Improved Felicm based Underwater Color Image Segmentation by using L_0 Gradient Minimization and DBPTGMF

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ABSTRACT
Image segmentation is the method of dividing a digital image into several segments. The aim of segmentation is to simplify or modify the signification of an image into meaningful form that is more significant and easier to examine. It is generally used to put objects and edges in images. Various methods of image segmentation are thresholding, compression-based, histogram based etc. From the survey it has been concluded that none of the method has been very much efficient for segmentation in various types of images. So, to overcome this issue, a new method of segmentation has been proposed. New hybrid image segmentation by using FELICM, L_0 gradient minimization and the Decision based partial trimmed global mean filter has been proposed in this paper. To evaluate the effectiveness of the proposed technique on different kinds of images, various performance metrics have been considered. The method has shown much effective results for underwater and natural images.

Keywords
Image Segmentation, Underwater images, FELICM

1. INTRODUCTION
The underwater image segmentation is assumed method for image analysis and object detection which is the one of typical research subject in computer visualization research area and also complicated in underwater image processing. Because underwater images are very sensitive to different noises and extra interference and due to this, it can obtain the fake information of images because of poor lighting, self shadow or false contour etc. This stresses on the requirement of image segmentation, which separates an image into pieces that have hard connections with objects to reproduce the real information collected from the actual world. Image segmentation is the mainly realistic approach between almost all usual image recognition systems.

Image segmentation is the separation of an image into sections or groups, which correspond to various objects or division of objects. Every pixel in an image is assigned to one of a number of these groups. A good quality of segmentation is usually one in which pixels of similar category have similar grayscale of multivariate values and form an associated region and nearest pixels which are in different categories have dissimilar values. Basically, Image segmentation is the method of separating an image into several segments. The goal of segmentation is to make simpler or modify the representation of an image to some extent that is more important and not difficult to analyze. Image segmentation is generally used to find objects and edges (shapes, bends, etc.) in images. More accurately, image segmentation is the process of passing on a label to every pixel in an image in a way that all pixels with the same label split definite optical characteristics. The outcome of image segmentation is a collection of segments that mutually enclose the whole image, or a group of contours extracted from the image. Every pixel in a section is related with respect to a few features or figure property, such as color, strength, no roughness and no edging.

2. LITERTURE SURVEY
Li, Bing Nan, Chee Kong Chui, Stephen Chang, and Sim Hengg [1] has concentrated on the execution of the level set division which subject to suitable instatement and ideal design of controlling parameters, obliging significant manual intercession. Another fluffy level set calculation is proposed in this paper to encourage medicinal picture division. It can specifically develop from the beginning division by spatial fluffy grouping. The controlling parameters of level set advancement are additionally assessed from the aftereffects of fluffy grouping. Besides the fluffy level set calculation is improved with by regional standards regularized advancement. Such changes encourage level set control and lead to more hearty division. Execution assessment of the proposed calculation was carried on medicinal pictures from diverse modalities. The results affirm its viability for therapeutic picture division.

Shokouhifar, Mohammad, and Gholamhasan Sajedy Abkenar [3] has presented clamor likelihood for every pixel inside the picture; then as per their commotion likelihood, the manufactured bumblebee settlement (ABC) calculation grouped all pixels into two gatherings: Normal and Noisy. In proposed calculation, ABC streamlining is utilized before performing the FCM grouping calculation. This decreased the reaction time with a higher quality than the past methodologies. At last, it portioned some genuine MR pictures with the proposed calculation and contrast it and alternate methodologies.

Mridula, J., K. U. N. D. A. N. Kumar, and Dipti Patra [2] has proposed another methodology for shade textured picture division. It is a two stage system, where in the first stage, textural gimmicks utilizing light black level co-event network (GLCM) are processed for districts of investment (ROI) considered for each one class. Return for capital invested goes about as ground truths for the classes. Ohta model is the shade model utilized for division. Mean at entomb pixel separation (IPD) part was discovered to be streamlined text based gimmick for further division. In the second stage, the peculiarity network acquired is thought to be the corrupted rendition of the picture names and Markov irregular field model is utilized to model the obscure picture marks. The names are assessed through greatest a posteriori estimation foundation utilizing iterated contingent modes calculation. The execution of the methodology is contrasted and that of utilizing GLCM and greatest probability classifier and with the particular case that uses GLCM in RGB color space. The system is discovered to be preferred as far as precision over the other two techniques.

P. Javier Herrera, Gonzalo Pajares, María Guijarro [4] has portrayed a novel pixel procedure of measurements and stereovision matching for acquiring difference maps from hemispherical pictures caught with fish eye lenses from backwoods situations. At a first division organize, the technique recognizes surfaces of enthusiasm to be either matched or disposed of and concentrates six characteristics of every pixel as peculiarities. This is attained by applying both Otsu and fluffy k-Means strategies. It is a mix of systems fittingly sequenced to computerize the methodology and encourage the matching. At a second stage, a stereovision matching methodology is outlined focused around the application of three stereovision matching requirements: epipolar, closeness, and uniqueness. The fundamental finding of this paper was the mix of methods in the both stages. The system is looked at against the utilization of straightforward peculiarities and some current closeness matching techniques utilizing likewise combo. The fundamental finding of this paper is the mix of methods in the both stages. The consolidated method expands the separation power and thus the stereovision matching correspondences.

Sharifah Lailee Syed Abdullah, Hamirul aini Hambali, Nursuriati Jamil [5] (2012) has researched major issues in picture division utilizing conventional division calculations and proposed an enhanced procedure for fragmenting pictures caught under the earth. Picture division alludes to a procedure of parceling a computerized picture into different districts with the plan to concentrates object of enthusiasm from the foundation. It is hard to deliver a huge limit esteem which needed for sectioning pictures because of non uniform enlightenment and contrast of reflection. Diverse brightening may create distinctive shade force of the item surface and accordingly prompt off base divided pictures. This paper proposed an enhanced thresholding-based division coordinated with an opposite system that could parcel regular pictures effectively. The division calculations execution was looked at quantitatively utilizing assessment strategy, Rand Index (RI). The investigation results demonstrated that Tstn can deliver great quality fragmented pictures. Moreover, this division strategy was turned out to be more correct than the customary thresholding and bunching calculations.

Umasankar Kandaswamy and Donald A. Adjeroh [6] has proposed a connection based change that minimizes the impact of enlightenment variety in shade composition investigation. Enlightenment variety is a key issue in color surface examination, with huge ramifications in different application ranges, for example, face and iris distinguish in biometrics, automated vision, and computerized scene understanding, optical stream calculations. Under fluctuating light, both the factual and structural substance of shade surface are altered, prompting changes in the watched composition surface. It impacts the brightening as a bother on a perfect color composition and demonstrates the spectra of the encompassing light have a huge effect on the watched surface examples in the individual shade channels. In human color steadiness it proposed multi fluctuation composition model to deliver brightening invariant pictures. It demonstrates that the multi change model prompted enhanced execution when contrasted and the state-of-the-symbolization calculations.

Marina P. Cipolletti, Claudio A. Delrieux, M. Cintia Piccolo, Gerardo[7] has proposed walking squares with direct insertion (MSI) for super determination fringe division and estimation calculation. This strategy is focused around least separation division over the starting picture, took after by shape following utilizing a super determination upgrade of the walking squares calculation. The MSI technique was demonstrated to beat different strategies in the writing in all conceivable circumstances, both for engineered and for Land sat pictures. The strategy is symmetric and powerful concerning changes fit as a fiddle, size, and introduction of the gimmicks, furthermore as for picture spatial determination. In polygonal shapes, it pursues the border around the vertices all the more regularly; creating vectorizations that are incorrect just near the vertices; i.e., just a couple of pixels in the entire figure are not effectively respected.

Hussain, S. Javeed, T. Satya Savithri, and P. V. Devi [9] proposed for the exact division of typical and neurotic tissues in the MRI mind pictures. The proposed division procedure at first performs grouping process by using Fuzzy Inference System (FIS) and FFBNN. The FIS was utilized to make the arrangement transform by producing the fluffy standards utilizing concentrated gimmicks. Five gimmicks were concentrated from the MRI pictures: they were two element measurable peculiarities and three 2d wavelet deterioration characteristics. The execution result has demonstrated the effectiveness of proposed tissue division method in dividing the tissues faultlessly from the MRI pictures. The execution of the division method is assessed by execution measures, for example, exactness, specificity and affectability.

Hanqiang Liu, Feng Zhao, Licheng JiaoFuzzy [11] (2012) has proposed the calculation a novel fluffy ghostly bunching calculation with strong spatial data for picture division is proposed which beat the clamor affectability of the standard ghastly grouping calculation. Firstly, a non-nearby weighted aggregate picture of the first picture has produced by using the pixels with a comparable design of every pixel. At that point a hearty light black based fluffy closeness measure was characterized by utilizing the fluffy participation values among ash values in the new produced picture. Along these lines, the likeness lattice got by this measure is just reliant on the quantity of the ash levels and could be effectively put away. At last, the phantom chart apportioning system might be connected to this likeness lattice to gathering the light black estimations of the new created picture and after that the comparing pixels in the picture are renamed to get the last division result.

E. M. Srinivasan, K. Ramar, A. Suruliandir [8] has proposed color composition descriptors to speak to the surface substance of the shade pictures. In these composition portrayal plans, little ranges of the picture are spoken to by fluffy based neighborhood surface examples and the whole picture is spoken to by recurrence event of such composition designs. Administered division of color pictures is performed utilizing these shade composition descriptors and guaranteeing results are acquired. From the results, it is noted that the proposed strategies give five sections comparing to the composition districts show in the information pictures. Accordingly, the proposed strategies could be utilized for surface division applications.

Guangyu Liu, Hongyu Bian, Hong Shi [10] examined the diverse attributes of sonar picture from the optical picture, and the greatest disadvantage among them is the presence of shadow impedance, to be specific for a sonar picture with shadow part, the conventional level set division calculation will frequently make the shadow as the division focus to be traded out in light of the fact that the gimmick of sonar target item is not critical enough; Secondly, to beat the shadow negative impacts in sonar picture division and attain particular division, this paper did sonar picture preprocessing by morphological top-cap and base cap change, then carried on level set. system without re-introduction and developed an enhanced level set sonar picture division framework. At long last, it was contrasted the enhanced level set technique and the conventional level set system in the reproduction trial, and the results demonstrated that the enhanced level set division strategy is more adjusted to sonar picture with uneven foundation.

Girolamo Fornarelli, Antonio Giaquinto [13] has proposed a multi-swarm grouping system to perform picture division. The pursuit of the ash levels sectioning the picture is done by a two-stage strategy. The previous is performed by a conventional swarm populace, moving in the hunt space as indicated by a base separation measure. The combo of the two swarm methodologies permits handling the downsides of the established standard without making utilization of a complex execution. The technique is unsupervised, since it recognizes the genuine number of ash levels to portion the picture consequently. The led tests demonstrate that the proposed strategy can yield satisfactory divisions with a restricted computational time, ended up being a fascinating instrument to face cases in which earnest time obligations must be fulfilled.

Nan Li, Hong Huo, Yu-ming Zhao, Xi Chen, and Tao Fang [15] has proposed a picture spatial grouping system, called fluffy C-implies with edge and neighborhood data (FELICM), which diminished the edge corruption by presenting the weights of pixels inside nearby neighbor windows. The edges were concentrated right away by shrewd edge location. Amid identification, two versatile limits got by multi-Otsu technique are utilized. At that point, diverse weights were set as per whether the window focus and the neighborhood neighbors are differentiated by an edge or not. Pixels, together with diverse weighted nearby neighbors, are grouped iteratively, until the last grouping result is gotten. The strategy might be specifically connected to the picture without any channel preprocessing, and the test comes about over remote sensing pictures have demonstrated that FELICM not just successfully takes care of the issue of segregated and irregular dispersion of pixels inside areas additionally got high edge exactnesses.

Xueliang Zhang, Pengfeng Xiao,, Xiaoqun Song, Jiangfeng She [14] (2013) proposed a Boundary-Constrained Multi-Scale Segmentation (BCMS) system remote sensing. Firstly, neighboring pixels are totaled to produce introductory division as indicated by the neighborhood best locale developing technique. At that point, the Region Adjacency Graph (RAG) is based focused around beginning division. At last, the neighborhood shared best area combining methodology is connected on RAG to deliver multi-scale division results. At long last, the neighborhood common best district combining methodology is connected on RAG to deliver multi-scale division results. A set of high spatial determination remote sensing pictures is utilized within the analysis, e.g., Quick Bird, World View, and airborne picture, to assess the viability of the proposed system. The division aftereffects of BCMS were contrasted and those of the business picture dissection programming e-cognition. The test has demonstrated that BCMS can deliver settled multi-scale divisions with exact and smooth limits, which demonstrates the vigor of the proposed technique.

3. PROPOSED ALGORITHM

This section contains the flow chart of the proposed algorithm. This algorithm is able to segment the various images like remote sensing and underwater images.

Step1. Input image: First of all, Image "I" will be passed to a proposed algorithm as an input image.

Step2. In this step PCA and OTSU threshold are applied separately.

(a) Principle Component Analysis : Apply RGB2PCA to convert given image in PCA plane.

$$[\mathrm{M},\mathrm{N},\mathrm{D}] = \mathrm{size}(\mathrm{I}(x,y)) \ \ldots\ldots \ (1)$$

Where M represent rows, N represent columns and D represent dimensions. I(x,y) is an input image.

(1) To convert RGB image to PCA, first each component of an RGB image should be converted into vector. Then all these vectors are concatenated by using following equation

$$\mathrm{IIV} = \mathrm{cat}(2, \mathrm{R}, \mathrm{G}, \mathrm{B}) \ldots\ldots.. (2)$$

Where IIV represent the Input Image Vector and cat represent the concatenate function.

(2) Then Eigen values are computed by using principal component function which is given by following equation

$$\mathrm{VV} = \mathrm{princomp}(\mathrm{IIV}) \ldots\ldots. (3)$$

Where VV represent the vector values and princomp is inbuilt function in MATLAB.

(3) PCA vector is obtained from vector values by using following equation

$$\mathrm{Vector} = \mathrm{VV}/(\textstyle\sum(\mathrm{VV}) \ldots\ldots.. (4)$$

(4) Finally PCA image is obtained from vector representation by using following function

$$\mathrm{OVI} = \mathrm{IIV} * \mathrm{Vector} \ldots\ldots\ldots (5)$$

Where OVI represent the output vector image and IIV represent the Input Image Vector

(b) OTSU Thresholding: Otsu's method is employed to automatically execute clustering-based image thresholding or the diminution of a gray level image to a binary image .In Otsu's technique the threshold that reduces the intra-class variance defined as a weighted sum of variances of the two classes:

$$\sigma_\omega^2(t) = \ \omega_1(t)\sigma_1^2(t) + w_2(t)\sigma_2^2(t) \ldots\ldots\ldots\ldots\ldots (6)$$

Weights ω_i are the probabilities of the two classes divided by a threshold (t) and σ_i^2 variances of these classes .Otsu show that minimizing the intra-class variance is the same as maximizing inter-class variance:

$$\sigma_b^2(t) = \ \sigma^2 - \sigma_\omega^2(t) = \ \omega_1(t)\omega_2(t)\,[\mu_1(t)\text{-}\mu_2(t)]^2 \ldots\ldots\ldots\ldots (7)$$

which is expressed in terms of class probabilities ω_i and class meansμ_i.

Step3. Canny Edge Extraction: It is an edge detection worker that employs a multi-stage technique to notice a large variety of edges in images.

1) Noise diminution. The gray image is convolved with a 5×5 Gaussian filter by standard deviation σ = 0.4.

2) Locating the intensity gradient of the image.

3) Non maximum suppression decides if the pixel is a enhanced applicant for an edge than its neighbors.

4) Drawing edges throughout the image and hysteresis thresholding.

Step4. It has included two steps i.e. Neighborhood Weighting and FELICM.

(a) Neighborhood Weighting: In this step, if the direct line between two pixels is cut off by an edge, these two pixels go to dissimilar regions.

(b) FELICM: It stands for Fuzzy C-Means with Edge and Local Information, which initiate the weights of pixels inside local neighbor's windows to decrease the edge poverty.

Step 5. Edge Pixel Processing: In this step, edges are extracted with the help of FELICM and Canny edge extraction.

Step 6. Clustering Result: In this step, Clustering is done with the FELICM method by using spatial and spectral information. Basically clustering is essentially a group of such clusters, frequently containing every object to each other.

Step7. DBPTGM Filter: DBPTGM filter is a Decision Based Partial Trimmed Global Mean Filter which is used for the revealing of impulse noise in an image.

Step8. L_0 Gradient Minimization: The L_0 gradient method is helpful for keeping the global edges and improving most important edges of the image. This method globally control total number of non-zero gradients between pixels to improve the important edges.

4. RESULTS AND DISCUSSIONS

4.1 Experimental Results

Fig. 1 (a) Original Image

(b) Segmented Result of Existing Technique

(c)Segmented Result of Proposed Technique

Fig.1has shown the results of segmentation of underwater image from existing technique and proposed technique. Underwater images are essentially characterized by their poor visibility because light is exponentially attenuated as it travels in the water and the scenes result poorly contrasted and hazy.

Figure 1(a) has shown the original image in underwater and figure 1(b) has shown the segmented underwater image from existing technique. Figure 1(c) has shown segmented under water image from proposed technique. So it has clearly shown that the result of proposed technique in figure 1(c) is better than the result of Existing technique in figure 1(b).

4.2 Performance Evaluation

The proposed algorithm is also tested on various underwater images. The algorithm is applied using various performance indices peak signal to noise ratio (PSNR), Mean squared error (MSE) and Root Mean Square Error (RMSE).

4.2.1Mean Square Error Evaluation

Mean square error is a measure of image quality index. The large value of mean square means that image is a poor quality. Mean square error between the reference image and the resultant image is:

$$MSE = \frac{1}{mn}\Sigma_{i=1}^{m}\Sigma_{j=1}^{n}\left(A_{ij} - B_{ij}\right)^2 \text{ ... ...(1)}$$

Where A_{ij} and B_{ij} are the image pixel value of reference image.

Table 1 is showing the quantized analysis of the mean square error. As mean square error need to be reduced therefore the proposed algorithm is showing the better results than the available methods as mean square error is less in every case. The mean Square error is reduced in each case than the existing technique. The proposed method is tested on the number of images and in each case shows the better results than the existing method.

Table 1: Mean Square Error

Underwater Images	Proposed Technique	Existing Technique
Image 1	0.0038	0.1177
Image 2	0.0065	01137
Image 3	0.0165	0.1513
Image 4	0.0032	0.2119
Image 5	0.0085	0.1301
Image 6	0.0115	0.2744
Image 7	0.0206	0.1324
Image 8	0.0004	0.0866
Image 9	0.00004	0.1157
Image 10	0.0032	0.1854

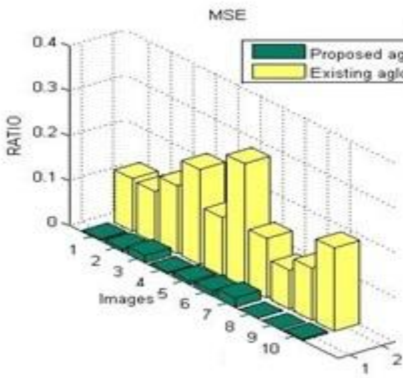

Fig 2: MSE Evaluation

Fig.2 has shown the quantized analysis of the mean square error of different images. It is very clear from the graph that there is decrease in MSE value of images with the use of proposed method over existing method. These decreased values represent the improvement in the objective quality of the image.

4.2.2 Peak Signal to Noise Ratio Evaluation

The PSNR block computes the peak signal-to-noise ratio between two images. This ratio is often used as a quality measurement between the original and a resultant image. The higher the PSNR shows the better the quality of the reconstructed image. PSNR value is computed by following equation:

$$PSNR = 10\,log_{10}\left(\frac{MAX_I^{\,2}}{MSE}\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Here, MAX_I is the maximum possible pixel value of the image.

Table 2 is showing the comparative analysis of the Peak Signal to Noise Ratio (PSNR). As PSNR need to be maximized; so the main goal is to increase the PSNR as much as possible. Table 2 has clearly shown that the PSNR is increased in the case of the proposed algorithm; therefore proposed algorithm is tested on the number of different underwater images providing better results than the available methods.

Table 2: PSNR

Underwater Images	Existing Technique	Proposed Technique
Image 1	57.4560	72.3172
Image 2	57.6079	70.0675
Image 3	56.3658	65.9805
Image 4	54.9031	73.1500
Image 5	57.0207	68.8591
Image 6	53.7805	67.5536
Image 7	56.9452	65.0297
Image 8	58.7878	78.0861
Image 9	57.5305	75.1006
Image 10	55.4827	73.0660

Figure 3 has shown the quantized analysis of the peak signal to noise ratio of different natural images. It is very clear from the plot that there is increase in PSNR value of images with the use of proposed method over existing methods. This increase represents improvement in the objective quality of the image. So the proposed method has shown better results than existing method in the graph representation.

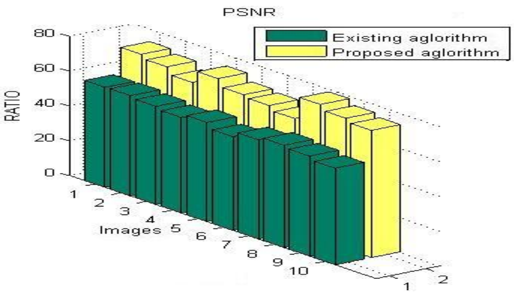

Figure 3: PSNR Evaluation

4.2.3 Root Mean Square Evaluation

RMSE is the measure of differences between values predicted by a model or an estimator and the values actually observed.

$$\text{RMSE} = \left(\frac{1}{N}\sum_{(x,y)}|d_c(x,y) - d_t(x,y)|^2\right)^{1/2} \ldots\ldots\ldots(18)$$

Where, N is the total number of pixels in the image, d_c is the computed disparity map, and d_t is the ground truth disparity map.

Table 3 is showing the comparative analysis of the root mean square error. Table has clearly shown that RMSE value is less in our case therefore the proposed algorithm has shown significant results over the available algorithm.

Table 3: RMSE

Underwater Images	Proposed Technique	Existing Technique
Image 1	0.0620	0.3431
Image 2	0.0803	0.3372
Image 3	0.1286	0.3890
Image 4	0.0563	0.4603
Image 5	0.0923	0.3607
Image 6	0.1073	0.5239
Image 7	0.1435	0.3639
Image 8	0.0201	0.2943
Image 9	0.0069	0.3402
Image 10	0.0569	0.4302

Figure 4 has shown the quantized analysis of the Root mean squared Error of different underwater images using existing method and the proposed method. It is very clear from the plot that there is decrease in RMSE value of images with the use of proposed method over existing method. These increased values represent the improvement in the objective quality of the image.

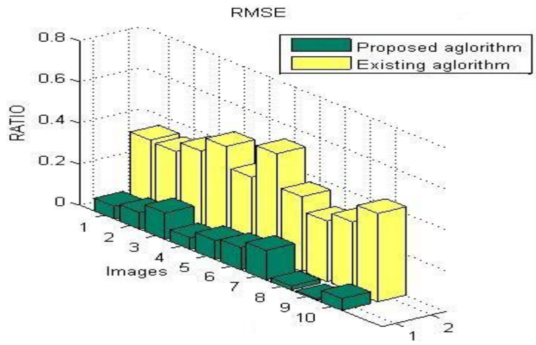

Figure 4: RMSE Evaluation

5. CONCLUSION AND FUTURE SCOPE

A good quality of segmentation is usually one in which pixels of similar category have similar grayscale of multivariate values and form an associated region and nearest pixels which are in different categories have dissimilar values. Basically, Image segmentation is the method of separating an image into several segments. After analyzing and going through the literature survey, the various gaps in study have been found like not much work have done over mixed regions and the effect of color have been neglected by various researchers.

A new hybrid image segmentation by using FELICM, L_0 gradient minimization and the Decision based partial trimmed global mean filter has been proposed in this paper. It has been found that the proposed method has been more suitable for obtaining the better quality of the image than the most of the existing methods. The experimental results have shown significant improvement over the available techniques. This work has not considered the effect of haze in underwater images. So in near future proposed technique will be integrated with the optical model of haze removal.

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