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Seg-Net: Automatic Lung Infection Segmentation of COVID-19 from CT images

G.Rajakumar[1]
Professor, ECE Department,
Francis Xavier Engineering College
Tirunelveli, Tamilnadu, India
gmanly12@gmail.com

R. Sharon Jeba Leela[2]
PG-Scholar, ECE Department,
Francis Xavier Engineering College
Tirunelveli, Tamilnadu, India
sharonjebaleelar.pg19.cs@francisxavier.ac.in

Dr.P.Ebby Darney[3]
Professor EEE, SCAD College of Engineering & Technology,
Cheranmahadevi, Tirunelveli, India
pebbydarney@gmail.com

K. Lakshmi Narayanan[4]
Associate Professor, ECE Department
Francis Xavier Engineering College
Tirunelveli, Tamilnadu, India
kyelyen@gmail.com

R. Santhana Krishnan[5]
Assistant Professor, ECE Department,
SCAD College of Engineering and Technology, Tirunelveli, India
santhanakrishnan86@gmail.com

Y. Harold Robinson[6]
School of Information Technology and Engineering,
Vellore Institute of Technology,
Vellore, Tamilnadu, India.
yhrobinphd@gmail.com

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Abstract.COVID-19 is a deadly disease which causes infection in both animals and human beings. It is a zoonotic disease that scatters worldwide in the beginning of the year 2020. COVID-19 is termed as Coronavirus Disease 2019 that makes the whole world to suffer from this existential infection. The lung contamination is found automatically by chest Computed Tomography images that help to tackle COVID-19. During the separation of the diseased portion from the X-ray slices, it produces lots of demands which include huge difference in the disease attribute and low intensity difference in the middle of infected tissue and usual tissues. The collection of huge quantity of information is impossible in a short period of time and pedagogy of the deep model. For overcoming the Lung disease separation of COVID-19 by using Seg-Net is suggested to analyze the affected portions automatically from chest X-ray scan. Here, Convolutional Neural Network (CNN) architecture for semantic pixel-wise segmentation named as Semantic Network is utilized. Seg-Net segmentation is a core trainable engine that contains an encoder network and also a corresponding decoder network that is continued by a pixel-wise classification layer. The structure of the encoder network is physiographic and it is equal with the 13 convolutional layers in the Visual Geometry Group 16 network. The originality of the semantic network is located in this method of decoder up samples with the lower resolution input map features. Exactly, the pooling was applied by the decoder that indicates max pooling process in the corresponding encoder for behaving like the non-linear up sampling. Comprehensive observation in COVID-19 real CT volumes and the SemiSeg are determined and it is suggested that the Semantic network performs the cutting edge segmentation models, and then it promotes the state in the art presentation.

Keywords:COVID-19, Lung Segmentation, Convolutional Neural Network (CNN), Computed Tomography (CT) images.

I. INTRODUCTION

Medical imaging is the function which produces clear depiction of internal formation of the body for scientific and medicinal learning and therapy and also visible perspective of the inner tissues. By using this function the disorder can be identified and managed easily. It generates the information bank of regular composition and function of the organs to understand clearly about the anomalies. This process consists of both organic and radiological imaging that is utilized in the electromagnetic energies, magnetic scopes, thermal and isotope imaging. Though, there are more technologies for recording the information about the position and purpose of the body. It consists of lots of limitations analyzed to restrain for giving the images.

Corona virus is the huge ménage of viruses that can produce infection in every living organism. There are many corona viruses from that, seven corona viruses will cause the infection in human beings throughout the world. Though there are seven corona viruses people get affected commonly by only four corona viruses. The four common human being corona viruses are HKU1, 229E, OC43 and NL63. The infection normally produces a wheezing (i.e. the patient cannot breathe easily) that begins with normal cold and it leads to the dangerous infections like MERS that is Middle East Respiratory Syndrome and SARS that is Severe Acute Respiratory Syndrome. COVID-19 is the corona virus found nowadays and it is called as Corona virus Disease 2019 which is an infectious disease. It is a zoonotic infection that is produced by SARS-CoV-2 that is Severe Acute Respiratory Syndrome Corona virus 2.

Initially World Health Organization (WHO) named the deadly infection as Novel Corona virus Infected Pneumonia (NCIP) and they named this virus as 2019-nCoV which is 2019 novel Corona virus.

Then, on 11th of February in year 2020, the World Health Organization formally changed the name of this virus by the medical conditions of COVID-19 as a reduction of Corona Virus Disease 2019, which was released in tweet. An epidemic of the virus COVID-19 is induced by 2019 novel corona virus (SARS-CoV-2) which was started in Wuhan, Hubei Province, China in the month of December and in year 2019. The contemporary epidemic is formally pervasive. After all the intelligence about this virus (COVID-19) is quickly spreading, the bookworms are advised to keep on renovate oneself repeated.

Convolutional Neural Network was proposed by Fukushima in the year 1988. It was not utilized extensively, because it consists of limitations in the computation of the

equipment for preparing the network. From the beginning of 1990 and it is applied in a gradient- based learning algorithm to CNNs and acquired the prosperous consequence for the manuscript digit classification problem. Scientist developed CNNs and described the state of the art which produces the results in lots of identification tasks. CNNs have different benefits over DNNs, which includes being human visual processing system, being extremely developed by the construction for preparing 2D and 3D images and being effective at assimilate and extracting conception of 2D attribute. The max pooling layer of CNNs is sufficient in consuming acclimate difference. Furthermore, controlled of infrequent connections with the restrict weights. For example, the CT image is taken from the COVID-19 suspected person and the taken image is given as the input image to this proposed method and check whether this proposed method is able to detect the COVID-19 from the CT image by using CNN process.

II. Related Work

Gordaliza, et. al., (2018) proposed an automatic way which enables the robust segmentation of the infected lungs which have the infections which is joined with the parenchyma and they are influenced by the respiratory variation antiquity in a Mycobacterium Tuberculosis contamination pattern. The important ways in the separation of fine bronchi tissue and the air passage tree which is then replaced by the rejection of the linty borders. The achievement was related with the separation is obtained by using: 1) a half operating device and 2) a beginning which is dependent on linty accordance. The accord apportionment which results by the generality of voting by the three adept clarifications is regarded through the ground control.

S.Wang, et. al., (2017)proposed an information directed pattern, described the Central Focused Convolutional Neural Networks (CF-CNN) for dividing lung clot in x-ray scan. This methodology is used to merge the major two observations: 1) the suggested pattern takes the disparate position in the clot delicate characteristics in the couple of the three dimension and the two dimension CT images repeatedly, 2) once ordering the depiction voxel, then the impacts with the acquaintance of the voxels may differ as respected by the epidemic of the computative area. It is an incident by suggesting a novel central pooling layer that retains more data in a voxel patch center, and then it is replaced by using multi scale patch learning approach. Besides, a loaded experience is used for assisting the instruction pattern and the instructed models are chosen based on the standard of the apportionment problematic.

III. System Implementation

A novel coronavirus 2019 is detected by the advanced segmentation of infection present in lung by using Deep Residual Network (Resnet50) is suggested here to find the affected portion in the chest X-ray scan automatically. SqueezeNet CNN (Convolutional Neural Network) is used for lung segmentation. After segmentation, to extract the features, and for advancing the recognition of the affected area in the lungs by using residual network Technique. Residual network technique is first analyzed and then applied in the process of the conclusion of COVID-19, for example evaluating the affected regions and checking the longitudinal infection changes.

The proposed work is having the followed main contribution over the lung segmentation for diagnosis of COVID-19.

- Image Preprocessing
- Lung Segmentation-Seg-Net
- Feature extraction
- Residual Network Classification.

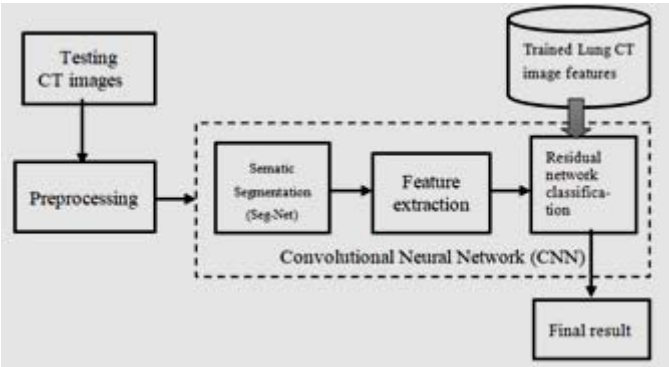

Fig 1. Proposed Block Diagram.

A. Preprocessing

The pre-treating or straining process is used for decreasing the deterioration which is analogous to the cacophony. While arranging coherent cacophony constraint strainers, it will have batch of effort. The cacophony like the shadow on the input depiction is extracted by utilizing the pre-treating strainers like the average strainers. Here the process of extracting the cacophony from the input is very important stage and it is obligatory for intensify lung depiction grade then makes the attribute abstraction intrinsic greater dependable on the advance of wide and small input depiction.

B. Lung Segmentation

The proposed work is implemented with the CNN based semantic segmentation (Seg-Net) method for lung detection.

Semantic Segmentation (SEG-NET)

Every encoder behaves like the convolution layer with the filter bank in each and every encoder network for generating a group of the map features. This process is called as batch normalized. The rectified linear unit is used here which is in the form of element. The next step consists of the max pooling layer it has 2 2 window then with the stride of two which is known as non-overlapping window then it is functioned to produce the output as the sub sampled with the factor of two.

The translation of the invariance for less spatial shifts is by using max pooling layer which is located in the input image. The consequence in the sub sampling bounteous of the given image has the condition for every pixel in the map features which is called as spatial window. The max-pooling and sub sampling has several different layers which is concluded with the huge amount of translation invariance in the classification of robust that corresponds the losing of spatial resolution for the featuring of maps. For segmentation the progressively lossy representation of the image is not favorable for the boundary depiction which is very essential. This im-

portance for apprehending and keeping the boundary data in the feature of maps in the encoder network during sub sampling is in the process.

The memory through the inference is not restraint and the encoder map features are stored. The case is not usually utilized in the feasible implementation so; it is submitted for storing the information. This process includes collecting the max-pooling indication, which is the position in the feature value is the maximum value in every pooling window then it is recollected in every single encoder feature map. This is performed by utilizing 2 bits for every 2x2 pooling window and it gives large efficient for storing which compares for recollecting the feature maps in float precision. The smaller storage of memory produces the moderate loss in the accuracy yet it is used in the feasible implementations. The CNN encoder designed and formulated by using VGG-16 as the basic design and additionally it consists of de-convolution-based decoder. It is designed using the most efficient units. It consists of 13 convolutional layers which correspond with the first 13 convolutional layers in the VGG-16 network and it is for the classification of the object. Every encoder has the corresponding decoder layer.

Encoder

• In encoder network, there are convolution layers and max pooling layers.

• Each encoder has 13 convolutional layers fromVGG-16 network.

• During max pooling in 2x2, the indices are deposited.

Decoder

• In decoder network, upsampling and convolutions are performed.

• It consists of softmax classifier for each pixel.

• During upsampling, the max pooling gives the corresponding encoder layer and then it is called as upsample.

Seg-Net Encoder Addition executes improved result beside corresponding variants.

1. The greatest production is consummate once the encoder feature maps are deposited in full.
2. Immense decoder develops the presentation in the specified encoder network.

C. Feature Extraction

Feature extraction is the procedure of planning a current Convolutional Neural Network design which is very monotonous step and it needs the large capacity of the information and also the assets during the implementation. The precoached designs like AlexNet will assimilate during the transfer learning. Here, AlexNet works which is depending on the architecture of CNN for transfer learning. Originally, the precoached AlexNet designs along the ImageNet dataset force is extracted for the feature extraction along the ImageNet dataset with the comprehend filters of the Convolutional Neural Network architectures, by using these steps feature coordinate is collected. The precoached CNN pattern has the initial category of layers which consists of the least number of features that has the complementary crucial details alike the edges. Finally, completely connected layers of pre coached network are extracted. The completely connected layer neuron is now added in the head of the Convolutional layers. They are used for gathering the removed features from the Convolutional layers. Finally, the inspection of the various completely connected layers the features have the effective perception as the decision.

D. Residual Network (ResNet)

ResNet has been created by Kaiming He beside the aim of creating the ultra-deep networks which unlike go through by disappearing incline predicament which is precursors. ResNet is designed with several individual numbers of layers such as 34, 50, 101, 152 and even 1202. ResNet50 is the famous network has forty nine convolution layers and one fully connected layer in bottom of networks. Absolute of total weights and MACs to entire network is 25.5M and 3.9M consequently.

Residual Network (ResNet) is a conventional feed forward lattice which has the remaining connection. Then, the output of the residual layer is explained by bases in the outputs with the (l-1)th that is proceeded by the precursory layer which is explained as xl-1. F(xl-1) is the output behind executing different performance and for example the convolution which is with dissimilar sizes of the filters, Batch Normalization (BN) is pursued by the stimulation responsibility, like Rectified Linear Unit(ReLU) on xl-1. The accomplishment output of residual of unit is xl that might be expressed by the following equation

$$xl = F(xl-1) + xl-1.$$

Residual network (ResNet) contains lots of the fundamental residual blocks. Despite, functions present in residual block could be differed based on the non-identical structural design of the residual networks. The comprehensive description in the residual network was suggested and then the surrogate advanced residual network perspective is called as the accumulated residual metamorphose was produced. Newly, some interchangeable alternative of the residual designs is initiated and it is depend on the ResNet structure. Additionally, various developed architectures are integrated by the establishment of the Residual units.

IV. RESULTS AND DISCUSSION

This section deplits the simulation we got in this proposed work. In this process the first step is giving the input CT image for processing. The following fig 2 represents the sample CT lungs image tested with this proposed work.

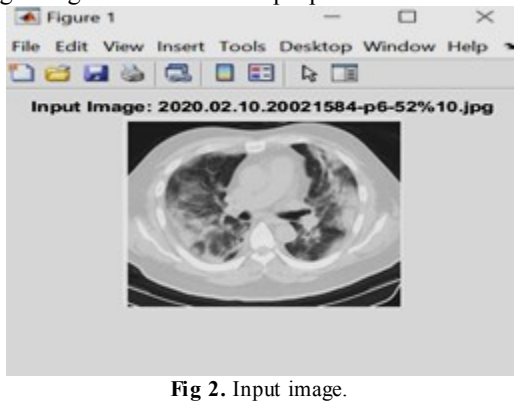

Fig 2. Input image.

The next process is converting RGB image into gray image. The input images consume more memory to process and for that reason; firstly, the image is converted into grayscale where only one band is going to represent the pixel value that varied from 0 to 255. The following fig 3 shows the grayscale images.

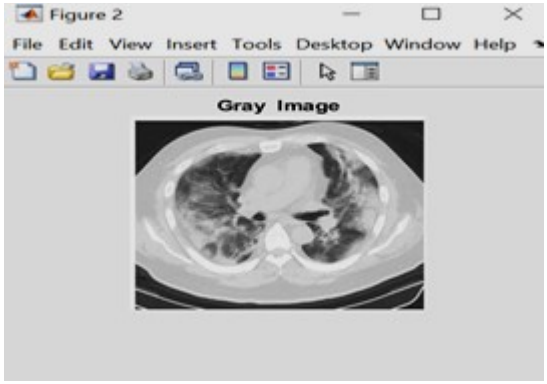

Fig 3. Grayscale image.

The preprocessed image is the extraction of the lung from the x-ray input along with the other pixels is given as '0'. In preprocessed image the image contrast is improved, and the noises are removed. After grayscale conversion, improve the contrast of the image by using an average filter. The following fig 4 represents the preprocessing image.

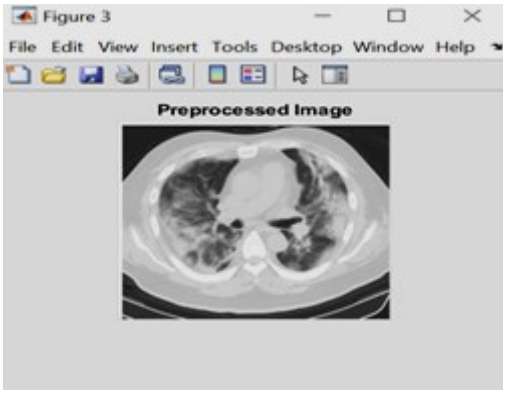

Fig 4. Preprocessed image.

After preprocessing the image is contoured. The process of initial contour is used for contour the lungs separately in the CT image. The following fig 5 represents the Initial Contour.

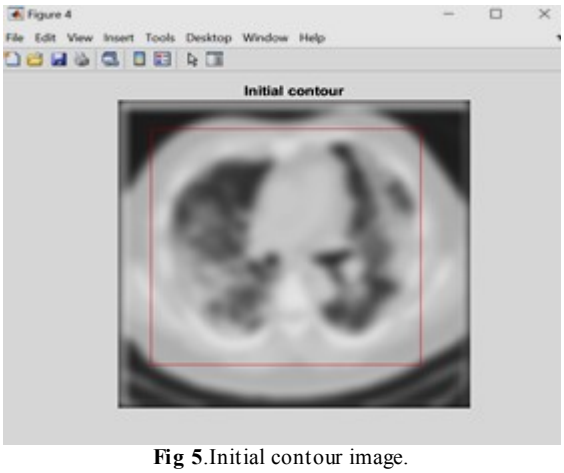

Fig 5.Initial contour image.

The image is now contouring. After contouring the image got iterated. Iteration stage is the operation of manipulating individual component in the digital structure. In order to operate all of the pixels, we need to be able to visit all the rows andthe columns completely in the image. The following fig 6 represents the iteration image.

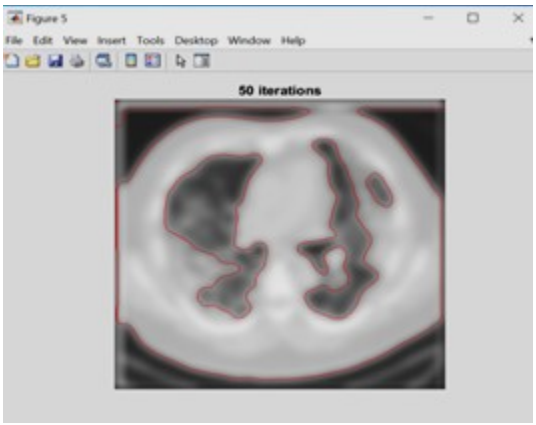

Fig 6.Iteration image.

The final boundary mask image will convert the segmentation gray image to black and white image. This process clearly separated the lung image from the CT image. The following fig 7 represents the final boundary mask.

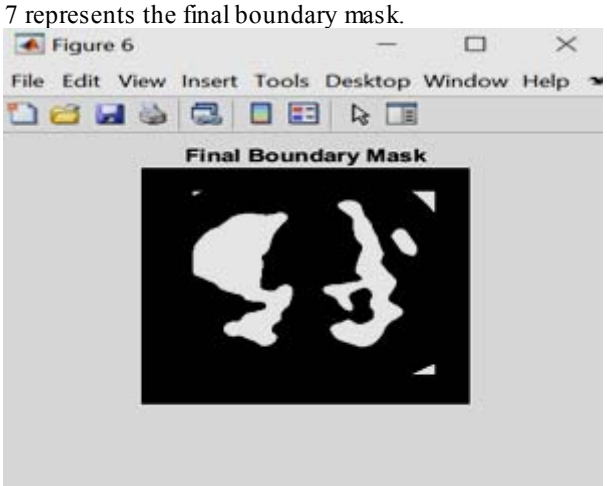

Fig 7. Final Boundary Mask Image.

After Segmentation the layer processing step is used to compare the image to the already trained CT images and produce the result. CNN based classification is processed to classify whether the image is positive or negative. The following fig 8 represents the layer index image.

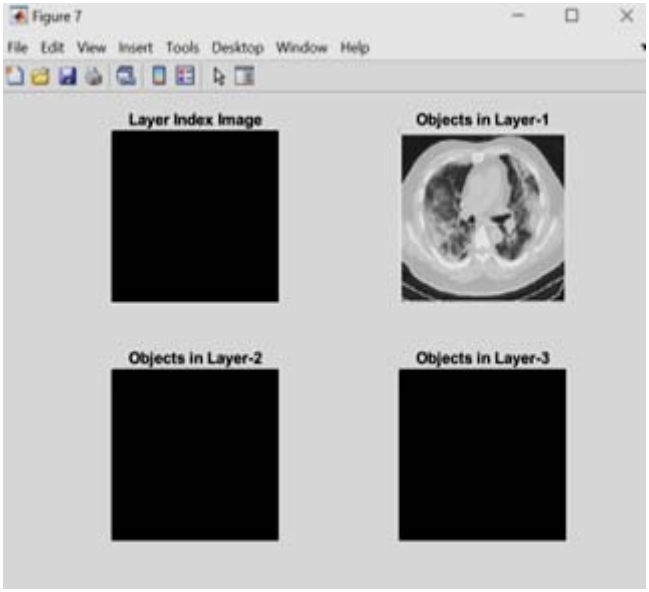

Fig8.Layer index image.

After the process of layer index processing, the COVID-19 infected portion is segmented from the CT lung image by comparing the image with the already trained images and in the next step it will produce the result. The following fig 9 shows the Segmentation maps.

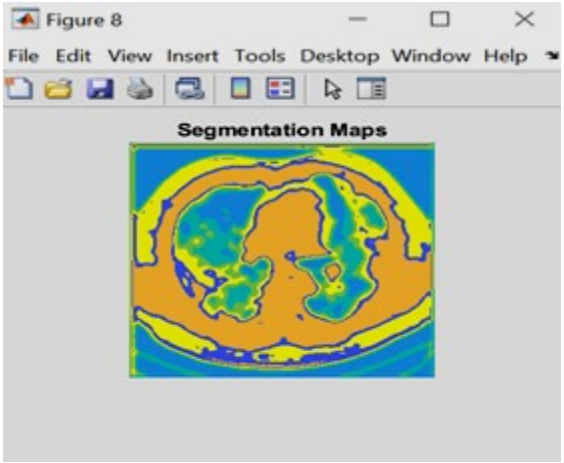

Fig 9. Segmentation maps.

After the process of the image by convolutional neural network the result is produced. The result shows whether COVID-19 is positive or negative. The following fig 10 represents the final output.

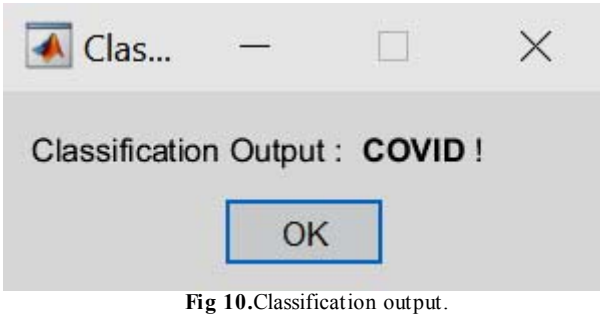

Fig 10. Classification output.

The accuracy of the output produced is 98.2%.

V. Conclusion

This paper proposes the detection of COVID-19 infection automatically in lung by using segmentation process from CT images, named semantic segmentation network in Convolutional Neural Network (CNN) and it is the pixel wise segmentation. This process is proposed for segmenting the infected regions from lung CT images. This structure holds admirable possible which can be seek during the evaluation in the detection of COVID-19, for example, computing the affected area, observing the longitudinal infection difference, and aggregation disguising transforming. The network achieved is higher accuracy. Seg-Net structure, which has been used less than other popular deep learning methods in previous studies, combined with image processing methods, has shown a successful result. The proposed Seg-Net method has the higher accuracy when compare with the existing methods like Attention-U Net, Gated- U Net, Dense-U Net. The Seg-Net has higher level of Sensitivity, Specificity and Precision.

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