A New Iterative Triclass Thresholding for Liver Cancer Image using BFO

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ABSTRACT
The idea of this paper is to detect the cancer from the liver image. The shape features of the cancer region are measured and it will be used for further diagnosis. The threshold for image segmentation is obtained by using triclass thresholding method. In this method, based upon the threshold the regions are divided into 3 classes. The first and second classes are foreground and background regions. The third class is a "to-be-determined" (TBD) region. This process is done iteratively and it continued until the preset threshold value is met. To obtain the optimal threshold value this method is combined with bacterial foraging optimization and with variants of bacterial foraging optimization. The result of this method is used for further diagnosis.

Keywords
TBD region, BFO, Optimization, Segmentation,

1. INTRODUCTION
In medical imaging, segmentation plays a main role to detect (or) locate the tumors, measuring the volumesof tumors, navigating the tumors for surgery, differentiating the benign tumors from cancer cells etc... In this paper, a segmentation method is used to detect the cancer from a CT scan / MRI scan liver image. Segmentation is a process of identifying the objects in an image which is used for further analysis. The segmentation is of many types. The main classification of segmentation is as follows: edge based, region based and clustering based [2]. The edge based is used for detecting the boundaries for measuring the area accurately whereas region based is very simple and free of noise but it consumes more time and power and clustering based is a process of grouping the similar objects[2].

Otsu method is a familiar method to segment the image which is a process of obtaining the threshold value in an grayscale image [3]. In this paper, Otsu method is used to find the threshold value with the help of within class variance and between class variances. Two stage multi-threshold Otsu method and Improved Otsu method is designed for improving the segmentation process [3]. But this [3] method uses two or more threshold values to segment the images which results in complexity. In paper [1], the iterative method is used to segment the weaker objects (or) pixels in an image. The triclassthersholding consists of 3 regions: Foreground, Background and To-Be-Determined (TBD) region. This TBD region is iteratively processed for better results. In this paper, this iterative method is used for medical imaging to segment the cancer accurately.

The optimization is a process or function to maximize the desired output. The Bacterial Foraging Optimization algorithm is used for optimizing the threshold values where their theoretical foundations and applications are analyzed in [4-6]. The Bacterial Foraging Optimization and Particle Swarming Optimization are compared in [7]. In [8], it describes how the general E.Coli.Bacterium which lives in human and animal intestine are works and how this behavior is applied in an optimization algorithm to improve their threshold value. In this paper, the triclass segmentation method is combined with the optimization algorithm called BFO to get accurate results.

Section 2, explains the general Otsu method and how the regions are separated from each other. Section 3 describes the proposed work of this paper andSection 4 includes the simulation results and discussions.

2. OTSU METHOD
It is a process of segmenting the image, which converts the grayscale image into binary image by means of threshold. Based upon the threshold the bi-modal histogram is calculated. From the histogram, the regions are classified. The regions are: Foreground and Background. The foreground region is a set of pixels above the threshold value whereas the background region is a set of pixels below the threshold value.

The intra-class variance is divided into two:

a. Within-class variance
b. Between-class variance

The within class variance is a sum of variances which are multiplied with their own probabilities and it is denoted as Y_w^2 (t).

$$Y_w{}^2(t) = P_1 X_1(t)^2 + X_2(t)^2$$

The between class variances is a square of difference between means which are multiplied with their own probabilities and it is denoted as Y_b (t)^2.

$$Y_b(t)^2 = P_1(\mathrm{t})\, P_2(\mathrm{t})*[M_1(t) - M_2(t)]^2$$

Where, P_1,$P_2$are the probabilities of two region

M_1,M_2 are the mean of two regions

X_1^2,X_2^2 are the variance of two regions

3. PROPOSED WORK

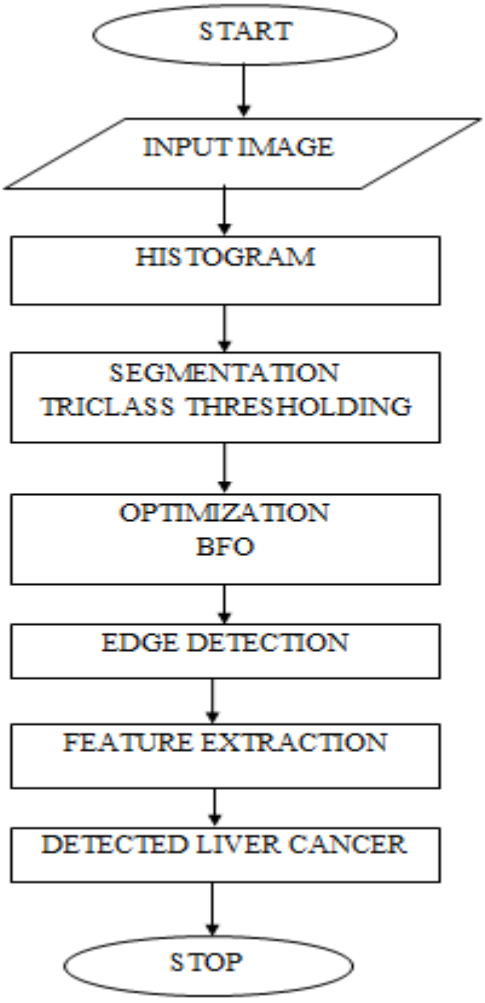

Fig.1 Flow chart of proposed work

The flow chart of the proposed work shown in figure 1, first the histogram of the input liver cancer image is taken. From that triclass segmentation is processed with the help of Otsu method. After obtaining the results, the objective function of triclassthresholding is found out and combined with the BFO. The feature extraction (i.e.,) some of the shape features are determined. The shape features are area, perimeter, major axis, minor axis, eccentricity, circularity, tortuosity etc.,

3.1 Triclassthresholding

In general, the segmentation is mostly done using the Otsu method (i.e.,) using two regions. The main drawback of this Otsu method is when the illumination increases, then the segmented output will not be an efficient one. So, the iteration method is followed to increase the efficiency. The triclass method is a process of splitting the regions into three. They are as follows: Foreground, Background and To-Be-Determined (TBD) regions.

Based upon the threshold, the regions are separated. The set of pixel value, to the left of the threshold value, is calculated with the mean denoted as $\mu_0^{[1]}$similarly the set of pixel to the right of the threshold is calculated with the mean denoted as $\mu_1^{[1]}$. Background is a region which is less than $\mu_0^{[1]}$values and Foreground is a region which is greater than the $\mu_1^{[1]}$. Here, the new region is introduced called TBD in-between $\mu_0^{[1]}$and $\mu_0^{[1]}$ which is shown in figure 2.

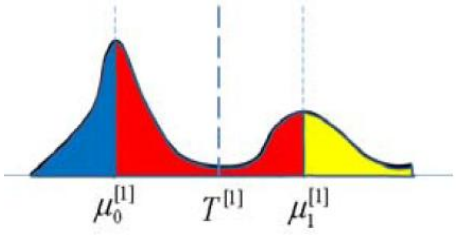

Fig.2 Histogram image

Figure (2) shows the example of a histogram image and the subscript denotes the mean of two sides (i.e.,) left and right of the threshold values. The superscript denotes the number of iterations. These iterations stop when the threshold value is less than μ_0.

3.1.1 Algorithm

Step 1: Start the process

Step 2: Get the input image

Step 3: Obtain the histogram of an image.

Step 4: Obtain the threshold by means of Otsu method.

Step 5: Calculate the mean μ_0 and μ_1.

Step 6: Assign: Lesser than μ_0 – Background
Greater than μ_1 – Foreground
Between μ_0 and μ_1 – TBD region

Step 7: Display the TBD region.

Step 8: Continue step 3-7 until the threshold value met the condition.

Step 9: Stop the process.

3.2 Optimization

Generally, optimization process is used to increase the effectiveness of an output as possible. There are various optimization algorithms used now-a-days to improve its efficiency. Some optimization algorithms are ant colony, particle swarm, cuckoo search, Bacterial Foraging etc.,The optimization algorithm is generally a procedure to compare the various solutions to get the optimal solution.

3.2.1 Bacterial Foraging Optimization

The bacterial foraging optimization is an algorithm whose process is similar to the behavior of an E.Coli., bacterium. The E.Coli bacterium lives in human intestine or animal's body. In general, E.Coli, bacterium searches for its nutrients to maximize its energy. The bacteria consist of flagella, which is used to moves the bacteria to gain its nutrients. The bacteria gains the nutrient by moving in either of 2 directions (i.e.,) swims or tumbles. The swim is a process of moving the flagella in anticlockwise direction whereas the tumble is a process of moving the flagella in clockwise direction. Normally, the bacterium moves in swim wise, if their directions change from swim to tumble then this bacterium falls suddenly.

The bacterial foraging optimization involves 4 steps: Chemotaxis, Swarming, Reproduction & Elimination and dispersal.

Some of the parameters used in this algorithm are, dimension of the search space, total number of bacteria, swarming length, number of steps for chemotaxis, reproduction, elimination and dispersal loop. The primary steps are as follows:

Chemotaxis: It is a process of identifying the bacterium direction. If the amount of nutrients is higher, then the bacterium swims throughout that direction. In image segmentation, the bacteria refers to the solution (i.e.,) threshold value and a nutrient refers to the best solution (i.e.,) optimal threshold value.

Swarming:It is a process of grouping all the bacteria to attain its nutrient. In this segmentation process, the threshold value is grouped to the nearest neighbor pixel values to attain its optimal thresholding which leads to efficient output. Here, cell-to-cell signaling is calculated.

Reproduction: The bacteria which are least healthy will die whereas the healthy bacterium split into two and placed in same location. Similarly, in this paper, if the pixel value is not as much optimal then it will be rejected.

Elimination and Dispersal: If the bacteria not able to gain the nutrients or if it is far away from the nutrients then it is eliminated otherwise the bacteria combined with the nearest neighbor bacterium to form a group and achieved with the maximized energy. In this paper, if the pixel values similar to the threshold value, then these pixels are grouped and attain with maximum optimal threshold.

4. RESULTS AND DISCUSSIONS

The simulation process is done using MATLAB 2011 (32-bit) version. The following simulation results shows that triclass segmentation of a cancer image.

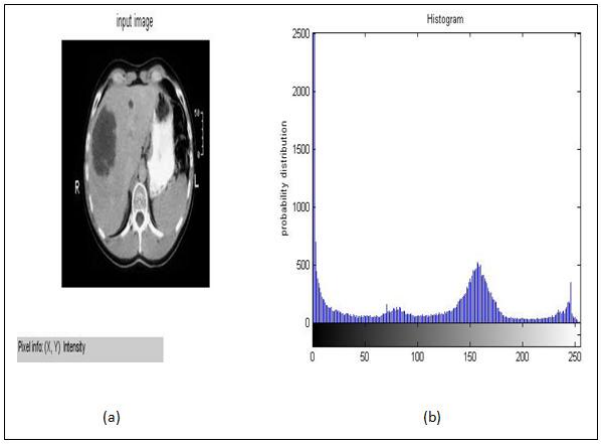

Fig.3 Histogram of liver cancer image

Figure 3(a) shows the image of liver cancer and 3(b) shows that histogram of the given liver image. The histogram is a graphical representation of the pixel values which is distributed in an image. Generally, it is a process of identifying how much time the single pixel value occurs in a given image.

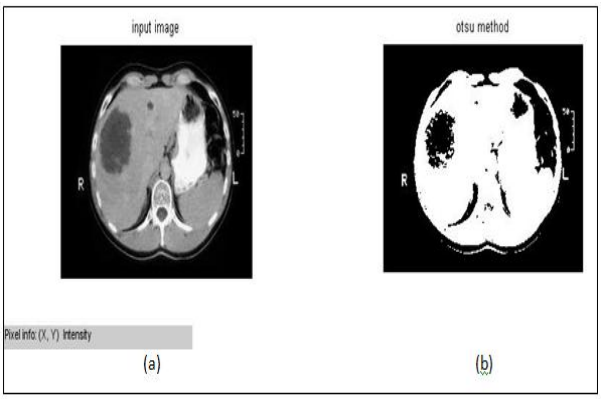

Fig.4 Otsu method

Figure 4(a), shows the input of the liver cancer image and 4(b) shows the cancer region segmented using Otsu method. This segmented region in liver area is a cancer part which is to be diagnosed for further analysis.

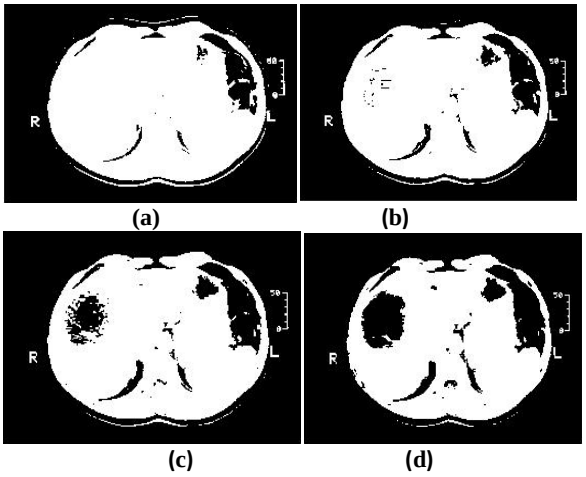

Fig.5 Iterations followed for triclass segmentation

Figure 5, the image (a) shows the first iteration of the iterative triclassthresholding method. But at this iteration, the cancer part is not detected. The iteration 2 detects some part of cancer region more than iteration 1. The next iteration detects almost all the cancer pixel value but it results in some misclassification of pixels. At last iteration, it detects the cancer region accurately for diagnosis purpose. This results shows clearly that, when the number of iteration goes on, the cancer region is detected accurately. So, the triclass method is more efficient than the Otsu method.

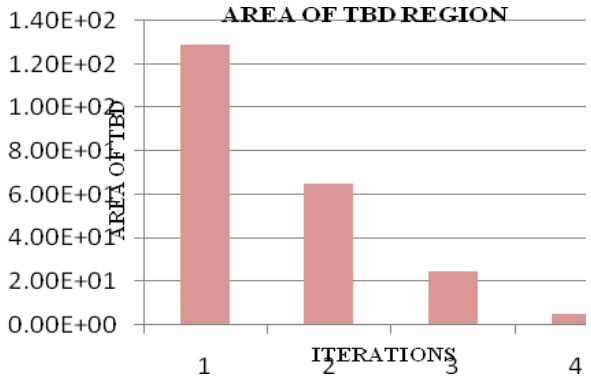

Fig.6 Percentage of TBD area

Figure 6 shows the percentage of TBD area, where the graph is plotted between percentages of area of TBD versus iterations. It is plotted to show, even when the area is reduced the triclass segmentation segment the image.

5. CONCLUSION

In this paper, the Otsu's threshold classified the images into three classes instead of two classes in an iterative manner.The three classes are true foreground and background, and a third TBD region that is to be processed at the each iteration. Here, the background and foreground are kept constant and it focuses only on third new region called TBD region. Ateach iteration, the tri-class approach keeps regions that are determined to be foreground and background unchanged and focuses on the third TBD region. At eachsucceeding iteration, the TBD region area decreases and more pixels are assigned to the foreground and background classes. After the process of iterative thresholding segmentation, the BFO optimization algorithm is combined with this obtained result to produce good results.

6. REFERENCES

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