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PNEUMONIA DETECTION AND SEGMENTATION OF CHEST X-RAY IMAGES BASED ON DEEP LEARNING

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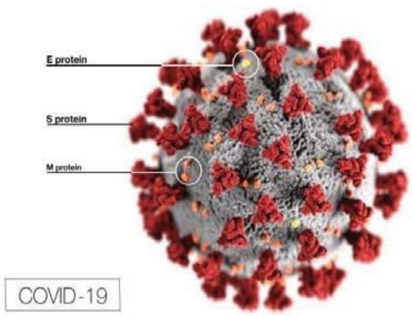
ABSTRACT— The goal is to locate pneumonia and assess its severity using deep learning networks and chest X-ray images. Methods: For train and test analyses, Kaggle's RSNA Pneumonia detection challenge [1] data is used. creating a bounding box to identify photos and determine the severity percentage of lung opacity in pneumonia-related images Results: The initial model has demonstrated a mean average precision (MAP) of 0.90 on the train set and 0.89 on the test set using 4668 X-ray images trained and tested on 1500 X-ray images. To assess the severity percentage in a chest x-ray image of pneumonia, it is intended to take use of previous research and create a more effective, highly accurate deep learning model.

KEYWORDS: COVID19, chest X-ray, mask RCNN neural network, pneumonia, and severity detection are some related terms.

I.INTRODUCTION

Corona virus, also known as COVID 19, is a highly contagious illness brought on by the 2019 novel corona virus (2019-nCoV), a species of corona virus that was previously known as the severe acute respiratory syndrome corona virus 2 (SARS-CoV-2).

Fig. 1. COVID19 labelled microscopic picture



The illness was given the COVID-19 designation by WHO on February 11, 2020. Middle East Respiratory Syndrome (MERS - COV) and Serious Acute Respiratory Syndrome are two of the more severe illnesses caused by the vast genus of viruses known as corona viruses (COV) [5]. (SARS - COV). The novel corona virus is a new strain that has not previously been found in humans (NCOV).

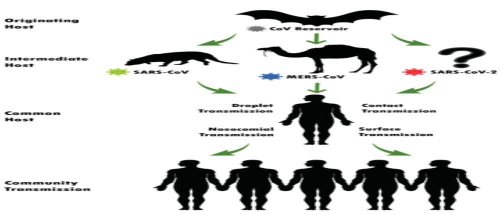


Figure 3: shows the chest radio graphs of a male, elderly patient from China who travelled to

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Hong Kong. Out of the daily obtained photos, three chest X-ray images were chosen. With fresh consolidative alterations in the right mid zone periphery and perihilar region on day 4, the consolidation in the right lower zone from day 0 continues. The mid zone modification makes the day 7 image look better [10]

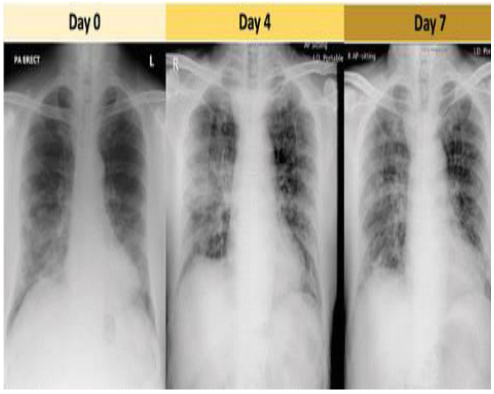
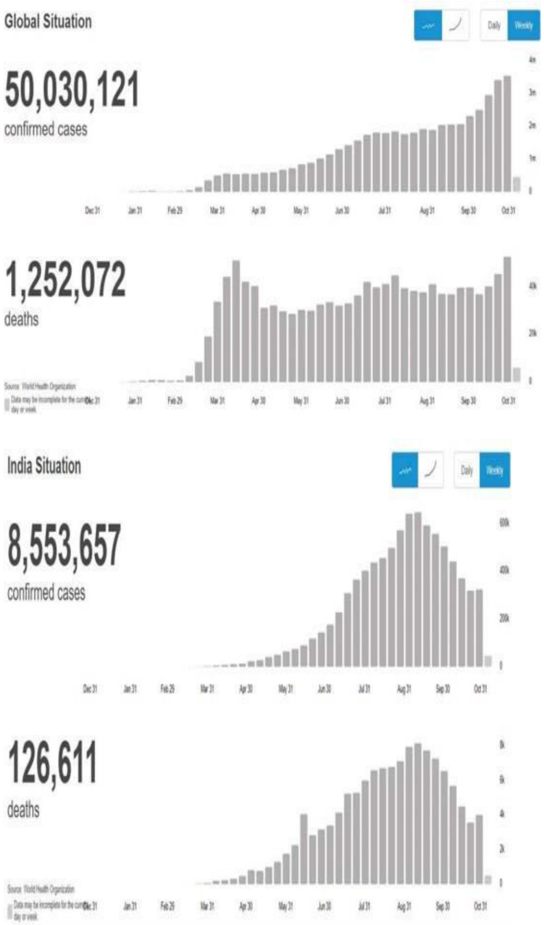


Fig. 2 depicts the specific route by which bats transmit COVID19 from animals to people. According to belief, it was spread to people by the ingestion of bat meat from wet markets. As it is thought to have zoonotic origins and is genetically related to bat corona viruses, it is likely that COVID19 originated from viruses that were already present in bats [7].

Patients who have a virus exhibit typical cold, fever, cough, and respiratory symptoms include shortness of breath and breathing difficulties. Patients may develop pneumonia, severe acute respiratory syndrome, renal dysfunction, and other conditions that can be fatal as infection severity worsens [5].

Reverse Transcription Polymers Chain Reaction is a further clinical test that is recommended for patients who exhibit respiratory symptoms. Medical professionals use PCR testing [9], which takes hours to complete and yields results, to identify COVID-19.

As more cases enter hospitals, the chest X-ray is instead used as the first component to examine the patient's clinical status. Patients are admitted for additional diagnostic evaluation if the X-ray reveals any abnormal findings. Patients are instructed to go home and wait for the results of the PCR test if the X-Ray is normal.



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The X-ray results in Fig. 3 strongly suggest the presence of COVID-19 infection with a pattern like ground glass region, which affects both lungs, particularly in the posterior segments in the lower lobes, and with an initial sub-plural and primarily peripheral distribution.

Radiology is crucial in determining whether a patient should be admitted for additional observation or sent home to wait for test results. The availability of the radiology specialist to interpret the image is one of the challenges with employing X-rays.

The idea for a deep learning system (Mask R- CNN) to analyse photos and find patterns of COVID-19 in patients was inspired by Artificial Intelligence (AI) technology and developed to help radiology experts interpret images more quickly and accurately.


(a)


(b)


(c)

The current COVID-19 epidemic is unprecedented, and as we can see from Fig. 4, it is having a significant effect on the entire world. It is both the most severe geopolitical event of the current generation and public health issue.

There has never been a greater pressing need for ongoing access to knowledge. The second most populous nation, India, which is now in lockdown and has reported about 59,662 cases and 1981 fatalities as of May 10, 2020 [5] owing to COVID-19, is particularly preparing for the worst. According to one of the projections [11], India may have to deal with 300 million cases, more than four million of which may be serious.

By recognizing the severity and type of the disease with pattern, X-ray pictures can be diagnosed more effectively and precisely with deep learning techniques such Mask RCNN. The data sets employed with X-ray pictures in the current model include (a) pneumonia, (b) no pneumonia and not normal, and (c) normal types.

A. Data set:

The data set for the model was obtained from the RSNA [1]

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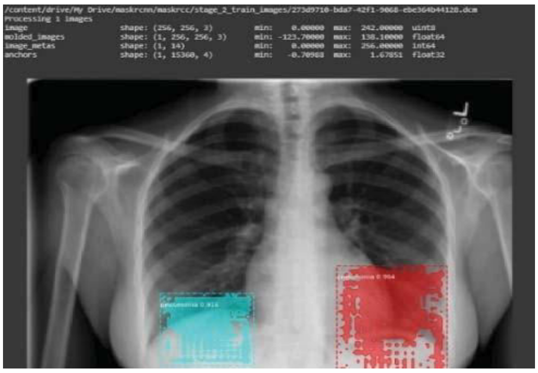
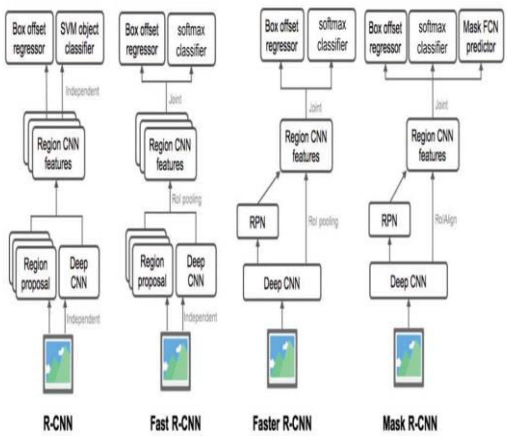
Pneumonia Detection Challenge competition on Kaggle. The Radiological Society of North America (RSNA®) reached out to the machine learning community on Kaggle as well as the US National Institutes of Health, The Society of Thoracic Radiology, and MD in an effort to increase the effectiveness of diagnostic goods and services. We worked together to create a high-quality data set for the real-world task.

B. Analysis of images:

The dataset's initial images are in the DICOM format. These are the medical images that are saved in the unique DICOM Files (*.dcm) format. They combine header metadata with the pixel data from the underlying raw image arrays. Most of the typical headers that contained personally identifying information about patients were eliminated. Understanding the data structure, image file format, and label types are all important, but the main goal is to find the bounding boxes that represent the presence (or absence) of pneumonia in a binary classification. Pneumonia (lung opacity), No pneumonia (lung opacity - not normal), and normal are the classifications from the data set. Although the data set contains multiple classes, the detection of pneumonia was done using a binary classifier.

III. RESULTS MASK- RCNN [12]: Mask RCNN generates high quality segmentation mask for each instance in addition to identifying objects in an image. On each ROI, or Region of Interest, Mask -RCNN adds a branch for segmentation mask prediction in a pixel-to-pixel technique, continuing with the previous classification branch and bounding box regression. Mask R- CNN is a framework that has quick inference and training times and offers a wide range of options in terms of architecture designs and strength.





A convolutional network for feature extraction and for B box recognition (both regression and classification) is applied with mask prediction separately to each region of interest on the

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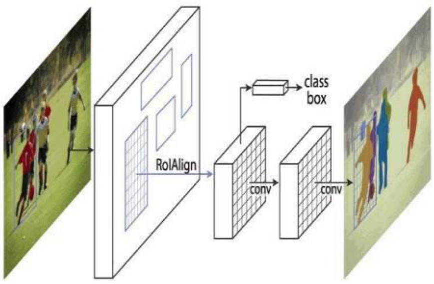
entire image in an architecture with Dense Net as the backbone.

Why Mask- RCNN? [14] Within a short period of time, Mask-RCNN has produced segmentation results with object identification. Mostly, the advancements are improved from baseline networks, like Fully Convolutional Network (FCN) and Fast/Faster RCNN frameworks for segmentation and object identification respectively. Such type of method is practically in-built with fast training and interpretation on the data.

When compared to Faster RCNN, Mask RCNN includes a branch for segmentation masks prediction on every region of interest (RoI), as well as a branch for classification and B box regression that was already a part of the network (Figure 7). Each area of interest is given a small FCN, and the segmentation mask is predicted at the pixel level using the mask branch. Mask RCNN enables varied architectural designs that are flexible and applying the network to train a model is simple.



Furthermore, a quick system is made possible by the mask branch, which guarantees quick testing and only incurs a minor computational penalty. Mask RCNN is a developed version of Faster RCNN since the Mask branch is essential for better outcomes. It should be noted that the Faster RCNN does not have a framework for the network's pixel-to-pixel arrangement, or from inputs to outputs. It is clear how the basic function of paying attention to instances results in the region of interest pool, or more specifically coarse spatial quantization for feature extraction.

Use a Fully Convolutional Network to predict m x m mask from each region of interest, allowing each layer of the mask branch to keep the explicit spatial dimensions (m x m object). Less modelling parameters are needed for this architecture (in Fig. 8), which ensures a quicker runtime. By examining the area of the masks from X-Ray pictures, pixel-level segmentation has the additional benefit of estimating the severity of the lung injury. Mean Average Precision is the test metric employed (MAP). Mask- RCNN outperforms COCO (Common Objects in Context) competition winners in a quicker runtime, according to MAP values.

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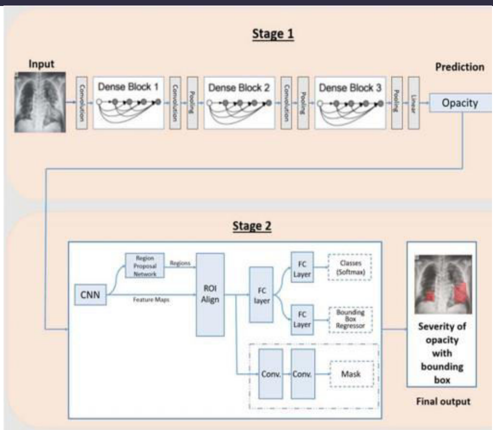
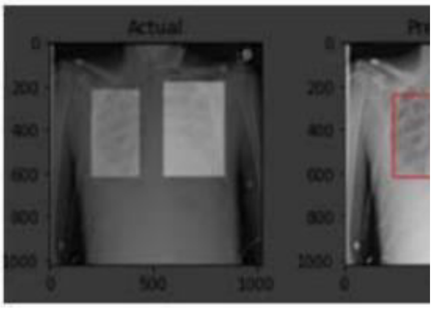


Fig. 10. Model Flowchart

(A)



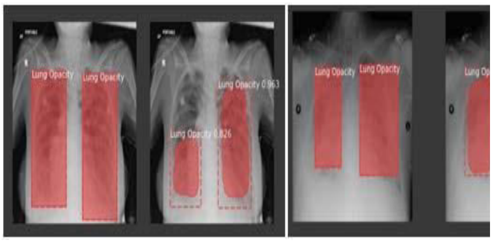


FIG: 11(a) Output of stage 1 (b) Output of stage 2

IV.PROPOSED METHOD

Stage 1: To differentiate between photos of patients with and without lung opacity, a simple object detection model is used. At this point, all X-ray images from healthy patients, patients who have pneumonia caused by a variety of other factors other than the virus, and photos from the unique corona virus are included in the input to the model.

The model's output just highlights the region of the lungs with the aid of a bounding box where opacity is present. Opacity is a sign of an anomaly brought on by pneumonia and COVID19 and denotes the presence of something other than air in the lungs.

Stage 2: A mask RCNN network is utilized in this stage to highlight the precise lung regions with opacity as well as the degree of it, and this was done at the pixel level.

The base network creates feature maps of the input image, and simultaneously sends these feature maps to the RPN. The RPN essentially functions as a CNN network that creates region suggestions for each feature map.

These proposed regions are forwarded to the ROI align layer, where coordinated bounding boxes and anchors are scaled and aligned to fit the feature map's dimensions. Two separate network heads are provided the output of the RoI align layer; one is used for class detection and locating bounding box coordinates, and the other is utilized to construct a mask.

Mask RCNN network implementation with four categories of Anchor pixels with sizes 16, 32, 64, and 128. These anchors are attempting to use bounding boxes to identify ROI (Fig. 9). Pre- trained weights from the [5] COCO data set are base lined using the original data set of +30000 train images. 4668 photos were used as the training data set for the model, and the model's performance on a test data set of 1500 images.

With a total data set size of 6168, the data set combines lung opacity, not normal, and normal classifications in the following ratios: 55:25:20. During the first six runs of epochs of the model training, the learning rate is set at 0.006 with a 200step size.

Later, during model tuning, the learning rate was decreased to 0.001 with a 200step size for the following 10 epochs. further decreased the learning rate for the final four epochs to 0.0006 for the size.

The bounding box is marked to comprehend the severity by providing the percentage of lung opacity (as seen in the image below) (before and after segmentation of images). MAP (mean Average Precision) of.90 on the train set and.89 on the test set were attained.

V.CONCLUSION

The goal is to take advantage of previous research and create a more effective, highly accurate deep learning model to determine the severity percentage in a lung x-ray image of pneumonia. The objective is to correctly monitor the target and display the severity percentage.

This can help doctors and radiologists diagnose patients more accurately, saving time and enhancing treatment consistency. In this work, a model based on X-ray scans was developed to assess the severity of the pneumonia by enclosing the affected area in a box.

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