**https://doi.org/10.46335/IJIES.2023.8.3.9** **e-ISSN: 2456-3463**
**Vol. 8, No. 3, 2023, PP. 46-51**

***International Journal of Innovations in Engineering and Science, www.ijies.net***

# Multi-Level Thresholding in Image Segmentation Using Remora Optimization Algorithm

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***Received on**: 29 March, 2023* ***Revised on**: 17 April, 2023* ***Published on**: 19 April, 2023*

***Abstract –*** *Image processing is commonly used to record more information that can be understood by humans or machines such as computers. Segmentation, thresholding and edge detection are important techniques used in computer aided vision and image processing. In digital images, visual search or subtraction can be done to reveal inconsistencies in the image to prove authenticity. To analyze the image more easily, the threshold is processed, which is a type of image segmentation that the pixel changes in the image to form the image. Initially, a color or grayscale image, for example, is converted to a binary image.*

*So, simple black and white pictures. According to the number of image segments, the method can be divided into two groups: two-layer and multi-layer. In two-layer thresholding, the image is divided into two regions. In this type of measurement, pixels with a gray value greater than a certain T value are classified as target pixels, and other pixels with a gray value below T are classified as background pixels. And multi-level thresholding is a technique that separates grayscale images into different regions. It sets multiple thresholds for an image and splits the image into some bright areas, changing the background and more. This method is suitable for objects with colored or complex backgrounds where two layers cannot produce good results. This article is designed to improve image recognition performance for Remora optimization algorithm at various levels in image segmentation technology.*

***Keywords-*** *Remora Optimization Algorithm for Multi-Level Thresholding in Image Segmentation (ROA-MTIS), Harris Hawks Optimization (HHO).*

## INTRODUCTION

Image segmentation plays an important role in image processing and multi-level image segmentation is one of the most effective image processing methods. Image segmentation in computer vision is used for most inspection or evaluation tasks in image processing and analysis. Dividing a digital image into different parts and separating the region of interest is an important area known as image segmentation. The basis of the image segmentation algorithm is the similarity principle or the discontinuity rule. In order to analyze images in detail, a multi-stage method based on Bee Acquisition Algorithm (BFA) for image classification is proposed.BFA is a meta-heuristic optimization algorithm inspired by the behavior of bees. The bee colony is divided into two groups of three types of bees according to a fixed ratio in order to reduce the number of control parameters and

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improve the use of the algorithm. Experimental results show that BFA is an efficient and robust multi-step algorithm [1]. Developing the ACOR algorithm based on 27 random backup strategies called RCACO and the chaos amplification strategy. When RCACO is applied to solve 29 consecutive OPs, the random backup strategy increases the convergence of the algorithm by 30.Using RCACO with the original ACOR, a well-known algorithm and enhancement algorithm, image segmentation is implemented at a low threshold and a high threshold.

When the segmentation results with PSNR, SSIM and FSIM are evaluated according to whether the threshold is low or high, all the results of RCACO-based segmentation are better than those based on other algorithms, and RCACO can achieve stable work at different rates. degree [2]. The improved cuckoo search image segmentation algorithm is used to solve the problem of weak image segmentation effect at many thresholds. First, image segmentation is explained, followed by chaotic population initialization, optimization of steps and probability selection. Masi entropy is a popular technique for determining the appropriate threshold for image thresholding.However, as the number of thresholds increases, the performance of Masi entropy-based multilevel thresholding algorithms becomes problematic.

To overcome this problem, we present a new method of difference-in-difference (DE) algorithm based on population-based metaheuristic performance for multilevel image thresholding based on Masi entropy. Finally, the maximum entropy threshold function in image segmentation is solved as an enhanced cuckoo search function. Experiments show that using the enhanced cuckoo search for image segmentation produces good results [3]. used a new method called MCET-HHO, based on the HHO meta-heuristic algorithm for multi-level segmentation.The optimization plan to find the best solution for the task was inspired by Harris' negative behavior based on the cross-entropy minimization process. If the threshold number follows the image detail, the MCET-HHO algorithm performs better as it allows precise segmentation while paying attention to the details that define the area of â€‹â€‹the image. Also, good results can be obtained if the gray level distribution in the histogram allows to identify areas with stronger groups than opposing groups.

The greater the difference between one intensity and the other, the harder it is to control the difference between the two images, keeping the main points similar to the original image, as it is easier to locate the starting point [4]. To find the best for grayscale images using the Thresholding method, a new meta-heuristic evaluation algorithm is used as it is suitable for solving large problems.The performance of the algorithm is compared to seven available algorithms by applying the algorithm to a set of quality images obtained from the Berkeley Segmentation Dataset (BSD) with a threshold of 2 to 50. size of the proposed algorithm outperforming other existing algorithms.

The proposed optimization algorithm, Balanced Optimizer (EO), can outperform all other algorithms in the parameters used to evaluate the quality of fragmented images at each threshold level [5]. A multi-level competitive approach based on 3D Tsallis entropy has been shown to be effective for optimization due to its aggressiveness, using new research called Attacking Manta Ray Gathering Optimization (AMRFO). This additional power makes the Manta Ray more rigid during the search to avoid the minimums in its path and move towards the optimum solution.The convergence of AMRFO is also advantageous compared to other cutting-edge algorithms. Since the 3D structure of the histogram stores more boundary information [7], the proposed method improves the output. Remora can be a unique animal that can swim with different sea creatures, pelagic boats and whales.

This search can save work and save you from enemy attacks. It is usually carried in hot water, although it follows its hosts to grow in contaminated water.Remora is best served by other fish or invertebrates. As for the gravity-rich ocean, it breaks off from its owner, eats its food, and then swallows it with its new owner and moves to another ocean. But sometimes like doing laundry, it is often eaten by food or ectoparasites, which makes up the outside of the transport. A new bionic optimization algorithm ROA is proposed. Inspiration is remora.Simulated the lifecycle of parasite feeding on multiple hosts. Choose two strategies with the best results and the best of movement - alternating whale and swordfish between different species.

In addition, an announcement of regret is planned to facilitate local reforms. This method for designing and building optimization introduces the Remora Optimization Algorithm (ROA), a new meta-heuristic optimization algorithm inspired by the "intelligent" remora in the ocean. From the concept of remora's parasitic disease and random host change, a framework based on remora has been developed [8].

https://doi.org/10.46335/IJIES.2023.8.3.9 e-ISSN: 2456-3463
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## LITERATURE REVIEW

**1. Multilevel thresholding based on bee collection algorithm for image segmentation:**

Multilevel thresholding is a simple image segmentation method. Determining the best method for multi-level measurement requires constant research and time. To improve foraging performance, this article proposes a population-based multi-level basic bee foraging algorithm (BFA). The proposed algorithm provides different flight paths for different bee species and uses single segment and multi segment search aiming to achieve a balance between usage and search. The colony was divided into several groups to increase diversity.

Social mitigation strategies are used to reduce recession and increase speed. The tests are performed with eight tests using different classes as test parameters. The performance of the proposed algorithm is compared with some state-of-the-art meta-heuristic algorithms. The results show that BFA is efficient and robust, produces good results with few restrictions, and outperforms other algorithms reviewed in this area on most of the test images.

**2.Chaotic Random Alternative Ant Colony Optimization :**for Two-dimensional Kapur Entropy Multithreshold Image Segmentation Although the implementation of the Ant Colony Optimizer (ACOR) has been successful for many problems, there are still improvements in its method, stability, and improved integration. and precision parts. Also, it is easy to stagnate, which means it cannot escape the local optimum (LO). To effectively mitigate these concerns, a method using a stochastic backup strategy and a chaos enhancement strategy has been developed. Also, our research reinforces his choice. In the new component, the convergence speed has been improved using only a random backup method. To improve the ability to detach from the LO and improve the accuracy of the joint, additional stress and selection improvement are applied to the ACOR.

Comparative experiments were conducted using 30 performance indicators to verify the effectiveness of the proposed method. It is clear from all the experimental results that the connection speed and accuracy of the proposed method is better than other similar methods. In addition, the RCACO system was found to be more reliable than other methods in excluding LO. Additionally, this article proposes several basic image segmentation methods. In this case, low-level and high-level image segmentation experiments are also performed. Experimental results also show that the segmentation results of RCACO images, low- and high-level classification are more satisfactory when compared with other search algorithms.

**3.Cuckoo Search with Differential Evolutionary Mutations and Masi Entropy for Multilevel Image Segmentation:**

Since the twentieth century, the cuckoo search (CS) algorithm has emerged as a powerful, flexible, fast and easy-to-do process for global search to solve many problems. things. persistent problem CS works like other Nature Inspired Algorithms (NIOAs) whose performance depends on the research and development phase. CS has demonstrated its effectiveness in solving optimization problems in many applications. In this study, the authors sought to increase the effectiveness of CS by combining six different differential evolution (DE) strategies. The results of this comparative study provide good insights and information for constructing different CS strategies using DE strategies or alternating strategies.

**4.The image segmentation method inspired by Harris Hawks:**

Segmentation is an important step in image processing as it simplifies the representation of images and facilitates their analysis. Compared to conventional bi-level thresholding, multi-level thresholding is more effective in segmenting digital mammograms because it uses more energy to represent different regions in the image. There are different types of segmentation in the literature; But most of these models can't take good pictures. Also, they are very expensive.

Recently, statistical methods such as Otsu, Kapur, and cross-entropy have been used in conjunction with evolutionary and population-based strategies to learn best multilevel partitioning. In this paper, a quantitative multilevel segmentation method is proposed using the Harris Hawks Optimization (HHO) algorithm with minimum cross entropy as a power function. It has been tested on standard images, Berkeley segmentation database and digital mammography medical images to demonstrate the effectiveness and efficiency of the HHO-based method. The proposed HHO-based solution is validated with other criteria and two machine learning algorithms K-word and Fuzzy IterAg. Comparisons were made between the three groups.

The first is to provide evidence of HHO optimization capability using the Wilcoxon test and the second is to verify segmented image quality using PSNR, SSIM and FSIM measurements. Then the third method is to compare the fragmented image with the ground truth by measuring PRI, GCE and VoI for

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Vol. 8, No. 3, 2023, PP. 46-51



analysis. Experimental results confirmed by statistical analysis showed that the teaching method produced good and reliable results in terms of quality, consistency and accuracy when compared to another method. This HHO-based approach improves on other segmentation methods currently used in the literature.

**5.A New Balanced Optimization Algorithm for Multithreshold Image Segmentation Problems:**

Image segmentation is considered an essential step in image analysis and research. Many techniques have been proposed to solve current problems and improve research quality, such as region-based, threshold-based, edge-based, and feature-based clustering in data. Because of the ease of image segmentation, researchers turned to thresholding techniques.

To find the best feature for grayscale images, we developed and used a new meta-heuristic method to solve this research problem. In addition, our improved algorithm can significantly improve the accuracy of segmented images for scientific research. The performance of our algorithm is compared to seven other algorithms such as whale optimization algorithm, bat algorithm, sine-cosine algorithm, salp swarm algorithm, Harris Eagle algorithm, crow search algorithm, and particle swarm optimization.

Based on the image quality test method derived from the Berkeley Segmentation Dataset, the performance of our algorithm and the well-known algorithms mentioned above are evaluated and compared. Based on independent results and analysis for each algorithm, our algorithm outperforms all other algorithms in terms of fitness value, peak signal-to-noise ratio measurement, standard deviation measurement, maximum error, and signal-to-noise ratio. However, our algorithm cannot reach some algorithms in terms of standard deviation value and CPU time and finds a large threshold.

**6.Berkeley Segmentation Dataset:**

The purpose of this study is to provide an empirical basis for image segmentation and boundary delineation research. To this end, we collected 12,000 hand-labeled segmentations of 1,000 Corel dataset images from 30 human subjects. Half of the segmentations were obtained by presenting the subjects with color images; the other half is to bring out the gray image.

Overall benchmarks based on this data include all grayscale and color segmentations of 300 images. The images were divided into a training set of 200 images and a test set of 100 images. We used this knowledge to develop new boundary detection algorithms and benchmarks for the task. In the spirit of shared learning, we are committed to maintaining a public database of results.

**7.Multilevel Threshold of Brain MR Images Used Against Manta-ray Gathering Optimization Based on Maximum 3D Tsallis Entropy:**

Multilevel image thresholding techniques using 1D or 2D Tsallis entropy have limited accuracy. To overcome this problem, we propose a multilevel threshold based on the maximum 3D Tsallis entropy. The concept of 3D Tsallis entropy is introduced.

Unlike 1D/2D Tsallis entropy, the 3D Tsallis entropy based method is more powerful and efficient even at low SNR and contrast. The Manta Ray Foraging Optimization (MRFO) algorithm is a new algorithm that solves optimization problems by simulating Manta Ray fish technology in the ocean through a mathematical model.

Due to the insufficient strength of the search team at the MRFO, they could not escape the local minimum and landed on it. To make this algorithm more efficient for segmentation, we introduce a new technique called Attack Manta Ray Gathering Optimization (AMRFO). A set of functional evaluation models and integrated functions (CEC 2014) are used to meet the requirements of the AMRFO algorithm. Statistical analysis was performed using Wilcoxon's signed rank test and Friedman's rank sum test. Interestingly, the results show that the proposed AMRFO outperforms the most advanced optimization algorithms.

In addition, the proposed method is compared with the 1D/2D Tsallis entropy-based method. For the experiment, 100 test images from the AANLIB MR image dataset were considered. Our method outperforms 1D/2D Tsallis entropy based methods. The proposed strategy can be useful for segmentation of multispectral color images.

**8.Remora optimization algorithm:**

In this paper, Remora optimization algorithm (ROA), a new algorithm based on biomimicry, natural heuristics and metaheuristics, is proposed. ROA is usually caused by parasitic behavior of fish. Adapting to different habitats in different hosts: In some large hosts, the Remora feeds on the host's ectoparasites or remains and hides from natural enemies such as large whales. In some small homes, fish follow the host and move to a nutrient-rich area for livestock, eg fast fish eating. For these two innovations, remora has also been evaluated

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based on experience. If it actively hunts, it updates the host and does a global update.
If it eats around the host, the remora does not change the host and continues to adapt locally. It is thought that this algorithm will give a new idea to more meme algorithms because the owners in ROA are boats, turtles etc. as well as changeable. The dynamic model and behavior above was simulated mathematically and the effectiveness of ROA was tested with 29 questions and 5 engineering questions. A comparison was made with the other 10 case heuristics. The analysis and comparison results show that ROA is extremely promising and competitively strong compared to other cutting-edge heuristics.

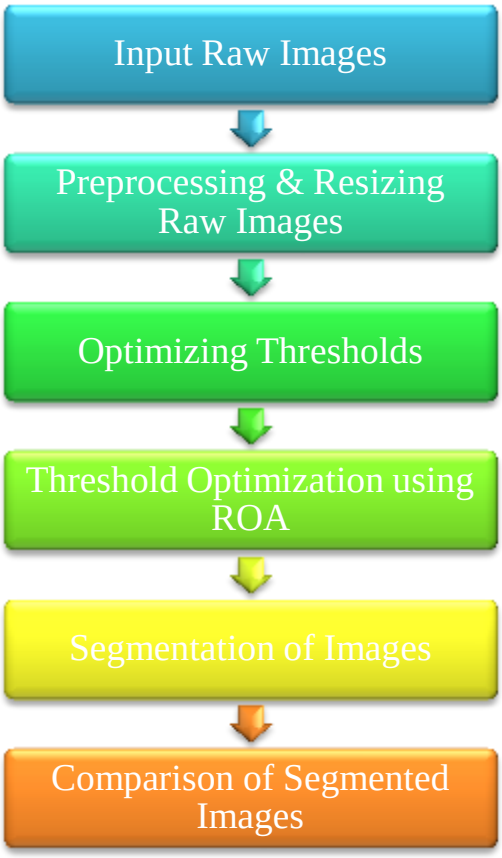
**Background of the Research:**

Image segmentation is an important factor enabling detailed analysis of images [1]. One of the most popular methods of image segmentation is multilevel thresholding, where the process is determined to divide the image into different classes [2]. However, the complexity of the computation increases when the required threshold is high [3]. In 2020 Rodríguez-Esparza et al. [4] proposed a multi-level classification method using the Harris Hawks Optimization (HHO) algorithm and the minimum cross-entropy as a power function. It has been tested on standard images, Berkeley segmentation database and digital mammography medical images to demonstrate the effectiveness and efficiency of the HHO-based method. Experimental results confirmed by statistical analysis showed that the teaching method produced good and reliable results in terms of quality, consistency and accuracy when compared to another method. 2021, Abdel-Basset et al.
, [5] proposed a meta-heuristic algorithm to find the best for grayscale images. This improved algorithm can significantly improve the accuracy of segmented images for scientific research. The performance of the algorithm is evaluated with a set of well-known test images from the Berkeley Segmentation Dataset (BSD).
The algorithm outperforms other algorithms in terms of cost of fit, peak signal-to-noise ratio (PSNR) metric, structural similarity index metric (SSIM), maximum error (MAE), and signal-to-noise ratio (SNR). However, the algorithm is unable to surpass the observed size of the standard deviation (Std) values and the central processing time (CPU).
In addition, the current method cannot obtain well segmented images. All of these prompted us to do this research.

## III- METHOLOGY

Here we aim to present the Remora Multilevel Threshold Optimization Algorithm for Image Segmentation (ROA-MTIS). Here, the input image is taken from benchmark data based on the Berkeley Segmentation dataset [6] used to validate the proposed method. Here, Tsalli entropy (TE) based on the multilevel three-dimensional (3D) Otsu threshold (TE-3D-Otsu) [7] is proposed to obtain the best results for image segmentation.
The proposed Remora Optimization Algorithm (ROA) [8] is used to set the threshold used to classify the image. The proposed ROA-MTIS was applied and performance measures such as squared error, maximum signal-to-average ratio, index of samples, quality ratio, and normalized correlation coefficient were calculated. Finally, the performance of the proposed ROA-MTIS method is compared with existing methods such as Harris-Hawkes Optimization (HHO) [4] and Meta-Heuristic Balance Algorithm (MHEA) for various thresholds in image segmentation. Multilevel Thresholding in Segmentation. (MHEA-MTIS) [5].

**Flow Diagram:**



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*International Journal of Innovations in Engineering and Science, www.ijies.net*

## IV- RESULT & DISCUSSION

A new ROA optimization algorithm is proposed. In this proposed study, several basic image segmentation steps were performed with the Remora optimization algorithm, which is more efficient than other optimization methods. In future work, the improved Remora optimization algorithm is planned to be used for more practical problems such as multi-start image segmentation, feature selection, and is also ready to comment on its various purposes for solving other engineering problems.

## V- CONCLUSION

The ROA method is applied to solve multilevel thresholding image segmentation tasks and obtain optimal threshold values by cross-entropy. The evaluation algorithms of the work is also compared to its peers. Finally, we conclude that the ROA method can generate high quality segmented images, outperforms in terms of segmentation accuracy and is more stable and promising.

The ROA method is used to solve the multilevel image segmentation problem and the cross entropy is matched. The evaluation algorithm of the study is also compared with its peers. Finally, we conclude that the ROA method can produce well segmented images, outperforms other segmentation accuracy methods, and is stable and reliable.

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