Analysis of Liver Cancer using Adaptive Neuro Fuzzy Inference System (ANFIS)

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ABSTRACT: In the fast developing world, cancer is one of the deadly diseases. Although there is much medical advancement, curing of cancer disease is not achievable. Among the cancer disease, Liver cancer is the second leading cause of cancer death. Liver cancer occurs when the liver cancer cells develops and changes in the DNA sequence. When these cells may begin to grow out of control and form a tumor in the liver. In 2012, 746,000 deaths are occurred due to liver cancer. Hence, new metrologies for early Liver Cancer are needed to determine the detection of the Liver Cancer. The aim of this paper is to study the Adaptive Neuro Fuzzy Inference System (ANFIS) technique in determining the liver cancer in human.

KEYWORDS: Liver Cancer, Noise Removal, Segmentation, Feature Extraction, Neural Networks, Adaptive Neuro Fuzzy Inference System**.**

I. INTRODUCTION

The liver is a football-sized organ that is presented in the upper right portion of the abdomen and above the stomach of the human body. The primary liver cancer also known as the hepatic cancer which begins in the organ liver. The cancer cell which migrates to the liver from other parts of the body is meant for secondary liver cancer or liver metastasis. The main reason of liver cancer is due to hepatitis B virus, hepatitis C type virus or using alcohol. According to the recent survey in 2013, 300,000 deaths from liver cancer were due to hepatitis B, 343,000 due to hepatitis C and 92,000 by alcohol.

II. LITERATURE OF LIVER CANCER

Signs and symptoms of Liver Cancer:
The followings are the signs and symptoms for liver cancer:
- Jaundice
- Abdominal Pain
- Unexplained weight loss
- Fatigue
- Nausea
- Vomiting
- Back pain
- General itching
- Fever

Causes of Liver Cancer
The main reasons for the causes of liver cancer are mentioned below:
- Cirrhosis is a chronic disease of the liver degeneration of cells.
- Diabetes
- Family history
- Liver diseases or inherited liver disease

- Low immunity
- Obesity
- Gender – the males are affected more by liver cancer when compared to females.
- Smoking

The liver cancer can be diagnosed using the HCC screening, Blood test, imaging scans like MRI or CT scan, biopsy is a small sample of tumor tissue is removed and analyzed the tumor is cancerous that is a malignant or non-cancerous is a benign.

III. DATA MINING

The term data mining refers to extracting the knowledge from large amount of data. The data mining consists of various methods. However, there are several accommodations have to be consider while choosing a best mining technique for an application. The best model is found by trying various algorithms by hit or fail experiment. We now discuss the applying of ANFIS algorithm for detecting liver cancer in human.

IV. PROPOSED METHOD

The proposed liver tumor identification is shown in the block diagram fig.1. This method precedes the CT image as input data and then preprocessing of the data and then applying the ANFIS algorithm. And finally generating the result.
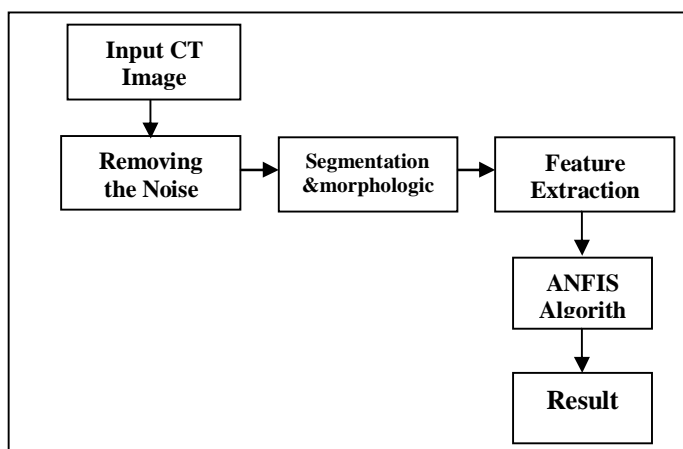

Fig1. Block diagram

Liver Cancer – CT Image

A CT Computer Tomography scan is used to define normal and abnormal structures in the human body. This provides precise data about the shape, size and position of the liver tumor. The CT scan liver image is improved by applying various image processing techniques. The affected cancer cells are present in the liver can be viewed in the fig.2.

Cancer cells in liver

Fig2. CT image of Liver

Data Preprocessing

The typical liver CT image undergoes an image processing techniques for image enhancement to improving the level of accuracy. The system goes through i) Noise Removal ii) Segmentation iii) Morphological Operation iv) Feature Extraction and then generating the ANFIS technique to the input data image.

i) Noise Removal

This is the most important technique to remove blur and occurrence of noises in the image due to vibrations or linear motion. The noise in the liver image reduces the quality of the image or even it tends to loss or damage of pixels in liver image. Hence it should be important to restore the CT liver image from noises before applying classification technique. The CT images may contain more Gaussian noise; a Gaussian filter technique can be used to remove noise drawn from a normal distribution.

ii) Segmentation

After the noise removal, the segmentation process is carried out. This step is used to change the representation of an image into a meaningful one so that it is easier to analyze and detect the liver cancer from CT image. This segmentation process is helps to locate objects and boundaries in images. This process will result in separating the liver from the rest of the image and only the liver cells is considered for detecting tumor in liver portion.

iii) Morphological Operation

In order to smooth the boundaries of the liver after the segmentation process, the morphological operations have to be carried out. It is used to fill the holes and small gaps in our image. The basic operations in morphological technique are erosion and dilation. Erosion means removing pixels from the boundaries in an image whereas dilation is adding new pixels to the boundaries to the liver CT image. The number of pixels added or removed from the object in an image depends on the size and the shape of the structural elements used to process the image.

iv) Feature Extraction

In this step, the input data is transformed to the set of features is called as feature extraction. It involves the locating of pixels in an image with distinctive characteristics. For instance, characteristic image portion that is inhomogeneity in their intensity or range. The features extracted from image serves as the comparison and similarity in images and used to identify and classify localization of anatomical structures.

V. ANFIS CLASSIFIER METHOD

Adaptive Neuro Fuzzy Inference System is the combination of best features of fuzzy inference system and artificial neural network. ANFIS serve as a basis for constructing a set of fuzzy if-then rules with appropriate membership functions to generate the stipulated input-output pairs. This is a fuzzy inference system with a back propagation that tries to reduce the error and improves the performance. The block diagram of ANFIS architecture is given in Fig.3.

The fuzzy inference system included the GUI parameter which is used for regulating this system. The four parameters are mentioned below:

1. Fuzzy Inference System (FIS) Editor handles input and output variables.
2. Membership Function Editor defines the shapes of all variable membership functions
3. Rule Editor is used for editing the list of rules in system.
4. Rule Viewer is used for monitoring the system and also to help in diagnose the behavior of specific rules.
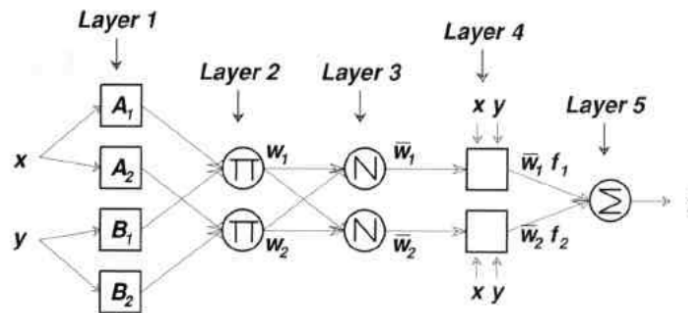
Fig3. ANFIS Architecture

In the first layer, all the nodes are created as adaptive nodes. The layer1 outputs are the membership grade of the inputs to the layer2, are given as:

$$O_i^1 = \mu A_i(x), i = 1,2$$
$$O_i^1 = \mu B_{i-2}(y), i = 3,4$$

In the second layer, the nodes are fixed nodes. The result of this layer can be represented as:

$$O_i^2 = w_i = \mu A_i(x)\mu B_i(y) \; i = 1, 2$$

In the third layer, the nodes are also fixed nodes. The output of this layer:

$$O_i^3 = \overline{w}_i = \frac{w_i}{w_1 + w_2} \; i = 1,2$$

In the fourth layer, the nodes are adaptive nodes. Here, the output of each and every node in this layer is simply the product of the normalized firing strength with the first order polynomial. Thus, the outputs of this layer are given by:

$$O_i^4 = \overline{w}_i f_i = \overline{w}_i(p_i x + q_i y + r_i) \; i = 1,2$$

In the fifth layer, there is a fixed node. This node produces the output by summating all incoming signals.

VI. ANFIS METHODOLOGY

In this method, the input is passed in the input layer and the output is seen in output layer. In this method (fusion) fuzzy logic and neural network learning algorithm the parameters are changed until we get the optimal solution. In our paper, we used this methodology to identify the liver cancer from a CT image.

Training the Neural Network in a number of normal and abnormal CT liver images is done to differentiate normal and liver cancer cells in the liver organ. The ANFIS is implemented in the software package called MATLAB with its fuzzy logical toolbox. In the Fig.4, five high possibilities of data for the cause of liver cancer values are given as the input to the input layer in the ANFIS algorithm and then it processed and the final optimal result is generated.
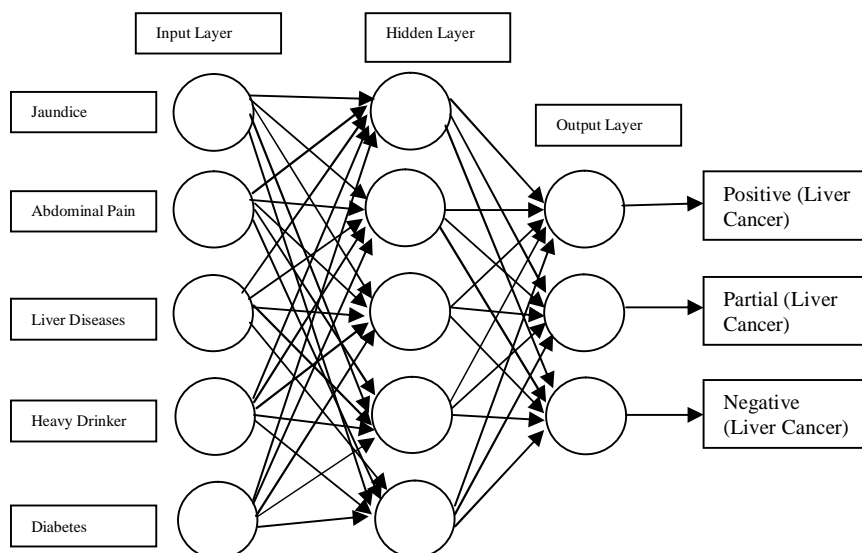
Fig4. Liver cancer prediction

Two separate data sets such as training and testing dataset can be used in ANFIS model.. The training data set was used to train the ANFIS model, whereas the testing data set can be used to verify the accuracy. The model data set for the detection of liver cancer is shown in the Tab.1.

Attribute	Type
Age	Above 40
Gender	More in males
Weight	Obese
Smoking habit	Heavy Smokers
Itching	Throughout body
Weight	Unexplained
Swollen Legs	Positive
Viral Infection	hepatitis B virus (HBV) or hepatitis C virus (HCV)
Alcohol	More Alcohol Abuse
Blood Test	High AFP (Alpha-fetoprotein) level
Abdominal Pain	Left Side

Tab1. Liver Cancer Data set

The experimental process for the detection of liver cancer in human is listed below.
1. Identify the problem from the patient.
2. Collect the data as medical images from hospital.
3. Analyze the data mining tool (MATLAB) for processing.
4. Input the CT image.
5. Apply the Image Preprocessing methods such as Noise Removal, Segmentation and Feature extraction.
6. Apply the Adaptive Neuro Fuzzy Inference System (ANFIS) Technique.
7. Training the selected algorithm on reduced data sets.
8. Evaluate the result.
9. Randomizing the data sets.
10. On randomized data sets perform steps 7 and 8.

11. Evaluate the performance and accuracy.

The evaluation process is carried out through the following four possible outcomes:

Possible Outcomes	Predicted result	Final Result of Liver Cancer
TP(True Positive)	Positive	Yes
FP(False Positive)	Positive	No
TN (True Negative)	Negative	No
FN (false Negative)	Negative	Yes

VII. FUTURE SCOPE

This paper reviewed the identification of Liver Cancer using the Adaptive Neuro Fuzzy Inference System in the two dimensional (2-D) CT Liver images. Instead of using 2-D Liver cancer CT images, the future enhancement work can be done in 3-D Liver images to get high degree of accuracy and performance for diagnosis liver cancer.

VIII. CONCLUSION

This paper provides the overview on liver cancer using Adaptive Neuro Fuzzy Inference System (ANFIS) data mining technique. This paper proposed by taking 2-D CT images as input. In data preprocessing step, the noise removal in the CT image, segmentation process, morphological operation and the feature extraction techniques has been discussed. We have also discussed the study of Adaptive Neuro Fuzzy Inference System for early detection of Liver Cancer in human. Implementations of these technique or combination of ANFIS with other data mining techniques can be made to help the medical field at early diagnosis of liver cancer.

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