International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-2, July 2019

Edge Detection of Different Images using Soft Computing Techniques

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Abstract–The technique by which an image or photograph is divided into several number of parts in order to analyze the segmented components such as colors, textures grey scale and edges/boundaries of the entities which are present in the image is called as image segmentations. Images obtained by segmentation methods are more understandable as compared to the original images. In the digital snap shot segmentation is essentially used to detect object boundaries present in the image. The paper presents the comparative analysis of image segmentation using soft computing methods.In this paper, we included genetic algorithm, ant colony algorithm, neural network, neuro-fuzzy genetic and adaptive neuro-fuzzy inference system. The techniques are tested on six standard test images. The peak signal to noise ratio (PSNR)is calculated for GA and ACO techniques. The results which are obtained by the above techniques prove that the value of PSNR for GA is much more as compared to the ACO technique.

Keywords: Segmentation, Soft Computing, ACO, GA, ANFIS, ANN, PSNR.

I. INTRODUCTION

Segmentation of an image into number of sections to study or evaluate them correctly is important part in image processing. There are many factors on which image can be segmented such as colors, Textures, grey scale value [1]. There is no general rule is present to segment the image. So, naturally there is so many general-purposed methods are presents for the segmentation process, which leads to a different study on Image Segmentation [2]. Image processing is the fundamental technique in the computer eyesight, with the help of this technique the images can be segmented, classified, quantified and the entities which are present inside the images. Image segmentation partitions an image intodifferent areas so that the entities present in the image can be easily detected on the bases of some predefined benchmark\criteria. There are number of benchmarks which are used most commonly in the image processing such as intensity values of the pixels, different color combinations, texture, range and curvatures of the objects etc. For the last few years number of researchers in the areas of medical imaging, remote sensing, pattern recognition, robot vision, transmission and encoding have made a remarkable investigation in the area of segmentation with the help of this image can be analyzed[3].

Revised Manuscript Received on 30 July 2019.
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The above mentioned techniques are estimated for the same dataset classification. The six test images are taken to implementation of the concept. For comparing the results, we are considering the accuracy performance parameterPeak Signal to Noise Ratio (PSNR).
The remaining paper is systematized as follows: Section II talk about the related work; Section III presents the problem definition for soft computing; Section IV gives the brief idea about the different computational intelligent techniques which are used to detect edges in the image; Section V gives the idea about theresults and discussion; Section VI gives the conclusion of the paper.

II. RELATED WORK

Freshly, many researchers have examined that the problems come in image segmentation can be solved with the help of genetic algorithm. The paper presented by Bhanu and Lee tells about the expanded and comprehensive work on GAs for image segmentation. [15, 16]The potential of GA is so high that it can handle very large and complex search spaces in the positions where very small amount of facts\information is present about the objective function which makes the use of GA more popular among others [6].
The paper presented by Ganesan P(2017) gives the idea of fuzzy logic-based methods which are practiced on user aligned satellite images. The results given by Modified Fuzzy C-Means (MFCM) are very high as compared to the others methods. The segmentation technique based on color search spaces is faster among the other techniques [9].
Navpreet Kaur (2017) presented the paper on in self-adaptive k-means clustering, in which the number of clusters is calculated by counting the peaks presents in the histogram. The segmented part of the image is converted into binary image for its size and estimation of the location. The gray level of the image is used to take out the textural and the growth analysis nature is used to detect the features based on color. To estimate the size and area of the tumor in the human body the size estimation algorithm is applied on the final segmented part of the image [10].

III. PROBLEMDEFINITION

There are two main problem solving techniques are present: first is soft computing and the second technique is hardcomputing. Soft computing workson approximation and complex problems can be solved with this by giving the solutions to the problems.Whereas on the other hand, Hard computing works on exactness where the solutions obtained very fast and they are exact. Soft computing is a relatively new idea, which comes in existence in 1994. Professor L. Zadeh gives the soft computing term with the aim to make full use of tolerance for inaccuracy,

unpredictability, stability andlower value of solution cost [3]. The ultimate objective of the soft computing is to copy the action of mind of human as close as possible. There are numerous applications of soft computing techniques.

The most commonly used and important application is image segmentation.Segmentation is the first step in image processing. In the past,a soft computing application uses the imagesegmentation methods because it astonishingly increases the separation and the identification facilities as compared with segmentation methods of images having gray level [4].

IV. DIFFERENT SOFT COMPUTING TECHNIQUES

Digital image processing used the various characteristic of soft computing techniques for better perceptive of the image. The brief ideas of different soft computing techniques are explained below [1]:

A. Genetic Algorithm

Holland J. in 1975 gives the idea ofGenetic algorithm which isworked on the theory of evolution [5].Population is the method of genetic algorithm [6]. In the search space each particle is giving a solution in the population which is encoded as chromosome and the algorithm will repeat the step to calculate the fitness of each particle and choose the particle with good result as the parents of next generation,now the two process which are known as crossover andmutation are performed to reproduce the next generation. Various problems have been solved with help of GA in image processing which includes image segmentation [7].

B. Ant Colony Optimization

The excellent technique which is used for optimization is known as Ant Colony Optimization (ACO) [1]. Nature is the source of inspiration for this type of optimization algorithm[2], for example ants behaviour\act that on moving from their house to the destination in search of food they deposit odor\scent which is also called pheromone on the ground to make some favourite pathsso that the other ants of the colony can followed the same favourite path in search of the food.It is helpful for answering the computation which is complex in nature. The goal of the ant is to find the best path in search of food [1]. The same phenomenon is accommodating by the ant colony optimization algorithm, artificial ants are formed with the help of these ants the best solution is obtained to the given problem of optimization.

C. *Neural* Network

The nervous system of the human being handled the information in the same way the Artificial neural network (ANN) processed the information in image processing operations.The weights which are also called interconnection between the layers of the network are altered so that the network can learn or grasp the knowledge.When the network fully grasps the knowledge or trained, it is capable of establishing the appropriate solution\output for the set of input data. Most important property of neural networks is Generalization [10].

D. *Neuro*-Fuzzy Genetic Systems

The cellular neural networks analyze the objects and background with the help of GAs which uses the fuzzy based fitness function [13]. The basis of the fitness function is graynessand spatial ambiguity measures. This type of combination is known as neuro-fuzzy genetic integration.The examples shown in figure 1 give integrating artificial neural network, genetic algorithm and fuzzy logic. To get the best optimal solutions the genetic algorithm altered the parameters for example L stands for low membership function, M stands for medium and H stands for high, and the input, *w*is weights of the interconnection of the neural network.

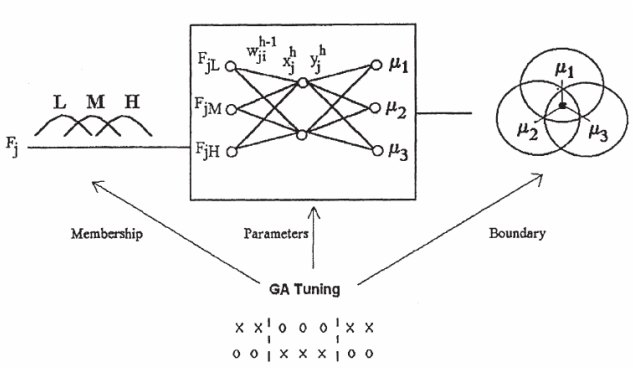


Fig. 1 Basic Diagram of ANFIS

A trained neural network provides the correct matching of the data which comes through output to the unseen input data. Learning process generally happens by means of teaching, where the algorithm of teachingrepetitively alters the weights of the connection [8].

E. *Adaptive* Neuro Fuzzy Inference System (ANFIS)

To detect object boundaries in the image ANFIS is used which is also known as Neuro Fuzzy Technique.Neural network and fuzzy logic techniques are joined to form a new technique which is named as ANFIS[9]. Test data set are used to build FIS. In this technique the best attribute of both the technique are used for example flexibility is given by neural network and uncertainty and imprecision of the system is given by fuzzy logic.The model is acquired by the Fuzzy logic and the fine tuning of the initial fuzzy models given by neural network to produce final model of adaptive neuro fuzzy inference system [7].

V. RESULTS& DISCUSSION

A. Preprocessing

The principle goal of this step is to increase the features of the image so that the segmentation of the image becomes more accurate [2]. Generally the contrast of the captured image by the camera is low, so for this reason to eliminate the noise\commotion from the image preprocessing is done. The very first step in preprocessing is to increase the contrast level to differentiate the different objects presents in the image [2].Then the image is divided into two level of image pixels(white and black) by means of binarization.

B. Segmentation

In this process the required object which is present in the image is separated from the background of the image [2].

C. Output

1) Calculate Peak Signal Noise Ratio (PSNR)and Root mean Square Error (RMSE)value of input image and the detected output edge image.

$$RMSE(n) = \sqrt{\frac{1}{N}||n - n\hat{}||^2} = \frac{1}{N}\sum_{i=1}^{N}(n - n\hat{})^2 (1)$$

In the equation 1n is input image, $n\hat{}$ is output image, N is the size of the input image

$$PSNR(n) = \frac{10\ X\log((255))}{RMSE(n)} (2)$$

The basic block diagram of segmentation of image is shown in fig. 2. Dataset image is shown in fig. 3. Using MATLAB is shown in fig. 4. All result images are shown in fig. 5.

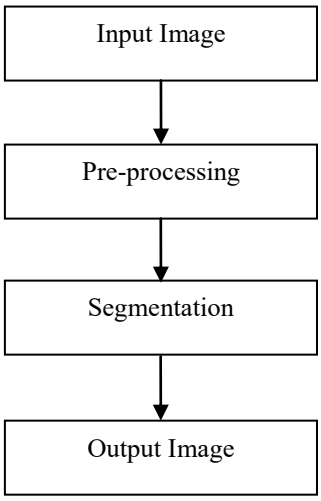


Fig. 2Basic Block Diagram of Image Segmentation

PeppersCameramanLena

Eight Boat Glass

Fig. 3 Shows Image Dataset

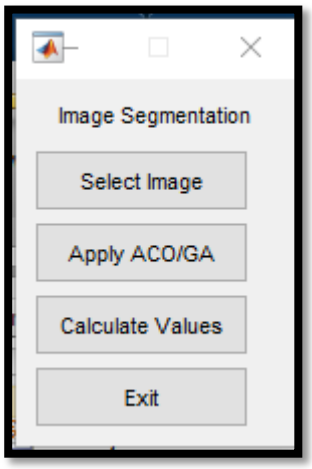
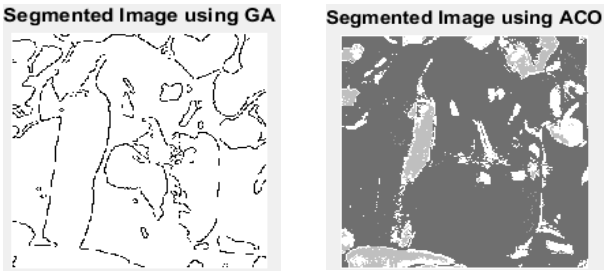


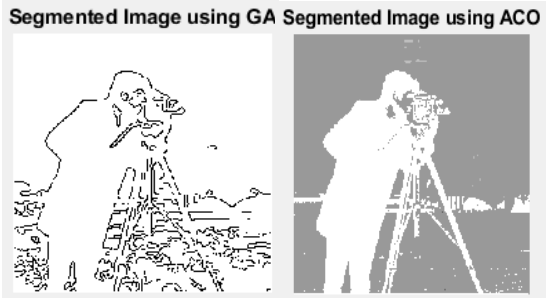
Fig. 4Image Segmentation using MATLAB

The whole process comprises of four steps:

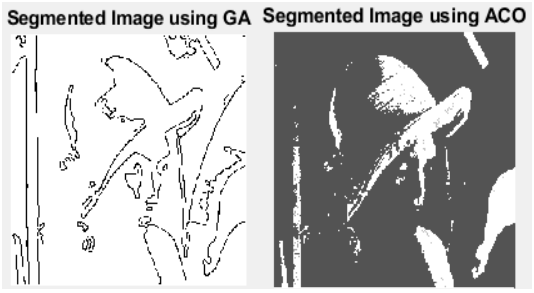
1. Select Image
   In this step input image is selected for further processing.
2. Pre-processing.
   In step pre-processing is performed on selected image i.e. reduce the size, RGB to gray conversion etc.
3. Segmentation.
   In this step segmentation is performed by using ACO or GA on pre-processed image.
4. Calculation.
   In this step calculation is performed and PSNR is calculated.
5. Exit
   In this step exit is performed.



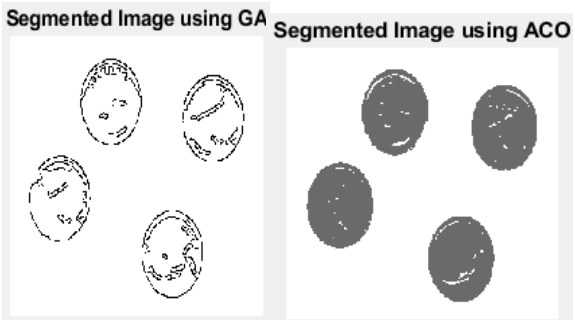
(a) Peppers



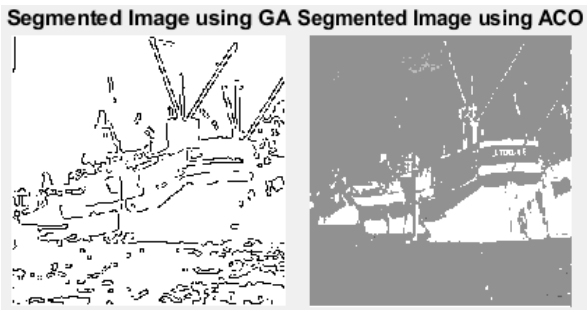
(b) Cameraman



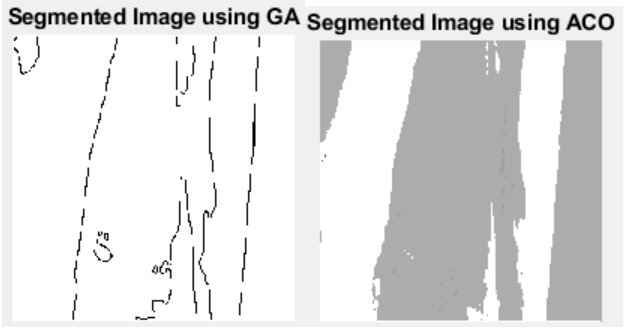
(c) Lena



(d) Eight



(e) Boat



(f) Glass

Fig. 5 Shows Result on Image Dataset

A comparison is carried out between GA and ACO based on PSNR value is given in table 1 and table 2.

TABLE I. PSNR COMPARISON OF TECHNIQUES

Image	GA PSNR	ACO PSNR
Peppers	12.9052	12.8552
Cameraman	12.975	12.938
Lena	15.28	15.21
Eight	4.445	4.440
Boat	11.725	11.681
Glass	10.682	10.650

TABLE II. COMPARISON OF TECHNIQUES [14]

Techniques	*Parameters*	*Future Use*
GA based Clustering Technique	Selection, Crossover, Mutation	It can be used as an efficient unsupervised image segmentation mechanism.
GA	Selection, Crossover, Mutation, Fitness function.[18]	it has scope of improvement in adaptive adjustment of mutation rate.
ANN	image enhancement, segmentation, registration, feature extraction, and object recognition	Appropriate for real time application and for medical image segmentation applications
ACO, Particle Swarm Optimization (PSO)	Posterior energy, pheromone update,Peak Signal-to-Noise Ratio (PSNR)and Average Signal-to-Noise Ratio (ASNR)	Nil
Contour-Based Technique Texture-Based Technique Knowledge-Based Technique	Nil	Hybridizations of Multi Objective Optimization techniques

VI. CONCLUSION

The paper presents the comparative analysis of soft computing techniques which are used to detect the edges of the entities present in the image.In this paper, we included genetic algorithm, ant colony algorithm, neural network, neuro-fuzzy genetic and adaptive neuro-fuzzy inference system. The techniques are tested on six standard test images. The peak signal to noise ratio (PSNR) is calculated for GA and ACO techniques. Experimental results show that the PSNR value of GA is higher than the ACO technique. GAs, on the other hand, is relatively more complex and time consuming method. The researchers can further study these techniques to minimize the overall execution time of the techniques. Now a day'sresearchers aremotivated towards this field.

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