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Lung Cancer Stage Identification Using Enhanced Model From Deep Learning

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ABSTRACT

Ddigital image processing techniques such as classification and segmentation are now widely applied in the medical area with the aim of early detection of diseases. From the lungs Computed Tomography (CT) scan images the images are pre-processing and the Region of Interest (ROI) is segmented. In this work trying to develop CNN algorithm for Lung Cancer detection from CT-SCAN images and for CNN training. We use CT-SCAN images dataset which is downloaded from Kaggle.com website. This application uses hybrids algorithm of CNN-LSTM to enhance the performance of lung cancer prediction. The first step is to build a hybrid model using 80% of the x-ray images of lung cancer and the second step is to use the remaining 20% of the data to classify lung cancer. Present in the CT scan are of two types' Normal' and 'ABNORMAL'. If the combined method (LSTM and CNN) will be used, accuracy, precision, fscore and recall will be developed far better than CNN. CNN algorithm is obtained 97% accuracy while hybrid CNN and LSTM has above 98% accuracy which is superior to CNN algorithm.

Keywords: Deep Learning (DL), Convolutional Neural Network (CNN), Hybrid Algorithm, Image Processing, Stage Identification, Medical Imaging.

I. INTRODUCTION

Lung cancer detection and stage identification have become critical areas of focus in medical research, as early diagnosis significantly improves treatment outcomes. Image processing techniques, particularly those involving deep learning algorithms, are now extensively used in the medical field to detect and analyze various diseases. Computed Tomography (CT) scans, widely regarded for their high-resolution imaging, are particularly valuable for diagnosing lung cancer.

The main objective of this project is to classify lung CT scans as normal or abnormal using CNN and Hybrid algorithms, based on extracted features. If an abnormal scan is detected, the stage (out of three considered stages) is identified. The performance of both classifiers is evaluated to select the best algorithm, and results will be displayed through a

Python GUI for optimal image data visualization. The ability to automatically process and analyse these CT scan images has revolutionized the early detection of lung abnormalities, which can often go unnoticed in the early stages without such automated assistance. In this project, we focus on leveraging DL models, specifically CNN and a hybrid CNN-LSTM approach, to classify lung CT scans as either normal or abnormal and, if abnormal, to identify the stage of cancer.

The dataset used for training and testing is sourced from Kaggle.com and consists of CT scan images that are pre-processed to enhance the features critical for lung cancer detection. Initially, the Region of Interest (ROI) in the CT scan images is segmented to focus on the most relevant areas for analysis. The primary objective of this project is to classify lung CT scans based on their characteristics, distinguishing between normal and abnormal scans. Once an abnormal scan is identified, the next objective is to determine the stage of lung cancer, with a focus on classifying it into one of three predefined stages. The first step of the project involves training a CNN model with 80% of the dataset and then testing the remaining 20% for accurate classification.

To further enhance the model's performance, a hybrid approach combining CNN with LSTM is employed. This hybrid method is expected to provide superior performance when compared to the standard CNN approach. The results are then evaluated and displayed through a Python-based GUI, which provides a user-friendly environment for visualizing and interpreting the classification outcomes. This approach aims to offer a reliable, automated tool for early lung cancer detection, helping healthcare professionals make informed decisions faster and more accurately.

II. REVIEW ON EXISTING WORK

Early detection of lung cancer and identification of the stage have been a hotspot recently, and numerous researchers as well as academicians pay more attention on new optimal approaches for deep learning and image processing. Cheran and Gargano [1] used artificial life models to introduce computer aided diagnosis for lung CT scan. El-Ghar [2] proposed a new CAD system for the early detection of lung nodules, with increased detection accuracy from improved image processing. Fiebich et al. [3] help to enhance the approaches toward the identification of PN in CA with the help of the CAD , mainly applied to chest CT images. As an example, a recent fairly extensive review of CAD in chest radiography was reported by Ginneken et al. [4] where issues and progress in the field were discussed.

The authors Gomathi and Thangaraj discovered a new algorithm in lung image segmentation based on FPCM algorithm to improve the measure of the segment. As a result, more reliable detection systems were initiated by Gurcan et al. [6] in the field of CAD system for lung nodules identification on thoracic CT images. Wahab Sait and Abdul Rahaman [7] used the deep learning concept to develop a lung cancer detection model, a strategy that confirms that artificial intelligence is capable of aiding in diagnosis. Tawfik et al. [8] engaged in proposing techniques for the early detection of lung cancer through improved Image processing and DL Mega structures for CT scan images. Shakeel et al. [9] complemented profuse clusters advocated through enhanced profuse clustering approaches and DL to swiftly train NN for the detection of lung cancer from computed tomography images. In their article, Javed et al. [10] gave a comprehensive overview of deep learning in pulmonary carcinoma diagnosis and study the development trend of AI-assisted medical imaging for early diagnosis and treatment strategy.

III. PROPOSED METHODOLOGY

The proposed methodology for lung cancer detection and stage identification using an enhanced DL model, combining CNN and LSTM algorithms, follows a structured three-step process: Cancer training, cancer testing, and Determining Cancer Stage.

A. Training Step: During the training phase, yes the CNN and the LSTM networks are the two approaches that we have in the hybrid model will be trained by a set of CT scan imagery images labeled with Normal and Abnormal. CNN specifically will be used to extract features from the CT scan images to determine areas of lung that have abnormality. These features will then be fed to the LSTM network to capture temporal dependencies so that the models' performance of detecting abnormalities is improved. The data set with be obtained from Kaggle and it will contain normal and abnormal lung CT scan to let the model recognize differences of healthy and possibly cancerous lungs.

B. Testing Step: The last stage of the research process is validation of the algorithm on new input CT scan images to determine how effectively it will classify the inputs as Normal or Abnormal. The model will predict the state of the test input images as either healthy lung tissue or the presence of the abnormality such as tumor. The accuracy of the proposed hybrid model CNN-LSTM will be assessed by comparing the generated forecast with actual labels of the test dataset.

C. Finding Cancer Stage: The last step is the use of the system for segmenting the abnormal CT scan images in order to define the region of interest that will yield to cancer staging analysis. Based on the segmented features and critical parameters such as tumor size, shape, and spread, the system will classify the lung cancer into one of three stages:

Stage 1: when the cancerous growth is still in an early stage, where the cancerous growth is still small, and can easily be removed using non-invasive procedures.

Stage 2: Tumor has progressed to a stage where cancer may be invasive and the size of the mass is more in that case.

Stage 3: Advanced stage where the cancer has metastasized and needs urgent attention in form of surgery among other extensive treatment.

This innovate hybrid CNN-LSTM model not only determines whether a lung CT scan is normal or abnormal, but also identifies the stage of cancer, enabling earlier and more effective medical action to be taken for the specific condition.

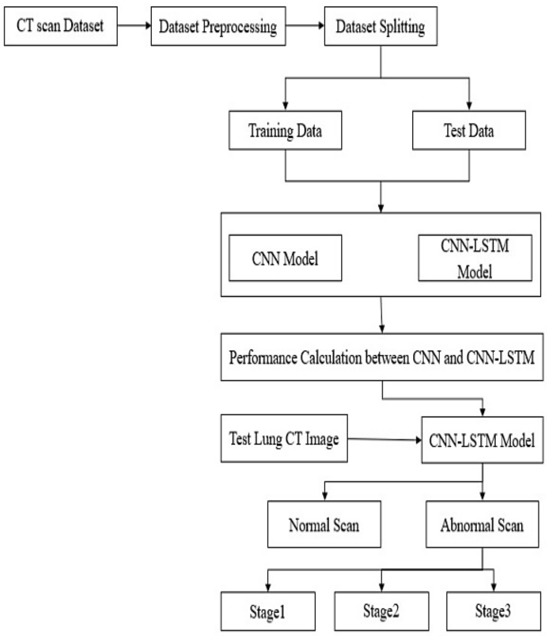

Fig. 3.1 Flowchart of Proposed model

In proposed model the dataset is selected of CT Scan images. The data set contains two categories a) normal lung CT scan image b) abnormal lung CT scan image. This both categories undergo preprocessing for resizing and normalisation. These pre-processed images are further splitted into training set and testing set. CNN and hybrid CNN-LSTM are used to check the performance of

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prediction. It is observed that CNN-LSTM performs better then CNN algorithm. So for further testing hybrid CNN LSTM algorithm is used. If the lungs CT scan image is obtained as abnormal then further it is checked for stage 1 , stage 2, stage 3. Stage 1 indicates that it's a starting stage while stage 3 is higher stage.

IV. RESULTS ANALYSIS

Proposed results are obtained by comparative analysis of CNN and hybrid CNN-LSTM in matlab software for lung cancer prediction from lung CT scan dataset. Complete analysis shows that proposed model is superior than CNN in prediction of lung cancer

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Fig.4.1 Sample image of Lung CT Scan

The pre-processed image is shown in above figure which is obtained by resizing the image to standard size. Original images are of random size so preprocessing technique will be applied to make all images to same size and then normalization to bring the images to bring pixels values to the range 0 to 1.

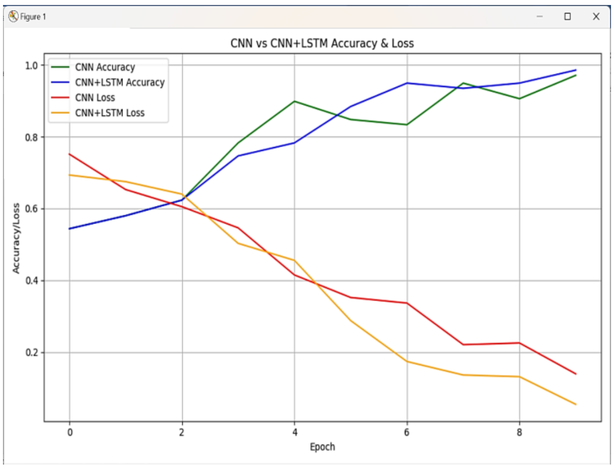

Fig.4.2 CNN and CNN-LSTM Technique Accuracy and Loss Graph

This is the performance graph plotted epochs versus accuracy/loss. It is observed from above graph that both accuracy and loss graphs have better performance for proposed hybrid CNN-LSTM model. With respect to epochs loss is decreasing more and accuracy is increasing more for hybrid CNN-LSTM algorithm compared to CNN algorithm.

Fig.4.3 Image scan predicted as Normal

The above lung CT scan is predicted as 'Normal'. As there is 'Normal' condition it is not observed for stages condition. Normal lung CT scan indicates that person is healthy and no further treatment is needed.

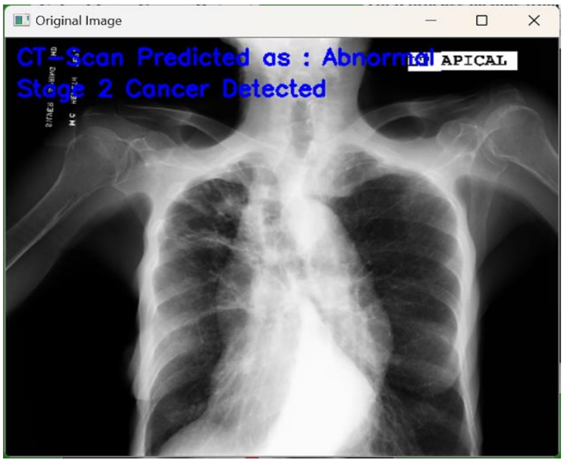

Fig.4.4 Stage 2 cancer is detected in Lung Scan

In give test lung CT scan image is predicted as Abnormal by proposed hybrid CNN-LSTM algorithm, Stage 2 cancer is predicted by proposed model. In our application stage 2 is nothing but two nodules of cancer are found is considered.

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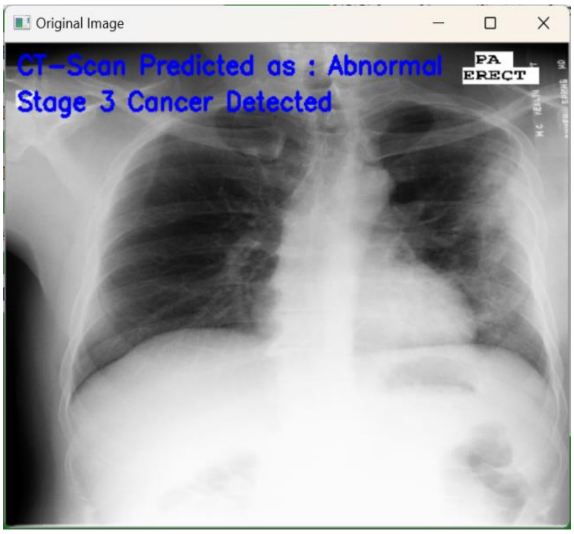

Fig.4.5 Stage 3 Cancer Detected in Lung Scan

In give test lung CT scan image is predicted as Abnormal by proposed hybrid CNN-LSTM algorithm, Stage 3 cancer is predicted by proposed model. In our application stage 3 is nothing but three nodules of cancer are found is considered.

V. CONCLUSION

Based on hybrid CNN-LSTM algorithm, the information system for detecting lung cancer proposed in this paper can effectively, and at an early stage, identifies lung cancer in CT images. With the help of this methodology, the classification of lung CT scans into normal and abnormal groups can be carried out with the help of algorithms Hybrid CNN and LSTM. Data acquired from CT scans were retrieved from Kaggle.com where CT images of different sizes made up the image dataset used in the hybrid algorithm CNN performance analysis revealed that the proposed hybrid algorithm outperforms the CNN algorithm in terms of accuracy and prediction. After training, it correctly determines whether the particular computed tomography contains normal or abnormal findings making the method more effective for timely diagnosis. That the integration of such a hybrid algorithm was successful, should be key to its role in improving medical practice regarding lung cancer diagnosis and subsequently, patient prognosis. Proposed CNN-LSTM algorithm has better performance compared to state of art algorithms. The performance accuracy of hybrid CNN-LSTM is more than 98% which superior to CNN algorithm

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