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A Review on Image Segmentation Using Different Optimization Techniques

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Abstract- Image segmentation is one of the most significant ways to simplify complex images into human or machine readable form. The main purpose of image segmentation is to extract or segment out particular area or region of image, so that that the analysis become easier regarding its shape, size, and its boundaries. It can also be used to separate foreground image from the background image. Image segmentation has its wide utility for medical image analysis, satellite images, as well in many other fields. Segmentation methods have been applied in various computer vision fields, such as scene interpretation and representation, content based image retrieval, object tracking in videos, medical applications etc. Here various segmentation methods and Optimization techniques are being discussed with their applications in various fields. The work done in the field of image segmentation using Swarm Optimization techniques like Genetic Algorithm, Particle Swarm Optimization, Fire-Fly and many more existing techniques are been discussed in this paper.

Keywords- Image Segmentation; Edge Segmentation; Region Segmentation; Data Clustering; Genetic Algorithm

I Introduction

Image segmentation is a part of pattern recognition which basically deals with identifying sub- patterns or fence off an entire digital image into number of non-overlapping sub regions so that on merging all sub-regions we can obtain the original image [1]. In the process of image segmentation each and every pixel is assigned a label in an image such that certain features or criteria is occupied by the pixel; this basically results in the set of segments that on the whole covers the entire original image. Every pixel in a region are companion to each other with respect to their attributes.

There are various techniques for image segmentation which tries to solve the problem of simplifying the information available in the given image for further processing.

1. Edge segmentation
2. Region Segmentation
3. Data Clustering [2].

Edge Segmentation- Edge based segmentation is basically used to detect the boundaries between two regions of a same image separated on basis of distinguishable on the basics of their grey level features. The correct edge detection is so important for the purpose of image analysis and pattern recognition problem because edges define the physical boundaries of each object in an image. The main concept of edge detection techniques is to work out for the local figure out of an image.
There are many operators like Sobel operator, canny operator, and Prewitt operator etc. with their own distinct mask values to proceed with the edge detection method. The main idea of edge detection is to scale down the volume of data and thus drain out the irreverent data, while retaining only the appropriate information of an image.

(1)Original image (2) Thresholding Based segmentation (3) Edge based segmentation

Fig: 1

Region Segmentation- Region based segmentation us used to break down an image into a number of regions. A classification has to be done for each pixel or pel on the basis of their features and properties to which class they belong. There are number of techniques to perform region based segmentation. Such as region growing, region merging and splitting etc.

Data Clustering- In the field of image segmentation data clustering is one of the mostly used techniques. It has usability not only in image segmentation but also can be used for image compression, pattern recognitions and image retrieval in image processing. With the help of this the whole image is segmented into number of clusters each with a unique class label. The classification of classes can be done on the basis of grey level values, texture, shades, depth

or motion. A numerous clustering algorithm are available for image segmentation which can be used alone or along with some other algorithm. Here the image segmentation can be done using data clustering technique based on image histogram analysis.

II LITERATURE SURVEY

In [3] in this paper a combination of Genetic Algorithm is being presented with OTSU (a thresholding based segmentation method) to gain the more efficient results and to solve the problem of global optimization in image segmentation which is structured as a nonlinear optimization problem. To deal with this difficulty a metaheuristic approach of Genetic Algorithm is used. Threshold value, CPU Time and Region Non Uniformity are the parameters on which basis the results are analyzed [3].

In [4] In this paper the a new technique has been proposed i.e. the use of ant colony optimization technique for image segmentation with hybrid K-means clustering method to overcome the problem of global optimization related to genetic algorithm. The results of previous existing techniques and proposed methodology are being compared in the form of PSNR values, MSE and Bit Error Rate [4].

In [5] in this paper genetic algorithm are used to get the accurate position and size of the area which is affected by cancer. The main aim of this paper is to ease the information extraction from the study of MR images. With passing time is has been observed that the study of MR images is typical due to the complexity in shapes and the overlapping between liver and other organs. It proposes the time reduction as well as the human effort reduction while studying the MR images. To compare the results of proposed genetic algorithm, the watershed technique is used as the base technique [5].

In [6] in this paper, hybrid of genetic algorithm and particle swarm optimization are used to optimize the results received by segmentation of medical images using Fuzzy c-mean and KFCM which are compared on the basis of quality parameters like: Rand index, global consistency error and variance [6].

Table (1) Summary of related work

	Technique used	**Problem**	**Improvement**
[3]	GA	To deal with non-linear optimization problem	Better Threshold Value, CPU Time, Region non Uniformity
[4]	ACO	To deal with global optimization	Improved PSNR, MSE, BER Values
[5]	GA	The complex study of MR Images; over-lapping of organs.	Accurate position and size of affected area.
[6]	GA + PSO	To get optimized result.	Better results as Rand index, global consistency error and variance

III CATEGORIZATION OF SEGMENTATION

Object-background Model - In image processing the extraction of foreground is an important task for further processing or for the detailed study of image for object recognition, this can be done with the help of 'Background Subtraction' technique which is also called 'Foreground Detection'. After preprocessing of image, to extract the 'region of interest' which is generally an object or positioning of object in images this technique can be used. For the detection of moving objects from the videos of static camera background subtraction technique is used. Object background models are basically primitive models based on histogram thresholding for image segmentation. Where image histogram represents the spectral variations, which is the main reason why image histogram is chosen for delineation of object in an image. Therefore determination of accurate threshold between background and object is an important task to identify the object from an image. Image model is being followed by number of threshold based method [7].

Markov Random Field Model- Markov random field (MRF) has a strong theoretical background, in visual processing and interpretation to make available the fundamentals for constructing contextual constraints. In the field of image processing the main concentration of MRF is on computer vision problems; like image restoration in low-level processing, image segmentation in medium-level processing and object matching and recognition in the high-level processing. In the medium-level domain for the purpose of image segmentation, MRF is defined over a nearest neighborhood. Multi-variant Gaussian distributions are used to display the image features. Here the Gaussian parameter's set is to describe the different texture types. On the basis of prior learning of all possible parameters, the textures can be categorized or recognized. If here is no training data available then parameter estimation can emerge as a difficult task.

Particle Swarm Optimization- Particle swarm optimization (PSO) is one of the techniques from swarm intelligence which are introduced by Kennedy and Eberhard in 1995 to solve optimization problems. PSO imitates the nature of bird flocking and fish schooling to direct the particles in finding the global optimal solutions. Means a number of birds are randomly trying to find a single available piece of food (solution) in that area (search space).

PSO can be described with the help of three simple behaviors of bird flocking which are separation, alignment and cohesion. Number of particles, position of agent in the solution space, velocity and neighborhood of agents are some of the parameters on which PSO works [8]. There are two "best" values in PSO to update each particle; those are pbest i.e. the personal best solution found by that particular particle and gbest is the best value among all the neighbors of that particle achieved so far. pbest value is the local best whereas gbest is the global best value [9].
In the field of Image processing PSO can be used to solve problems related to pattern recognition, to make a comparison between different clustering algorithms, a PSO based approach can be used to resolve the color image quantization problem.

Neural Model- Neural systems depend on reenactment of human mind preparing component called as Neurons. The structure of a neuron is appeared in the fig-1. Rectangular pieces compare to include increased by weights (Wi) and F compare to limit capacity and z relate to direct whole of weights increased with relating input. One can fabricate a system by expanding the quantity of neurons and number of layers or yields, including curved pieces in even and vertical mold. Layers in the middle of info and yield layers are known as concealed layers. The premises of Neural arrange lies in preparing of neural system. The point of preparing is to display the procedure of information era to such an extent that it can foresee the yield for unanticipated information. Preparing is for the most part related with regulated strategy. Nonetheless, unsupervised system can likewise be detailed [7].

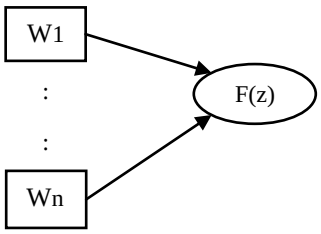

Figure.2 Structure of a Neuron

Ant Colony Optimization-Ant colony optimization (ACO) is basically a part of metaheuristic approach introduced by Marco Dorigon in 1992, this is simply inspired by the Ant System (AS) that is by the foraging behavior of real ants. There are four main components of this algorithm (ant, pheromone, daemon action and decentralized control) which construct the whole system. Here ants are the visionary agents that are used to imitate the expedition of the search space and profiteering from it. Ants spread a chemical material over the path they travel in the search space and its intensity changes due to evaporation over the time, this chemical material is known as pheromone. The intensity of the trail is indicated by the amount of pheromones dropped by ants in ACO, path with the higher intensity of trails provides the direction to the ants to move further. Assume the global memory of the system as the intensity of trail. For the purpose of collecting global information Daemon action is being used which is not possible to be done by a single ant and use the information to figure out whether it is mandatory to add extra pheromone for the purpose of convergence. The fourth component is taken in order to provide the robustness and flexibility to the algorithm within a dynamic environment, this service is provided by the decentralized control. The need of Decentralized system in ACO is because it provides flexibility in the face of ant lost or ant failure generally occurred in such type of systems. These components of Ant system plays an important role to a cooperative interaction that results to emergence of shortest path as a final outcomes of the ACO algorithm inspired by the Ant system [8].

Fire fly Algorithm- Fireflies are one of the most beautiful and attractive flies which generates a short and rhythmic flash light. This algorithm was brought in notice by Xing She Yang in 2008. It is not necessary that every firefly have same attitude of flashing. This flash is communicating and attracting each other by the flies. This algorithm proves to be one of the best algorithms in solving the optimization problem.

Three assumptions that has to be made for this algorithm re as follows-

- A firefly attracts to another firefly disregarding of their sex, as all fireflies are assumed to be unisex.
- The firefly with less intensity of flash attracts towards the firefly with higher intensity of flash, as it is assumed that the intensity of flash is directly proportional to attractiveness.
- Landscape of the objective function is the factor by which the intensity of flash is determined or affected [10].

Fuzzy Model- Fuzzy was firstly introduced in 1960s and 70s by Zadeh. It was introduced to overcome the short comes faced by the use of set based on crisps values set. As in traditional model the set theory and computational logics was only able to work in a bounded criteria based on only two values (black or white) no intermediate values (grey). It only works on either true (yes) or false (no); no other values were accepted by that model. This problem was totally removed by fuzzy logic or fuzzy set. Fuzzy models are used in many processing stages like image retrieval, object recognition and even in image segmentation etc. It provides an accurate bounder or edge detection with a fine segmentation of an image.

Animal Migration Optimization-Animal Migration Optimization (AMO) is one of be newly introduced nature inspired algorithm tossed by Li in 2013 used to solve the Optimization Problem and even provides good results for various optimization problems. It mimics the phenomena of animal migration either by changing their position or by individual replacement for optimal solution over the time. Animal migration process and animal updating process are the parameters on the basis of which we can divide Animal migration algorithm. The migration of group of animals from current place to another new place is demonstrated by the animal migration process; whereas how the animals are being updated using probabilistic method is demonstrated by the population updating process [11].

Animal Migration Process- Three rules are to be followed during animal migration process:

- Collision with neighbors should be avoided.
- Follow the same direction as their neighbors.
- Their neighbor should be near to them.

Population updating process- During this process, the algorithm shows how few animals migrate form the group and get merged with the new population. The replacement of individual with some new animals is done with a probability which is decided according to the quality of fitness [11].

Genetic Algorithm- Genetic Algorithms are the heuristic inquiry and streamlining procedures that copy the procedure of characteristic advancement. Subsequently hereditary calculations execute the advancement techniques by recreating development of species through characteristic determination .The essential idea of Genetic Algorithm is to emulate the idea of the 'survival of the fittest'; it reproduces the procedures saw in a characteristic framework where the stronger has a tendency to adjust and survive while the weaker has a tendency to give-up. GA is a populace based approach in which individuals from the populace are positioned in view of their answers' wellness. In GA, another populace is shaped utilizing particular genetic operators, for example selection, crossover and mutation [8].

Selection- Inspired by the role of natural selection in evolution -- an evolutionary algorithm performs a selection process in which the "fit" members of the population survive, and the "least fit" members are eliminated. In a constrained optimization problem, the notion of "fitness" depends partly on whether a solution is feasible (i.e. whether it satisfies all of the constraints), and partly on its objective function value. The selection process is the step that guides the evolutionary algorithm towards ever-better solutions [12].
Common selection methods are:

a. Roulette wheel selection.
b. Rank selection.
c. Tournament selection.
d. Random selection.
e. Boltzmann selection.
f. Stochastic Universal sampling.

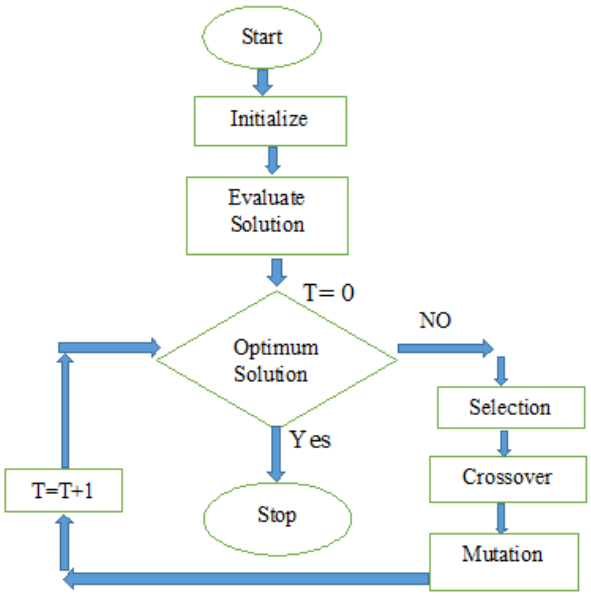

Fig.3: Flow Chart of Genetic Algorithm

Crossover- Motivated by the part of sexual multiplication in the development of living things – a transformative calculation at-entices to consolidate components of existing arrangements so as to make another arrangement, with a portion of the elements of every "standard ent." The components of existing arrangements are joined in a "hybrid" operation, roused by the hybrid of DNA strands that happens in proliferation of Biological creatures.
Similarly as with transformation, there are numerous conceivable approaches to play out a hybrid operation - some vastly improved than others - and the Evolutionary Solver really utilizes various varieties of two distinctive hybrid techniques [12].
The different hybrid procedures are:

a. Single point crossover.
b. Two point crossover.
c. Multi-point/N-point crossover.
d. Uniform crossover.
e. Three point crossover

Mutation- Inspired by the part of transformation of a living being's DNA in normal advancement – a developmental calculation periodically rolls out irregular improvements or changes in at least one individual from the present populace, yielding another hopeful arrangement. (This might be preferable or more terrible over existing population individuals).

There are numerous conceivable approaches to play out a "change," and the Evolutionary Solver really utilizes three distinctive mutation procedures. The consequence of a transformation might be an infeasible arrangement, and the Evolutionary Solver endeavors to "repair" such an answer for make it achievable; this is now and again, however not al-ways, fruitful [15].

The different change administrators are:

a. Flipping. ++
b.
c. Interchanging.
d. Reversing

IV CONCLUSION

In this paper various segmentation and optimization techniques are discussed. A comparison is done among few of them. It is observed that each technique has its advantages and disadvantages which may vary according to the application area in which it has to be used. The degree of accuracy in the results obtained by the use of model of segmentation or any optimization technique somewhat depends on the kind of image on which they are applied and in which circumstances. According to the requirement of problem even there combinations can be used in a framework to obtain better desired results.

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