Detection of Pancreatic Tumor using Bacterial Foraging Algorithm

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Abstract: ***Study and forecast are the central objectives taken into consideration for diagnosis of pancreatic tumor. The detection of pancreatic tumor in patients in premature stage increases the chance of survivability for the patients rather than diagnosis either in malignant stage. If the tumor is detected in the chronic stage, the possibility of survival for the patient is very less. Furthermore, the tumor forecasted in the premature stage will increase the survival rate of the patient based on appropriate medication and treatment. Currently, the forecast of pancreatic tumor in the premature stage focuses on attributed based image analysis of Magnetic Resonance Imaging (MRI). The MRI pancreatic images obtained from MRI scan forms the source of images to detect the pancreatic tumors at premature stage. A distinct detection method for identification of pancreatic tumors using image texture characters is proposed in this work. The statistical evaluation is done using MATLAB. Automated detection is done using Bacterial Foraging Algorithm (BFA) and the outcomes are compared with the results obtained from images which are kept for training, testing and validation which depend on template matching scheme.***

Key Words: ***Pancreatic cancer, Image retrieval, big data, Bacterial Foraging Algorithm, MRI scans images.***

1. INTRODUCTION

The pancreas is located in the abdomen. It is an elongated flat structure. It is a vital organ in the digestive system of the human body which produces insulin hormone. The blood sugar levels are controlled critically by this hormone [7, 8]. A part of the pancreas lies in between the stomach and the vertebral column tangled along with large intestine.

The submerged location of the pancreas makes it difficult in detection of pancreatic tumors when tested on the surface of the abdomen [9, 10]. Numerous indications of pancreatic tumor are not visualized in the premature stage and do not get exposed till becomes malignant preventing the other neighbouring organs to perform their functions of respiration, digestion and bile juice secretion. The location of the pancreas is shown in Figure 1.

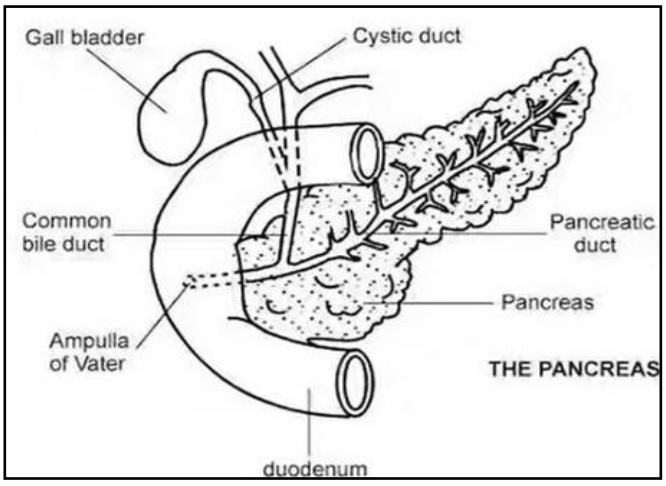

Figure 1. Location of Pancreas

2. LITERATURE SURVEY

This fragment emphasis the various methods implemented to detect the pancreatic tumors. The pancreatic cancer can be diagnosed at premature stage by preprocessing the CT images and using minimum distance classifier [1, 2] as stated by Jeenal Shah, et al., (2015). R. Balakrishna, et al., (2018) proposed that an accuracy of 60%

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is achieved during classification. The pancreatic cancer can be diagnosed at early stages from the CT images using various filters like median, Gaussian filters with image segmentation and Artificial Neural Network (ANN) classifiers [3, 4]. K. Jayaprakash, et al., (2012) has discussed that by using Gray level co-occurrence matrix (GLCM) features like energy, entropy, homogeneity, contrast and correlation and then classified using minimum distance approach [5, 6]. For this nearly 800 CT images of pancreas are used. In this analysis, nearly 50 images with pancreatic cancer were selected to extract the features and the deviation during classification is found to be 0.00573.

3. MATERIALS AND METHODS

The features are extracted using the Equations (1) - (5). The features include, energy, homogeneity, entropy, contrast and correlation. These features are then given to the BFA to categorize whether it is in normal condition or benign or malignant tumor in the pancreas.

Energy: It measures the no. of repeated pairs. It has high energy if its occurrence is also high.

$$\sum_{i,j} P(i, j)^2 \quad (1)$$

Entropy: It is a statistical measure of randomness to find the texture of an image

$$-\sum_{i,j} P(i, j) \log P(i, j) \quad (2)$$

Contrast: It is measure of intensity between pixel and its neighbor

$$\sum_{i,j} |(i-j)^2 \mid P(i, j) \quad (3)$$

Homogeneity: It measures local homogeneity of pixel pair. It is large if gray levels of pixel pair are similar.

$$\sum_{i,j} P(i, j)/[1+|(i-j)^2|] \quad (4)$$

Correlation: It returns how the pixels are correlated

$$\sum_{i,j} [(i-\mu_i)\ (j-\mu_j)\ P(i, j)]/\sigma_i\sigma_j \quad (5)$$

Where P(i, j) indicates the pixel value in the image 'P'.

3.1 Bacterial Foraging Optimization Algorithm

BFA is an influential method in optimization evils. E. coli bacteria attempt to make the most of the energy eating for each time so that BFA mimics the foraging strategy, in BF-system there is four main mechanisms, which are:

3.1.1 Chemotaxis:

Is a Simulation of the changing of an E.coli cell through swimming and plummeting by means of flagella, if: $\theta_i(j,k,l)$ = i'th bacterium on j^{th}chemotaxis, k'th reproductive, l^{th} elimination-dispersal move. C(i) = range of move used randomly which particular through the fall (flow duration element). Bacterium movement during computational chemotaxis is given in Equation 6.

$$\theta^i(j+1,k,l)=\theta^i(j.k.l) + c(i)\ \Delta(i)/[\sqrt{(\Delta^t(i)\Delta(i))}] \quad (6)$$

3.1.2 Swarming:

Through moving up the nutrient inclining a collection of E. coli cells position themselves and an itinerant circle while located amidst a semisolid environment by means of a particular nutrient chemo effecter observed as an interesting group behavior. In E.coli swarm the cell-to-cell, signaling is determined by: random target vector, whose elements be positioned within [-1, 1].

$$J_{cc}[\theta,P(j,k,l) = \sum J_{cc}[\theta,\theta^i(j,k,l)] \quad (7)$$

$$J_{cc} = \sum[-d_{attractant}\theta(-w_{attractant}\sum(\theta_m-\theta^i_m)^2] + \sum[-h_{repellant}\theta(-w_{repellant}\sum(\theta_m-\theta^i_m)^2] \quad (8)$$

J_{cc} (θ, P(j, k, l)) = object purpose worth, S = the sum of bacteria, P = the sum of variables there in bacterium which optimizing, θ = θ1, θ2,…, θp = a point in the p dimensional hunt area as in Equation (7) and (8) respectively.

3.1.3 Reproduction

The better bacteria asexually tear into two bacteria, and then located in the similar location while the least strong bacteria finally die. So that the swarm dimension steady

3.1.4 Elimination-dispersal

It is the event, which takes place for killing, or grouped in a new position, all bacteria in the area, this due to some changes appear in the environment of bacterium population.

Size of population 'S': the computational complexity of the algorithm can be significantly increased by increasing S. Length of chemotaxis step 'C(i)' : C(i) is a kind of a 'movement dimension' for the algorithm. Chemotactic step 'Ns': creates a prejudice in the un-regular movement.

Reproduction number 'N_{re}': the algorithm may join impulsively at a small rate of 'N_{re}', when 'N_{re}' increased the difficult of computational increase. Elimination - Dispersal number 'Ned': selecting 'Ned' appropriately, the algorithm swoop of restricted optima furthermore addicted to best worldwide.

Parameters important cell-to-cell attractant functions 'J_{cc}': high 'J_{cc}' incomes the cells to have a burly tendency to group, small 'J_{cc}' incomes a small tendency to group, so that the equilibrium among the strengths of the cell-to-cell attractant signals with nutrient concentrations is extremely significant [11-13]. Figure 2 shows the sequence of BFA Flowchart.

4. METHODOLOGY

The tumor cells when found to multiply at a rapid rate due to uncontrolled growth is accompanied by constipation, fever, loss of appetite, drastic loss of body weight, fluid accumulation and respiratory problems causing malicious tumors. Screening of pancreatic tumors mostly precedes an anatomic methodology over X-ray imaging or MRI scanning which requires the pancreatic tumor to be advanced where it is significantly thicker than the healthier tissue.

The human perception may mislead the radiologists to wrong diagnosis in case of benign or malignant tumors persisting in the pancreas. Variation in diagnosis may produce adverse effect on the patients. The block diagram of the proposed work is given in Figure 3. Hence to improve the accuracy, this system is made automatic using machine vision algorithms. The MRI images consist of benign and malignant images. The important steps in detection of benign and malignant tumors in pancreas include de-noising using Gaussian filter. Then the texture based features like entropy, homogeneity, correlation, contrast and energy. It contains nearly 99 images out of which 51 images are used

for training, 30 images for testing and remaining 18 images for validation. The classification is done using BFA.

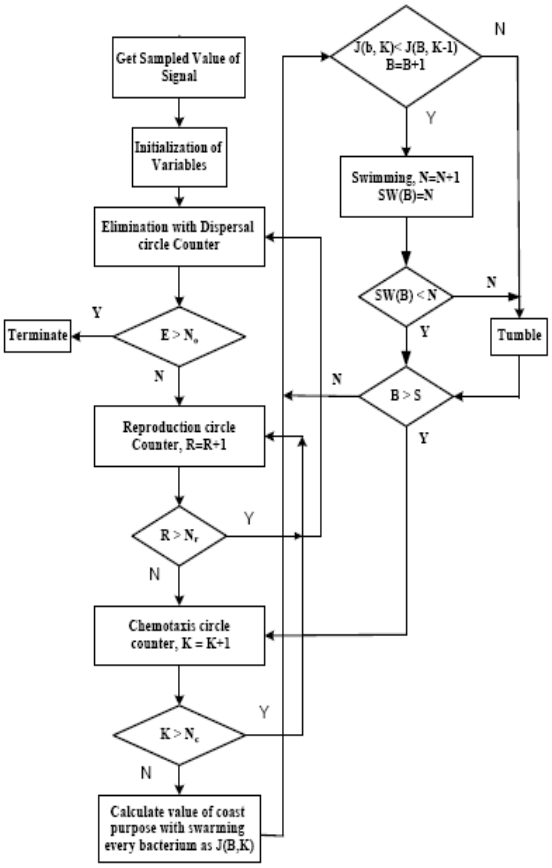


Figure 2. Flowchart for BFA

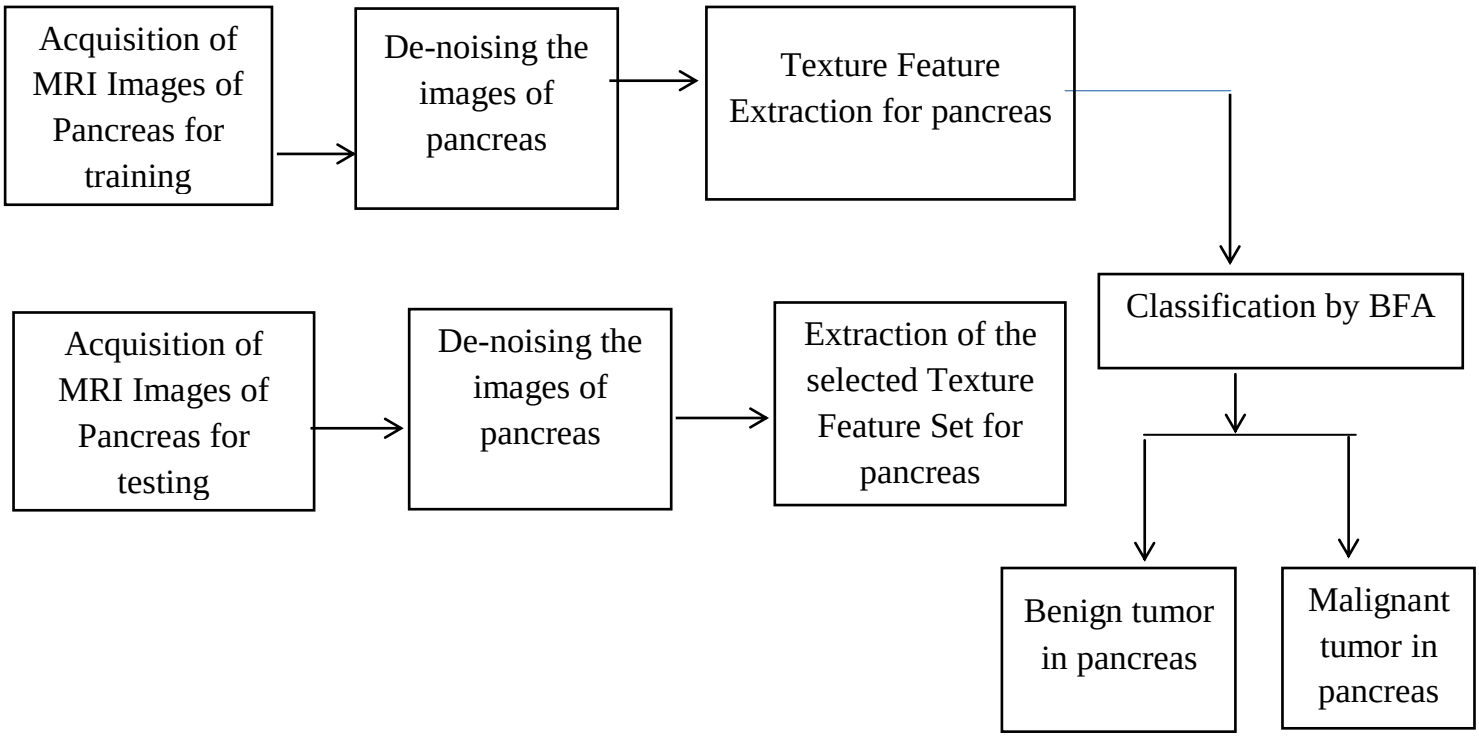


Figure 3. Block diagram for diagnosis of pancreatic tumor

5. RESULTS AND DISCUSSION

The MRI images of the pancreas corresponding to normal, benign and malignant conditions are taken from the open source (https://pubs.rsna.org/doi/full/10.1148/radiographics). Figure 4 illustrates the normal images of the pancreas. The benign and malignant tumor in pancreas is indicated by a medical arrow in Figure 5 and 6 respectively.

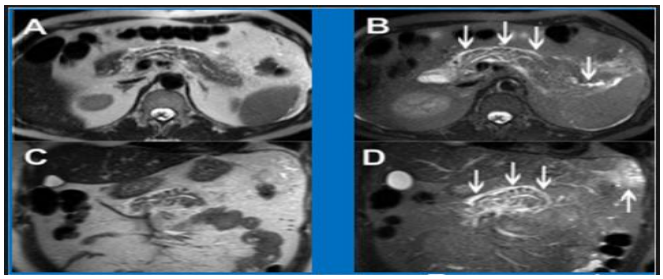


Figure 4. Normal MRI images of Pancreas

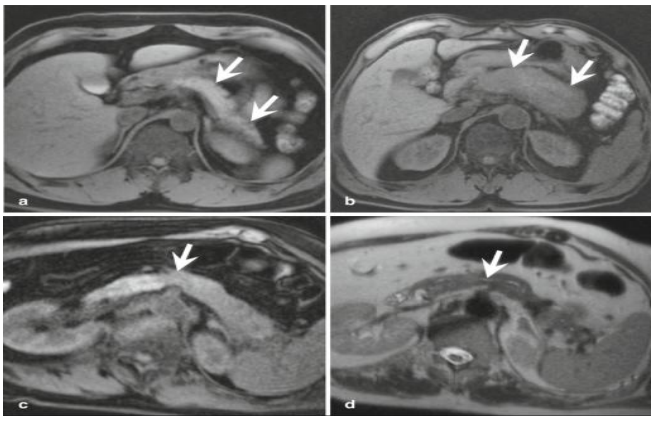


Figure 5. MRI images of Pancreas with Benign tumor

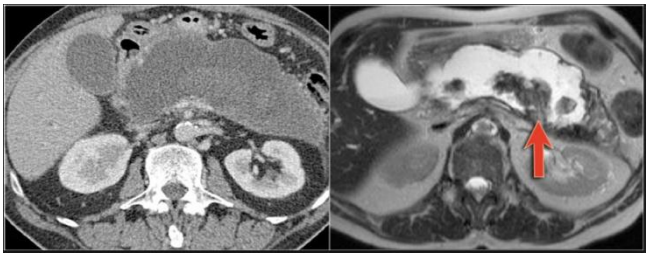
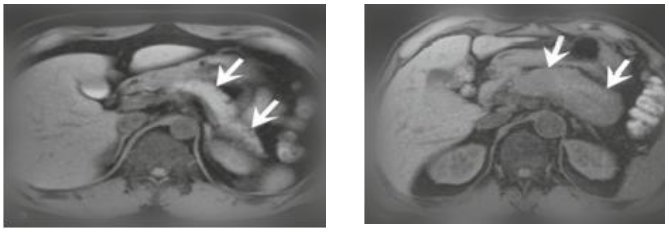
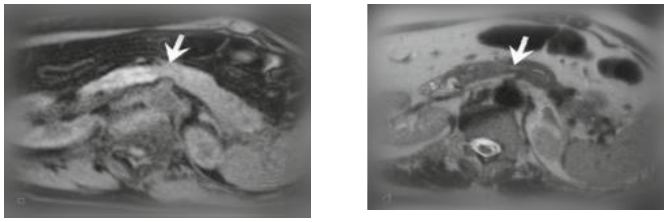


Figure 6. MRI images of Pancreas with Malignant tumor

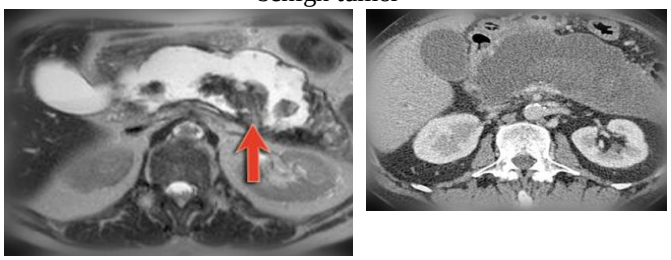
These images are de-noised for noise removal using Gaussian filter. The output is shown in Figure 7. The Peak Signal to Noise Ratio (PSNR) is 43dB. Then the texture features like entropy, energy, homogeneity, correlation and contrast are recorded in Table 1 for few MRI samples of the pancreas.



De-noised output for normal pancreatic images



De-noised output for abnormal pancreatic images with benign tumor



De-noised output for abnormal pancreatic images with malignant tumor

Figure 7. Output for De-noising by Gaussian filter

Table 1. Feature Extraction for MRI images of pancreas with benign tumor

S. No	Entropy	Energy	Homogeneity	Correlation	Contrast
	42	44	42	1	45
	51	44	52	1	46
	51	44	42	1	40
	42	51	52	1	42
	42	51	42	1	43

Table 2. Feature Extraction for MRI images of pancreas with Malignant tumor

S. No	Entropy	Energy	Homogeneity	Correlation	Contrast
	31	33	32	-1	30
	31	24	25	-1	32
	31	33	32	-1	34
	22	33	25	-1	35
	22	24	32	-1	38

These values are normalized and classified using BFA to identify benign and malignant tumors. The results are displayed in Figure 8. A comparative analysis in terms of % Accuracy is illustrated in Table 3.

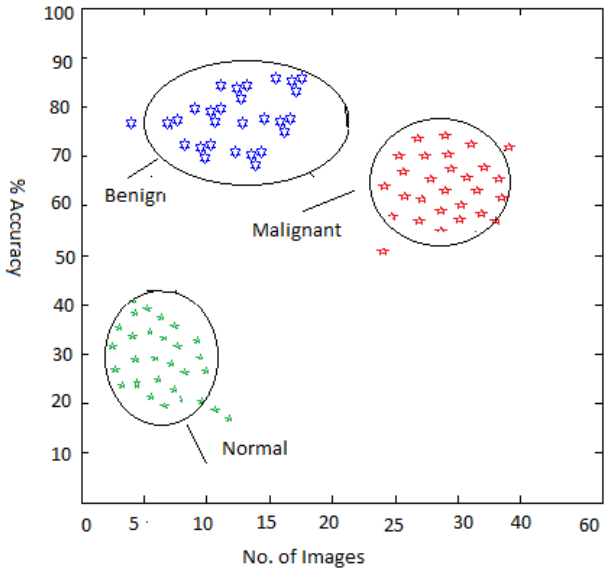


Figure 8. Output for BFA for identification of pancreatic tumors

Table 3. Performance Analysis

S. No	Algorithm used for Classification	% Accuracy		
		Normal	Benign	Malignant
1.	Minimum Distance Classifier	61	62	60
2.	Texture features with minimum distance approach	75	74	72
3.	Texture features with BFA	88	89	89

6. CONCLUSION

In this work the pre-processing of the images are done by using three filters namely Median, Gaussian and Wiener, In that based on Peak Signal Noise Ratio (PSNR), Signal Noise Ratio (SNR) and Mean Square Error (MSE) parameters, wiener filter gives maximum PSNR value and then the feature extraction is done by SFTA and BFA is used to train, test and classify and the performance measure shows that the BFA produces more relevant results.

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