Volume 6, Issue 3, March 2016 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Identification Procedures through Soft Computing in Medical Technology

[1]Sudhir Dawra, [2]Pushpneel Verma
[1] Associate Professor, Department of Computer Science & Engineering, Ideal Institute of Technology, Sadarpur-Sikroad, Govind Puram, Ghaziabad, Uttar Pradesh, India
[2] Assistant Professor, Department of Computer Science & Engineering, Bhagwant Institute of Technology, Muzaffarnagar, Uttar Pradesh, India

Abstract: ***We have covered and implemented techniques and novel methods for Medical Technology. In this paper we are going through different methodologies of Soft Computing (SC) which are used for these CAD systems. The Methods coming under this are Neural Networks, Fuzzy Logic, and Genetic Programming. In this paper we will first briefly discuss what makes Soft Computing different from traditional Computing. What were the drawbacks of traditional computing which were removed by it. And introduce the three ingredients of Soft Computing and then review the work done by different people using these tools. Our main emphasis is on images used for medical diagnosing. We will review the different algorithms used for studying these medical images. And also discuss positives and negatives faced by these algorithms. In this paper we will try to answer what work has been done in the field of medical image processing using Soft Computing and what is its future. We will discuss how they are contributing to medical imaging for improving the health and well being of people worldwide.***

Keywords: CAD, LSCT, EIT, CNN

I. INTRODUCTION

Why Computer Aided Diagnosis: In An attempt to overcome the limitation of human behaviour the Computer Aided Diagnostic systems were designed. As the human body is very complicated and it is characterized by practically infinite number of disease and there symptoms. And there are chances of false diagnosis even by a specialist due to unintentional skipping of important information by human mind. So these CAD systems helped in reducing the interpretation time and perceptual error and have capability of handling uncertainty, inexact, incomplete or immeasurable data. These systems can easily be used to analyze large amounts of data, looking for complex patterns within it, which suggest previously unexpected associations.

The purpose of CAD is to locate the area which needs diagnosing. The computer diagnostic expert system is mainly divided into three parts they are: Knowledge Base, Inference Engine and User Interface. The Knowledge Base contains expert level information required to solve the problem related to specific domain. The Inference Engine uses Knowledge in the Knowledge Base and also records the facts related the current problem. The diagnostic system provides graphical interface for domain Knowledge introduction and interact with expert using the system for diagnosing. So computer's result is used as a second opinion by a specialist while diagnosing and ultimate diagnoses made by an expert only.

In Medical imaging system we make use of images which are an efficient way to acquire, process, display and interpret information about complex systems. These images reveal certain characteristics of the object under consideration and how these characteristics change with time. A general purpose imaging system includes a physical device that is sensitive to energy radiated by the object we wish to image. There is a device called DIGITIZER, which converts the output of the physical sensing device into digital form, which is understandable, by computer system. Finally this computer system processes the image and result in some diagnosis. So image processing is one of the basic components of CAD system. So its function is to enhance and extract the features of parts under consideration. Recent developments, which are the base of medical imaging, are X-Ray, Computer tomography, magnetic resonance, ultrasonography, and nuclear medicine. These developments are contributing a lot in improving the health and well being of people worldwide.

Examples of these systems are as: CAD system for lung cancer screening using CT (LSCT) by H.Jiang and his team [1],CAD system for pulmonary based on helical CT images by K.Kanazawa and his team [2],CAD system for coronary calcification based on helical CT images by Y.Ukai and his team[3],A 3D Ultrasound System for Medical Diagnosis by Joao Sanches and his team[4],An Image Processing Environment for Guiding Vascular MR Intervations by R.Vander Weide and other[5].

II. SOFT COMPUTING

Certain limitations of traditional computing introduced the concept of Soft Computing in Computer Aided Diagnosis. One of the main drawbacks of traditional computing was local minimization problem and the other was of

mathematical models. So Soft Computing may be viewed as a consortium or various computing tools to exploit the tolerance for imprecision and uncertainty to achieve tractability, robustness and low cost.

The main constituents of Soft Computing are Neuro Computing (NC), Fuzzy Logic (FL), and Probabilistic Reasoning (PR). Fuzzy Logic primarily provides a paradigm for dealing with imprecision and approximate reasoning of belief etc and Neuro Computing deals with learning, whereas Probabilistic Reasoning deals with probabilistic uncertainty.

III. NEURAL NETWORKS

They are called connectionist, parallel, distributed systems or adaptive systems as they are composed by series of interconnected processing elements that operate in parallel and all interconnected processing elements change or "adapt" simultaneously with the flow of information and adaptive rules. They perform in two different modes, learning (or training) and testing. And there are algorithms in ANN, which trains net for different applications. We can see presence of these algorithms in medical science too. As these algorithms train net for diagnosing different diseases of patients.

Some Examples are: Hopfield Net (Suitable for pattern storage and recall and for optimization), Multilayer Perception (classifier and function approximator), and Self-Organizing Feature Map (basically does clustering but can be used for generating semantic maps and designing classifiers).

The various steps of image processing are and the role or ANN in performing the each step is discussed as:

1) Preprocessing: This is the very step of image processing which included image reconstruction, restoration, and image enhancements. The role of neural networks is in approximation of a mathematical transformation in image reconstruction and doing mapping by a trained network to perform a certain task, usually based directly on pixel data (neighbourhood input, pixel output).

An ADALINE Network is trained to perform reconstruction of a 2D images based on 1D measurements of electrical impedance tomography(EIT) by A.Adler & R.Guardo[6].Hopfield network containing summation layers was trained by Srinivasan Et al, for reconstructing CT images[7].Chu and Yang worked on cellular neural networks (CNN)for suppression of noise in image restoration. Although this network was quite fast but had a disadvantage of setting the parameters by hand [8].Feed forward networks had shown there great presence is edge detection during enhancing the image, these networks were trained to detect edges in input window [9].There is one limitation of adaptive networks used as there parameters are likely to be tuned according to specific sensors used or taking images.

2) Data Reduction: It includes image compression and feature extraction. ANNs have been trained such that it recreates input data to perform image compression. Its architecture forces the network to project the original data onto a lower dimensional manifold from which the original data should be predicted. Feature extraction is a means fro controlling the so-called curse of dimensionality. There is a wide class of ANNs that can be trained to perform mappings to a lower-dimensional space for feature extraction these features were further used for segmentation, image matching or object recognition.

Good compression rate is seen with adaptive NN as they are trained on specific image material. Self-organizing maps were used for clustering features during reducting and extraction of image features. C.Amerijckx, M.Verleysen, P.Thissen Et al, used self-organized Kokonen map for image compression [10]. Even Hopfield network were trained for this purpose.

3) Recognition: It is a process of assigning labels. It consists of locating the positions and possibly orientations scales of instances of objects in an image. ANNs have been trained to locate individual objects based directly on pixel data. Another less frequently used approach is to map the contents of a window onto a feature space that is provided as input to neural classifier. These networks take input either as pixel or a vector consisting of local, derived features. The output of these networks is the estimated displacement vector to the object centre.

Feed forward networks were used recognition of radio opaque markets in X-Ray images by M.Egmont Petersen &T.Arts [11]. Florescence images were analyzed for recognizing tumor using feed forward network. And also this same network was used for lung nodule detection by M.G.Penedo, M.J.Carreira, A.Mosquera Et al [12]. Miler, Et al

Trained different NN to recognize region of interest corresponding to specific organs within EIT of the thorax [13]

4) Understanding: It couples techniques from segmentation or object recognition with knowledge of expected image content. Neural (decision)trees on extracted structures or neural belief networks can be used to image content. This knowledge is then used to restrict the number of possible interpretations of single object as well as to recognize different configuration of image objects.

Aizenberg et al used CNN to improve resolution in brain tomographics [14].SOM were used by Rajapakse & Acharya with multi layer adaptive resonance architecture (MARA) for segmentation of CT images of heart[15].In another study,Ozakan et al.used NN trained with back propagation learning algorithm for segmentation and classification of MRI images of normal and pathological human brain.

IV. FUZZY LOGIC

Special thing about Fuzzy Logic is that it aims at modeling imprecise mode of reasoning that play great role in uncertain environment. Two concepts that play a central role in its applications one is LINGUISTIC VARIABLE that is, a variable whose values are words or sentences in a natural or synthetic language. The other is a fuzzy *if-then rule*, in which the antecedent and consequents are propositions containing linguistic variables.

A Fuzzy clustering neural network algorithm was used for classifying ECG Beats by S.Osowoki, Tran Hoai Linh [16]. They used fuzzy self organizing neural networks trained with Gustafson Kessel (GK) algorithm for classification of

ECG Beats. This network was quite tolerant to noise and changes in ECG characteristics. Youngsik Choi & Raghu Kushnapuram proposed a fuzzy smoothing algorithm for image enhancement [17]. In this algorithm they made use of three different filters for enhancing the image. The filters were selected based on linguistic variables depending on local information. This algorithm showed good results on retinal images. So it is conditional and adaptive smoothing algorithm. Fuzzy classifier for cardiac abnormalities by R.Acharya, A. Kumar, P.S.Bhat, C.M Lim, S.S. Iyengar, N.Kannathal, S.M.Krishnan[18] on the basis of equivalence relationship matrix for each class under reference. Shashikala Tapaswi & R.C Joshi, proposed an algorithm for classifying bio medical images which made use of Neuro Fuzzy approach [19]. In this algorithm using pixel descriptors features are extracted and this feature vector is used to train the neural network for classifying different classes based on fuzzy interpretation .New thing in this algorithm is combination of texture vector with color vector into one vector which extract the region of interest.

There is good scope for Neuro-Fuzzy hybrid system is processing medical images. And lot work has been done and there is lot yet to come. As learning capabilities of ANN and linguist rules of fuzzy removed the limitations of one another to some extent

The first integration of fuzzy neuron into silicon is due to Yamakawa (1989).An account of neuro Fuzzy references can be found in good number.

V. GENETIC ALGORITHM

Evolutionary computation uses natural selection such as Genetic Algorithm (GA) and Genetic Programming (GP) of beings to create powerful search technique. The basic principles of Genetics Algorithms (GAs) were first proposed by Holland. They are another biologically inspired computing tool for optimization. Genetics Algorithms are parallel and randomized search techniques, where a population of solutions evolves over a sequence of generations to possibly a globally optimal solution. They work simultaneously on multiple points in the search space, not on a single point, unlike conventional search techniques .The basis of a GA is that a population of problem solutions is maintained in the form of chromosomes, which are strings encoding problem solutions which are then evaluated according to an objective scoring function. Using genetic operators i.e. crossover and mutation it results in new generation. The cycle of evolutionary process stops when the best fitness of the population does not improve any more for a long while. Whereas in Genetic Programming (GP) there is use of Natural Selection theory in computers, to automatically generate programs. It was presented by John Koza, based on the idea of Genetic Algorithms. Instead of a population of beings, in GP there is a population of computer programs.

Andrei Petrovski, Bhavani Sudha and John McCall developed a GA algorithm for Optimizing Cancer Chemotherapy [20]. The search process aims at chemotherapy schedules that satisfies treatment constraints and optimize the optimation objective. McCall, J.Petrovski also worked on solving the multi-constrained and multi-dimensional problem of Cancer Chemotherapy optimization using GA's Matthew G.Smith and Larry Bull used Genetic Programming and a Genetic Algorithm to pre-process data before it is classified using the C4.5 decision tree learning algorithm[21].

The GP used to construct new features from those available in the data, a potentially significant process for data mining since it gives consideration to hidden relationships between features. [22] The GA is used to determine which such features are the most predictive. This showed good results in diagnosing patient of liver, thyroid disorder, and cancer. Capabilities of feature extraction of GA and FL can be combined to make hybrid systems. As by training neutral networks with different features, GA is used to obtain the optimal parameters to combine them. A very good example of this is treatment of cancer using evolutionary and fuzzy modeling by C.A.Pena Reyes. [23] So these methodologies are surly going to contribute a lot in improving human health and well being of humans.

VI. CONCLUSION

We discussed the main ingredients of Soft Computing and explained how they have helped in the designing a system which can process medical images for diagnosing. It has been proved as a boon for medical science. It removed certain limitations of traditional computing. There is a great scope of hybrid systems in future which are surely going to overcome the restrictions of systems based on individual soft computing technique. They will surely result in fast diagnosing during critical time. There is scope for improving the sensitivity in detecting lesions by computer. The improved algorithms can increase the sensitivity and the lower number of false positives. Such algorithms should be designed which take less CPU time which can act instantaneously in critical time while diagnosing a patient. So Soft Computing has done a lot in the field of medical science and there is lot to be done in future. It has enlargened our domain of research. So in near future it is going to show its presence in fields which are still hidden from it. Future Developments will use fused paradigms to achieve improved results in Bio medical applications based on Neuro-Fuzzy and GA's-Fuzzy-Neuro-Fuzzy systems. And will offset the demerits of one paradigm by merits of other.

REFRENCES

[1] H.Jiang,S.Yamamoto,S.Lissaku,M.Matsumoto,Ytateno,T.linuma,Computer–Aided Diagnostic system for lung cancer screening by CT,Elseveir Science Computer aided Diagnosis in Medical Imaging(1999),125-130.

[2] K.Kanazawa, Y.Kawata, N.Niki, H.Satoh, H .Ohmatsu, R.Kakinuma, M.Kaneko, K.Eguchi, N.Moriyama, Elseveir Science Computer–Aided Diagnosis in Medical Imaging (1999), 131-136.

[3] Y.Ukai, N.Niki, H.Satoh, S.Watanabe, H .Ohmatsu, K.eguchi and N.Moriyama Computer Aided Diagnosis System for coronary calcification based on helical CT images Elseveir Science Computer-Aided Diagnosis in Medical Imaging (1999), 351-356.

[4] Jao Sanches, Jorge S.Marques,Fausto Pinto and Paulo J.Ferreira, A 3D Ultrasound System for Medical Diagnosis, Springer-Verlag(2003),893-901.
[5] R.Vander Weidea, K.J.Zuidervelda, C.J.G.Bakker, C.Bos, H.F.M.Smits, T.Hoogenboom, J.J.Van Vaals, M.A.Viergever, An Image Processing Environment for Guiding Vascular MR Interventions, Springer-Verlag(1998),317-324.
[6] A. Adler, R.Guardo, A neural network image reconstruction technique for electrical impedance tomography, IEEE Trans. Med. Imaging 13(4) (1994), 594-600
[7] V.Srinivasan, Y.K.Han, S.H.Ong, Image reconstruction by a Hopfield neural network, Image Vision Computing.11 (5) (1993), 278-282
[8] W.Chua, L.Yang, Cellular network: Applications, IEEE Trans. Circuits Systems 35(10) (1988)1273-1290.
[9] V.Chandrasekaran, M.Palaniswami, T.M.Caelli, range image segmentation by dynamic neural network architecture, pattern recognition 29(2) (1996)315-329.
[10] C.Amerijckx, M.Verlysen, P.Thissen Et al., image compression, IEEE Trans.Neural Networks 9(3) (1998)503-507.
[11] M.Egmont Petersen and T.Arts,recognition of radiopaque markers in X-Ray images using neural network as non-linear filter, pattern Recognition Lett.20(5)(1999),521-533.
[12] M.GPenedo, M.J. Carreira, A.Mosquera Et al., Computer-aided diagnosis: a neural –network based approach to lung nodule detection, IEEE Trans, Med. Image 17(6) (1998), 872-880.
[13] Miller, A (1993), the applications of neural networks in imaging and signal processing in medicine. PhD. Thesis, faculty of science, Deptt.of physics, University of Southampton.
[14] Aizenberg I, Hiltnerb J Et al (2001), cellular neural networks and computational intelligence in medical image processing, Image and vision Computing, 19(4), 177-183.
[15] Rajapakse and Acharya, (1990) Medical Image Segmentation with MARA. In International, Joint Conference on Neural networks, Vol.2.
[16] S.Osowoki,Tran Hoai Linh, Fuzzy Clustering neural network for classification of ECG Beats, IEEE(2000),26-30.
[17] Youngsik Choi and Raghu Kushnapuram, A Fuzzy Rule based image enhancement method for medical applications IEEE (1995) eight symposium on computer based medical system.75-80.
[18] R.Acharya, A. Kumar, P.S.Bhat, C.M.Lim, S.S.Iyengar, N.Kannathal, S.M.Krishnan, classification of cardiac abnormalities using heart rate signals, Medical and Biological Engg. and Computing 2004, 288-293
[19] Shashikala Tapaswi and R.C Joshi, Classification of Bio Medical images using Neuro–Fuzzy approach, Springer-Verlag (2004), 568-581
[20] Andrei Petrovski, Bhavani Sudha, and John McCall, Optimizing cancer chemotherapy using genetic algorithm, Springer-Verlag (2004), 633-641.
[21] Mathew G.Smith and Larry Bull, Feature construction and selection using genetic algorithm, Springer-Verlag (2003), 229-237.
[22] Anil K.Jain, 'Fundamentals of Digital Image Processing', Prentice Hall, 1989.
[23] Rafael C.Gonzalez, Richard E.Woods, 'Digital Image Processing', Pearson education, second edition.

