Medical Report Generation and Chatbot for COVID_19 Diagnosis Using Open-AI

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Medical Report Generation and Chatbot for COVID_19 Diagnosis Using Open-AI

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Abstract:
The novel corona_virus (COVID_19) is an infectious disease have catastrophic impact on health and spread across the world. A crucial step in COVID-19 detection is to develop an automated and efficient classification system so that prompt treatment and medical care can be provided to the patients. However, most of the medical imaging systems just present the conditions of lung and scans are generated in large quantities that add a huge burdens to the workload of radiologists. Consequently, an intelligent system having capacity of lesions analysis in images and automatically creating a medical reports is of great significance for diagnosis of COVID_19. In this paper, we propose to use the fine tuned GPT3 and OPT350m models to automatically generate the medical text reports based on the segmented lesion regions of COVID_19 CT scan of patients. The proposed approach also provides the GPT3 based chat bot for the users to ask questions regarding COVID_19 identification. The custom trained chat bot responds to the user or practitioner queries based on the generated report by the fine tuned GPT3 and OPT model(350m). The experimental results showed that proposed models achieved beyond the state-of-the-art performances on medical report generation using COVID_19 CT scan data set. We conclude our research study by enumerating few future research directions in COVID_19 report generation.

Index Terms: Text Report Generation, Chat bot, COVID-19 diagnosis, Deep learning, CT scan, Open AI, Segmentation

Introduction:
Corona Virus (COVID_19) is caused by Severe Respiratory Syndrome SARS-CoV-2, which is a highly contagious disease. Millions of people around the world are affected by this
disease. However, identifying the infection manually using radio images is highly challenging as it is highly prone to human errors and time-consuming. Artificial Intelligence techniques have been exploited in the development of accurate and automated diagnosis of COVID-19 [23][24][25][26]. Several researchers have attempted to designed a classification systems and scanning tools for COVID-19 diagnosis. For example, RT-PCR is the standard scanning tool to identify the severe respiratory syndrome SARS-COV-2 and COVID-19. However, RT-PCR procedure is considered as complicated very time-consuming. Chest X-Rays and CT scans modalities are mostly utilized to obtain the accurate and fast diagnosis of COVID-19.

Automated generation of medical reports is a critical application in industry and academia. Text report generation is similar to the task of image captioning, however RL-based method for medical report generation are considered suitable because of limited data scale [2]. Particularly in case of COVID-19, having large amount of training data, Open-AI large language models are utilized for text report generation task. The Open AI text generator is AI tool that is trained on a large corpus of text and help in generating texts. Text generation using GPT3 uses artificial intelligence and machine learning to allow users for text generation which sounds like natural. Open AI, GPT3 can be generalize for language understanding tasks without specific task related architecture [3].

In medical domain, Open AI model need to understand the domain and provide accurate description of CT scan images in a consistent way and cover the terminologies. In the proposed study, robust image description is illustrated in automatically generated medical report. In our proposed approach, large-scale language models are used as the pre-trained model for further domain specific fine-tuning. GPT3 is a transformer based large language model, trained on a large corpus of textual data. The model is specifically designed for tasks of natural language processing such as machine translation, text classification and question answering. In proposed method, the GPT3 model is fine-tuned on COVID-19 data set, and has shown good performance than open pre-trained transformer language model. GPT3 extracts few sample sentences from the task-specific training data, embed these samples in the prompt, and generates sample sentences of COVID-19. In short, proposed method achieves knowledge distillation by training the small model using soft labels predicted by the large language models. By customizing the GPT3, the reliability of output in increased by
having more consistent results. In addition, customize version of GPT3 is specific to our medical domain (COVID_19), which improves the latency and result in reduction of cost. The prompt used to generate text in customize version of GPT3 are much shorter as compared to large language model GPT3. In case of fine-tuning of OPT350m, the model is first trained on our own created textual COVID_19 data set. For automatic medical report generation on the COVID_19 CT scan data set, a text data set is constructed from 2900 images to fine-tune the OPT350m model. Proposed model is trained on the COVID_19 CT data set for further fine-tuning as shown in figure 1.

The proposed GPT3 model provides the accurate and robust analysis of identified symptoms. Rather than informing the patients that they are diagnosed with COVID_19, a healthcare professional can use this medical report to have compete picture of diagnosis and location of abnormalities and percentage about lung effectiveness. The comprehensive medical report generated by the proposed model increases the credibility of doctor diagnosis and gives patients robust and accurate information about their health. This research study has future applications and wide clinical values across other diseases. Furthermore, automatically generated medical report cannot eliminate healthcare professionals work, but can be used as an effective tool in reducing their workload experienced during COVID_19.

This research study has future applications and wide clinical values across other diseases. Automatically generated medical report using proposed approach has the potential to provide assistance in COVID_19 diagnosis, abnormality detection and quantification of the lung effectiveness. The comprehensive medical report generated by proposed model increases the credibility of doctor diagnosis and gives patients robust and accurate information about their health. In addition, automated system performing assessment of disease severity and medical report generation can useful for hospitals having personnel shortage with high volume of patients[18].

Besides, the automated diagnostic system is an important public health tool to reduce cost and increase diseased detection accuracy, while open AI can help to increase the diagnosis efficiency of imaging based techniques. Proposed system can help in detecting mild symptoms from CT scans of patients and reduce the need of professionals to analyze as
automated generated medical report highlight all the clinical details or infection present in the CT scan image.

The main contributions of the proposed research can be outlined as follows:

- A pre-trained VGG16 model has been fine tuned that can accurately classify the patients as COVID_19, normal or other disease on the basis of patient's CT scans. CNN model is optimized for accurate detection and good accuracy.
- Image segmentation is performed to identify the region of interest from CT scan of patient. In addition, percent of lung effectiveness in upper and left lower lobe is determined to quantify the lung effectiveness.
- A template is designed to generates the instruction prompt from the segmentation results. this generated prompt is given as input for text report generation from Open AI language models.
- To automatically generate the medical reports on the COVID-19, a textual data set is constructed from 2900 COVID_19 CT Scan images
- An OPEN AI based, two language models (GPT3 and OPT350m) are fine-tuned for automatic text report generation from COVID_19 CT Scan HUST19 data set.
- A GPT3 based chat bot is designed for question answering of COVID_19 identification and its details

The paper is organized as follows: Literature review is described in Section 2. Section 3 includes the Methodology. Implementation and experimental Results are provided in Section 4. Finally, in Section 5, clinical value of proposed system is elaborated. Conclusion and future works are summarized in section 6.
Figure 1: Architectural Diagram of Proposed Approach
II. Literature Review

1. Lesions Segmentation

As segmentation plays a significant role in identification of infectious region but does not produce quantitative data for expert analysis and assessment [6]. Evaluating the volume of infections, lungs and extent of infected region of lung are crucial to assess the COVID_19 level or stage. In addition, quantifying the impairment is also considered necessary for COVID_19 treatment. Few of the research studies have quantitatively assess the infectious regions of lung in CT scan image of COVID_19 patients. Zhou [7] analyzed the CT scan of 62 COVID_19 patients. They also mentioned that examination of CT scan of COVID_19 patients showed diverse patterns with lung parenchyma. Their findings suggest some measure for the specialist to monitor the disease. Research done by Liu [8] focused on quantification of lesions from CT scan image of COVID_19 patients and also predict the progression of disease from early days to severe illness. Three CT features from the classification of lungs were identified automatically representing semi consolidation, ground glass opacities, and consolidation volume present in each lung. In another study, Shen [9] described the significance of metrics for evaluating the disease degree such as lesions volume, volume, mean density of lesions, percentage of lesions of overall lung, right and left lung and lobe. They compared the results achieved by computational calculation and values identified by specialist. They point out that after the segmentation of lesions is performed, these metrics can be calculated using the mathematical formulation.

2. Report Generation

Medical imaging technologies (CT or CXR) are widely used for facilitation of COVID_19 diagnosis. Since manually writing the report is considered to be more time consuming, an intelligent medical system automatically generating the medical reports is essentially important in both industry and academia. Guangyi [10] proposed a method named as Medical VLBERT for abnormality identification from CT scan image and medical report was generated automatically on the basis of identified lesions region. An alternate learning method with knowledge pre-training and transferring was used. A data set was constructed which comprises of 368 medical reports by radiologists and 1104 CT scans of lungs for
medical report generation. They trained the proposed model on COVID_19 CXR data set and then fine-tuning was performed on COVID_19 CT scan images. Visual captioning RL-based method [11] are considered inappropriate for report generation because of large training data set requirement. Many researchers focused on report generation using CXR data set [11], [12], [13]. TieNet [13] used the text embedding and image features to construct a framework for report generation using CXR data set. In addition, BERT model [14] is trained on general corpus domain so existing language models are not considered accurate for report generation in medical domain.

III. Methodology:

To automatically generate the more accurate medical reports, a GPT3 model is fine-tuned in the proposed research based on the segmented lesion regions of COVID_19 CT scan of patients. A VGG16 model is optimized by changing the hyper-parameters for COVID_19 detection and multi-class classification using CT scan HUST19. Adaptive thresholding based image segmentation of lung CT scan is performed on the basis of CNN model prediction. Furthermore, quantification of lung effectiveness is also performed to identify the seriousness of problem which can be helpful for the practitioners. Findings of CNN fine-tune model and the segmentation process is given as input to proposed fine tuned GPT3 model for text generation. OPT350m model is also fine-tuned for text generation purpose and chat-bot is designed to provide the responses to users queries.

Both large language models are based on the transformer architecture having ability to process sequential data. Major difference between these models are that GPT-3 is accessible through API instead of publicly available to control misuse and harmful application development whereas OPT350m is publicly available. In addition, with respect to training of these large language models. OPT350m requires the textual data for training and this datasets is constructed in the proposed approach from 2900 COVID_19 CT Scan images. Furthermore, GPT3 model understand the terminologies and more accurately generate the report as compared to OPT350M.

1. Pre-processing

A set of operations are performed in constructing the process of COVID-19 detection, segmentation and text generation. Prepossessing is first step of the proposed approach which includes the noise removal from image, image thresholding, and certain morphological operations. Region of interests are identified from the CT scan image of lung that is helpful is
for further analysis in the segmentation process. Morphological operations are used for image shape extraction required for analysis. Dilation and erosion operations are employed to sharpen the area of interest in an image. Furthermore, Image is converted to grayscale and region properties are measured in the pre-processing step. Adaptive thresholding is used to perform the image segmentation in order to extract the lesions.

2. Classification

The CNN model prove to give good results in several medical imaging applications [27]. In the proposed approach, pre-trained VGG16 model is used for producing high performance as training model from scratch requires a huge data set. Thus, Using the models not only save the time but also speed up the learning process. Transfer learning is used and different parameters are modified for training the COVID19 CT scan image data set for the proposed approach as shown in figure 2. This model is retrained on the CT scan HUST19 data set. Fine tuning is performed by the removal of last layer. Flatten layer is added including the dropout rate (0.5) and softmax activation function in fully connected layer is added with an output size of three which represents three different classes (COVID-19 positive, negative and No information). It has been observed in the proposed approach that VGG16 model achieves the good performance in the detection and classification process. Few of the parameters are fine-tuned to improve the performance of classification. To obtain the optimum performance, the learning rate, number of epochs, weight decay and momentum should be set to 0.001, 300, 0.05 and 0.7 respectively, in the VGG16 model. The categorical cross-entropy is used as the loss function.

Figure 2: CNN based Classification of COVID_19 CT Scan Image
3. Lesions Segmentation

Segmentation of Lung is significantly important pre-processing step as the tissues surrounding the lungs on CT scan image need to be removed in order to accurately analyse the lung features. Lung segmentation mask is created using U-net for generating lung segmentation of each CT scan image of COVID_19 positive. Furthermore, the area of lung is then extracted using the lung mask. Adaptive thresholding is used for extraction of region of interest. The outer part of lung mask is smoothed using morphological operations such as opening and closing. Connected objects are separated using the opening operation while outline of lung is smooth and holes are filled using the closing operation. CT scan irregularities connected with COVID-19 infections were identified and extracted which can be used for the assessment of progression of disease. Ground glass opacities, vascular dilation and consolidation are the main features extracted from the CT scan image of COVID_19 patients. Images having no information of COVID_19 and Normal CT scan classified by the CNN are not subjected for the segmentation process.

4. Quantification and Assessment of COVID-19 infection

To check the disease severity and lung effectiveness, it is significant to measure the volume of lesions. The proposed method provides the location and quantification information of the infectious region from COVID_19 CT scan of patient. It segment out the lung lobes along with infected regions of COVID_19. After the process of segmentation, quantification of COVID_19 infection is performed by computing several metrics such as volume of infected region in whole lung. In addition, percentage of affective in whole lung as well as in each lobe was also computed to measure the COVID_19 severity and infection distribution in each lung. Figure 1 represents the overall pipeline for COVID_19 quantitative assessment. A CT scan is first classified using the optimized pre-trained VGG16 model. The output of classification process is analysed to see if output of the classification step is positive, then image segmentation will be performed to extract out the abnormalities. In addition, quantitative metrics calculation is performed to quantify the patient infection regions. The quantification of lung provides the severity information of COVID-19. Therefore, the regions of lesions present in CT scan of COVID_19 positive patient are classified as consolidation, ground glass opacities and vascular dilation respectively. Ground glass
opacities are in the form of fine mesh and consolidation are located near bundle of blood vessels. In addition, its is possible to measure the change of level of lesions caused by COVID_19. The lung is divided into four segments [28] as shown in table 1 and the volume of overall lung as well as volume of the infected regions present in each segment of lung is quantified. And so the specialist has more information to assess the extent of disease.

<table>
<thead>
<tr>
<th>Categories</th>
<th>Lung Regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung Lobe</td>
<td>Lower Left Lobe</td>
</tr>
<tr>
<td></td>
<td>Upper Left Lobe</td>
</tr>
<tr>
<td></td>
<td>Lower Right Lobe</td>
</tr>
<tr>
<td></td>
<td>Upper Right Lobe</td>
</tr>
</tbody>
</table>

Table 1: Segmentation of Lung CT Scan

5. Medical Text Report Generation Using GPT3

GTP-3, the large language model is trained on general corpus domain. Consequently, base language model is fine tune on the COVID_19 data set related to medical domain for text report generation. To prepare GPT-3 for report generation about COVID_19, a prompt containing scientific description of the lungs was given as an input. Different version of the instruction prompts such as using synonyms, abbreviations, terminologies, few and more number of words were given to generate the text using the fine tune GPT3 model. The model predictions about COVID_19 variants was surprisingly good and generate accurate names of the abbreviations used in the instruction prompt. Similarly, OPT was also trained on the COVID_19 datasets to generate the medical reports. Report generated by the proposed GPT3 and OPT350m models were compared to analyse how the quality and quantity of words and terminologies affects the text generation process.

6. Chat Bot

Chat bots used the natural language processing and AI (artificial intelligence) to understand the user’s aim, and respond accordingly. GPT3 provides a machine learning based platform to train and deploy the AI models. A GPT-3based AI chat bot is developed in the proposed
research which is trained by giving the GPT3 responses and then respond to prompt based on the generated output from GPT3. A GPT3 chat bot learn from few example of paragraphs, understand the patterns and improve the responses or output on the basis of these patterns. Chat bot is trained on the queries related to COVID_19 so that it can generates the responses to new questions. The custom trained chat bot respond to queries based on the generated report by the fine tuned GPT3 and OPT model.

IV. Experimentation & Results:

During the current COVID-19 pandemic, the availability of CT scan datasets is necessary and significant to provide the deepen understanding and valuable information about this viral infection.

1. Experimental setup and Data set. This section illustrates the data set considered for experimentation purpose. Datasets chosen for experimentation purpose have no missing values, up to date and accurate. Hust19 is multi class data set comprises of three types of CT slices such as Non_informative CT (NiCT), Positive CT (pCT) and Negative CT (nCT). NiCT contains 5705 scan images which have no information about lung parenchyma whereas pCT includes 4001 CT scan images that contains imaging features related to COVID-19 pneumonia. The third type of Hust19 data set, negative (nCT) comprises of 9979 CT images which were not related to COVID19 pneumonia. The HUST19 CT scan comprises of 19,685 CT scan slices. Data set is open source and is available on [https://bioengineeringcommunity.nature.com/posts/hust-19-for-predicting-covid-19-clinical-outcomes](https://bioengineeringcommunity.nature.com/posts/hust-19-for-predicting-covid-19-clinical-outcomes). Hust19 was made available under a CC BY-NC 4.0 license. Hust19 was accumulated from lab of union hospital, Wuhan. It contains number of chest CT (computed tomography) images and clinical features from patients having or without COVID-19.

2. Pre-Processing

Pre-processing of hust19 data set is performed to remove the noise and improving the quality of image for further analysis. As we can see in the figure 3, pre-processing step extract out the features from image which can be used for the segmentation and classification of image. Covid positive, negative and no information image is given as an input to the pre-processing step which shows that some of the features are extracted in Covid positive image that could be used for the indication of COVID_19.
3. Segmentation & Quantification

Segmentation of the image is only performed if the image is classified as Covid positive by pre-trained VGG16 multi class classifier. The process of segmentation extract or segment out the abnormalities or region of interest present in the image which are used to identify the severity of COVID_19 virus. Image is divided into the four quadrants as shown in figure 4, and each quadrant is analyse separately to identify the presence of ground glass opacities, consolidation, vascular dilation. Figure 4 shows the vascular dilation present in the CT scan of patient who is COVID_19 positive.
a) COVID_19 Severity Measures

The percentage of lung effectiveness is calculated by the volume of effected lung regions which is effected because of consolidation, ground glass opacities and vascular dilation to the whole volume of lung mask. These regions are identified using the segmentation process. If the percentage of effectiveness is greater than 40%, then it is classified as severe illness and need immediate medical attention. The extent of lung effectiveness is also measured across each lobe. The percentage of each of the four lobes are combined to compute the total lung effected or severity value. A value more than 40 percent indicates the severe effectiveness. Different clinical observations such as low, moderate and severe critical types were determined in COVID_19 patients. Previous research studies showed that the degree of disease severity was associated with the disease prognosis and clinical treatment. Missed diagnoses result in delay of appropriate clinical treatment and critical COVID-19 patient treatment requires immense medical resources. Consequently, early identification of COVID_19 patients is particularly essential for clinical practice and that's why 40% is chosen as a severity measure.

Severity Score (SS) = volume of abnormality region/volume of lung mask

The percentage of lung effected is determined to show to severity of the disease. Each lobe is quantitatively analyse to identify the severity of disease. Percentage of total lung effected or severity score due to Covid_19 is shown in figure 5. It is shown that overall 19.45% of lung is affected in figure 5 and left lower lobe is affected most as compared to other lobes of lungs.
4. Classification

As Deep transfer learning and CNN's are widely used in medical imaging applications. In transfer learning, networks VGG16 is used by fine-tuning the certain hyper parameters for COVID-19 diagnosis. The COVID_19 detection was carried out by classifying the CT scan of patients using multi-class classification. VGG16 efficiently classify a thousand of images having distinct types such as COVID_19, healthy and No-Information. The accuracy of model achieved is shown in figure 6.
Figure 7: ROC curve three types of CT scan Images

Accuracy of classifier and ROC curve is shown in Figure 6 and 7. The number of images, and epochs used for training was 300 and 300 respectively.

5. Instruction Prompt Generation

Instruction prompt generation is crucial part in text report generation. Terminologies, abbreviations, synonyms, quantity and quality of words used in the instruction prompt effect the text generation process of large language models such as GPT3 and OPT350m. A prompt generation template is designed as shown in figure 8 which generates the instruction prompt after getting the information from fine-tune VGG16 and segmentation part of the proposed method. If the CT scan result is positive, image is sent out for segmentation and template based model writes an instruction prompt describing the few details of segmentation results such as this percentage represents the ground glass opacities or presence of consolidation and vascular dilation in CT scan of image. In case of CT scan results is negative, it will not generate any instruction prompt for text generation. Threshold is defined on the overall percentage of lung effectiveness to represent the severity of COVID_19 such as patient in critical condition or need immediate doctor checkup.
Automated medical text report generation using fine tuned GPT3 model is performed. The output of prompt generation process performed in the previous step is given as an input to fine tuned GPT3 model. The template based prompt output includes the details of ground glass opacities, vascular dilatation, consolidation and lung effectiveness which are extracted using the proposed segmentation method. The fine tuned GPT3 model generates a detailed sentences explaining the overall findings of classification and segmentation step. Basic architectural diagram of the GPT3 text generation process is shown in figure 9.
A medical report generated by GPT3 using the instruction prompt are shown in table 2. Instruction prompt generated against each image is also shown along with the generated text report. The medical report generates using the proposed GPT3 model fine tuned in COVID_19 data-set is compared with GPT3 model which is trained on large corpus of data against the same instruction prompt. It has been observed that the fine tune model understand the terminologies, abbreviations, synonyms used in the instruction prompt. In addition, quality and quantity of words used in the instruction prompt didn't effect the performance of text report generation. The proposed model provides the reasoning against the instruction such as we can see in table 2, when the condition on the lung effectiveness is removed. The proposed model still able to conclude that patient is in critical condition based on the lung effectiveness value. Furthermore, proposed model also gives definition of terms used in the instruction prompt.
7. Medical Report Generation using OPT350m

Table 2: Medical Report generated using the Fine tuned GPT3 Model [30]
OPT is transformer language model, trained on large collection of text data. Fine tuning of the model is performed on our own constructed COVID_19 text data as shown in figure 10. Quality of text and the number of words used in the instruction prompt effect the response generated by the OPT350m model. Responses generated by the OPT350m by giving several instruction instruction prompt as an input are shown in table 3.

![Architectural Diagram of OPT350m Text Report Generation](image)

It has been observed from responses generated by OPT350M, that the fine tune model understand the abbreviations used in the instruction prompt where as the original OPT350m model didn't understand the terminologies or abbreviations. Similarly, number of words used in the instruction prompt also effect the response generated by OPT350m. In addition, fine tune model just connect the input provided through the instruction prompt and didn't provide any logical reasoning against the instruction used in the prompt. Furthermore, fine-tune OPT350M model generates better response as compared to the original model fine tuned on the large corpus domain.
**Use abfraction (GGO). Use more number of Words**

Covid-19 is Positive, 5.521% of Lungs show GGO. Lower Left Lobe was most affected, Upper Right Lobe was least affected. Vascular dilatation, no consolidation

The CT scan findings show that Covid-19 is positive and that 5.521% of the lungs show ground glass opacity (GGO). The lower left lobe was most affected, while the upper right lobe was least affected. There was no consolidation found. No, all patients had a mild fever. We do not have high rates of viral spread in this population. So far, we have tested 5,511 patients, 3,942 patients were hospitalized. All patients are below normal BMI (above 55 kg/m2); 3 patients have higher than normal serum sodium concentrations (1 patient). A total of 1,971 people are currently on ventilators and are being monitored in the hospital and other facilities. More information about the status of the medical team and the Covid-19 control can be found here:

SARS-CoV-2 is Positive, 5.521, Lower Left, Upper Right, yes Vascular dilatation, no consolidation

https://www.covelt.org/about/hospital/cov-mitcfcovarum

The prevalence of pneumonia caused by the COVID-19 pandemic varies widely and it can take months or years for symptoms to develop in the affected area,” Dr. Peeples

---

**Use Synonym (SARS-CoV-2), Less number of Words**

SARS-CoV-2 is Positive, 5.521, Lower Left, Upper Right, yes Vascular dilatation, no consolidation

The CT scan results show that SARS-CoV-2 is present and that 5.521% of the patient's lungs are affected by GGO. The lower left lobe is the most affected area, while the upper right lobe is the least affected. There is also evidence of vascular dilatation but no consolidation.

SARS-CoV-2 is Positive, 5.521, Lower Left, Upper Right, yes Vascular dilatation, no consolidation

---

**Use Abbreviation (GGO). More number of Words**

Covid-19 is Positive. 5.521% of Lungs show Ground Glass Opacities, Lower Left Lobe was most affected, Upper Right Lobe was least affected. Yes Vascular dilatation, found consolidation, Patient in critical Condition

The CT scan results indicate that the person has Covid-19 and that 5.521% of their lungs are affected by GGO. The lower left lobe is the most affected and the upper right lobe is the least affected. There is also evidence of vascular dilatation but no consolidation.

SARS-CoV-2 is Positive, 5.521, Lower Left, Upper Right, yes Vascular dilatation, no consolidation

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**Use Less number of Words, Use Synonym (Covid-19) remove threshold on lung effectiveness (Patient is in critical Condition)**

Covid-19 is Positive, 5.521% of Lungs show Ground Glass Opacities, Lower Left Lobe was most affected, Upper Right Lobe was least affected, yes Vascular dilatation, found consolidation, Patient is in critical Condition

The following CT scan results show that the patient has Covid-19 and that 45.29% of their lungs are affected by GGO. The lower left lobe was the most affected, while the upper right lobe was the least affected. Vascular dilatation was also found, as well as consolidation.

Vascular dilatation is more common in patients with Covid-19 than in those without the disease, which is when a substance in the lung vessels to widen. Consolidation is also present. The patient is in critical condition.

How much you willing to pay? Please let us know.

SARS-CoV-2 Variant

If you're interested, please go to my website and select a payment plan.

http://www.covelt.org/sars/abtech-pay-plan

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**Use more Words, Remove abbreviation (GGO). More number of Words**

Covid-19 is Positive, 5.521% of Lungs show Ground Glass Opacities, Lower Left Lobe was most affected, Upper Right Lobe was least affected, yes Vascular dilatation, found consolidation, Patient is in critical Condition

The following CT scan results show that the patient has Covid-19 and that 45.29% of their lungs are affected by GGO. The lower left lobe was the most affected, while the upper right lobe was the least affected. Vascular dilatation was also found, as well as consolidation.

In summary, only SARS-CoV-2 in that group showed consolidation. Vascular dilatation is more common in patients with Covid-19 than in those without the disease, which is when a substance in the lung vessels to widen. Consolidation is also present. This is when a small area in the lung becomes established due to inflammation.

Covid-19 is a real pandemic that is going to take on the world. There are going to be people suffering, who will be going by ambulance to hospital, which is going to do some damage to the patient and then he will get cured without any problems in his life. What is different is that there are going to be people, who will get infected, and they will be going to hospital and getting treated by the doctors. You should get Covid-19 test results from a reliable source that will help you in curing and bring you back to better health. Also there are going to be people who are going to go by ambulance to get treated. The reason is that there is going to be more and more places, that

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**Use more number of Words (Remove information (GGO), Remove threshold on lung effectiveness (Patient is in critical Condition)**

Covid-19 is Positive, 45.29% of Lungs show Ground Glass Opacities, Lower Left Lobe was most affected, Upper Right Lobe was least affected, yes Vascular dilatation, found consolidation, Patient is in critical Condition

The following CT scan results show that the patient has Covid-19 and that 45.29% of their lungs are affected by GGO. The lower left lobe was the most affected, while the upper right lobe was the least affected. Vascular dilatation was also found, as well as consolidation.

Vascular dilatation is more common in patients with Covid-19 than in those without the disease, which is when a substance in the lung vessels to widen. Consolidation is also present. This is when a small area in the lung becomes established due to inflammation.

5.521, Lower Left, Upper Right, yes Vascular dilatation, no consolidation

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8. Comparison with Existing Segmentation & Report Generation Techniques:

Several studies [15][16][17] focused on lung segmentation, severity, quantification and classification of COVID_19. These studies primarily objective was overall estimation of lung regions but didn't focused on quantification of effectiveness against each lobe. In addition, one of the research study [19] also performed quantification of effected lung regions because of COVID_19 but they didn't generate a report to describe the details about the findings. A research study [17] used the COVIDNet CT images data set to perform detection of COVID_19. This study only highlight the presence of abnormalities in the CT scan while we validate our proposed algorithm by using the same data set. Segmentation, quantification and classification is also performed on the same dataset which showed better performance than existing technique [17] as it identify and quantify all the abnormalities present in the image as shown in figure 11.

Authors in [22] focused in text report generation using CXR images. Medical report describe only the condition of lungs and its abnormalities but didn't focused on quantification, reasoning and explanation of abnormalities present in the segmented lesions as our proposed approach generates a response as shown in figure 12.
<table>
<thead>
<tr>
<th>Original Image</th>
<th>Fine tuned GPT3 Response</th>
<th>Fine tuned OPT350m</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="CT Scan Image" /></td>
<td>A CT scan of the lungs is used to check for lung damage or disease. The results of the scan can show how severe the disease is and how much of the lungs are affected. The SARS-CoV-2 virus can cause lung damage and make it difficult for a person to breathe. The CT scan results show that 45.29% of the patient's lungs are affected by the virus. The lower left lobe is the most affected, while the upper right lobe is less affected. There is also evidence of vascular dilatation and consolidation in the lungs. This shows that the patient is in a critical condition and requires immediate medical attention.</td>
<td>The SARS-CoV-2 virus is positive, which means the person has COVID-19. 45.29% of their lungs are affected by the virus, with the lower left lobe being the most affected and the upper right lobe being the least affected. Vascular dilatation is present, which means the virus has caused the walls of the blood vessels to widen. Consolidation is also present, which is when a substance in the lung tissue becomes solidified due to inflammation.</td>
</tr>
</tbody>
</table>

Figure 12: Medical Report Generated Using Proposed Approach using CT Scan Image [30]

Most of the studies focusing on report generation outlined the findings of segmentation process in the generated report. None of the study provides the detailed analysis of these findings and logical reasoning. In addition, generated report using the proposed approach not only understand the terminologies but also provides explanation of the terminologies used in the medical report of Patient CT scan [22],[29].

9. Chat bot
A customized chat bot named as Health Bot is developed on the Discord platform and natural language processing is used. It enables the users to ask questions about COVID_19 in their own words and can receive the related responses. The health bot is designed based on text report generated using fine-tune GPT3 and OPT350m model. So users can interact with the Health bot through Discord platform and can ask what they want. The response generated by the Health bot is based on the content from the fine tuned GPT3, OPT350m models generated report. There is no need to follow a structured format to ask the questions from Health bot. The COVID_19 CT scan image is given as input to chat bot which ask the user if he want to analyze the image. Option is provided to users to choose the language models for text report generation as shown in figure 13.
The Health bot is directly connected with fine tuned GPT3 and OPT350m model to generate the response based on the questions asked by user as shown in figure 14. Users can not only get the information about COVID_19 but also can give the CT scan image to analyse its effectiveness. In addition, Health bot also provide relevant information regarding the terminologies used in the report and can see the effected lung area in the generated response as well.
Healthcare professionals can integrate the GPT-3 model based chat bot into their systems which provides the responses based on the generated report as well as GPT3 domain knowledge. But we restrict the chat bot to provide the responses based on the customize GPT3 model generated report as the model is only trained on the medical data set to avoid inaccurate responses. However, chat bot is able to provide responses based on original GPT3 domain knowledge. Chat bot is only able to provide information based on the proposed model trained on COVID data set and have the predictive capabilities constraint.

V. Discussion & Clinical Value of Proposed System

The proposed system provides an efficient, detailed, automatic evaluation and report generation of CT scan images linked with COVID_19. Automated diagnosis of disease can be helpful in facilitating rapid response in identification, assessment of severity, extent or quantification of infected lung and disease progression in patients having COVID_19 symptoms. Manual calculation of disease severity is difficult as either we need annotation so affected lung regions which is time taken or subjectively assess the affected lung regions. A precise, robust and automated measurement of severity score or quantitative output of lung will provide take into account the reproducibility and time issues. Furthermore, the segmentation of abnormality present in lungs can be used for visual inspection and analysis. The automated computation of SS (Severity Score) computed by proposed method would be useful in clinical scenarios such as assess the disease severity and prioritize the patients, disease progression and earlier detection of COVID_19. Automated system performing assessment of disease severity and medical report generation can useful for hospitals having personnel shortage with high volume of patients[18].

VI. Conclusion:

In our proposed approach, large-scale language models are used as the pre-trained models for further domain specific fine-tuning and text report generation. GPT3 is an artificial intelligence tool by Open AI which is fine tuned on COVID_19 CT Scan HUST19 data set and used to generate the textual reports. The proposed approach used GPT-3 and OPT350m large language models for automatic test report generation. Text generated by both these language models are analyzed and compared on the basis of quantity, quality, abbreviations and synonyms, terminologies used in the instruction prompt. GPT-3 relatively generate good
responses and understand the abbreviations and synonyms used in the text. The experimental results showed that proposed text report generation approach achieved good performances on terminology prediction and report generation using HUST19 COVID-19 CT scan data set. The custom trained chat bot is designed which respond to queries based on the generated report by the fine-tuned GPT3 and OPT model. The proposed method has the potential to provide assistance in COVID-19 diagnosis, detection of regions having abnormalities, quantify the lung effectiveness and can used for monitoring disease progression in future. The comprehensive medical report generated by proposed model increases the credibility of doctor diagnosis and gives patients robust and accurate information about their health. This research study has future applications and wide clinical values across other diseases. Automatically generated medical report cannot eliminate healthcare professionals work, but can be used as an effective tool in reducing their workload experienced during COVID-19.

The proposed system is trained with only few number of COVID-19 abnormalities such as consolidation, vascular dilation and ground glass opacities. In future, proposed system will be comprehensively trained to account other abnormalities as well. In addition, system only consider the CT scan images for quantification and report generation. A similar study can be done using chest X-Ray images. Furthermore, the power of GPT-3 model remains matchless, however, GPT3 lack semantic understanding and have limited reasoning.

Data Availability

The datasets generated and/or analyzed during the current study are available here, https://bioengineeringcommunity.nature.com/posts/hust-19-for-predicting-covid-19-clinical-outcomes. The text datasets constructed during the current study is available from the corresponding author on reasonable request.

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**Additional Information**

HUST19 dataset in this article are paper is in the article’s Creative Commons license. All data set images are available under CC BY-NC 4.0. The link of Licence is provided here; (https://creativecommons.org/licenses/by-nc/4.0/)

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