International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2019): 7.583

COVID-19 Pandemic Detection in Chest X-ray Images by Deep Features with SVM Classifier

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Abstract: ***The X-ray scanner is the first imaging technique that plays an important role in the diagnosis of coronavirus disease 2019 (COVID-19). The early recognition of COVID-19 is now a very important mission for the medical practitioner. The COVID-19 spread so quicklyamong humans and around 1,236,791 infected humans with more than 67,249 death cases in the world, this number of infections is continuously increasing till the present time. In this consequence, it is a very important mission to recognize the infected humans so that can be separated to reduce the spread of COVD-19 among humans and save the people life. In this paper, we presented a method that uses deep feature extraction done by Convolutional Neural Networks (CNNs) and the classification done by Support Vector Machine (SVM) with nonlinear kernel function algorithms to recognize COVID-19 in Chest X-ray images. However, due to the limited availability of annotated medical images, the classification of medical images remains the biggest challenge in medical diagnosis. The results of the proposed method were Accuracy, Recall, False Positive Rate (FPR), and True Negative Rate (TNR), 91.53%, 91.68%, 91.06%, and 8.32% respectively. this rate of Accuracy shows the success of the proposed method and can be used in hospitals for the detection of COVID-19 in Chest X-ray images.***

Keywords: Detection COVID-19 in Chest X-ray images, coronavirus disease 2019 pneumonia, COVID-19, deep feature, SVM, Chest X-ray images.

1. Introduction

In the last days of December 2019, a number of cases of the novel coronavirus disease 2019 pneumonia (COVID-19) involving that the common onset symptoms were cough, fever, fatigue, or indicating myalgia as clinical manifestations have been found in Wuhan, Hubei Province, China [1]. The evaluation of the complete genome sequence of the respiratory samples suggests that it is a new kind of beta coronavirus [2], which resembled extreme acute respiratory syndrome coronavirus (SARSCoV) [3]. At 11th of February 2020, the World Health Organization (WHO) formally named it coronavirus disease (COVID-19) made from Corona (CO), Virus (VI), and Disease (DI). WHO has presently declared the outbreak of the public health emergency of a worldwide concern [4]. In 2nd of April 2020 the cases of COVID-19 reached 1,007,793 confirmed cases and in 3rd of April 2020 reached to 1,095,140 that means during 24 hours the confirmed cases increased 87,347 and this number daily increasing represent a very dangers disease [5], so the early prediction of coronavirus (COVID-19) is a very important task to sort the people so quickly among other people and the In this consequence, it is very a good deal to identify to become aware of infected human beings so that prevention of unfolding can be taken and in results can reduce the distribution of this disease to save the life of people and the uninfected people, in this study, we aimed to set up an early detection model to recognize healthful instances from COVID-19 pneumonia and with pulmonary, Chest X-ray images that can be used to train and test in deep learning techniques. Figure 1 represent the cases of COVID-19 in a world are increasing and figure 2 represent the number of newly infected Vs. number of recovered and discharged patients each day since 22th of January till 3ed of April, 2020 [5].

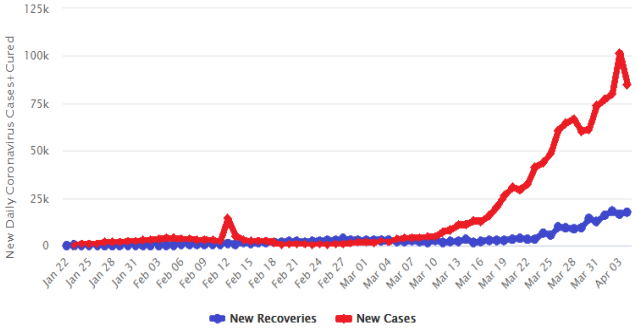

Figure 1: Represent the number of newly infected Vs. number of recovered and discharged patients each day in the world.

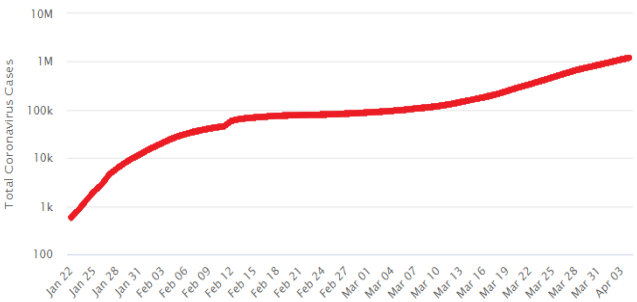

Figure 2: Represent the confirmed cases of COVID-19 in the world

In present days the detection of COVID-19 disease by using RT-PCR or chest X-ray imaging we can see CT imaging more ability, practical and rapid method to diagnose and assess COVID-19, especially in the epidemic area," the authors wrote. Chest CT, a routine imaging tool for pneumonia diagnosis, is fast and relatively easy to perform. Recent research found that the sensitivity of CT for

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Coronavirus disease 2019 infection was 98% compared to RT-PCR sensitivity of 71%. For the current study, researchers at Tongji Hospital in Wuhan, China, set out to investigate the diagnostic value and consistency of chest X-ray imaging in comparison to RT-PCR assay in COVID-19. That study was including 1,014 cases who undergo both chest CT and RT-PCR tests that happened between January 6 and February 6, 2020. The output results exhibited that 601 cases (59%) had positive with RT-PCR results, but with positive chest CT scans had 888 (88%) cases So that, the sensibility of chest CT in proposition COVID-19 was 97%, depended on positive RT-PCR output results. About 81% of the patients with negative RT-PCR results but positive chest CT scans were re-classified as highly likely or probable cases with COVID-19, by the comprehensive analysis of clinical symptoms, typical CT manifestations, and dynamic CT follow-ups [6]. COVID-19 it causes sharp aerobic Symptoms and is correlating with correlating high ICU admission and deads. The current clinical experiment for treating these patients uncover that the RT-PCR disclosure of viral RNA from spit or nasopharyngeal sweep had a low positive average in the early stage. However, a high proportion of unnatural chest X-ray images were obtained from patients with this disease. Yet, a high ratio of unnatural chest CT images was obtained from patients with this disease. The semblance of CT imaging of COVID-19 cases had their own advantages, different from the manifestations of CT imaging of other viral pneumonia such as Influenza-A viral pneumonia. Therefore, clinical doctors called for exchange nucleic acid testing with lung CT as one of the early diagnostic standards for this new type of pneumonia as soon as possible. CT imaging is a kind of advanced X-ray machine that tests so soft structure of the active human body part and clearer image of the inner-soft organs and tissues [7]. Using X-ray scanner is an easy, less harmful, fast, and cheap. With the fast development of computer technology, digital image processing technology has been widely applied in the medical field, involving image enhancement and organ segmentation and repair, supplying support for subsequent medical diagnosis [8],[9]. Deep learning technologies, such as convolutional neural networks (CNN) with the powerful capability of nonlinearity modeling, have overall applications in medical image handling too [10]-[13]. Related works had been performed on the prognosis of pulmonary nodules presented by [14],[15]. The classification of malignant tumors and benign presented by [16]. The ailment detection and the pulmonary tuberculosis tests [17]-[19] worldwide. Author used nominee contagion regions were first segmented out using a 3-D deep learning type from a pulmonary Chest X-ray image set. These detached images were then classified into Influenza-A viral pneumonia, Coronavirus disease 2019 and irrelevant to infection groups, together with the conformable confidence scores using a location-attention classification model. To this end, the contagion kind and total confidence score of this CT case were thoughtful with Noisy-or Bayesian function. The experiment outcome of the benchmark dataset offered that the overall accuracy was 86.7 % from the perspective of chest CT images cases as a whole presented by [20]

2. Chest X-ray images COVID-19 Dataset

In this paper, the datasets have been used were freely available and collected from virus sources published by [21] contains two classes balance negative and positive in each class have 25 images in a total 50 Chest X-ray images. In addition, we collected more images from internet sources and [22] for both classes in a total we got 146 Chest CT images balance. We tested our proposed method for all images and were 25% for the test images and 75% for Train images. Figure 3 shows the examples of image normal case and infected with COVID-19 [21].

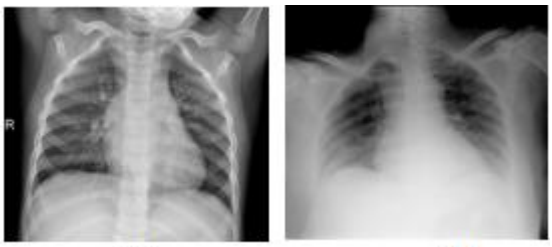

Figure 3: Examples of chest X-ray image [21]. (a) normal case. (b) infected case with COVID-19.

3. Proposed Method

In the proposed method, first preprocessing to modify the X-ray image sizes to be the same dimensions as the input layer in CNN (Alexnet). Next, Alexnet is used to extract deep features and learn from input chest X-ray images by mathematical operations. Then, A binary classification has been used by Support Vector Machine (SVM) to predict COVID-19 in Chest X-ray images. Finally, the class name of the input Chest X-ray image will generate from the SVM output. The overall architecture of the COVID-19 detection model being used is shown in Figure 4.

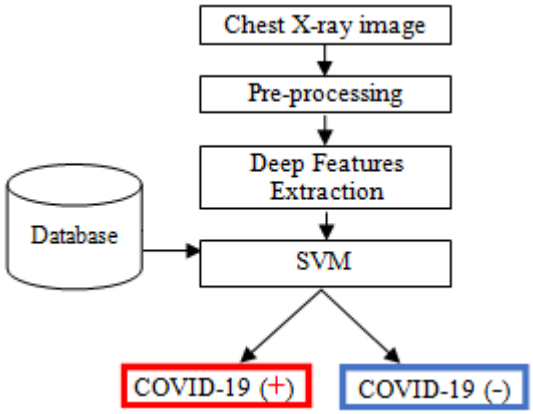

Figure 4: proposed method

In the proposed method, we have used Deep Neural Network (DNN) architecture for COVID-19 detection in Chest X-ray images as a pre-training task and test the network's ability to implement feature extraction and classification while the databases have limited number of images. Since the big amount of Chest X-ray images are very important to learning a convolutional neural network and It's often trained on not too large amounts of images to be able to extract deep features good generalization, Furthermore, several authors

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have investigated training CNNs using few numbers of images [23],[24]. After extract the X-ray image deep features, the input image is first transmitted through the CNNs network, and the extracted deep features are achieved from the fully connected layers, then we use Support Vector Machine (SVM) as our final classifier to detect the COVD 19 because of its classification effect on nonlinear data. Support Vector Machine (SVM) was presented firstly by [25]. SVM shows many advantages in solving nonlinear and high dimensional pattern recognition, is a robust discriminative classifier, several authors used SVM classifier, with efficiency for many pattern recognition and medical classification [26]. The SVM was trained on the deep features extracted from our CNNs. The 6th fully connected (FC) layer in Alexnet will generate deep features with length 4096 variables. The input training dataset and the testing dataset of SVM-RBF are the output features of the training dataset and the testing dataset of CNN, respectively. The training class and the testing class of SVM-RBF are respectively the same as the testing class and the training class of CNNs. This paper used a Radial Basis Function (RBF) as a kernel function in order to solve nonlinear problems.

4. Performance Evaluation

In this study, the results evaluated by a Confusion matrix do define the performance of the proposed method.

True Positive (**TP**): in reality, it's a COVID-19 (Positive) and detected as COVID-19 (Positive) (correctly).
False Positive (**FP**): in reality, it's a COVID-19 (Positive) and detected as COVID-19 (Negative) (incorrectly).
True Negative (**TN**): in reality, it's Negative and detected as COVID-19 (Negative) (correctly).
False Negative (**FN**): In reality, it's COVID-19 (Negative) and detected as COVID-19 (Positive) (incorrectly).

By the TP, FP, TN, and FN evaluate in the mathematical equations (1), (2), (3), and (4) Accuracy, Recall and Precision or called Positive Rate (FPR), and True Negative Rate (TNR) respectively.

$$Accuracy = \frac{[TP] + [TN]}{[TP] + [TN] + [FP] + [FN]} \quad (1)$$

$$Recall = \frac{[TP]}{[TP] + [FN]} \quad (2)$$

$$Precision = \frac{[TP]}{[TP] + [FP]} \quad (3)$$

$$TNR = 1 - FPR \quad (4)$$

5. Results

In this study, we tested the Accuracy of the COVID-19 detection in Chest X-ray images. All the requirements in this experiment were implemented test, train with Neural network, Image processing, computer vision toolboxes and app of classification in MATLAB 2018-b and the computer with Intel (R) Core™ -i7-7500U, CPU (2.9 GHz) with RAM 12GB, it helped us to give a good performance and a good processing time. The deep features generated by Alexnet with nonlinear SVM classification outcomes were Accuracy, Recall, False Positive Rate (FPR), and True Negative Rate (TNR), 91.53%, 91.68%, 91.06%, and 8.32% respectively. The proposed classification model for the detection of COVID-19 has achieved at 91.53% accuracy. In this multi-center case study, we had presented a novel method that could detect COVID-19 fully automatically by using deep learning technology.

6. Conclusion

In this paper, we presented a novel algorithm that could recognize Coronavirus disease 2019 fully automatically by the aid of deep learning. Overall accuracy 91.53 %, this rate of accuracy could be used in hospitals to recognize Coronavirus disease 2019 from Chest X-ray images. Planed future work do use other models of CNNs and change parameters of the SVM classifier or try to use other types of classifier that may improve the performance and time consuming some of the authors used Principal Component Analysis (PCA) after Fully Connected layer aimed to reduce the number of variables of features presented by [27].

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