

Web Based Liver Lesion Detection Using Texture Parameters

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Abstract: Telemedicine is the combination of communication technology and information technology to give healthcare advice from a distance. In this paper, a web based system is developed for identification of liver disease. An ultrasound image is read as input from web browser and its diagnosis is produced as output on web browser itself. Mainly, the work aims at providing an easy to use web based interface. The preprocessing of input image takes place using Gaussian filter. Use of morphological operations is employed to remove extra flaws in an image. Threshold based segmentation is applied to the image and features are extracted using gray-level co-occurrence matrix. The neural network classifier is used on segmented images to determine the liver condition as healthy or diseased.

Keywords: Liver, Neural-network, Texture features, Web-based system, GLCM

I. INTRODUCTION

The increase in demand in communication technology as well as information technology has proved a tremendous application like in medical field. It gives good result by identifying and analyzing clinical information. It also provides swapping of data across long distance using telemedicine technology. It is very helpful for human advancement as well as economic profitability [1], [2]. Telemedicine is a technology in a medical research area. It provides healthcare information to a remote user and also interchanging of information covering through large distance area by using telecommunication [3]. The service can be made easily available for common people and medical experts who stay physically away from each other. By using a web interaction system for client/user, a user submits an ultrasound image through a web browser. The input is processed and the result is obtained and displayed back on browser. Medical ultrasound also called as ultrasonography could be diagnostic imaging technique supported by applying ultrasound. Its aim is commonly to search out organ condition or to determine any pathological information associated with the organ. The paper is organized into five sections. Discussion related to existing literature is in second section. Working methodology is illustrated in section 3. Experimentation carried out and results obtained are discussed in section 4. Finally, the last section concludes the work proposed.

II. LITERATURE SURVEY

We find lots of work done on medical images in general. In [4], authors have used the measurement of ultrasound image texture to reinforce the flexibility of ultrasound to

acknowledge benign from malignant breast lesion cysts, and fibrocystic, fibroadenoma were examined. By open biopsy, every lesion is determined by using fractal and statistical analysis method. Analysis was done for image texture that was done on digitized video output from the scanner.

In [5], have classified the tissue features based on parenchyma liver disease that have spreading nature. The ultrasound liver images were taken for examining the disease by using the computerized echographic technique. Pattern recognition algorithm is used for tissue characterization and also for image brightness and structure. Variations in structural properties are reflected in the ultrasound image structure and brightness.

In [6], authors have used ultrasound speed and frequency dependency of attenuation coefficient in human breast biopsy. The goal is to discriminate normal from pathological tissues and benign from malignant tissue. Different static methods are used to analyze a breast biopsy. The performance of testing and validation is done using neural network.

The main motive behind proposed method is to design a web based system for detecting or classifying the normal liver from the diseased liver. The system detects the abnormality of an organ by taking inputs through a browser and displays the result back in browser itself.

III. PROPOSED METHODOLOGY

This section explains about the method that is used in our experimentation.

Input image: An ultrasound scanner is used for scanning images of liver. The B-scan images are selected. The

accumulated images are stored in jpeg format. Input image is taken for the preprocessing in. The pre-process is carried out to remove the unwanted noise to get the improved results in further steps namely, segmentation, feature extraction and classification. Image processing algorithms are used for ultrasound image preprocessing, segmentation and classifying the diseased and normal image. The input images are taken from the website radiopedia.org [7] for experimentation. The proposed methodology is shown in Fig 1.

Preprocessing of Image: The images are preprocessed using Gaussian filter. Noise present in an image is removed.

Morphological Operation: The morphological operations like dilation, erosion, closing, opening and inverting of image are applied on the preprocessed ultrasound image.

Segmentation: Segmenting required region of interest (ROI) is extracted from ultrasound liver image. The segmented ROI is used for feature extraction.

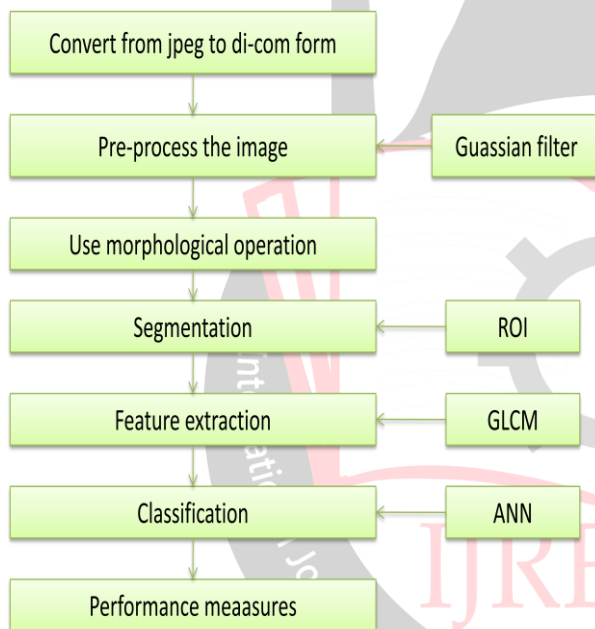


Fig 1: Methodology

Feature Extraction: The feature extraction is carried out and it is calculated using gray level co-occurrence matrix (GLCM) [8]. Various statistical parameters are calculated using equations (1) to (13).

Contrast: It calculates the local variation in the GLCM. It estimates the quantity of local variation that holds out in an image. The contrast is high when there is large amount of variation in image texture.

$$Contrast = \sum_{i,j} |i - j|^2 p(i, j) \quad (1)$$

Energy: It gives the total amount of squared elements in the gray level co-occurrence matrix. It calculates the textural homogeneity of joined pixel recurrence. It recognizes disorder present in the texture.

$$Energy = \sum_{i,j} p(i, j)^2 \quad (2)$$

Cluster shade: The skewness of matrix is measured. A new image is created $i+j$ and moved to the neighboring pixels and the values are computed. For asymmetric image the cluster shade is maximum [9].

$$Cluster\ shade = \sum_{i=0}^{G-1} \sum_{j=0}^{G-1} \{i + j - \mu_x - \mu_y\}^3 \times p(i, j) \quad (3)$$

Homogeneity: Calculates the closeness of the distribution of segments within GLCM to GLCM diagonal.

$$Homogeneity = \sum_{i,j} \frac{1}{1 + (i-j)^2} p(i, j) \quad (4)$$

Correlation: The linear dependency of gray-level on neighboring pixel points is measured. It shows the local grey-level dependency in texture image. Maximum value is obtained for similar regions.

$$\sum_{i=0}^{G-1} \sum_{j=0}^{G-1} \frac{(i \times j) \times p(i, j) - [\mu_x \times \mu_y]}{\sigma_x \times \sigma_y} \quad (5)$$

Variance: It puts maximum weights on the element that differ from average value of $p(i, j)$. It measures the heterogeneity and variability of pair of pixels. The difference and sum of variance is also measured for variables, in a matrix.

$$Variance = \sum_{i=0}^{G-1} \sum_{j=0}^{G-1} (i - \mu)^2 p(i, j) \quad (6)$$

Auto-correlation: The repeated pattern can be detected by using autocorrelation.

$$Auto - correlation = \sum_{i=0}^{G-1} \sum_{j=0}^{G-1} \frac{(i \times j) \times p(i, j) - [\mu_x \times \mu_y]}{\sigma_x \times \sigma_y} \quad (7)$$

Entropy: It measures the randomness of an image that is, entropy is high when $p(i, j)$ are equal and entropy is less when $p(i, j)$ are unequal. The sum of entropy and difference entropy is measured.

$$Entropy = \sum_{i=0}^{G-1} \sum_{j=0}^{G-1} p(i, j) \times \log(p(i, j)) \quad (8)$$

Maximum probability: The most continual color in an image or shapes can be detected by using maximum probability function.

$$MAX = (prob(x, y)) \quad (9)$$

Sum average: It is the measure of sum of all values divided by the total number of values.

$$Sum\ Average = \sum_{i=0}^{2G-2} ip_{x+y(i)} \quad (10)$$

Dissimilarity: Dissimilarity it is a statistics measure that explains the slight difference in a grey level matched set of an image.

$$Dissimilarity = \sum_{i,j} |i - j| p(i, j) \quad (11)$$

Inverse difference moment: It is a statistical measure. In an image the local homogeneity can be measured using IDM.

$$IDM = \sum_{i=0}^{G-1} \sum_{j=0}^{G-1} \frac{1}{1+(i-j)^2} p(i, j) \quad (12)$$

Cluster Prominence: It is measure of asymmetry. When prominence is maximum the image is least symmetric. For mean values there is peak in glcm matrix when value is less for Prominane. Small variation in grey-level indicates when value is less.

$$Cluster\ prom = \sum_{i=0}^{G-1} \sum_{j=0}^{G-1} \{i + j - \mu x - \mu y\}^4 \times p(i, j) \quad (13)$$

Where

$P(i, j)$ = i, j are grey-level occurrence elements of glcm.

x, y = indicates rows and columns

G = The image can be represented as a function that assigns some gray level in G to each pixel or pair of coordinates in x and y

N = no of grey level in an image.

μ = mean of glcm.

σ^2 = reference pixel variance intensity in glcm

Web Server: The liver diagnostic process inhibits using internet environment through which diagnosis takes place. The Netbeans IDE is used that support java application and also web application. The process can be run by the integration of image processing and a web application to perform the operation of segmentation and classification. In this system, a remote user is provided with a web page through which a person can select a jpeg file format from the system. After submitting the image with provided button, the image processing algorithms run in Matlab and the various steps like preprocessing, morphological operation, threshold based segmentation texture parameters extraction and classification take place. The classifier's outcome is returned back to the user on the web browser.

IV. EXPERIMENTATION

The algorithms are implemented in Matlab. For this study, ultrasound images are collected from websites [7]. Around 40 images of liver are selected. Among this, 30 normal and 10 abnormal liver images are present. All operations performed in preprocessing stage are shown in Fig 2. Image is preprocessed using Gaussian filter to remove noise present in ultrasound image. Morphological operation is applied for image is shown in Fig 3. The segmentation is most important part of image processing. The thresholding based segmentation method is applied and particular region of interest is selected. Then features are extracted using GLCM matrix of the segmented portion. Entire analysis process is shown in Fig 2 and 3.

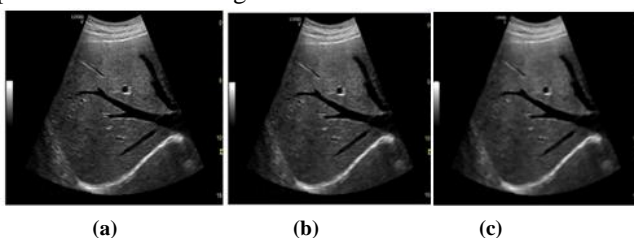


Fig 2: (a) Original image (b) Resize image (c) De-noised image

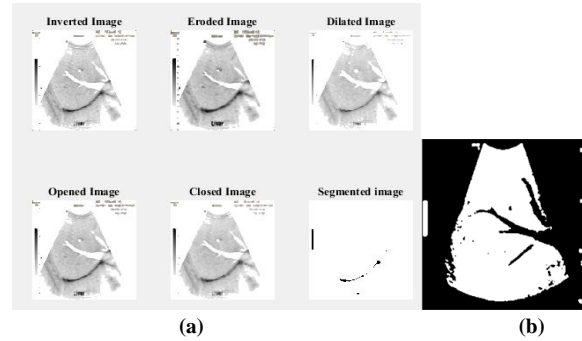


Fig 3:(a) Morphological operation (b) Segmented image

The neural network tool is used for classification. We have created a neural network and trained. About 70% data are selected randomly for training. Testing is performed with remaining images. Training and testing using neural network classifier is performed and good result were obtained.

Performance Parameters

The true positive rate also called sensitivity is the probability of observing in some area to determine percentage of positives that are rightly recognized. It is the percentage of diseased organs rightly recognized as diseased.

$$sensitivity = \frac{true\ positive}{(true\ positive + false\ negative)} \quad (14)$$

Specificity also called the true negative rate determines percentage of negatives that accurately recognized. It is the percentage of normal people accurately recognized as not having the sick condition). The specificity and sensitivity is calculated using True positive (TP), False positive (FP), True negative (TN) and False negative (FN) by formula shown in equation (14) and (15).

$$specificity = \frac{true\ negative}{(true\ negative + false\ positive)} \quad (15)$$

True positive: Normal image accurately recognized as normal.

False positive: Normal image inaccurately recognized as diseased.

True negative: Diseased image rightly recognized as diseased.

False negative: Diseased image wrongly recognized as normal.

After calculating these equations the ROC curve is plotted as x-axis indicates sensitivity and y-axis shows specificity [10] as shown in Fig 4. Accuracy of 92% is obtained using equation (16).

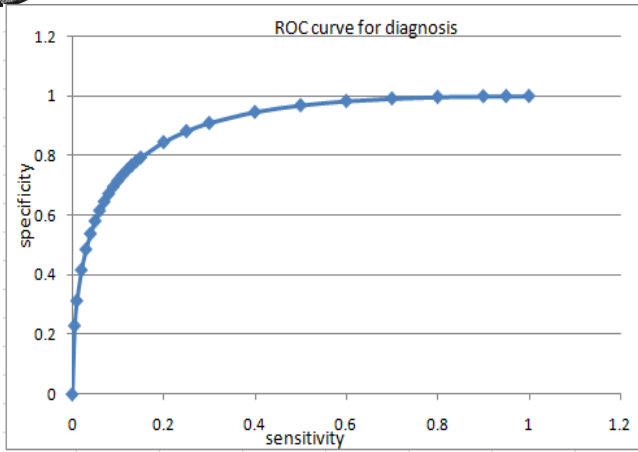


Fig 4: ROC curve for diagnosis

$$Accuracy = \frac{\text{correctly predicted class}}{\text{Total testing class}} * 100 \quad (16)$$

The Fig 5 shows the home page of web interface design for diagnostic system for liver.



Fig 5: Home page of web interface

The Fig 6 shows the image uploading page. Image is uploaded from hard disk then submitted for further processing.



Fig 6:Image uploaded page

The Fig 7 shows the status of organ. That is, the liver is identified as normal or diseased. In this example, it is categorized as normal liver.

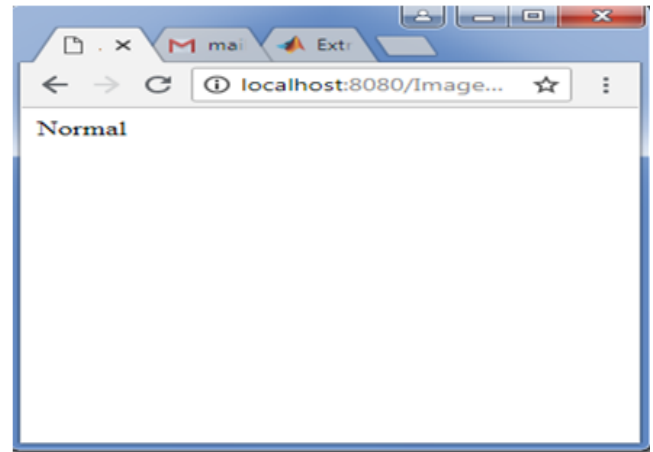


Fig 7:Status displayed as normal

The Fig 8 shows the status of organ. That is the liver is identified as abnormal.

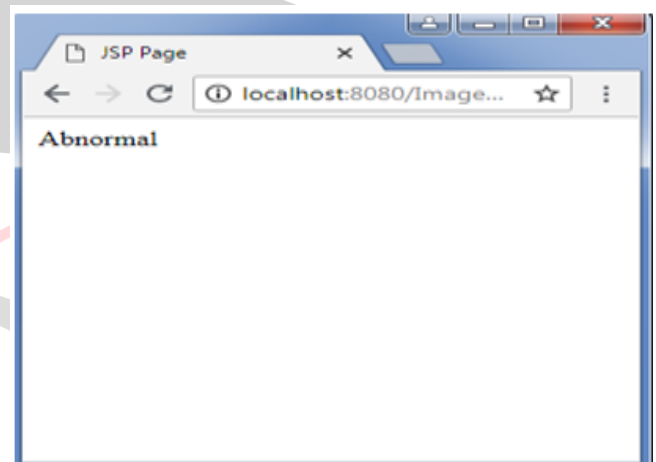


Fig 8: Status displayed as abnormal

The above figure 6 to 9 shows web pages designed and their appearance for the diagnosis of liver condition. It has an image upload button through which we can send an image and it displays normal and abnormal. The diagnosis result shown by clicking the status button.

V. CONCLUSION

This paper presents a work on classification of liver into healthy and unhealthy liver utilizing image texture parameters. A web based analytic classifier developed encourages the easy and simple access of system. The efficiency of the system is shown through the specificity and sensitivity. Accuracy of 92% is obtained. The developed system can be used by the medical experts easily.

REFERENCES

- [1] J. Zhao, Z. Zhang, H. Guo, L. Ren, S. Chen, "Development and recent achievements of telemedicine in China", Telemedicine and E-Health, vol. 16, no. 5, pp. 634-638, 2010.
- [2] M. Donati, T. Bacchillone, L. Fanucci, S. Saponara, F. Costalli, "Operating Protocol and Networking Issues of

- a Telemedicine Platform Integrating from Wireless Home Sensors to the Hospital Information System" Journal of Computer Network and Communications, Hindawi Publishing Corporation, vol. 1, pp. 1–12 2013.
- [3] Kulanthaivel and Ravindran, "Web Based Diagnostic Classifier System for Kidney Lesions using Image Texture Parameters", IEEE Indicon 2005 Conference, Chennai, India, II – 13 pp 220 - 223 Dec. 2005
- [4] B.S. Garra B.H .Krasner, S.C. Horii, S. Ascher, S.K. Mun, R.K.Zeman,"Improving the distinction between benign and malignant breast lesions: the value of sonographic texture analysis", Ultrasonic imaging, vol.15, pp.267-285, 1993
- [5] U. Haberkorn, I. Zuna, A. Lorenz, H. Zebran, G. Layer, "Echographic tissue characterization in diffuse parenchymal liver disease – Correlation of image structure with histology", Ultrasonic imaging, vol. 12, pp. 155-170, 1990.
- [6] J.S. Ostrem, A.D. Valdes, P.D. Edmonds, "Application of neural nets to ultrasound tissue Characterization", Ultrasonic Imaging, vol.13, pp.298-299, 1991
- [7] <https://radiopaedia.org/play/5388/entry/77255/case/9667/studies/10293>
- [8] <https://in.mathworks.com/matlabcentral/fileexchange/22187-g lcm-texture-features>
- [9] X. Yang, S. Tridandapani, J. J. Beitler, David S. Yu, E. J. Yoshida, W. J. Curran, T. Liu, "Ultrasound GLCM texture analysis of radiation-induced parotid-gland injury in head-and-neck cancer radiotherapy: An in vivo study of late toxicity" Medical Physics vol. 39, Issue 9, pp 5732–5739, Sep 2012.
- [10] <http://www.rad.jhmi.edu/jeng/javarad/roc/JROCFIT.html>

