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A LITERATURE REVIEW ON HEURISTIC ALGORITHMS IN IMAGE SEGMENTATION APPLICATIONS

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Abstract

Segmentation is characterized as the process of dividing an image into distinct parts. Segmentation is utilized to identify an object or extract relevant information from digital images. Thresholding is a simple image segmentation methodology which yields a binary output from gray scale input images. In this paper, a literature review on various heuristic algorithms such as Firefly algorithm, Cuckoo search algorithm, genetic algorithm, artificial fish swarm algorithm, Swarm intelligence algorithm etc.

Keywords: Firefly algorithm, Cuckoo search algorithm, genetic algorithm, artificial fish swarm algorithm, Swarm intelligence algorithm.

I. Introduction

Segmentation is the procedure by which an image is grouped into various units that are homogeneous with respect to one or more characteristics. It is an important task in image processing applications. The main objective of segmentation is to simplify the image into a form which is more meaningful and easier to analyze. Segmentation allows us to analyse an object or region in a more meaningful manner. Image segmentation can be done by three distinct methodologies. They are- Intensity based segmentation, Edge-based segmentation, Region-based segmentation. Thresholding is the most commonly used intensity based image segmentation technique which converts gray scale images into binary image. [1] The performance of thresholding algorithms mainly depends on selection of threshold value. Various statistical properties such as maximum likelihood, moment, entropy and between class-variance has been utilized for selecting a proper threshold.

Automatic global thresholding can classified into six groups-Histogram shape based method, Clustering method, Entropy based method, Objective attribute based method, Spatial method and local methods.[2] Histogram shaped methods are those in which the information regarding peaks and valleys are extracted from the smoothed image. Clustering method will model the histogram as a mixture of two Gaussian density functions. Otsu is a most commonly used clustering strategy. Entropy based method utilizes either the entropy of object and background regions or between the original and binary image. Kapur is most widely used entropy based segmentation. Object attribute based method examines the similarity between gray level and binary image. Spatial methods utilizes the spatial information about the pixels.

The rest of the paper is organized as follows. Section II explains about existing heuristic algorithms for image segmentation applications and conclusion is provided in section III.

II. Prior work

[3] Thresholding is the methodology which is used to segment an image and isolate regions of interest from an image. Threshold values and number of class's parameters mainly affects the segmented output. In this paper, Sridevi.M et al has put forward a novel methodology utilizing evolutionary computing to select optimum threshold value. In order to reduce the processing time, the proposed strategy disintegrates the source image utilizing genetic algorithm. The segmented output will be then finally mapped onto the original image. The proposed strategy is compared with other multi-level thresholding methodologies such as GA-Otsu, GA-Kapur and wavelets. Experimental outcomes illustrates that the proposed methodology consumes less time and yields better results when compared to existing methodologies.

[4]In this paper, Paulo S. Rodrigues et al has put forward a novel segmentation technique that utilizes a non-extensive Tsallis entropy as a kernel in the firefly algorithm. Conventional firefly algorithms are swarm based meta heuristic approach which is inspired by fireflies. In order to improve the efficiency of the firefly algorithm, the author has proposed a non extensive Tsallis entropy approach for multi-thresholding which is more efficient than conventional cross entropy approaches. In this paper, the author has initially pointed out and examined the main downside of firefly methodology. The major downsides of conventional firefly algorithms are -low convexity, Harder to search for partitions in the search space under the presence of plateaus.

The arguments has been built which starts from a continuous version of the minimum cross-entropy for the 1LOTP. For 2-modal symmetric Gaussian functions, it is better to utilize traditional real time analysis techniques to show that any

intensity value near the ideal one is a candidate to solve the optimization problem. The only solution for this problem is to improve the convexity of the objective function. Therefore, entropy-based approaches has been proposed in this paper. In this paper the author has compared five evaluation functions such as cross-entropy, exponential cross-entropy, modified cross-entropy, Shannon and Tsallis entropies. Experiments were conducted on classical images and synthetic data obtained through 2-, 3-, 4- and 5-modal Gaussians.

[5] Image segmentation is a vital technology in image processing applications. Among the existing segmentation strategies, thresholding methodology is the simplest and most efficient technique. Though, thresholding methodology utilizing two dimensional histogram yields better outcomes than one dimensional histogram, it is a time consuming process. To overcome the above downside, the Yezhiwei et al has put forward a novel approach for two dimensional threshold selections that utilizes artificial fish-swarm algorithm and two-dimensional Fisher function criterion. The Artificial fish-Swarm is a augmentation algorithm that imitates fish-swarm behavior. Experimental analysis demonstrates that artificial fish-swarm algorithm can successfully determine the ideal threshold in order to segment images. The proposed approach is important in applications that requires real time processing. The author has concluded by stating that the proposed approach can be extended to solve generic image segmentation problems.

[6] Recently, Rajinikanth et al. proposed a detailed comparative study on PSO and BFO algorithm based bi-level and multi-level thresholding for a class of standard gray scale test images. They also proposed the Bat Algorithm (BA) based image segmentation procedure. The author has attained the optimal thresholds by maximizing Otsu's between class variance function.

The performance is demonstrated by considering five benchmark (512 x 512) images such as mandrill, bridge, living room, crane and bee and compared it with the existing algorithms such as Particle Swarm Optimization (PSO), and Bacterial Foraging Optimization (BFO) . The performance evaluation of the BA, PSO and BFO algorithms is carried out by utilizing quality metrics such as objective function, Peak Signal to Noise Ratio (PSNR), and Structural Dissimilarity (SSIM) index. Qualitative and quantitative analysis illustrates that BA provides better objective function, PSNR and SSIM compared to PSO, and BFO.

[7] Thresholding is a prevalent image segmentation technique that changes gray-level image into a binary image. The determination of ideal thresholds has remained a test over decades. Most of the traditional methods inspect the histogram

of the image. The ideal thresholds are regularly found by either minimizing or maximizing an objective function concerning the values of thresholds. In this paper, Sathya.P. Duraiswamy et al has proposed a molecule swarm optimization (PSO) for multilevel thresholding. This algorithm is utilized to maximize the Kapur's and Otsu's objective function. The execution of the PSO algorithm has been tried on ten sample images and it is observed to be predominant than Genetic Algorithm(GA).

[8] An essential strategy for image processing and design acknowledgment is multilevel thresholding. In this paper Ming-Huwi Homg et al has put forward multi level thresholding by utilizing Artificial Bee Colony algorithm. The effectiveness of the proposed methodology is compared with distinct routines such as- the particle swarm optimization (PSO), the hybrid cooperative-comprehensive learning based PSO algorithm (HCOCLPSO), the Fast Otsu's method and the honey bee mating optimization (HBMO).

Experimental analysis illustrates that the proposed algorithm can eliminate numerous thresholds which are near the ideal ones. On comparing MEABCT with four thresholding strategies it is obvious that the MEABCT has enhanced the quality of segmented image and also the calculation time is shorter for proposed algorithm.

[9] In this paper, P.D. Sathya et al has put forward Bacterial Foraging (BF) algorithm which utilizes Tsallis objective function for multilevel thresholding. This paper concentrates on the development of a novel optimal multilevel thresholding algorithm which is suitable for multimodal image histograms. Bacterial foraging algorithm is an emerging methodology which is utilized to solve multidimensional global optimization problems.

The main idea behind foraging strategy lies in the assumption that the animals should search for and procure nutrients in such a way that the energy intake per unit time is maximized. This foraging methodology has been framed as an optimization problem by using optimal foraging theory. The proposed strategy has been compared with particle swarm optimization (PSO) and genetic algorithm (GA) algorithms. Experimental outcomes illustrates that the proposed methodology outperforms PSO and GA by maximizing the objective function and Peak Signal to Noise Ratio (PSNR). Also BF algorithm converges at a faster rate than PSO and GA algorithms, thereby enhances stability.

[10]In this paper, Sanjay Agrawal et al has put forward a novel approach to determine a optimal threshold for multi level thresholding by maximizing the Tsaalis entropy utilizing cuckoo search algorithm. This method is imagined as a constrained optimization problem. The solution to the proposed strategy is determined by converging meta-heuristic

search algorithm. Cuckoo search algorithm is inspired by brood parasitism of certain cuckoo species that lays their eggs in nests of other host birds which are found in different places. The results of proposed algorithm are compared with Bacteria Foraging Optimization(BFO),Artificial Bee Colony(ABC) algorithm, Particle Swarm optimization (PSO)and Genetic Algorithm(GA). An important feature of the proposed strategy is that Tsallis entropy utilizes global and objective property of the image histogram easily. Qualitative and quantitative analysis demonstrates the effectiveness of the proposed strategy. The author has concluded by stating that the proposed strategy can be extended to applications such as image enhancement and image fusion.

[11] In this paper Diego Oliva et al has put forward a multilevel thresholding (MT) algorithm which utilizes harmony search algorithm (HSA). HSA is an emerging evolutionary strategy which resembles musicians who improvise new harmonics while playing. HAS algorithm exhibit improvised search capability with low computational overhead. The proposed strategy encodes arbitrary samples from a plausible search space inside the image histogram and are assumed as candidate solutions. the effectiveness of the proposed strategy is assessed quantitatively by considering objective functions that are utilized by the Otsu's or Kapur's techniques. Followed by this, a set of candidate solutions are chosen through HSA operators until an ideal solution is determined. Qualitative and quantitative assessment illustrates that the accuracy of the proposed strategy. The author has provided a comparison between two versions of HSMA. The first one utilizes the Otsu as the objective function while the other one uses Kapur as the objective function. Outcomes illustrates that otsu function yields better results than Kapur function. The proposed algorithm has been compared with various optimization algorithms such as GA, PSO and BF to demonstrate the effectiveness of Harmony Search Algorithm.

[12] In this paper, S. Gopinathanet al has initiated to study various thresholding methodologies which can perform thresholding automatically. Segmentation is the strategy of decomposing an image into multiple segments. Thresholding and clustering are the major image segmentation techniques which are based on gray level histogram of an image. The gray level image can be converted into a binary image by choosing a proper threshold. Certain methodologies that determines the threshold automatically are Otsu, Kapur, Triangle, Iterative and manual thresholds. The author has utilized the above methodologies to segment different types of images like like X-ray, Computed Tomography (CT-Scan), magnetic resonance imaging (MRI), synthetic aperture radar (SAR) and Ultrasound. Experiments were conducted on the above medical modalities to illustrate the validity of the methods.

III. Conclusion

In this paper, various heuristic algorithms has been reviewed from the most recent published research work.

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