Original Research Article

DIGITAL HEALTH

DIGITAL HEALTH
Volume 10: 1–16

DOI: 10.1177/20552076241257045
journals.sagepub.com/home/dhj

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SVM-RLF-DNN: A DNN with reliefF and SVM for automatic identification of COVID from chest X-ray and CT images

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Abstract

Aim: To develop an advanced determination technology for detecting COVID-19 patterns from chest X-ray and CT-scan films with distinct applications of deep learning and machine learning methods.

Methods and Materials: The newly enhanced proposed hybrid classification network (SVM-RLF-DNN) comprises of three phases: feature extraction, selection and classification. The in-depth features are extracted from a series of 3×3 convolution, 2×2 max polling operations followed by a flattened and fully connected layer of the deep neural network (DNN). ReLU activation function and Adam optimizer are used in the model. The ReliefF is an improved feature selection algorithm of Relief that uses Manhattan distance instead of Euclidean distance. Based on the significance of the feature, the ReliefF assigns weight to each extracted feature received from a fully connected layer. The weight to each feature is the average of k closest hits and misses in each class for a neighbouring instance pair in multiclass problems. The ReliefF eliminates lower-weight features by setting the node value to zero. The higher weights of the features are kept to obtain the feature selection. At the last layer of the neural network, the multiclass Support Vector Machine (SVM) is used to classify the patterns of COVID-19, viral pneumonia and healthy cases. The three classes with three binary SVM classifiers use linear kernel function for each binary SVM following a one-versus-all approach. The hinge loss function and L2-norm regularization are selected for more stable results. The proposed method is assessed on publicly available chest X-ray and CT-scan image databases from Kaggle and GitHub. The performance of the proposed classification model has comparable training, validation, and test accuracy, as well as sensitivity, specificity, and confusion matrix for quantitative evaluation on five-fold cross-validation.

Results: Our proposed network has achieved test accuracy of 98.48% and 95.34% on 2-class X-rays and CT. More importantly, the proposed model's test accuracy, sensitivity, and specificity are 87.9%, 86.32%, and 90.25% for 3-class classification (COVID-19, Pneumonia, Normal) on chest X-rays. The proposed model provides the test accuracy, sensitivity, and specificity of 95.34%, 94.12%, and 96.15% for 2-class classification (COVID-19, Non-COVID) on chest CT.

Conclusion: Our proposed classification network experimental results indicate competitiveness with existing neural networks. The proposed neural network assists clinicians in determining and surveilling the disease.

Keywords

Deep neural network, SVM, reliefF, chest x-ray, chest CT, COVID-19

Submission date: 17 January 2024; Acceptance date: 8 May 2024

Introduction

In December 2019, the novel coronavirus disease (COVID-19) spread from Wuhan City, Hubei Province, in the People's Republic of China. COVID-19 is the descendant of the SARS Corona Virus (SARS-CoV) virus. The new viral disease is Severe Acute Respiratory Syndrome Corona Virus-2 (SARS-CoV-2). This new viral disease continues to have a traumatic and disastrous effect on the health

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