https://doi.org/10.46335/IJIES.2024.9.1.16 **e-ISSN: 2456-3463**
Vol. 9, No. 1, 2024, PP. 90-94

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

Masi Entropy Based Multi-Level Thresholding Segmentation: A Review

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***Received on**: 17 March, 2024* ***Revised on**: 20 April, 2024* ***Published on**: 22 April, 2024*

Abstract – *The division of an image into a valuable collection of homogenous subparts is known as segmentation, and it is one of the most important basic steps in image processing applications. While there are many different techniques to segmenting images, thresholding is a common similarity-based technique. However, the majority of current research indicates that when the number of threshold values maximises, temporal complexity is the primary concern. Various meta-heuristic algorithms can be employed to address computational temporal complexity problems. Better convergence is not possible due to exponential growth of the search area caused by concerns with higher dimensionality. Histogram-based techniques are frequently used in the majority of publications to create threshold values. However, there is ineffective spatial correlation between the pixels.Using hybrid methodologies, an efficient multi-level thresholding segmentation will be introduced to produce better image segmentation outcomes.*

Prior to performing multilevel image thresholding, the collected images will be pre-processed using Quantized Haar Wavelet Assisted Histogram Equalisation (QuaWHe) for effective noise removal and image quality enhancement. A set of threshold values will be obtained through multilevel image thresholding using the 2D practical Masi entropy histogram function (2D-MentH). The goal is to identify the best threshold values for improved image segmentation by utilising the Reinforcement Learning assisted fire-fly oriented multiverse optimizer (RL-FF-MVO), which will result in higher segmentation accuracy and lower error rates. To demonstrate the higher performance of the suggested method, it is necessary to compare its performances with those of the current state-of-the-art methods using several performance indicators.

Keywords- Quantized Haar Wavelet Assisted Histogram Equalisation (QuaWHe), 2D practical Masi entropy histogram function (2D-MentH).

I. INTRODUCTION

Image segmentation is one of the most difficult and important steps in pattern recognition or image processing-based applications [1]. Images are divided into different classes based on characteristics such as texture, intensity, contrast, etc. One of the most effective methodologies of the image segmentation approach is thresholding, which is carried out depending on the pixel segmentation of images [2-3]. As a result, it can be used for large-scale applications in different industries such as microscopic imaging, Remote sensing, Infrared imaging, Medical imaging, and so on. On the other hand, if one considers the number of threshold values, bi level and multi level thresholding are two types of categorization forms [4-5]. By using a single threshold value, foreground and background can be distinguished by image division as objects and background.

Multilevel Thresholding uses more than 2 threshold values to divide the images into different classes [6]. Grayscale Thresholding on Image Histogram is a well-known multilevel thresholding approach that is used in many applications. Otsu Thresholding and Kapur Thresholding strategies[7-8] are significant approaches to segmentation based on multi-level thresholding. Segmentation can be used as a part of the pre-processing process in Computer Vision, Object Recognition, Fault Detection, Weather Forecasting etc. Most segmentation approaches depend on similarities and discontinuity[9]. Depending on the grey levels and multi-threshold values, pixel levels are divided into different classes. Traditional approaches affect segmentation quality levels by not adhering to estimated threshold values [10].

The application of conventional techniques for threshold selection is computationally costly since it needs to search over a large sample space in order to find the optimal threshold values [11–12]. In this case, the best threshold values can be chosen using meta-heuristic optimisation approaches [13]. Different multilevel thresholding techniques rely on image histograms, but they have limitations such as insufficient application knowledge and disregard for spatial contextual information, which makes them less effective [14–15]. Generally speaking, threshold-based techniques are used in non-parametric approaches and statistical parameters in parametric methods. In most studies, the additional computational time is overlooked when dealing with large amounts of image data. For better results, there also needs to be a greater focus on process speed and segmentation accuracy.

Most research studies incorporate threshold estimation approach with meta-heuristic algorithms to get this [16]. The majority of scholars have recently shown an interest in using and implementing nature-inspired algorithms to solve real-world and continuous optimisation problems [17–18]. Grey Wolf Optimizer (GWO), Colony Predation Algorithm (CPA), Bat Algorithm (BA), Particle Swarm Optimizer (PSO), Moth Search Algorithm (MSA), Ant Colony Optimizer (ACO), Slime Mould Algorithm (SMA), and other algorithms were inspired by the foraging and leadership tactics of certain social creatures, such as bees, bats, and ants. However, in the current studies, convergence, searching ability, and local optima difficulties are revealed [19–20]. Therefore, an effective multilevel thresholding picture segmentation method is needed for improved

II. LITERATURE REVIEW

Emmanuel and colleagues [21] presented an enhanced GWO for multilayer picture segmentation relying upon levy flight (LGWO). Levy flying strategy's main goal was to solve local optimal problems in order to maximise population variety and prevent early convergence. The Otsu method and the Kapur methodology were used to evaluate LGWO's performance. Peak signal to noise ratio and CPU computational time were used to assess the performances. The PSNR value of the Kapur technique for LGWO was found to be 24.06 for the living room picture, while the threshold range was set between 2 and 8. Higher computational complexity was the main problem our research encountered.

The eight chaotic maps—sine, gauss, singer, chebyshev, logistic, sinusoidal, circle, and tent—were used in the development of the chaotic enhanced rao (CER) method by Olmez et al. [22]. The number of thresholds in the defined CER technique were not identified manually; instead, they were identified automatically. Metrics such as the feature similarity index measure (FSIM), PSNR, structural similarity index (SSIM), root mean square error (RMSE), and others were used to quantify the performances of existing CER techniques. The BSDS300 dataset was used to analyse the performances, and a threshold range of 1 to 20 was used. However, segmentation was not exceptionally accurate, which led to an increase in processing time.

For the best multilayer threshold selection, Li et al. [23] took into consideration the goal functions of fuzzy and Otsu entropy. Fuzzy Coyote Optimisation Algorithm (FCOA) was created after the selection process was completed using fuzzy median integration of neighbourhood data in the local area. In order to produce a differential scaling factor and produce an improved COA, the differential evolution policy of COA was pursued in this study through a number of iterations. Better segmentation quality can be acquired by examining performance metrics such as PSNR, FSIM, and so forth. The threshold range was chosen between 2 and 5. However, during the simulation phase, problems with overfitting and convergence appear.

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In order to determine the ideal multilevel thresholds, Abualigah et al. [24] introduced a hybrid Marine Predators Algorithm (MPA) and Salp Swarm Algorithm (SSA). Using an image histogram, the obtained answers from the suggested model were explained. The SSA operators were hired in order to increase MPA's exploitation potential. Several common metrics, including as PSNR and SSIM, were examined in order to determine the suggested model's efficiency. Two experiment sets with three colour and two grayscale images were used to test the suggested model. Baboom photos have a maximum SSIM of 0.798 when the threshold range is set to 5, however the PSNR results are noticeably ineffectual.

Oppositional learning-manta ray foraging optimizer-vertical crossover (OL-MRFO-VC) is an integrated methodology that Ma et al. [25] presented for colour picture segmentation. To assess the effective configuration in each image, the suggested technique was coupled with Kapur entropy. Improving the exploratory and exploitative instances through increased processing speed was the main goal of this study. The proposed approach used three datasets—the BSDS500, cityscapes, and Intel image—to assess the performance using several metrics, such as FSIM, PSNR, and SSIM. The model's resilience was shown to be lower, despite the little time consumption.

III. METHOLOGY

One important area of image processing applications that directly affects the quality of the resulting images is image segmentation. Appropriate threshold values are determined by a more effective segmentation method using multilevel thresholding. Meta-heuristic algorithms have been used in the majority of research projects now in existence, however they have several drawbacks, such as decreased convergence accuracy and local optimality problems. Furthermore, because of dimension problems, the search space expands exponentially, raising computing complexity. Image segmentation cannot be carried out appropriately due to these current problems. A unique artificial intelligence system based multi-level thresholding picture segmentation technique is developed to address these difficult problems.

Following their acquisition from publicly accessible web sources, the image data are pre-processed in order to reduce noise and improve image quality. The obtained RGB images are first converted to grayscale and pre-processed using the Quantized Haar Wavelet Assisted Histogram Equalisation (QuaWHe) method. A 2D practical Masi entropy histogram function (2D-MentH) is used to do the multilayer image thresholding in order to produce a set of threshold values. Reinforcement Learning assisted fire-fly oriented multiverse optimizer (RL-FF-MVO) is used to choose the appropriate threshold range from the obtained values that will improve the segmentation output. Here, the FF-MVO algorithm is used to select the best values while integrating reinforcement learning to reduce computing complexity. Based on this study, efficient segmentation results.

IV. RESULT & DISCUSSION

The main contribution of this proposed work is summarized below,

In this paper work, The suggested model's performance will be evaluated using metrics such as Noise Quality Measure (NQM), SSIM (Structural Similarity Index), Mean SSIM (MSSIM), PSNR (Peak Signal to Noise Ratio), Mean Absolute error (MAE), and Mean Square error (MSE). The effectiveness of the suggested procedure is demonstrated by comparing it with several other pre-processing methods currently in use.

V. CONCLUSION

In this paper, Image segmentation using Thresholding algorithms are discussed. The performance of the 2D practical Masi entropy histogram function (2D-MentH) based multilevel thresholding for image segmentation have been tested with standard images and computed the processing time to determine the optimal thresholding, and results are also com- pared with the other bio-inspired multilevel thresholding methods. 2D practical Masi entropy histogram function (2D-MentH) based multilevel thresholding observed to be faster than the existing bio-inspired techniques for image segmentation.

The segmentation results of 2D practical Masi entropy histogram function (2D-MentH) algorithm for multilevel thresholding are promising and hence the proposed method can be effec-tively used for multilevel image segmentation problem.

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