IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727,
PP 20-24
www.iosrjournals.org

Artificial Neural Network and Cancer Detection

Santosh Singh[1], Ritu Vijay[1], Yogesh Singh[2]
[1] *(Department of Computer Science and Electronics, Banasthali University, Banasthali, INDIA)*
[2] *(Department of Physiology, SMS Medical College & Attached Hospitals, Jaipur, INDIA)*

***Abstract*:** *In medicine at present, neural networks are a 'hot' research area, particularly in cardiology, radiology, urology, oncology etc. In the area of computer science, this new technology has been accepted. The purpose of a neural network is to map an input into a desired output. Combining neurons into layers permits artificial neural networks to solve highly complex classification problems. The various types of neural networks are explained and established. In medicine, applications of neural networks like ANNs are described, and a detailed historical background is provided. This paper focuses on the role of neural network in medical imaging.*

Keywords: *Neural Network, Neurons, Oncology, Radiology*

I. INTRODUCTION

Due to direct contact to outer environment upper respiratory infection is more prone to infect by direct and indirect means. Spread of disease at threatening level can be controlled by early detection of disease. Various invasive and noninvasive techniques are available for early detection however noninvasive techniques are prefers in general practice to reduce financial overburden. Also, basic investigation instruments are easily available at rural setups. Chest imaging is one of the most popular imaging techniques for upper respiratory infection. If the person does not recover in course time, the advance investigation is necessary to rule out the disease. However the detection of respiratory infection is easily misdiagnosed. Sometime overburden of patients in OPD and physician / radiologist is in hurry for reading visualization. Both of the reasons are barriers of Image recognition of pulmonary abnormality. With this on screen-film radiographs is notoriously unreliable and increase the rate of misdiagnosis. Muhm and colleagues [1] report that 90% of peripheral nodules and 75% of perihilar nodules detected during a lung cancer screening program were visible in retrospect on earlier radiographs. Austin and colleagues [2] reviewed 27 cases of potentially respectable lung cancer that were missed on chest radiographs.

Nowadays cancer is one of the most serious and widespread health problems in the world. Out of which Lung Cancer is one of the most common malignant diseases causing more than one million deaths every year. It is the most serious dilemma according to stage of discovery of the cancer cells in the lungs. Cancer is generally refers to the growth of new tissues abnormally. This is called a tumor or neoplasm. A tumor may be localized or invasive, benign or malignant. Cancer is classified according to the part of the body where it starts [3]. Example, Lung cancer, Breast cancer, Skin Cancer, Blood Cancer, Colon Cancer, Brain Tumor etc. On the other hand, it is the most challenging problem among other cancers due to the cancer cells structure. Lung cancer, which was relatively rare during the 1920s, became more common among men in the subsequent two decades and nowadays, the leading cause of death from cancer is due to late diagnosis. "Detection of lung cancer in its early stage is the key of its cure." To do this, various techniques such as X-ray (Chest Radiograph), CT, PET, MRI scan, Sputum Cytology etc. are available. However, most of these techniques are expensive and time consuming. Along with these, the new CAD (Computer - Aided - Diagnosis) techniques is increasing. These techniques help to detect the occurrence of lung nodule in its early stage.

To deal with the issues that cannot be addressed by traditional image processing algorithms or by other classification techniques, ANN has been applied to medical images. By introducing ANN, algorithms developed for processing the medical image and analysis often become more intelligent than conventional techniques. Artificial Neural Networks (ANNs) play an imperative task in the medical world in solving different acute diseases and even other mild disease. It is a part of AI (artificial intelligence) and, has been accepted as new technology in computer science.

1.1 Neural Network

An inspired by the way biological nervous system, an ANN is an information processing system which contains numerous processing neurons which is highly interconnected. Neural Networks are a form of multiprocessor computer system with a high degree of interconnection, simple processing elements, adaptive interaction between elements and simple scalar messages. These neurons work together in a distributed manner:

- To learn from the input information
- To coordinate internal processing, and
- To optimize its final output

Like people they learn from experiences. There are two types of learning methods supervised and unsupervised. Supervised learning is a learning process that needs to be trained ahead of time with lots of data whereas unsupervised learning process does not require a desire response [4].

There are many types of neural networks available such as

- Adaptive Resonance Theory (ART):

The basis of this theory is the plasticity-stability dilemma of the learning process.

- Cellular Neural Network (CNN)

Based on the Cellular Automata Theory

- Backpropagation Neural Networks (BPNN)

These are simple Multilayer Perceptron (MLP) networks that use the Backpropagation (BP) learning rule.

- Feedforward Neural Network

It is composed of layers of neurons and the information moves in only one direction — forwards in this type of network.

- Radial Basis Function Neural Network (RBFNN)

These are powerful techniques for interpolation in multidimensional space. A RBF is a function which has built into a distance criterion with respect to a center.

- Kohonen Self-organizing Neural Network

It is a form of unsupervised learning.

- Learning Vector Quantization Neural Network (LVQNN)

It can also be interpreted as neural network architecture.

- Recurrent Neural Networks (RNNs)

RNNs are models with bi-directional data flow and can be used as general sequence processors.

II. LITERATURE SURVEY

Artificial Neural Networks (ANNs) plays an impressive and vital role to solve various health problems like acute diseases and even other mild disease. Fatam Taher et al use HNN (Hopfield Neural Network) and FCM (Fuzzy C-Means) algorithm for segmenting sputum color images and compare their classification their study shows HNN is better than FCM, and successfully allows extracting the nuclei and cytoplasm regions [5].

JIA Tong, et al worked on scheme based on HRCT images to detect true positive nodule candidates in lung field [6].

A novel lung segmentation technique was proposed by Lin-Yu-Tseng et al to improve segmentation accuracy as well as to separate and eradicate the trachea from lungs [7]. Anita Choudhary et al used Digital Image Processing Techniques to achieve more quality and accuracy [8]. Azian Azamini Abdullah et al described the development of an algorithm that detects symptoms of lung cancer in X-ray films by CNN (Cellular Neural Network) templates simulation [9].

The sensitivity is also important in this aspect as a result by use of the Massive Training ANN (MTANN) filter, the specificity and sensitivity of CAD system was enhanced significantly with a difference-image technique achieved 96% sensitivity reported by Suzuki K et al. In the consequence of Shi Z et al found a neural network ensemble (NNE) in chest radiograph for reducing false positive for nodules detection in computer aided diagnosis [10] [11].

Parveen S S et al designed a new CAD technique to detect the suspicious region automatically by segmenting the real time lung image using automatic region growing method to increase the diagnostic accuracy [12].

A new method is proposed by Yang Song et al for lung tumor and lymph node abnormalities from PET-CT thoracic images based on the low-level intensity and neighborhood features and high-level contrast-type features, with a two-level SVM classification. In handling a large range of irregular patterns, it showed high detection performance and capability [13].

A new implementation was done by Ye X et al, for detecting the nodules both solid and ground- glass opacity (GGO) by calculating 3-D local geometric and features of statistical intensity [14]. Raman Maini et al presented a comprehensive review of image enhancement techniques. The point processing methods are most

primitive, yet essential image processing operations and are used primarily for contrast enhancement. When they applied each algorithm separately, they presented the effectiveness of each of them and to achieve more effective image enhancement they advised to apply a combination of these methods [15].

Ashwin et al represents an expert-trained medical diagnosis system using a modified BFGS trained neural network method instead of a conventional neural. The classification of the input based on the presence or absence of cancer was implemented successfully using the neural network toolbox of MATLAB 2011a and accuracy of 96.7% with high value of specificity and sensitivity of 94.30% and 92.10% respectively which has been obtained by the method they proposed [16]. Vinod Kumar et al present a neural network based approach that identify lung cancer from raw chest X-ray images to attain more quality and accuracy in the processed examination [17].

S. Sivakumar et al presented WFPCM (weighted Fuzzy-Possibilistic C-Means) algorithm based on adding weight component to both the possibilistic value and membership and shows a comparative study with various validation measures to explore the accuracy of WFPCM [18].

Shamala B Terdale et al successfully developed CAD system that detects lung nodules with diameter ≥ 2mm. The developed system helps to identify the suspicious nodules and thus to increase the sensitivity of the diagnosis [19]. Mokhled S. AL-TARAWNEH proposed efficient technique for segmentation principles to be a RoI foundation for feature extraction obtaining. The comparison of other used techniques and the proposed technique gives extremely hopeful outcome [20].

Varalakshmi K focused on two problems one is segmentation of organ of interest, and second is classification. For this purpose they proposed a hybrid approach called neuro- fuzzy algorithm. Neural fuzzy algorithm was developed to extort appropriate diagnostic rules. It also classified the true nodules from the ROIs. Conclusions drawn out from these experiments indicate that the proposed system can identify small lung nodules accurately as high as 89.3%. Meanwhile, the false positive per image was reduced as low as 0.3 [21]. Ju-Won Lee et al proposed a method to quickly detect what the object on a chest radiograph is. This method comprises the functions of image sampling, median filter, neural network image equalizer and neural network pattern recognition. They confirm that the proposed method has enhanced the problems of conventional methods [22]. A hybrid neural-digital computer-aided diagnosis (N.CADx) system is proposed by J S Lin for early detection and classification of cancerous lung nodules of size 3-15 mm. This system has enormous prospective in many medical applications [23].

Image quality assessment as well as improvement is dependent on the enhancement stage where low pre-processing techniques are used which is based on the segmentation principles.

Several algorithms have been successfully applied to cancer detection such as neural network, K-nearest Neighbor (KNN) and Self organizing maps (SOM) by many researchers.

Table 1. A review of previous research work of different types of neural network architecture in medical imaging

S. No.	ANN Types	Outcome	Image Type
1.	Cellular Neural Network	Detect Boundary / area	X-ray
2.	GA and CNN	Detect nodular shadows	X-ray
3.	Hybrid Neural Digital CAD	Classify 3-15 mm size nodules	X-ray
4.	ANN Feed Forward	Increase sensitivity & accuracy	X-ray
5.	Artificial CNN & application	Detect False Positive & increase sensitivity	X-ray
6.	Convolution Neural Network	Decrease False & Increase True Positive	X-ray
7.	Two - level Convolution Neural Network	Reduce False Positive	X-ray
8.	NN Ensembles	Reduce False Positive	X-ray
9.	J-net	Improve sensitivity & accuracy	CT Image
10.	Massive Training ANN (MTANN)	Enhancement of lung nodules	CT Image

A brief breakup of different types of ANN architecture, which is done in the past by a number of researchers, is given in above table. The work done performed by researchers is good in many cases but there is always a scope to perform better.

III. CONCLUSION

Lung Cancer is leading killer in the world. Most of the nodules can be detected if process parameters are carefully selected. Novel early detection technologies are needed to maximize the chance for a potentially curable stage of lung cancer. It is concluded that new systems have to be developed to detect and quantifies cancer with high accuracy and less computational time, which is favorable for physician to ease the treatment. ANN is a very attractive field in MIP (Medical Image Processing). The table shows that most of the studies are based on X-ray; very few studies have been worked on CT images. The aspiration of the study is to develop an approach to detect lung nodules using CT images.

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