scientific reports

OPEN

COVID-19 detection from chest X-ray images using transfer learning

Enas M. F. El Houby

COVID-19 is a kind of coronavirus that appeared in China in the Province of Wuhan in December 2019. The most significant influence of this virus is its very highly contagious characteristic which may lead to death. The standard diagnosis of COVID-19 is based on swabs from the throat and nose, their sensitivity is not high enough and so they are prone to errors. Early diagnosis of COVID-19 disease is important to provide the chance of quick isolation of the suspected cases and to decrease the opportunity of infection in healthy people. In this research, a framework for chest X-ray image classification tasks based on deep learning is proposed to help in early diagnosis of COVID-19. The proposed framework contains two phases which are the pre-processing phase and classification phase which uses pre-trained convolution neural network models based on transfer learning. In the pre-processing phase, different image enhancements have been applied to full and segmented X-ray images to improve the classification performance of the CNN models. Two CNN pre-trained models have been used for classification which are VGG19 and EfficientNetB0. From experimental results, the best model achieved a sensitivity of 0.96, specificity of 0.94, precision of 0.9412, F1 score of 0.9505 and accuracy of 0.95 using enhanced full X-ray images for binary classification of chest X-ray images into COVID-19 or normal with VGG19. The proposed framework is promising and achieved a classification accuracy of 0.935 for 4-class classification.

Since December 2019, coronavirus has been disseminated from China to many other countries. Coronavirus which is called SARS-CoV-2 causes COVID-19 as named by World Health Organization (WHO) on February 11, 2020. World Health Organization announced COVID-19 disease resulted from the coronavirus as a world pandemic in March 2020[1]. The disease has disseminated to nearly all countries, resulting in millions of people's deaths among confirmed cases based on the statistics of the WHO[2]. By July 2023, nearly 700 million confirmed cases, and almost 7 million confirmed deaths were recorded in the world[3,4]. Most patients with the virus experience mild to moderate respiratory illness and heal without needing special treatment. But, some suffer from complications and need medical attention. Older people and those with underlying medical conditions like cardiovascular disease, diabetes, chronic respiratory disease, or cancer are more likely to develop serious illnesses. Anyone can get sick with COVID-19 and become seriously ill or die at any age[5].

Although the last diagnosis of COVID-19 depends on transcription-polymerase chain reaction (PCR) tests, in states of people with intensive respiratory symptoms the diagnosis protocol depends on medical imaging, which helps doctors to recognize the disease as the sensitivity of PCR is strongly variable[6]. As chest radiography imaging such as computed tomography (CT) imaging and X-ray have been used successfully for the diagnosis of pneumonia, they have a high sensitivity for the diagnosis of COVID-19[2]. The suspected case undergoes an X-Ray session and if more details are required, a computed tomography scan (CT-scan) session is taken. Therefore, X-ray[7] and CT scan images[8] are being used as diagnostic methods for COVID-19 and to detect the effects[9] of the virus[6,10]. The availability and accessibility of X-ray imaging in many imaging centers and clinics is more present even in rural regions as it is standard equipment in healthcare systems. Particularly, chest X-ray is more readily available than CT, because CT scanners require high equipment and maintenance costs. CT is not very suitable for COVID-19 screening as well because of its cost, imaging time, and radiation exposure whereas X-ray is more cost and time effective in dealing with such a common virus[11].

Systems and Information Department, National Research Centre, Dokki 12311, Cairo, Egypt. email: enas_mfahmy@yahoo.com; em.fahmy@nrc.sci.eg