects the lungs and promptly mutates before the patient receives any diagnosis led medication [1, 2]. The situation becomes more severe when the symptoms match the normal flu, as in the Southeast and Central Asia cases. Experts found out that the incubation period of COVID-19 virus is approximately 1 week [3]. This observation is crucial because the infected patient acts as a virus carrier during this period and unintentionally transmits it. Due to its rapid contagious nature, its spread is much faster than its detection. Machine learning methods [4, 5]are extremely popular in healthcare applications.There are various methods used to detect the presence of a COVID-19 virus in patients, such as RTPCR test [6], X-ray imaging [7, 8], computed tomography (CT) scan [9], rapid antigen [10], serological test [11].

Medical images and artificial intelligence (AI) have been found useful for rapid assessment to provide treatment of COVID-19 infected patients. Therefore, the design and deployment of AI tools for image classification of COVID-19 in a short period of time with limited data have been an urgent need for fighting the current pandemic. Radiologists have recently found that deep learning (DL) developed in AI, which was able to detect tuberculosis in chest X-rays, could be useful for identifying lung abnormalities related to COVID-19 and help clinicians in deciding the order of treatment of high-risk COVID-19 patients. The role of medical imaging has also been confirmed by others as playing an important source of information to enable the fast diagnosis of COVID-19, and the coupling of AI and chest imaging can help explain the complications of COVID-19.Regarding the image analysis of COVID-19, chest X-ray is an imaging method to diagnose COVID-19 infection adopted by hospitals, particularly the first image-based approach used in Spain. The protocol is that if a clinical suspicion about the infection remains after the examination of a patient, a sample of nasopharyngeal exudate is obtained to test the reverse-transcription polymerase chain reaction (RT-PCR) and the taking of a chest X-ray film follows. Because the results of the PCR test may take several hours to become available, information revealed from the chest X-ray plays an important role for a rapid clinical assessment. This means if the clinical condition and the chest X-ray are normal, the patient is sent home while awaiting the results of the etiological test. But if the X-ray shows pathological findings, the suspected patient will be admitted to the hospital for close monitoring. In general, the absence or presence of pathological findings on the chest X-ray is the basis for making a clinical decision in sending the patient home or keeping the patient in the hospital for further observation.Further, given spikes in new COVID-19 cases and the re-opening of daily activities around the world, the demand for curbing the pandemic is to be more emphasized.

**2. RELATED WORK**

In the last few months, World Health Organization (WHO) has declared that a new virus called COVID-19 has been spread aggressively in several countries around the world [18]. Diagnosis of COVID-19 is typically associated with the symptoms of pneumonia, which can be revealed by genetic and imaging tests. Fast detection of the COVID-19 can be contributed to control the spread of the disease. Image tests can provide a fast detection of COVID-19, and consequently contribute to control the spread of the disease. Chest X-ray and CT are the imaging techniques that play an important role in the diagnosis of COVID-19 disease. The historical conception of image diagnostic systems has been comprehensively explored through several approaches ranging from feature engineering to feature learning.Convolutional neural network (CNN) is one of the most popular and effective approaches in the diagnosis of COVD-19 from digitised images. Several reviews have been carried out to highlight recent contributions to COVID-19 detection [12-14]. For example, in [15], a CNN was applied based on Inception network to detect COVID-19 disease within CT. In [16], a modified version of ResNet50 pre-trained network has been provided to classify CT images into three classes: healthy, COVID-19 and bacterial pneumonia. CXR were used in [17] by a CNN constructed based on various ImageNet pre-trained models to extract the high-level features. Those features were fed into SVM as a machine learning classifier to detect the COVID-19 cases. Moreover, in [18], a CNN architecture called COVID-Net based on transfer learning was applied to classify the CXR images into four classes: normal, bacterial infection, non-COVID and COVID-19 viral infection. In [19], a dataset of CXR images from patients with pneumonia, confirmed COVID-19 disease, and normal incidents, was used to evaluate the performance of state-ofthe-art convolutional neural network architectures proposed previously for medical image classification. The study suggested that transfer learning can extract significant features related to the COVID-19 disease. Having reviewed the related work, it is evident that despite the success of deep learning in the detection of COVID-19 from CXR and CT images, data irregularities have not been explored. It is common in medical imaging in particular that datasets exhibit different types of irregularities (e.g., overlapping classes) that affect the resulting accuracy of machine learning models.

**3. RESEARCH OBJECTIVES**

The goal of this research work is to develop a set of different COVID-19 diagnosis and classification models. The novelty and the contribution of this work is as follows:

* Development of hybrid deep learning-CNN model for COVID-19early detection from chest X-ray images.
* To introduce hybrid optimal deep learning-CNN tool for chest X-ray image diagnosis and classification.

**3.1SIGINIFICANCE**

In medical diagnosis, it is always necessary to obtain higher efficiency in the performance of disease diagnostic, even a little arise in accuracy makes substantial difference. Usually, optimal feature selection techniques such as metaheuristic and heuristic are used in classification to obtain higher accuracy. Recent days, evolutionary computation algorithms getting more attention as a critical metaheuristic family member. In addition, many feature selection techniques are employed for the applications of medical diagnosis [20-22]. Hence, this work aims to implement an efficient feature selection methodfor enhanced diagnosis of chest X-ray image for COVID-19 detection.

**4. PROPOSED OUTCOME**

Diagnosis of COVID-19 is typically associated with both the symptoms of pneumonia and Chest X-ray tests. Chest X-ray is the first imaging technique that plays an important role in the diagnosis of COVID-19 disease. Figure 1 shows a negative example of a normal chest X-ray, a positive one with COVID-19, and a positive one with the severe acute respiratory syndrome (SARS).



Fig. 1: (a) normal. (b) COVID-19. (c) SARS chest X-ray image.

The proposed methodology involves four major processes such as pre-processing, segmentation, feature extraction, and classification.

**4.1 Pre-processing**

The acquisition of images process must be non-uniform in several terms. Thus, the main goal of the pre-processing step is to enhance the image parameters such as quality, clarity, etc., by removing or reducing the unwanted parts of the image or the background. The main steps of the pre-processing are grayscale conversion, image enhancement, and noise removal. In this proposed system, firstly all the images are converted into grayscale. Then two filters which are known as Gaussian filter (GF) and Weiner filter (WF) are used for image enhancement and noise removal. Along with filters, to remove the unwanted hair from the skin lesion, the black hat method is used. The aim of image enhancement is to intensify the image quality by increasing its visibility. Generally, most of the skin lesions comprises of body hair, which can act as an obstacle in the process of achieving high accuracy at the time of classification. So, the unwanted hair from the images is removed.

**4.2 Segmentation**

Segmentation is the process of separating the region of interest of the image. This separation can be done by considering each pixel of the image with a similar attribute. The main advantage here is instead of processing the entire image, the image which is divided into segments can be processed. The most common technique is to indicate the edges of the region. The other approaches such as thresholding, clustering, and region growing use detection of similarities in the region.

**4.3 Feature extraction**

Feature extraction is considered as the most crucial part in the entire process of classification. The extraction of relevant features from the given input dataset for performing computations such as detection and classification further is called feature extraction.

**4.4 Classification**

Finally, classification is the last stage of the diagnostic process where the proper class label is determined.

**5. PERFORMANCE VALIDATION**

Here, two chest X-ray image datasets can be utilized such as Dataset-1 contains total of 950 X-ray images labelled with more than fifteen types of disease findings such as: pneumocystis, streptococcus, klebsiella, legionella, SARS, lipoid, varicella, mycoplasma, influenzas, herpes, aspergillosis, nocardia, COVID-19, tuberculosis, and others. This image dataset contains anteroposterior (front to back), front postero-anterior (back to front) and lateral (side) X-ray image views. Front postero-anterior images give clear lung representations.Dataset-2 contains total 5856 chest X-ray images labelled in three categories: normal, viral pneumonia, and bacterial pneumonia.A comprehensive qualitative results analysis takes place to ensure the effective performance of the proposed models on the applied dermoscopic images. In addition, a set of performance measures namely TP, TN, FP, FN, accuracy, F1-score, sensitivity, specificity, and are employed to determine the diagnostic performance.

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