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Edge- Cloud Collaboration Based Covid-19 Detection on X-Ray Images

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ABSTRACT

The Coronavirus disease 2019 (COVID19) pandemic has led to a dramatic loss of human life worldwide and caused a tremendous challenge to public health. Immediate detection and diagnosis of COVID19 have lifesaving importance for both patients and doctors. The availability of COVID19 tests increased significantly in many countries, thereby provisioning a limited availability of laboratory test kits additionally, the Reverse Transcription-Polymerase Chain Reaction (RT-PCR) test for the diagnosis of COVID 19 is costly and time-consuming. X-ray imaging is widely used for the diagnosis of COVID19. The detection of COVID19 based on the manual investigation of X-ray images is a tedious process. Therefore, computer-aided diagnosis (CAD) systems are needed for the automated detection of COVID19 disease. This paper proposes a novel approach for the automated detection of COVID19 using chest X-ray images. The Fixed Boundary-based Two-Dimensional Empirical Wavelet Transform (FB2 DEWT) is used to extract modes from the X-ray images. In our study, a single X-ray image is decomposed into seven modes. The evaluated modes are used as input to the multiscale deep Convolutional Neural Network (CNN) to classify X-ray images into no-finding, pneumonia, and COVID19 classes. The proposed deep learning model is evaluated using the X-ray images from two different publicly available databases, where database A consists of 1225 images and database B consists of 9000 images.

Key words: COVID 19, X-ray, Disease.

1 Introduction

COVID-19 is an infectious disease caused by severe acute respiratory syndrome coronavirus 2 and instigates respiratory infections in humans. This virus first emerged in Wuhan, China, back in December 2019. As of 1 November 2021, there have been 246,594,191 confirmed cases of COVID-19, including 4,998,784 deaths, making it one of the deadliest pandemics in history. The outbreak due to COVID-19 was declared a Public Health Emergency of International Concern on January 30, 2020, and was escalated to a global pandemic status on March 11, 2020, by The World Health Organization (WHO). Once a person is infected by COVID-19, he or she may exhibit mild symptoms, such as fever, fatigue, cough, loss of taste, or smell. There is a small percentage of patients that suffer from severe and critical conditions, in which the virus leads to pneumonia, multi organ failure, and even death.

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Vaccination is one of the solutions to end the pandemic. The development and its enrollment, however, are long and complex processes. Currently, the technique that is widely considered as the gold standard to diagnose COVID-19 according to WHO guidelines, is reverse transcription-polymerase chain reaction (RT-PCR).

2 Literature Survey

The outbreak of Coronavirus Disease 2019(COVID-19) has spread rapidly across the world. Due to the large number of infected patients, computer-aided diagnosis with machine learning algorithm is urgently needed to the diagnosis of COVID-19 with a series of features extracted from CT images.

3 Proposed System

In the system, we propose a Distributed COVID-19 diagnosis model training method on CXR images. A lightweight model-based distributed training algorithm is designed for theCOVID-19 diagnosis. The false positive rate is much reduced in the proposed system. We propose a Distributed COVID-19 detection model training method on CXR images with edge-cloud collaboration, named DisCOV. Specifically, to improve the training efficiency and guarantee the model accuracy, a distributed lightweight model-based training algorithm is designed with the cooperation of edge computing and cloud computing. In addition, a resource allocation algorithm is developed during the training to jointly minimize the time cost and energy consumption. Extensive experiments based on real-world CXR image datasets demonstrate that DisCOV is better performed and more promising than the existing baselines.

4 System Modules

The state-of-art works provide a reliable medical decision support system to aid in efficient decision making by the healthcare professionals. Several kinds of research have been conducted to make the machine learning algorithms support edge devices and minimize their latencies along with a security improvement. To support edge devices of different sizes and complexity, the machine learning algorithms need to be optimized. In the field of computer science, deep learning has shown revolutionary improvement due to its efficiency in accessing different datasets, powerful parallelization, and specialized hardware development. The processing power of the edge devices is too low to deploy the deep learning architectures. The proposed architecture is mainly implemented to support end devices with power constraints and perform computationally efficient operation

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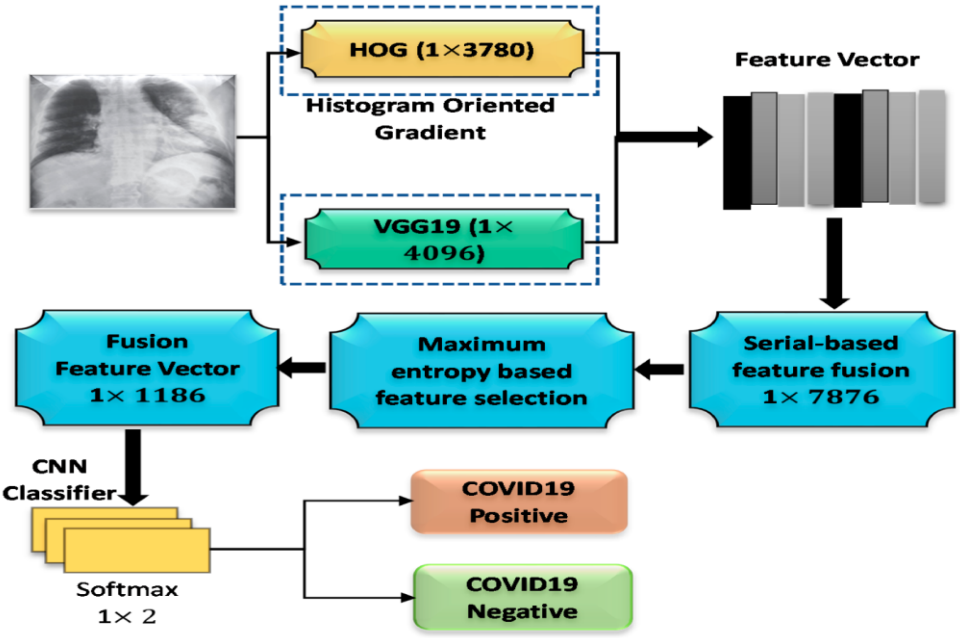

Figure 1: *Outline of the system module*

4.1 Layer-1: Data generation

The data regarding the illness (COVID19 and Pneumonia) is acquired from this layer. To diagnose pneumonia and COVID19, we retrieved the CT scan results of the patients. To help the government and other NGO agencies to provide medical aid, resources, and services to the patient. The data acquired is transformed into the edge layer for further processing where different edge devices are present including the patient's edge device.

4.2 Layer-2: Edge layer

The edge layer is mainly used for processing and classification of the CT scan images acquired. It acts as an intermediate between the cloud and the physical layer. The edge layer minimizes the network traffic and latency. The proposed MOMENTS optimized HRFDL model is implemented in the edge layer with resource-constrained edge devices. The resource-constrained devices can also act as IoT devices. To increase the computational efficiency different hardware accelerators are also attached to the end devices. If any abnormalities exist in the patient's CT scan, then the disease diagnosed is sent as a message to the user. To further notify the healthcare institutions and the officials the patient ID along with the location is sent to the cloud for further processing.

4.3 Layer-3: Cloud layer

The cloud layer performs various complex tasks to overcome the limitations associated with edge devices such as data storage and low computational power. The cloud layer performs centralized operations over multiple Virtual Machines (VM). The data stored in the centralized

data warehouse can be accessed via government authorities and authorized medical practitioners. The cloud layer normally does the following operations:

Resource management for disease outbreaks

The increase in the number of COVID19 and pneumonia patients leads to a shortage of medical equipment. To identify these diseases different medical types of equipment are needed such as testing devices, respiratory devices, ventilators, and oxygen cylinders. Since ventilators and respiratory devices are crucial in treating the disease, appropriate equipment handling is necessary. Hence a tradeoff between these types of equipment, supply, and demand needs to be achieved. The places that face an increase in COVID19 patients need a more supply of this equipment. Hence with the help of the cloud, one can track a disease outbreak, the number of people affected, and offer resource optimization.

Managing the patient's data

The records related to the number of patients being infected, number of mortality, number of active cases, and the number of recoveries. Since we need regular updates about the disease outbreak, this information is continuously monitored. Based on the information, necessary precautions are taken to control the virus spread and treat the patients.

Tracking the outbreak

Since the infection rate and disease spread is high, it is necessary to control the disease outbreak and identify the locations of potential danger. Both the local information and the newly identified disease cases are uploaded to the cloud periodically. Since the information is accessible by the public, in this way both the public and the civic bodies are alerted.

5 Conclusion

Due to the current COVID-19 pandemic and the limitations of the diagnosis method, deep learning-based methods can be adopted as an alternative tool for detecting COVID19. The deep learning models generally, however, require high computational resources which are not suitable for deployment in primary care clinics in cities and rural areas. As these areas may have limited internet access, a cloud-based approach is also not preferred.

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