Using Deep Ensemble Learning & Deep CNN For Cancer Prediction

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ABSTRACT

Cancer is one of the dangerous diseases known to mankind. There are thousands of women who are affected by Cervical Cancer. Here we focus on classification of Lungs & cervical cancer cells .We aim here to minimize analytical errors while diagnosing the cancer .The project has many different types of cell classes .This cell are classified into cancer categories. The classification of Pap smear images to detect cervical dysplasia. This classification is to be done with deep learning methods. The main purpose here is to get better result and accuracy while detecting cervical dysplasia. Deep Neural Network with Convolutional Neural Network is used to classify the cells into different categories. Models are trained and tested with different parameters for better accuracy. Then they are ensembled with averaging of models. The models were able to produce pretty good results. The accuracy of predicted and true labels were high. This makes sense that using this methods to reduce the human errors will be significantly high and efficient. The models were able to produce accuracy above 80%, with ensemble it was higher than single models. This tells that if single models are ensembled with other different models then they can perform pretty good and then they can have much more higher accuracy than the single models. The project executed on CPU+GPU gives higher result than execution on CPU. The RAM of machine also plays important role in Time Complexity of model. GPU increase the performance of model and same time reduces the execution time. For this project Kaggle Online Cloud Library is used. Early detection of the cancer is an enormous challenge. Analysis and cure of lung malignancy have been one of the greatest difficulties faced by humans over the most recent couple of decades. For Lung Cancer, early identification of tumor would facilitate in sparing a huge number of lives over the globe consistently. This paper presents an approach which utilizes a Convolutional Neural Network (CNN) to classify the tumors found in lung as malignant or benign. The accuracy obtained by means of CNN is 96%, which is more efficient when compared to accuracy obtained by the traditional neural network systems.

Keyword:- *Carcinoma, Neural Network , Data Augmentation, Ensemble, Deep CNN.*

I. INTRODUCTION:

Lung cancer is one of the most dreadful diseases in the developing countries and its mortality rate is 19.4% [1]. Early detection of lung tumor is done by using many imaging techniques such as Computed Tomography (CT), Sputum Cytology, Chest X-ray and Magnetic Resonance Imaging (MRI). Detection means classifying tumor two classes (i)non-cancerous tumor (benign) and (ii)cancerous tumor (malignant)[2]. The chance of survival at the advanced stage is less when compared to the treatment and lifestyle to survive cancer therapy when diagnosed at the early stage of the cancer. Manual analysis and diagnosis system can be greatly improved with the implementation of image processing techniques. A number of researches on the image processing techniques to detect the early stage cancer detection are available in the literature. But the hit ratio of early stage detection of cancer is not greatly improved. With the advancement in the machine learning techniques, the early diagnosis of the cancer is attempted by lot of researchers. Neural network plays a key role in the recognition of the cancer cells among the normal tissues, which in turn provides an effective tool for building an assistive AI based cancer detection. The cancer treatment will be effective only when the tumor cells are accurately separated from the normal cells. Classification of the tumor cells and training of the neural network forms the basis for the machine learning based cancer diagnosis [3].This paper presents a Convolutional Neural Network (CNN) based technique to classify the lung tumors as malignant or benign. Cervical cancer starts in the cells lining (the lower part of the uterus). Normal cells of cervix gradually develop pre-cancerous changes first and then develop into cancer. Cervical cancer is fourth leading cause of

cancer death in women. This is second highest in women after breast cancer. Early detection of such cancer and diagnosis can increase survival rate of patient. Particularly in China, the number of women suffering from cervical cancer is rapidly increasing. Approximately 500,000 new cases of cervical cancer gets reported from those 28.8% are from China[4].

2. OBJECTIVES

1. The project should successfully process the real time feed and detect suspicious object without human.
2. The security of public vicinities can be ensured.
3. The accuracy level to be achieved will be higher.

3.AIM

Based on chest CT images here we use CNN. Initially lung regions are extracted from CT image and in that region each slices are segmented to get tumors. To train CNN architecture, the segmented tumor regions are used. Then, CNN is used to test the patient images. To detect whether the tumor present in a patient's lung is malignant or benign, is our main motive here. Figure1 shows the block diagram of the proposed system. As shown in the figure, the trained system will able to detect the cancerous presence in lung CT image. Also,the end result will show that the human and technical error can cause a lot of errors in prediction of cervical cancer. If the human error is reduced then a lot of problem can be simplified and then they can be overcome from human and technical errors. Speed of diagnosing image will increase, this yields to faster predictions.

4. RELATED WORK

4.1 General Image information and machine learning methods[3]

Generally the images are classified by two methods, they are also called as screening methods:

1. Cytological examination
2. Human Papilloma Virus(HPV) testing

Cytological examination is widely used method,in this main method is Papsmeartest. Papsmear test has several disadvantages such as cell sneed to be selected order selected manually. Accuracy of the analysis is not always guaranteed, there are technical and human errors are present.
Many studies in this filed have focused two things in particular to tackle this problems.

I. Image segmentation
II. Feature extraction

4.2 Processing and segmentation [4]

Cyto-technician have divided every image into three parts background, cytoplasm, and nuclei feature extraction converts image information into a format suitable for the classifier the paper 1 has implemented this method using MATLAB. Atlas this features then gathered and classified with the help of RF classifier Second paper discuss about segmentation feature extraction and categorisation of this features Segmentation is only tool to extract the ROI fragmentation segmentation work of present study is inspired by Mainly Stable External Region (MSER) technique introduced by matlab. MSER is a method for blob detection images. Filters are used to pre-process the data. They enhance quality of data filters also used to remove the background noise etc. This makes images clear.

4.3 Feature extraction [1]

Feature extraction is a process which can be used to transfer microscopical day observed visual parameters to quantitative values, different classes a total of 121 features comprising of 5 shape descriptor, 50 texture and Ripplet descriptor extracted from a Pap smear image.

4.4 Shape feature [11]

The shape descriptor used for the study are the area perimeter, eccentricity, compactness and circularity of the nucleus which composed the vector.

4.5 Texture feature [2]

Out of 50 texture feature 6 texture descriptors for extracted using first order statistics which includes features like mean, variance, skewness, energy, and entropy remaining 44 features were extracted using different methods.

4.6. Deep Learning approach[3]

Paper[3] discuss Deep learning approach for analysis of lungs & breast cancer images convolution neural network and random forest classifier has been used in this process to categorize two images into false positive and false negative Deep learning is used to learn about the features of images and then the learning model is used to predict the test images.

5. SYSTEM ARCHITECTURE

5.1 Detailed Methodology

What is Neural Network?

In this chapter the detail implementation of model, data augmentation, design of model all thing related to convolutional neural network are discussed start for integration Artificial Intelligence and neural network. then it moves to convolutional neural network. tell that the implementation and detail of convolutional neural network is explained. then the implementation of convolutional neural network in Keras and python is given here API and structure of Keras has been discussed. Theield of Artificial Intelligence tries to match with Human intelligence in Artificial way.It used computer to imitate human intelligence. We know that Human brain has neurons in them. Every neurons carries information from one to another and also computes that information present in neuron.

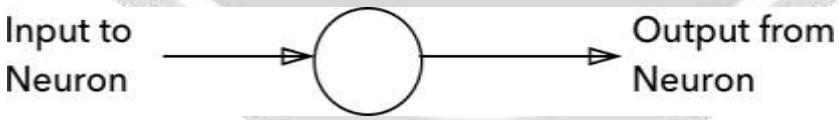

Figure 1

The above diagram shows how input is provided to neuron and then after computation output is generated. Artificial neural network is based on many neurons. This neurons are not biological, but they are artificial which uses computers to compute some data and give the output for it.

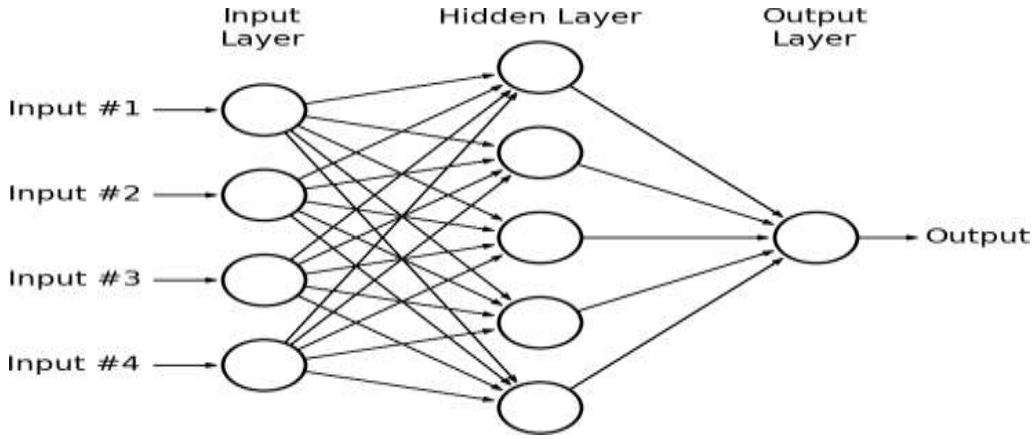

Figure 2

The performed data is then generated to output layer where output is used to generate desire output. The networks are used to compute and generate outputs. Hidden layer is important in generation of Output of the program. There are different types of Neural Networks as following;

1. Convolutional Neural Networks
2. Recurrent Neural Networks
3. Gated Recurrent Unit
4. Hopfield Network

As our main objective of this study is to detect whether the tumor present in a patient's lung is malignant or benign. Figure1 shows the block diagram of the proposed system. As shown in the figure, the trained system will able to detect the cancerous presence in lung CT image.

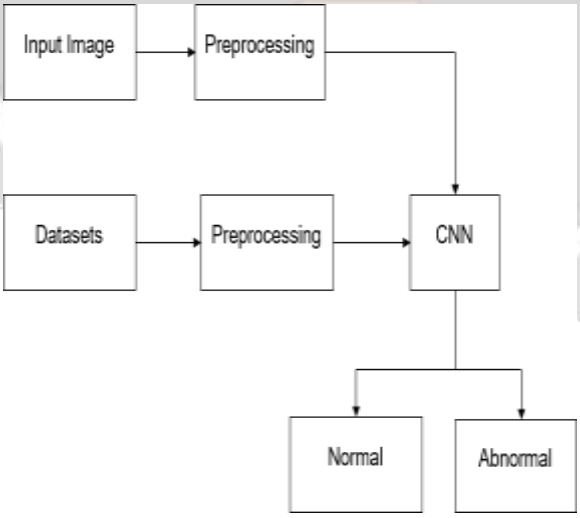

Fig 3. Block Diagram for Proposed System for Lung Cancer Detection

6. DATASET

Lung Image Database Consortium (LIDC) and Image Database Resource Initiative (IDRI) are the sources for our dataset. LIDC and IDRI consist of 1000 CT scans of both large and small tumors saved in Digital Imaging and Communications in Medicine (DICOM) format.

7. PREPROSESSING

In preprocessing stage, the median filter is used to restore the image under test by minimizing the effects of the degradations during acquisition. Various preprocessing and segmentation techniques of lung nodules are discussed in [6].The median filter simply replaces each pixel value with the median value of its neighbors including itself. Hence, the pixel values which are very different from their neighbors will be eliminated.

Fig 4.a Input image

Fig 4.bMedian filtered

Fig 4.c Input image

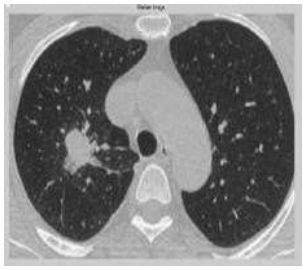

Fig 4.d Median filtered

8. TECHNIQUES

8.1 What is CNN?

CNN is a type of neural network in this neural network images, videos, text given for analysis classification at cetera. Convolutional neural network consists of several years first layer is called Input and the last there is output layer in between there are many layers. This are also called as hidden layers. The word hidden layer in is also called as Deep hence this type of network also often called as deep neural network.

8.2 Pooling layers:

Pooling layers are used to reduce the data of dimension. In pooling layers the dimension of data is reduced. There are types of pooling layers such as Max pooling, average pooling. Pooling layers areusedtocombinetheoutputofneuronclustersatonelayer.Globalpoolinglayershavestandard size of 2 x 2. Average pooling uses average value from cluster whereas Max pooling uses maximum value from cluster.

8.3 Activation layer:

Definition of activation function :- Activation function decides, whether a neuron should be activated or not by calculating weighted sum and further adding bias with it. The purpose of the activation function is to introduce non-linearity into the output of a neuron.

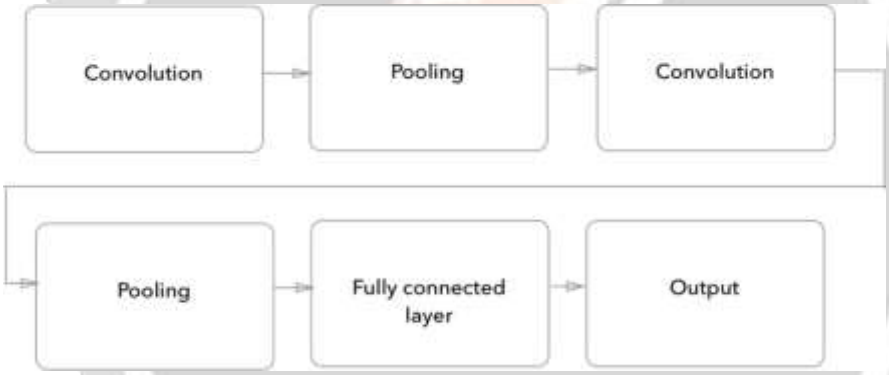

Fig 5. Pooling Function

8.4 Data Augmentation:

The data has 5 classes Normal, Mild, Moderate, Severe, Carcinoma. Each class has 100 images. For Deep Learning the more no. of data is must. This data makes model to learn properly hence the data is then Augmented using following script.

```
import Augmentor
p=Augmentor.Pipeline("/path/to/images")
p.rotate(probability=0.7,max_left_rotation=10,max_right_rotation
=10)p.zoom(probability=0.5,min_factor=1.1,max_factor=1.5
```

8.5 Deep Learning:

Deep learning composed of several layers of nonlinear nodes, combine input data with a set of weights so that assigning significance to inputs for the corresponding task the algorithm is attempting to learn in supervised and/or unsupervised behavior. The sum of product of these input and weights is passed through activation function of nodes. The output of each layer's is fed simultaneously as input to the subsequent layer starting from input layer. Learning can be performed in multiple levels of representations correspond to various levels of abstraction.

8.6 Convolution Neural Networks (CNNS)

In CNN architecture, usually convolution layer and pool layer are used in a mixture. We implement here two types of operations viz. max pooling and means pooling. In mean pooling, the average neighborhood is calculated within the feature points and in max pooling it is calculated within a maximum of feature points. Mean pooling reduces the error caused by the neighborhood size limitation and retains background information. Max pooling reduces the convolution layer parameter estimated error caused by the mean deviation and hence retains more texture information. Figure 6. shows the architecture of CNN.

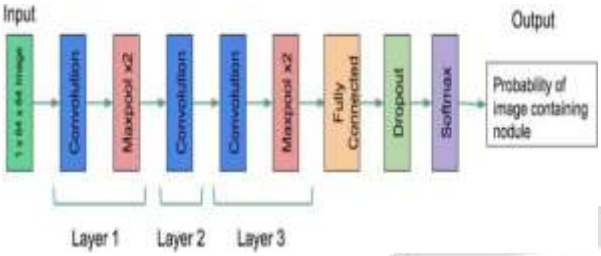

Fig 6.Architecture of CNN

The input to a convolutional layer is an image of size m x m x r, where r is the number of channels. There are k filter kernels of size n x n x q where $n < m$, $q \leq r$ and may vary for each kernel in convolutional layer, which are convolved with the input image to produce k feature maps. Each map is then subsampled with mean or max pooling over p x p contiguous regions (p – ranges from 2to5) and an additive bias and sigmoidal nonlinearity is applied before or after the subsampling layer. The figure 6 shows the layer of a CNN.

7. RESULTS

The neural network based on convolutional and watershed segmentation has been implemented in MATLAB and the system is trained with sample data sets for the model to understand and familiarize the lung cancer. A sample image has been fed as an input to the trained model and the model at this stage is able to tell the presence of cancer and locate the cancer spot in the sample image of a lung cancer. The process involves the feeding the input image, preprocessing, feature extraction, identifying the cancer spot and indicate the results to the user. In case of the malignancy is present, a message indicating the presence of will be displayed on the screen along with the given input image as shown in Figure 8.

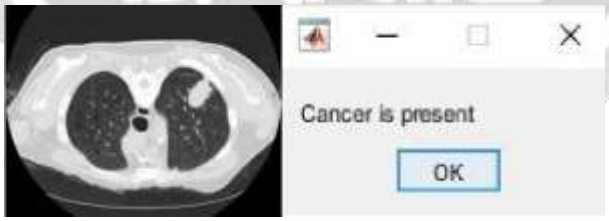

Fig 8. Output for Cancerous Image

Lung cancer detection using the convolutional neural network which model by the end to end learning, i.e. Initialize the weights, Learning rate, gradient moment and hidden neurons. In the neural network, hidden units to form a zero matrix whatever weights will change to be hidden units would change the matrix value. Some of the parameter used for training the model of the neural network is shown in Table 1:

Parameter	**Value**
Learning rate	0.0001
Weight	0.0002
Bias	0.1
Gradient moment	0.9
Hidden neurons	250
Epoch	100

Table 1:f FC layer with compute the class score

CNN has two layers such as 2 convolution layers and 2 subsampling layer which is used to increase the accuracy of detection. The confusion matrix parameters derived from
CNN output are given in Table.2

SN	Parameters	Values
1	Training images	70
2	Test images	30
3	True Positive	7
4	True Negative	22
5	False Positive	0
6	False Negative	1
7	Specificity	1
8	Sensitivity	0.875
9	Overall Accuracy	0.96

Table 2:Confusion matrix

The confusion matrix shows the true positive, true negative, false positive and false negative. From the analysis true positive gives the correctly classified the lung cancer images and false positive gives the misclassification of images which means that the lung cancer is wrongly predicted as non-cancerous image.

9.CONCLUSION

The classification of Cervical cancer image was successful with some classes. The class 2,3,4 performed very well. They had pretty good accuracy which can match industry standards. While classifier with 5 class doesn't perform to the expectation.

The Accuracy table for Proposed CNN model and Proposed CNN model with ensemble has been given as following

Classifiers	Accuracy	
	Proposed CNN model	Proposed CNN model with Ensemble
2-Class	86.1	86.7
3-Class	88.9	90.4
4-Class	72.1	73.8
5-Class	51.6	53.4

Table 3. Accuracy table for Proposed CNN model

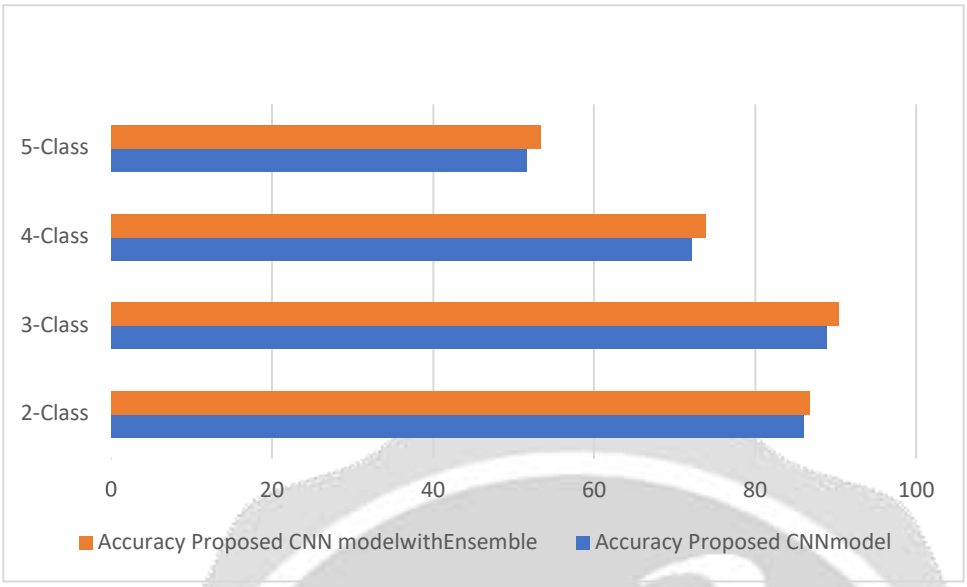

Figure 7. Accuracy of Various Classifers

We can clearly see that the ensemble performance is better than single individual proposed CNN model.

A convolutional neural network based system was implemented to detect the malignancy tissues present in the input lung CT image. Lung image with different shape, size of the cancerous tissues has been fed at the input for training the system. The proposed system is able to detect the presence and absence of cancerous cells with accuracy of about 96%. The accuracy of Lung cancer detection with the proposed convolutional neural network based method was compared with that obtained by previous works in Table 3

Authors	Sensitivity	Specificity
Albrt Chon. et al	43%	85%
Devi Nutiyasari, et al	86.30%	###
Proposed Method	100%	###

Table 3. Comparison of Results with the Previous Works

In addition to deep convolutional network, the same dataset was classified by multilayer perceptron network Backpropagation algorithm with using GLCM features. The results show only 93% accuracy [10].In this proposed work, the specificity obtained is 100% which shows that that there is no false positive detection. Also, the accuracy, sensitivity and specificity of the proposed system is high when compared to previously available conventional neural network based systems.

In the near future, the system will be trained with large datasets to diagnose the type of cancer with its size and shape. The overall accuracy of the system can be improved using 3D Convolutional Neural Network and also by improving the hidden neurons with deep network.

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