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An Investigation of Artificial Neural Network AWS Cluster for Picture Segmentation of Marine Images

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Abstract:

This study explores underwater picture segmentation due to low lighting, focusing on concerns and issues related to this area. Underwater photos are useful for oil well monitoring, marine engineering, and studying underwater flora and animals. The fuzzy problem is addressed using fuzzy clustering techniques, which use thresholding and clustering. However, fuzzy-based methods are less effective and have not been extensively studied in underwater environments due to their varying levels of efficiency.

Keywords— **Edge-based segmentation, clustering, hybrid segmentation, and image segmentation.**

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1. INTRODUCTION

The first step in image analysis and pattern recognition is image segmentation. Using segmentation, a picture can be categorized into numerous groups. Histogram thresholding [1], edge-based [2], hybrid [3], and fuzzy [4] approaches can be used to categorize image segmentation techniques. The assumption behind histogram thresholding is that each region in the image is represented by a single color. High frequency picture characteristics are used in edge-based segmentation. Region thresholding, clustering, region growth, merging, and splitting are the foundations of region-based segmentation. The benefits of both global and region-based segmentation techniques are combined in hybrid segmentation [3].

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The undersea environment causes a variety of issues for underwater photographs. The first is density: light is refracted as it descends deeper into the water due to the denser medium that is the water. When light enters water at an angle of intersection between air and a denser medium, it travels at a right angle and produces the appropriate image; at an obtuse angle, it refracts. The light illumination is lost as a result of this. True color loss is another issue. Pure water absorbs colors at varying rates and has a strong cyan or blue-green hue. The fourth issue is visual contrast; under bad lighting conditions and with uneven illumination, contrast is diminished. Every one of these

The medical imaging industry is the main application for fuzzy clustering based approaches. Clustering is the process of grouping objects that are similar in size, shape, and color. It is concerned with identifying comparable objects.[7] Fuzzy C-Means clustering and K-Means clustering are the two primary types of clustering. Fuzzy C-Means clustering is what we're employing to segment images. One object can be included in many clusters using fuzzy C-Means clustering. In computer vision, image segmentation is the process of dividing a digital image into several segments, or groups of pixels also referred to as super pixels. This means that clustering is often used in data mining for cluster analysis. The soft K-Means algorithm is another name for the fuzzy C-Means clustering. The following categories of image segmentation techniques exist: grouping algorithms, repeatedly until the desired outcomes are achieved. [6]One way to think of the normalized cuts technique picture segmentation is as an ideal graph partitioning. A weighted undirected graph, G = (V, E), is displayed for the image. It is possible to divide this image graph into two smaller graphs. An unsupervised clustering approach called K-Means clustering divides the input data points into several classes according to their intrinsic distance from one another.

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2. REVIEW WORK

Dunn created the fuzzy C-Means clustering technique in 1973, and Bezdek refined it in 1981.Based on the distance between the data point and the cluster center, we must assign each data point in Fuzzy C-means to a corresponding cluster center.

3. CONTRAST IMAGE ENHANCEMENT TECHNIQUES:

Contrast is the brightness difference between two surfaces. Histogram equalization and CLAHE are the two main categories of histogram improvement methods. Contrast limit adaptive histogram equalization, or CLAHE, has two applications: contrast augmentation and histogram equalization. CLAHE stands for adaptive histogram equalization image enhancement. Non-linear contrast enhancement and linear contrast enhancement are the two types of contrast enhancement.

Improvement of linear contrast The linear amplification of contrast in an image is what linear contrast enhancement makes visible to us. Piecewise linear contrast enhancement, percentage linear contrast enhancement, and max-min linear stretch enhancement are the three main forms of linear contrast enhancement. A gray scale image has pixels that range from 0 to 255. Assume that an image consists of 44–59 pixels. Next TheMax-Min Linear contrast enhancement-Max-Min Linear contrast enhancement tells us about Minimum contrast range and Maximum contrast range of an image, Let an image pixels lies between 43 to 48 then the Minimum range of image will be 0 to 43 and Maximum range will be from 48 to 255.In gray scale image there are total 256 no. of pixels because Gray scale image lies between 0 to 256 number of total intensity values is the total number of individual intensity numbers. If an image lies between 0 to 256 intensity values then total number of intensity values is 256.

Piecewise Linear contrast stretch: Percentage Linear contrast stretch enhancement is about enhancement of certain points of an image, If an image lies between 43 to 48 then Piecewise Linear contrast stretch is enhancement of image in certain points like from 43 to 45 and 46 to 47. Nonlinear contrast image enhancement: In Nonlinear contrast image enhancement there many types, in which CLAHE and Histogram equalization [8].CLAHE and Histogram Equalization are enhancement techniques used in the contrast enhancement of the image. CLAHE and Histogram Equalization are used for contrast enhancement of certain limits of pixels. On-Linear contrast enhancements give many results for single input so it became hard to obtain the image between many images. Histogram equalization is one of Non-Linear contrast limit enhancement in which certain number of histogram peaks is enhanced. In Histogram Equalization Image is redistributed in the Pixel values for each user specified ranges like 32, 64.44.Histogram Equalization [5] Enhances the Peak values of the Image. Histogram Equalization enhances the image by enhancing darker side of Images to brighter and by enhancing the brighter side of Image to brighter side of image. Histogram: Histogram tells us the graph plot of contrast of an Image.

Contrast: Contrast is the Image Intensity values of an Image. Contrast decides the brighter and darker part of an Image.

Limit of Contrast One method of adaptive histogram equalization is called Adaptive Histogram Equalization (CLAHE). In the process of fixing the Histogram Equalization problem, CLAHE is employed to enhance photographs. CLAHE splits the image into interconnected rectangular regions. CLAHE establishes the image's uniformity. Image stretching can also be used to increase the contrast of the image. Picture augmentation with noise and picture blurring are further methods for improving images. Image modification is another Contrast enhancement technique used to create an enhanced image [7]. Use the picture resizes function to adjust the image's size. All of these image enhancement techniques are used for the improvement of the gray scale image.

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4. PROCESS FLOW GRAPH

Clustering Based Methods

There are various clustering based methods out of which popular methods are reviewed here sequentially.

A) K-Means clustering: Determining K new centroids, one for each cluster, are the fundamental concept of clustering. It is advisable to strategically locate the centroids since different locations yield varied outcomes. Placing them as far apart as possible will be preferable. The following stage involves assigning each data set point to the closest centroid. The first stage is finished and K new centroids are now recalculated when there is no point. It comes from earlier outcomes. Repetition of the preceding step is now necessary to associate the data with the closest centroid; this procedure will continue until centroid

B). Move further. Finally in the process K new centroids move their position we repeat this until the centroids do not movefurther.

This algorithm aims at minimizing the following objective function, in this case a squared error function. The objective function is:

$$J = \sum_{j=1}^{k} \sum_{i=1}^{n} \| x_i^{(j)} - c_j \|^2 \quad (6)$$

Where $\| x_i^{(j)} - c_j \|^2$ is the distance measure between a data Point $x_i^{(j)}$ and the cluster centre c_j. $\| x_i^{(j)} - c_j \|^2$ Is the indicator of the distance between n data Points and their respective cluster centers? It can be proved that the procedure will always terminate, the K-Means algorithm does not necessarily find the most optimal Configuration corresponding to the global objective function minimum.

The algorithm is also for randomly selected Clusters. The K-Means algorithm is used multiple points toreduce this effect. Clustering deals with scalability, Interpretability, usability, dealing with different type of Attributes, discovering clusters with proper dimensions, Ability to deal with noise, minimum requirements to determine the input parameters and high dimensionality.

K-Means [10] as shown in Figure 1 is Exclusive clusteringalgorithm in which data belongs to single centroid.

Fuzzy C-Means clustering is the overlapping clustering. In Fuzzy clustering single data is connected to each cluster. In overlapping clustering every data is connected to every cluster. Fuzzy C-Means clustering is most efficient than any other clustering like K-Means clustering method.[11] Below the Process Flow graph of K-Means clustering is drawn.

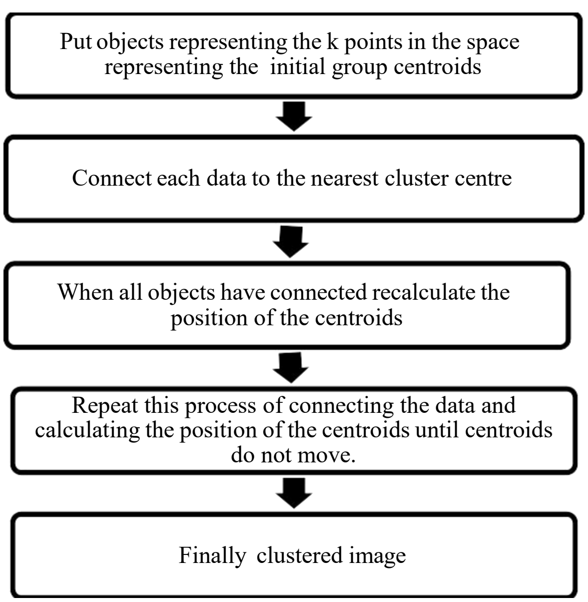

Figure 1- Process flow graph of K-Means clustering algorithm

Fuzzy C-Means clustering algorithm is based on the minimization of the following objective function:

$$J_M = \sum_{i=1}^{N} \sum_{j=1}^{C} u_{ij}^m \| x_i - c_j \|^2, \quad 1 \le m < \infty$$

Where m is fuzziness exponent and any real number greater than 1,u_{ij} is the degree of membership of x_i in cluster j,x_i is the ith of d-dimensional measured data, c_j is the d-Dimension center of the cluster and $\|*\|$ is any norm expressing the similarity between any measured data and the center.[9]

Fuzzy portioning is carried out through an iterative optimization of the objective function shown above should be in the above range. With the update of membership u_{ij} and the cluster center c_j by

$$u_{ij} = \frac{1}{\sum_{k=1}^{C} \left(\frac{\| x_i - c_j \|}{\| x_i - c_k \|} \right)^{\frac{2}{m-1}}} \quad (1)$$

This equation can be further elaborated as;

$$= \frac{1}{\left(\frac{\| x_i - c_j \|}{\| x_i - c_1 \|} \right)^{\frac{2}{(m-1)}} + \left(\frac{\| x_i - c_j \|}{\| x_i - c_2 \|} \right)^{\frac{2}{(m-1)}} + \cdots + \left(\frac{\| x_i - c_j \|}{\| x_i - c_k \|} \right)^{\frac{2}{(m-1)}}} \quad (2)$$

Where cluster center c_j is defined as;

$$c_j = \frac{\sum_{i=1}^{N} u_{ij}^m . x_i}{\sum_{i=1}^{N} u_{ij}^m} \quad (3)$$

Where$\| x_i - c_j \|$ is the distance from i to current cluster centre j,$\| x_i - c_k \|$ is the distance from I to other cluster centers k. Iteration will stop when

$$\max_{ij} \{ | u_{ij}^{(k+1)} - u_{ij}^{(k)} | \} < \varepsilon,$$

Where ε is a termination criterion between 0 and 1, whereas k is the iteration steps. This procedure converges to a local minimum or a saddle point ofJ_m.

The algorithm is composed of the following steps:

1. Initialize U=[u_{ij}] matrix,$U^{(0)}$.
2. At K-step calculate the centers vectors $C^{(k)} = [c_j]$ with $U^{(k)}$

$$c_j = \frac{\sum_{i=1}^{N} u_{ij}^m . x_i}{\sum_{i=1}^{N} u_{ij}^m} \quad (4)$$

3. Update $U^{(k)}$,$U^{(k+1)}$

$$u_{ij} = \frac{1}{\sum_{k=1}^{C} \left(\frac{\| x_i - c_j \|}{\| x_i - c_k \|} \right)^{\frac{2}{m-1}}} \quad (5)$$

4. If $\| U^{(k+1)} - U^{(k)} \| < s$ then stop the process otherwise return to step 2.

Advantages of Fuzzy C-Means clustering:

1. Fuzzy C-Means clustering gives the best result for overlapping data set and comparatively better than K-Means algorithm.[15]
2. In k-Means clustering each data belong to one cluster center, but in Fuzzy C-Means clustering each data belong to each cluster center, so the data connected to every cluster center.[12]

Disadvantages of Fuzzy C-Means Clustering algorithm:

1. We get best result but number of iterations should be high.

2. The information about no. of clusters is apriority.
3. Euclidean distance measures can unequally weight underlying factors.

There are many more segmentation methods available, like clustering, of which there are two varieties: fuzzy K-Means and C-Means clustering techniques. Fuzzy clustering is more often used than K-means clustering. Images can be three-dimensional, as in a statue, or two-dimensional, as in a picture or on a screen. They can be captured by optical instruments such as mirrors, lenses, telescopes, microscopes, and natural phenomena like water or the human eye.[13]

Fuzzy C-Means clustering algorithm as shown in Figure 2, is of many types like Fuzzy C-Means clustering algorithm with using thresholding like CLAHE and Histogram Equalization. CLAHE is contrast limited adaptive histogram equalization. Fuzzy clustering is Fuzzy C-Means clustering algorithm. Below the process flow graph of Fuzzy C-Means clustering algorithm is drawn.

The initial group centroids are represented as objects in the form of point spaces in this instance. Until the required value is attained, the procedure iterates repeatedly.[14] The fuzzy C-Means and K-Means clustering algorithms' primary issue is the distance measure. Data points' distance values are computed using the Euclidean distance. Although Euclidean distance is more frequently utilized than Mahalanobis distance, Mahalanobis distance is still used for measuring distances.

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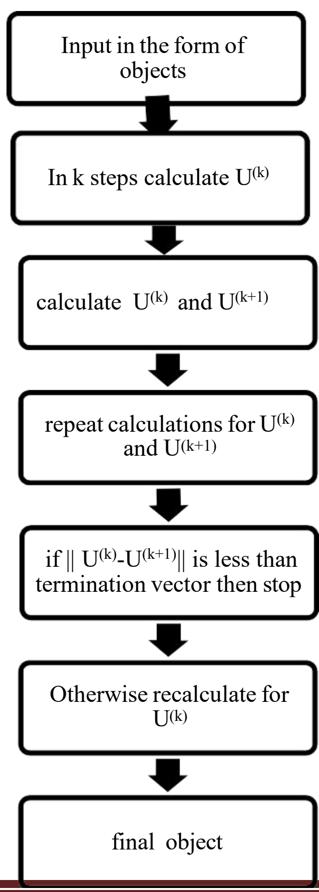

Figure 2 Process flow graph of Fuzzy C-Means clustering algorithm

4. PROBLEM SOLUTION

1. The segmentation performance may be enhanced by pre contrast enhancement.
2. Using two images for clustering rather than a single fuzzy clustering algorithm could enhance system performance.
3. Reducing the complexity of fuzzy-based approaches is also necessary.
4. In an underwater situation, using C means might yield better results than K means.

Conclusion: segmented and used as a second input alongside the original marine image. The results of fuzzy C-Means clustering are good. We examine it and use the results as input. Compared to other clustering methods, fuzzy C-means clustering produces superior results.

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