

ECG-CCNet: Cardiovascular(Cardiac) and COVID-19 Disease Classification Using Deep Convolutional Neural Network Learning Pipeline Approaches From Electrocardiography(ECG)- A Study

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Abstract Experimental studies demonstrate that COVID-19 illness affects the cardiovascular as well as the pulmonary / lung tract. The limits of existing COVID-19 diagnostic procedures have been revealed. In contrast, to present diagnoses, such as low-sensitivity conventional RT-PCR testing and costly healthcare scanning equipment, implementing additional approaches for COVID-19 illness assessment would be advantageous for COVID-19 epidemic management. Furthermore, problems generated by COVID-19 on the cardiovascular tract must be detected rapidly and precisely using ECG. Considering the numerous advantages of electrocardiogram (ECG) functionalities, the proposed study offers a novel pipeline termed ECG-CCNet for examining the feasibility of employing ECG pulses to diagnose COVID-19. This study is a two-phase transfer learning (TL) approach is suggested for the prognosis of COVID-19 disorder, which includes feature mining utilizing DCNNs models and ensemble pipelining using ECG tracing imageries generated from ECG signals of COVID-19 diseased sufferers relying on the anomalies induced by COVID-19 pathogen on cardiovascular structures. A complete classification performance of 93.5% accuracy, 87% recall, 87.03% F1-score, 95.66% specificity, 87.16% precision, and 95.33% AUC attained by abnormal heartbeats, COVID-19, myocardial, and normal/healthy classification. This experiment is considered a high possibility for speeding up the diagnostic and treatments of COVID-19 individuals, reducing practitioners' efforts, and improving epidemic containment by utilizing ECG data.

Keywords Electrocardiography (ECG) trace image, Deep learning, cardiovascular diseases diagnosis, Convolutional neural networks (CNN), COVID-19 detection & Classification, Biomedical image signal processing.

I. INTRODUCTION

Coronaviruses are a vast viral subfamily that can produce a variety of illnesses in both mammals and mankind. COVID-19 originally surfaced at the start of December 2019 in Wuhan region, China; it has since expanded at an extraordinary rate around the continent [1]. Fever, coughing, and breathlessness are the most prevalent indications. Tuberculosis, chronic lung failure, kidney failure, pneumonia, and mortality may occur in extreme situations. As of 20 June 2022, the 533 million cases worldwide, with 6.3 million deaths due to COVID-19 [2]. Despite the fact that without viable treatment for COVID-19, which the WHO proclaimed an epidemic disease on 11 March 2020 [3], there have been encouraging advancements in antigen research. According to published resources, vaccine efficacy is relatively good, with 1186 million dosages of COVID-19 vaccine provided to the whole community in this article's drafting [3].

RT-PCR screening is currently the WHO official standardized approach for diagnosing COVID-19 [4]. Despite the fact that those testing are the benchmark due to their

adequate sensitivity percentages, they have significant limitations. These require a lengthy timeframe to provide results, excellent laboratory conditions, and skilled experts to execute the examinations [5]. It may generate a poor outcome even if the individuals have identified COVID-19 [6]. Various alternative tests and procedures that produce quicker and more reliable findings are still being investigated. Biomedical screening using X-ray and CT scan modes is one of these ways employed for the rapid recognition of COVID-19. Lung X-rays and CT pictures conceal important knowledge that could aid in diagnosing lung illnesses. Many studies have established the existence of differences in chest radiography images recorded prior to the onset of COVID-19 signs. Furthermore, multiple investigations have shown that X-ray and CT scans are more reliable than PCR testing in diagnosing COVID-19 [7], [8], and [20]. Nonetheless, due to the closeness of COVID-19 characteristics with other kinds of pulmonary diseases, these approaches necessitate the involvement of a professional radiologist to diagnose in-hospital patients[9].

Although the COVID-19 primarily affects the circulatory tract, it impacts other essential human organs, including the cardiovascular system [9]. Computer vision algorithms based on deep learning(DL) are very successful and beneficial, particularly for diagnostics and monitoring. Cardiovascular changes [10,11] have promoted using ECG as a screening tool for COVID-19 assessment. Considering the numerous advantages of ECG use, such as mobility, accessibility, the convenience of use, affordable, harmlessness, and real-time inspection, the automated identification of COVID-19 using ECG may be of substantially worth in addition to PCR testing and thoracic X-ray or CT imaging. The cardio-vascular tract is an essential area in which the infection interferes with regular circulation. ECG physiologic impulses, on either hand, are an excellent predictor of pathological disorders in the heart and lungs. The usual approach to analyzing ECG imaging with DL approaches is retrieving handcrafted characteristics and constructing DL & ML classifiers. As an alternative to the present diagnosis techniques, a novel, safe, affordable, precise, rapid ensemble pipeline dubbed ECG-CCNet is proposed to aid in the automated analysis of cardiovascular and COVID-19.

The major contributions of the projected work are:

- The new method is based on 2-D ECG tracing imageries to detect cardiovascular and COVID-19, which is a unique technique for experimental analysis.
- ECG-CCNet extracts 2-levels of deep features from four DCNNs of distinct structures. The potential of using ECG

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