A COMPREHENSIVE REVIEW OF ARTIFICIAL INTELLIGENCE USED TO COMBAT COVID-19

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INTRODUCTION

Coronavirus disease (COVID-19) has had a significant impact on global health since the start of the pandemic in 2019. Over 422 million people have been infected globally and 5.8 million have died as a result of the disease.

Artificial Intelligence (AI) solutions have played a major part in this pandemic for diagnosing and treating patients with COVID-19. In this research, we review these modern tools deployed to solve a variety of complex problems.

Research goals include:

- **Analyzing medical images using AI** models for identification, classification, and tissue segmentation of the disease.
- **Exploring prognostic models** that were developed to predict health outcomes.
- **Focusing on contact tracing** to analyze geographical and managerial efforts taken to combat this pandemic.

This comprehensive review of the different AI methods and modeling efforts will shed light on the role of AI and what path it intends to take in the fight against COVID-19.

MEDICAL IMAGING

Classification

**Image classification** models are a type of Deep Learning AI used to categorize an image into a predetermined category. In relation to COVID-19 and medical imaging, there could be two categories – images with COVID-19 present, and images that are normal (without COVID-19).

Many studies have more categories for diseases such as pneumonia. This helps the model differentiate between COVID-19 and Pneumonia, instead of classifying any sign of illness as COVID-19.

A classification model uses convolutions to extract image features and ends by passing the information through a fully connected layer that returns the classification.

Figure 1. An example of a Convolutional Neural Network model architecture used for the classification of patients with COVID from X-Ray and CT scans. Each layer uses filters to extract vital information.

SEGMENTATION

**Image segmentation** models are a type of Deep Learning AI used to categorize each pixel in an image. A segmentation model works by performing convolutions that extract image features (which shrinks the image) and then reversing the process to grow the image back to its original size.

This resulting image is the segmentation or output of the model. The output image can be used to **find where the signs of infection are in the original image**. This allows users to easily verify the model by comparing the segmentation to the actual signs of infection.

Figure 2. Illustration of different segmentation and classification models used within Deep Learning, a subset of Artificial Intelligence.

LONGITUDINAL STUDIES

**Serial Medical Imaging Datasets**

Longitudinal studies were conducted in order to better understand how COVID-19 affected patients over time. This involved using serial medical imaging data that showed disease progression at different points in time. This gave researchers the ability to track disease severity and improve classification and segmentation models.

**Prognostic Models**

The development of prognostic models allowed researchers to **diagnose COVID-19 more accurately at different disease stages** while providing critical information on a patient’s prognosis. Some of the patient outcomes that could be predicted included:

- Mortality
- Hospital admission
- Intensive care unit admission
- Hospital length of stay

These predictors also provided valuable information to healthcare systems for the allocation of scarce medical resources.

Figure 3. Number of Journals by Publisher reviewed in this work. SICUS: Scientific Journal of Chian University- Sulaimaniya, UNCD: International Journal of Noncommunicable Diseases, IEEE: Institute of Electrical and Electronics Engineers, ETASR: Engineering, Technology and Applied Research, MDP: Multidisciplinary Digital Publishing Institute, T&F: Taylor & Francis, ASP: American Scientific Papers

DISCUSSION

There are 49 papers that are currently included in this review that span from over 15 publishing sources. The publication years for these studies include:

- 2 from 2020.
- 28 from 2021.
- 19 from 2022.

The medical imaging datasets that were used in these papers were either publicly available datasets such as those found on The Cancer Imaging Archive (TCIA) or from private institutions and hospital systems.

Early challenges in COVID-19 imaging came from this lack of large-scale, publicly available data that often-contained unlabeled data requiring large amounts of preprocessing.

Several authors created custom models that used architectures such as U-Net or ResNet and built on the structure to better fit the task. These specialized models frequently outperformed basic architectures.

Contact Tracing and University Response to COVID-19 are areas of research that are currently being incorporated into our final review.

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