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Performance Comparison Between Convolutional Neural Network-Based Artificial Intelligence SiCoSa with a Combination of 2 Radiology Specialists at Universitas Airlangga Hospital in Diagnosing COVID-19 on Chest X-Ray Images

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ABSTRACT

Introduction: COVID-19 can be detected in various ways, namely RT-PCR as the gold standard which is relatively expensive and long or with imaging such as X-Ray which is relatively cheaper and fast. However, X-Ray for diagnosing COVID-19 has a drawback, namely for radiologists to interpret it. Artificial intelligence is here to address this issue of radiologist availability. ***Method:*** This study is an analytic observational study using a cross-sectional design based on secondary data. Sampling was done by non-probability sampling technique. The area of the AUROC curve used to determine a diagnostic tool. The wider the AUROC curve the better a diagnostic tool. ***Research Result:*** In this study, a sample of 500 images was obtained with 460 chest X-ray images true positive COVID-19 and 40 chest X-ray images true negative COVID-19. SiCoSa with MobileNetV2 architecture has sensitivity, specificity, and AUROC respectively by 100%, 0%, and 0.5 while SiCoSa with ResNet 50 architecture has a sensitivity, specificity, and AUROC respectively at 82.61%, 20%, and 0.5131. Interpretation both 2 Radiology Specialists at Universitas Airlangga Hospital have sensitivity, specificity, and AUROC respectively 69.35%, 100%, and 0.8467. ***Conclusion:*** SiCoSa has lower performance than the Interpretation of 2 Radiology Specialists at Universitas Airlangga Hospital in differentiating COVID-19 pneumonia and non-COVID-19 pneumonia.

Keywords: artificial intelligence, SiCoSa, COVID-19, chest x-ray image

INTRODUCTION

Background

Today the use of technology in various fields of life is a normality and even a necessity, including in the branch of medical science, namely radiology. Corona Virus Disease 19 (COVID-19) is an example of real evidence. Corona Virus Disease 19 (COVID-19) is a new respiratory disease caused by a virus called Severe Acute Respiratory Syndrome Coronavirus 2 (SARSCoV-2). COVID-19 was first detected since 8 December 2019 and got identified as a group of pneumonia problems in Wuhan, Hubei Province, China at the end of December 2019. COVID-19 spread significantly and very quickly as a result, WHO decided that COVID-19 became a public health emergency and received international attention. Currently, COVID-19 has become a common enemy; everyone has to fight it to avoid the worst conditions. Due to the lack of specific antiviral agents to treat the infection and vaccines, several control measures have also been introduced worldwide to prevent transmission [1].

Apart from COVID-19, there were still Severe Acute Respiratory Syndrome (SARS) diseases from 2002 to 2003 and Middle East Respiratory Syndrome (MERS) in 2012 which were caused by other corona virus but the infection capacity was lower than COVID-19 so that they did not cause global health cases even though the death rate was higher than COVID-19 [2].

Several tactics have been implemented to suppress the relatively rapid increase in the number of patients. Attempts to refute this disease are very difficult or even impossible, but we can still delay this high rate of growth to maintain equilibrium using the capacity of medical care. That way, the number of deaths can be reduced. These strategies include tracing the patient base, city/country isolation, and mass screening. The COVID-19 RT-PCR test and throat swab test, which are the golden standard for testing for COVID-19, are time consuming and relatively expensive. To overcome this, X-ray inspection can be used as an alternative so that patients can be treated immediately [3].

However, the use of X-rays is not without challenges. The biggest problem with using X-rays is the patient population undergoing the examination and the physician population interpreting the image data. In the case of pneumothorax, both of these causes variability in the interpretation of medical images. The wide variability has the potential to deviate from the physician's interpretation. To overcome this problem, AI was developed to assist in making a diagnosis. One of the programs with AI is SiCoSA (Sistem Cerdas Klasifikasi COVID-19 ITS-Unair), an application that can assist in the rapid diagnosis of COVID-19 in collaboration with Universitas Airlangga and Institut Teknologi Sepuluh Nopember. This artificial intelligence-based application uses X-ray imaging and deep learning in the form of CNN [4].

On March 11 2020, WHO declared COVID-19 a global pandemic. In Indonesia, COVID-19 has officially been detected since March 1 2020. Indonesia has experienced an increase in positive cases of 34,257 people with 542,938 active cases and cumulative positive confirmations of 2,911,733 people as of July 19 2021 [5]. In the city where the research was held, namely Surabaya, there was an increase in positive cases of 1,191 people with 9,098 active cases and a cumulative positive confirmation of 37,012 as of July 18, 2021 [6].

Research on the effectiveness of AI in diagnosing patients with COVID-19 pneumonia using Chest X-Ray (CXR) was carried out using SiCoSa. SiCoSa is an intelligent system for predicting COVID-19 on medical X-ray images. This program uses 513 CXR COVID-19 obtained from Universitas Airlangga Hospital (RSUA) for the period May 2022 – June 2022 and 750 CXR other than COVID-19 obtained from the NIH Chest X-ray dataset for the period before COVID-19 in its development [7].

SiCoSa is expected to be able to assist health service providers both in technical terms in the form of faster diagnosis and in terms of costs due to the availability of expert medical personnel and/or CT scans to determine clinical COVID-19 in various hospitals or related health institutions. Because it is based on an online system, SiCoSa can be used in all places that have internet access. SiCoSa is equipped with a user-friendly and interactive interface.

Apart from the various advantages offered, AI also has weaknesses so that it is not used as a substitute for a radiologist but helps a radiologist to save time reading thousands of X-ray photos in this pandemic case so they can do other things. SiCoSa is a complement to the detection of COVID-19 based on RT-PCR and Rapid tests. The use of AI to screen and diagnose existing health emergencies such as COVID-19 has the potential to dramatically change the way medical care is approached in the future. Any tool that will be implemented in the future must have a good cost-benefit ratio for healthcare, be able to adapt to situations in heterogeneous settings, and also be useful outside the zenith of the COVID-19 pandemic, enabling accurate comparisons with other types of disease[8].

Research Problem Formulation

How does the ability of SiCoSa compare to the interpretation conclusions of two radiologists in diagnosing COVID-19 pneumonia and not COVID-19 pneumonia on chest X-rays image with RT-PCR as the golden standard?

Purpose

To determine the sensitivity, specificity, and AUROC of SiCoSa and 2 Radiology Specialists.

Benefit

It is hoped that this research will be useful in helping medical practitioners speed up services in dealing with COVID-19 and help minimize the possibility of a misdiagnosis in people affected by COVID-19 so that treatment can be accelerated. It is also hoped that this research can provide an overview of the role of artificial intelligence in diagnosing diseases using X-ray photos, especially COVID-19 disease and can provide knowledge to the public regarding the development of procedures for diagnosing COVID-19 so that sufferers with suspected COVID-19 or patients use it as a alternative so that appropriate therapy can be carried out as soon as possible to prevent complications such as cytokine storms that can cause death.

METHODS

Types and Design

This type of research is analytical research.
The research design chosen was a cross sectional study.

Population, Sample Size, and Sampling Technique

The population in this study was all chest X-ray data of COVID-19 and Non-COVID-19 pneumonia patients in the SiCoSa and/or RSUA testing data.

The sample in this study is X-ray photo data of COVID-19 and non-COVID-19 pneumonia patients for the period July 2021 – January 2022 taken using a non-probability sampling technique that meets the following criteria:

- Inclusion Criteria:

Chest X-ray images data of male or female pneumonia patients over 5 years of age. The pneumonia is caused by either COVID-19 only or non-COVID-19 only. No overlapping. The data is also equipped with positive RT-PCR for COVID-19 pneumonia or negative RT-PCR for non-COVID-19 pneumonia. As well as X-ray photo data of this pneumonia patient for the first time diagnosed by SiCoSa and radiology specialists and the lung picture look intact.

- Exclusion Criteria:

Chest X-ray photo data of COVID-19 and non-COVID-19 pneumonia patients used as learning data in the SiCoSa program or in other words previously diagnosed data.

For radiology specialists, the results obtained were taken from both agreement. The size of the research sample is 500 people. The sampling technique in this study was non-probability sampling with the consecutive sampling method.

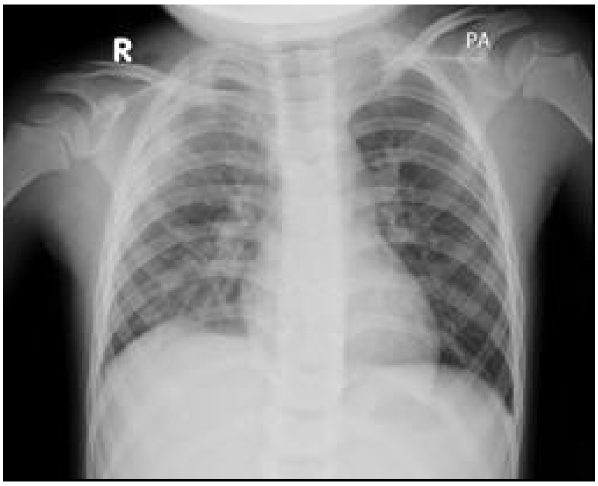

FIGURE 1: Sample Dataset.

Instruments

- Hardwares:

Chest X-ray imaging device (Siemen) and Device to access SiCoSa and save the results.

- Softwares:

Chest X-ray image datas, SiCoSa web, Office tools app.

Location and Time

This research was conducted at RSUA, Surabaya, East Java. This research was conducted after an ethical test with research implementation between September 2021 - July 2022.

Data Analysis Technique

Data that has been grouped is calculated for sensitivity and specificity. Then the Receiver Operating Characteristic (ROC) curve is created using a computer application and the Area Under ROC (AUROC) curve is calculated with value interpretation

0.5 = useless, unable to differentiate the two diagnoses
0.5<...<0.7 = sub-optimal or poor
0.7≤...<0.8 = fair
0.8≤...<0.9 = good
0.9≤...<1 = very good
1 = Golden standard

RESULTS

The composition of chest X-ray dataset as well as the prediction SiCoSa and radiology specialists made was shown in Table 1. With the prediction result, confusion matrix can be made that could be seen at Table 2. Confusion matrix contains sensitivity and specificity needed to draw the ROC Curve. The wider the AUROC of the predictor made, the better its performance. ROC curve of each predictor are shown in Figure 1.

TABLE 1: Dataset Composition.

RT-PCR		True Positive	False Positive	True Negative	False Negative
		460	0	40	0
SiCoSa	MobileNetV2	460	40	0	0
	ResNet50	380	32	8	80
2 Radiology Specialists		319	0	40	141

TABLE 2: Confusion Matrix of The Predictor.

	SiCoSa		2 Radiology Specialists
	MobileNetV2	MobileNetV2	
Sensitivity	100%	100%	69,35%
Specificity	0%	0%	100%

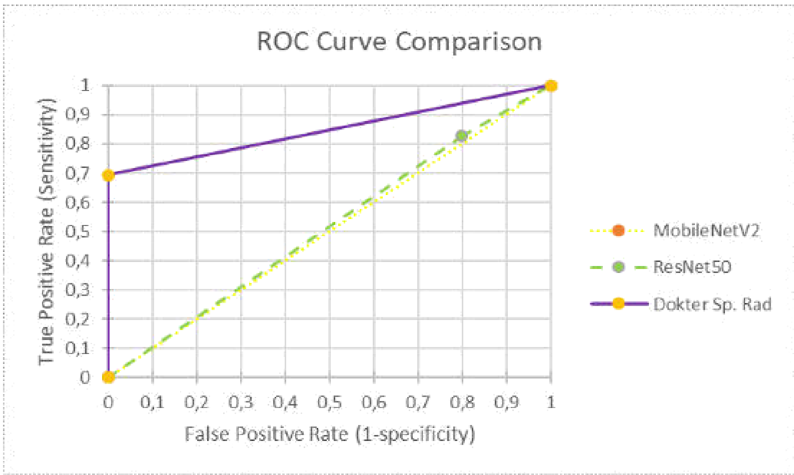

FIGURE 2: Roc Curve Comparison.

DISCUSSION

Sensitivity refers to the test's ability to correctly detect sick patients who are actually sick. Based on the sequence, MobileNetV2 had the greatest sensitivity, namely 100%, followed by ResNet50 (82.61%), then radiologiy specialists (69.35%).

Specificity relates to the test's ability to correctly screen healthy patients who are actually not sick. The specificity of a test is the proportion of those who are truly not sick with a negative test result. Based on the sequence, radiologists have the greatest specificity, namely 100% followed by ResNet50 (20%), then MobileNetV2 (0%).

Based on the data above, SiCoSa has a sensitivity value that is inversely proportional to its specificity value. According [9], more and more claims have much higher sensitivity than radiologists. This high sensitivity is due to bias in the COVID-19 dataset. In the case of this study, the learning data used by SiCoSa for positive cases of COVID-19 were obtained from Universitas Airlangga Hospital while for negative cases of COVID-19 were obtained from the National Institute of Health Chest X-Ray Dataset. The use of chest x-rays taken from RSUA for this study could be one of the reasons why SiCoSa tends to produce positive predictions so that it has a high sensitivity value while having a low specificity value.

This is also supported by research [10] which found that CNN could disaggregate portable radiographs by inpatient ward and emergency department in the MSH data with 100% accuracy that these patient groups had a significantly dissimilar prevalence of pneumonia. In fact devices based on different generators have been used in inpatient units (Konica Minolta) and emergency departments (Fujifilm), and the latter is stored in an image and communications filing system (PACS) in reversed color scheme (i.e., air appears white) along with use special text indicating laterality and use of portable scanners.

Based on AUROC, the best performance is held by radiologists with AUROC 0.8467, followed by ResNet50 with AUROC 0.5131, then MobileNetV2 with AUROC 0.5.

CONCLUSSION

SiCoSa has lower performance than the Interpretation of 2 Radiology Specialists at Universitas Airlangga Hospital in differentiating COVID-19 pneumonia and non-COVID-19 pneumonia.

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CONFLICT OF INTEREST

We have no conflict of interest to disclose

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