A Comparative Study of Fuzzy Logic with Artificial Neural Network Techniques in Cancer Detection

Mrs. Rucha D. Thakur
Assistant Professor
Department of Electronics Engineering
Datta Meghe Collage of Engineering, Technology & Research, Wardha, India

Abstract— Now a day's artificial intelligence has been playing an important role in the research community of bio-medical engineering. In this paper I presented an comparative study of computer-aided diagnosis for medical image segmentation and edge detection using Neural Network & Fuzzy logic. This idea is presented with case study of skin cancer detection using Artificial Neural Network & Fuzzy Logic. The processed image is then registered for analysis. The aims of increasing awareness of how Neural Networks or Fuzzy Logic can be applied to these areas will help to find the disease affected area prominently can be achieve using pre-processing and post-processing . Diseases can be detected in its early-state and can be cured saving many lives.

Key words: ANN, Fuzzy Logic, ABCD Rule, Image Fusion, Segmentation, Real Time Medical Image, Skin Cancer

I. INTRODUCTION

Biomedical Engineering is an interdisciplinary domain. It links many disciplines such as engineering, medicine, biology, physics, psychology, etc. Diagnosis of skin cancer requires medical image segmentation & edge detection; it is requiring having a quantitative assessment of an image under diagnosis. This can be achieved using medical image segmentation [3].

Image segmentation is the process of partitioning a digital image into multiple segments i.e. sets of pixels. The segmentation of image by considering the textural property of anatomical structures and regions of interest plays crucial role in most medical imaging applications. The segmented image is more meaningful and easier to analyse. This image is then used as input. If it is constructed using Artificial Neural Network then chances of correct and efficient response will be increased this is found from study.

Medical imaging is the technique and process used to create images of the human body for clinical purposes (diagnose or examine disease). In reality, these images are rich in color and texture. Color is that attribute of light-energy which is related to the wavelength. It is well known that color carries a very important part of information regarding objects of interest in an image. This concept is used in color-based segmentation of images. For medical image segmentation [3] Gray level alone may not be sufficient, as many soft tissues have overlapping Gray level ranges. In order to discriminate between disease area and rest of the images initially a set of features is found using the cell counting system. Thus the use of the textural properties of the anatomical structures could be useful. To achieve this, either ANN or Fuzzy Logic can be used as explained below.

A. Artificial Neural Network:

Artificial neural network is one of the techniques for better understanding of human biological processes that can be utilised in biomedical applications. It is currently the next promising area of interest. The benefit of using Artificial Neural Networks is that they are not affected by factors such as fatigue, working conditions and emotional state.

Neural networks [1] are ideal in recognising diseases using medical image database since there is no need to provide a specific algorithm on how to identify the disease. Neural networks learn by example so the details of how to recognise the disease are not needed. The needed thing is a set of examples that are representative of all the variations of the disease. The quantity of examples is not as important as the 'quality'. The examples need to be selected very carefully if the system is to perform reliably and efficiently.

B. Fuzzy Logic:

Fuzzy logic is a superset of conventional Boolean logic that has been extended to handle the concept of partial truth values between completely true and completely false. Fuzzy set theoretic models try to imitate human reasoning and the capability of handling uncertainty whereas neural network models attempt to emulate architecture and information representation scheme of human brain [1]. Hence Neuro-Fuzzy computing acts as more intelligent systems. Artificial neural network is used for learning and adaptation where as fuzzy systems are used to supplement its application domain.

Nilkamal S. Ramteke, RKNEC [2] gives their research to detect and analyses skin cancer severity. He proposed fuzzy logic based cancer severity quantification of skin cancer image [2]. In his research he explains Skin Cancer detection and analysis from given photograph of patient's cancer affected area, which can be used to automate the diagnosis and therapeutic treatment of skin cancer. The proposed scheme uses Wavelet Transformation for image improvement, de-noising and Histogram Analysis whereas ABCD rule[2] with good diagnostic accuracy worldwide is used in diagnostic system as a base and finally Fuzzy Inference System for Final decision of skin type based on the pixel color severity for final decision of Benign or Malignant Skin Cancer.

II. CASE STUDY

A. Case I:

In first case Neural network algorithms are used to prepare an medical image using image fusion technique [6]. Using this fused image, chances of accuracy of disease detection has increased. This medical image for registration in

diseases detection system is prepared using following two steps as explained below.

1) Preprocessing

Image preprocessing with neural networks generally falls into one of the following two categories: image reconstruction and image restoration. The Hopfield neural network [6] is one of the most used neural works for image reconstruction as the major advantage of using Hopfield neural network for medical image reconstruction is that the problem of medical image reconstruction can be taken as an optimisation problem, which is easily solved by letting the network converge to a stable state while minimising the energy function. Reconstruction of images also has to face noisy data. Suzuki Etal developed neural network based filters [4] (NFs) for this problem [18]-[19]. He also proposed a new neural edge enhancer (NEE) based on a modified multilayer neural network, for enhancing the desired edges clearly from noisy images. The NEE [5] is a supervised edge enhancer: Through training with a set of input noisy images and teaching edges, the NEE acquires the function of a desired edge enhancer. Compared with conventional edge enhancers, the NEE was robust against noise, was able to enhance continuous edges from noisy images, and was superior to the conventional edge enhancers in similarity to the desired edges.

2) Image Segmentation

The feed forward neural network is the most used neural network for medical image segmentation. Use of Hopfield neural network to segment some organs from a medical image [6] is the best approach. Among different techniques artificial neural network ensembles are employed for major disease like cancer detection. The ensemble is built on two-level ensemble architecture . The first-level ensemble is used to judge whether a cell is normal with high confidence where each individual network has only two outputs respectively normal cell or cancer cell. The predictions of those individual networks are combined by some a method. The second-level ensemble is used to deal with the cells that are judged as cancer cells by the first-level ensemble, where each individual network has several outputs respectively, each of which represents a different type of skin cancer cells. The predictions of those individual networks are combined by a prevailing method, i.e. plurality voting. Experiments show that the neural network ensemble can achieve not only a high rate of overall identification but also a low rate of false negative identification, i.e. a low rate of judging cancer cells to be normal ones, which is important in saving lives due to reducing missing diagnoses of cancer patients.

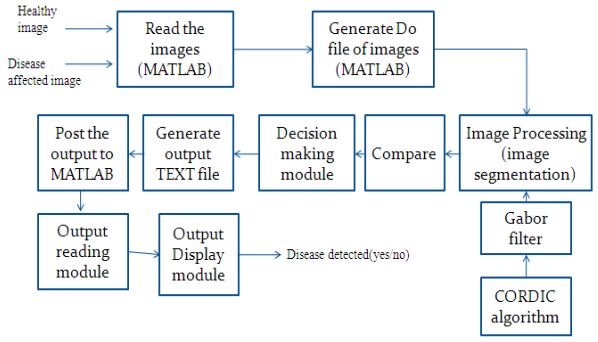

Fig. 1: Cancer detection using ANN generated medical image

Finally the prepared image is fed as one of the input to disease detection system as shown below in Figure (1)[1] . This medical image under diagnosis is compared with healthy skin of the same area. In the next step these images are converted to Gray scale images which is o be compared further. The mismatch between these two segmented images. The pixels which are not matching in two images will give the percentage of diseases affected area. As the ANN generated input image is of very good quality & noise free, the percentage of correct result is more.

B. Case II:

This case presents a new approach for Skin Cancer detection and analysis from given photograph of patient's cancer affected area, which can be used to automate the diagnosis and therapeutic treatment of skin cancer.

The proposed scheme is using Wavelet Transformation for image improvement, de noising and Histogram Analysis whereas ABCD rule[2] with good diagnostic accuracy worldwide is used in diagnostic system as a base and finally Fuzzy Inference System for Final decision of skin type based on the pixel color severity for final decision of Benign or Malignant Skin Cancer. The proposed methodology by Nilkamal S. Ramteke, RKNEC is shown below.

It will detect wether skin is cancer affected or not using following steps.

1) Step 1- Image Acquisition

The first aim in skin cancer detection is to find melanoma in skin. For this purpose it use computer aided diagnostic system which involves acquisition of the digital image of affected skin.

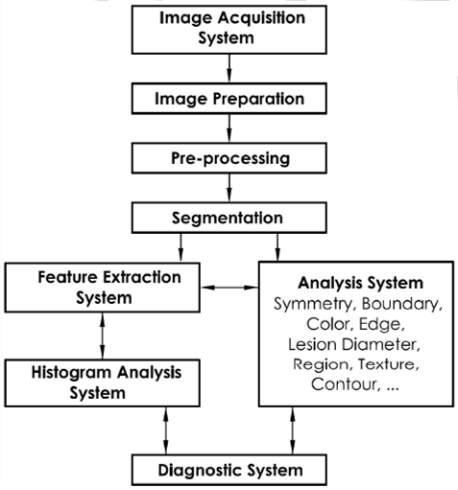

Fig. 2: Proposed scheme of skin cancer detection and diagnosis

2) Step II -Image Pre-Processing

Digital images of skin cancer are collected in Bitmap or JPEG format from different sources. Thus it prepares the image from ordinary image to first RBG then Gray scale and at the end binary. Image pre-processing makes an acquired-prepared image suitable for a particular application. The pre-processing step removes the undesirable parts, enhances the image, corrects the image skew and removes noise from the image. In first case it uses neural edge enhancer (NEE) for enhancing the desired edges clearly from noisy images. The NEE was robust against noise, was able to enhance continuous edges from noisy images, and was superior to the conventional edge enhancers in similarity to the desired

edges. Thus case I prepare an efficient image for input then case 2.

3) Step III -Image Segmentation

Changing the image representation into a meaningful and easy-to-analyze one is the primary aim of segmentation. Image segmentation is used to locate objects and boundaries in improved images. Images are scanned from top-left to bottom-right and from bottom-right to top-left. During each scan, unique labels are assigned to each detected regional minima.

4) Step IV -Feature Extraction

The segmented image is further used to extract features such as texture, color and shape. Then the segmented image is classified based on the extracted features, viz. the texture and color. The segmented image is classified based on the extracted features, viz. the texture and color.

5) Step V- Histographic Analysis

In this steps the image is compressed using Wavelet transform. Further on compressed image ABCD rules (Asymmetry, Border irregularity, Color variegation, Diameter > 6mm) are applied.

6) Step VI -Decision Making System

The algorithm design using Fuzzy Logic will give the decision whether the skin is cancer affected or not.

- Rule1: If "skin color" (input variable) is Light Red then decision (output variable) Healthy skin.
- Rule 2: If "skin color" (input variable) is Medium Red then decision (output variable) is Rash skin.
- Rule 3: If "skin color" (input variable) is Dark Red then decision (output variable) is Cancer skin.

III. Conclusions

This paper presented a survey of skin cancer detection system using ANN & Fuzzy Logic System is presented. The conclusion found that if ANN is used for medical image preparation, we will get noise free input for Diagnosis. Thus chances of correct prediction are more.

On the other hand if Fuzzy algorithms are applied for decision making system for diagnosis of skin cancer It gives as correct result as we achieve with using ANN applying condition that ABCD rules are successfully applied.

This concept will be helpful in detecting early stage of disease and saving the lives of peoples.

References

[1] Rucha R. Thakur, Swati R. Dixit and Dr.A.Y.Deshmukh," VHDL Design for Image Segmentation using Gabor filter for Disease Detection", International Journal of VLSI design & Communication Systems (VLSICS) Vol.3, No.2, April 2012.

[2] Nilkamal S. Ramteke and Shweta V. Jain, "Analysis of Skin Cancer Using Fuzzy and Wavelet Technique – Review & Proposed New Algorithm",International Journal of Engineering Trends and Technology (IJETT), Volume 4 Issue 6- June 2013

[3] K.S. Cheng, J.S. Lin, C.W. Mao, "The Application of Competitive Hopfield neural network to Medical Image Segmentation", IEEE Transactions on Medical Imaging. Vol.15, no.4, pp.560-567, August 1996.

[4] K. Suzuki Etal, "Efficient Approximation of Neural Filters for Removing Quantum Noise from Images", IEEE Trans. Signal Process .vol.50,no.7, pp.1787-1799, July 2002

[5] Kenji Suzuki, Isao Horiba, Noboru Sugie and Michio Nanki, "Neural Filter with Selection of Input Features and Its Application to Image Quality Improvement of Medical Image Sequences", IEICE Transaction on Information and Systems . Vol.E85, no.10, pp.1710-1718, 2002.

[6] A.P. James, B. V. Dasarathy," Medical Image Fusion: A survey of the state of the art" ,Medical Image Fusion: A survey of the state of the art, Information Fusion, 2014

[7] S. J. Sangwine,"Color image processing,", Electronics & communication engineering journal October 2000

[8] Malarkhodi.S, Dr.R.S.D.Wahida Banu, Malarvizhi.M, "VLSI Implementation of Uterus Image Segmentation Using Multi-Feature EM Algorithm Based on Gabor Filter", 2010 Second International conference on Computing, Communication and Networking Technologies

