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Improved Algorithm to Identify the Images in Underwater

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ABSTRACT

Image enhancement technique is one of the widely used techniques to improve the image quality by enhancing the visibility of the images. Different filtering techniques are available in the literature for pre-processing of underwater images. The filters used normally improve the image quality, suppress the noise, preserves the edges in an image, enhance and smoothen the image. Underwater image pre-processing is absolutely necessary due to the quality of images captured under water. In this paper provides the enhancement of preprocessing using bilateral filter and contourlet transform algorithm for image enhancement and Kmeans and fcm for segmentation. GLCM is used for feature extraction and SVM is used for image classification.

Keywords: Bi Lateral Filter, Contourlet Transform, FCM Algorithm, Kmeans Segmentation, GLCM Feature Extraction, SVM Classification, underwater images.

INTRODUCTION

In image processing the data in the image are digitized in order to enhance the image. The purpose of doing so is to store the image with excellent quality for future references and for studies. Underwater imaging has always been a challenge for photographers. It is important to capture the activities of underwater for scientists to discover and recognize the

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images to discover several untold stories. But due to diffusion effects of light, light absorption it gets difficult to capture the exact image without alteration. Due to which the images merge to become bluish as you go deeper into the sea or ocean. These poor images are being processed to make it more readable and visible to the user. The information in the image is altered and improved so that the visual impact of the image satisfies the observer needs. It alters information like edges and contrast to differentiate the image from its background.

Qualitative objective approach is being used in this method to enhance images. This enhancement process involves operations like pseudo coloring, contrast stretching, noise clipping and noise filtering etc. We will discuss various image enhancement techniques which are applied on underwater images to analyze the performance of the methods. It is being applied on underwater images because the quality of these images are affected due to various factors like bending of light, light absorption, scattering of light and light reflection. Hence we have focused on techniques which are applicable on underwater images. We have implemented bilateral filter and contourlet transform algorithm for image enhancement and Kmeans and fcm for segmentation. GLCM is used for feature extraction and SVM is used for image classification.

EXISTING SYSTEM

Firstly we will be evaluating the various soil algorithms and sensors used for quantitative determination of surface soil properties for hyper spectral images. We have considered both methodologies- the physical analyses and statistical multivariate procedures. The major parameters to evaluate these methods are soil organic carbon (SOC), clay and iron oxide content. These soil algorithms are being tested on hyper spectral imagery for two types of data sets namely, airborne data (GSD <5m) and associated EnMAP satellite simulated data (GSD 30m). In this study various types of soils are considered and the properties of each with arid/semiarid through temperature environments in resp.

Drawbacks

- High amount of noise is involved and it provides low contrast in images.

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- Partitioning neurons with bare hands is not possible.

We have used Gaussian filtering to remove blurriness in the image and also remove noise and detail. For one dimension, the Gaussian function is:

$$G(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{x^2}{2\sigma^2}}$$

Where σ represents the standard deviation and the mean of the distribution is assumed to be 0. Wavelet is a mathematical function which is used to partition functions or continuous-time signal for different scale levels. In this method we can assign frequency range to each scale component. The wavelet transform resembles the Fourier transform. In wavelet transform the wavelets are discretely sampled and it captures both frequency and location information which the Fourier transforms cannot perform.

RELATED WORK

UCM- Unsupervised Color Correction Method is used for underwater image enhancement. This method is based on the contrast correction of RGB color, color balancing and contrast correction of HSI colors as well. Initially, [1] the color values are equalized followed by contrast correction method to increase the Red color by increasing the red histogram to maximum. Blue color is also increased to minimum. Finally, the saturation and intensity components in the HSI color model is applied for contrast correction. This helps in increasing true colors through saturation and illumination through intensity. [2] A lot of noise is present in the image due to various reasons like poor visibility, low contrast little color variations; blur effect, pepper noise and non uniform lighting. There are several filtering techniques to remove these noises from underwater images. One such method is the image enhancement using median filter which helps in estimating the depth map and improve the quality of the image by removing noise particles. RGB Color level Stretching is also used to improve the quality of the image. Forward UCM can also be used in such scenarios. [3] Another method is the improved image contrast enhancement using histogram equalization which goes well with multiple-peak images. Firstly, Gaussian filter is used with optimum parameters. Secondly, the histogram is categorized into several groups based on the valley values of the image histogram. Thirdly, we have implemented our proposed method where 60 normal images are considered and the results are compared with

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HE and RHE. The testimonial confirms that the proposed method out performs the other methods by delivering good performance in image enhancement. [4] Standard computer vision techniques are also applied to underwater images to find the mean values of the stretched histogram. Manual and auto level techniques are being applied to achieve best results. The agenda of this paper is to obtain the best technique that can be used to enhance underwater images in terms of color correction. The outcome should result in non divers having the underwater effect by visualizing these images. [5] We have implemented four filters namely wavelet denoising, contrast equalization, homomorphic filtering and bilateral filtering are used on degraded images in order to remove low contrast, non uniform illumination, noise and diminished colors. Homomorphic filtering is used to correct non-uniform illumination of light. Wavelet denoising is used to remove additive Gaussian noise in the underwater images. The bilateral filtering smoothens the underwater image. Finally the contrast stretching is used to normalize the RGB values. [6] The edge preserving filters considered in this research are anisotropic diffusion filter, homomorphic filter and wavelet denoising by average filter. The transmission of property of underwater severely affects the images due to transmission of limited range of light, low contrast, blurring of image, diminishing color and disturbance of light. Pre-processing helps in removing the non-uniform lights or color and also to adjust the intensity. The outcome of all the filters is compared to analyze on the attributed PSNR and MSE values. The speckle in the image is removed by anisotropic filter. This filter helps in preserving the edges, suppresses the noise in the image and improves the quality of the image by smoothening the image. The MSE is said to be low and PSNR is said to be high whereas in wavelet filter also the PSNR is high and MSE is low. Hence finally the elapsed time is calculated to estimate the best performing filter. The SRAD filter consumes less number of seconds to process an image when compared to other filters. [7] This method also removes the artificial light present in the image by using depth map technique. The depth of the water is simply calculated using the background color. The color change compensation is performed using residual energy ratio method. Wavelet compensation and dehazing technique is proposed in this research work to analyze the raw image sequence and recover the true object. We have also included artificial light removal technique along with the proposed method. We have tested the method on both real world data and pretended [8]. The anisotropic filter helps in suppressing the noise, preserving the edges, and smoothening the image. Homomorphic filter helps in correction of

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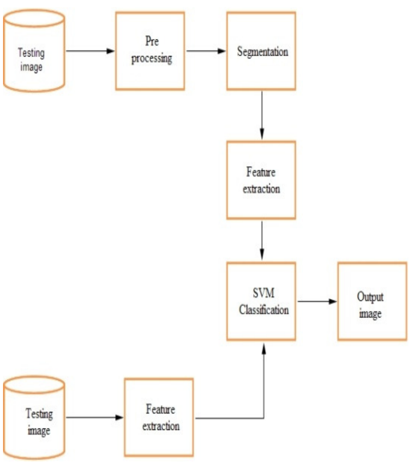
non uniform illumination and improves the contrast of the image. It is a frequency filtering technique. Finally the wavelet filter suppresses the noise i.e. is the Gaussian noise which is default in all camera images and other instrument images. [9] Image enhancement all-together delivers the information content of the image in a readable visual impact to the observer. The features of the image like edges, noise clipping, pseudo coloring, contrast stretching are enhanced. Finally various image enhancement techniques are studied and compared on the parameters of Root Mean Square Error (RMSE), Correlation coefficient (CC) and Peak Signal to Noise Ratio (PSNR). It is concluded that the edge adaptive hybrid filter fetches best results compared to the histogram processing, contrast stretching, AWMF, negative enhancement and EASF.

Block Diagram



Methodology of Proposed System

Bi Lateral Filter

Filtering is maybe the most basic operation of image processing and computer version. In the broadest sense "filtering", the estimation of the filtered image at a given location is an element of the estimations of the input image in a small neighborhood of a similar location.

For example, Gaussian low-pass filtering calculates each pixel is replaced by a weighted average of its neighbors, in which the weights diminish with distance from the area of focus. The formal and quantitative explanations of this weight difference can be given, the instinct is that images vary gradually over space, so close pixels are probably going to have comparative values, and it is in this manner suitable to average them together. The noise values that degenerated these close-by pixels are commonly less corresponded than the signal values, so noise is midpoint of away while signal is saved. The assumption of slow spatial variations comes up short at edges, which are therefore blurred by linear low-pass filtering. How can we prevent averaging across edges, while still averaging within smooth regions? Numerous efforts have been committed to decreasing this undesired effect. Bi Lateral filtering is a simple, non-linear, edge preserving and noise reducing smoothing filter for images.

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Contourlet Transform

Development of LR image from one of the HR training images utilizing low resolution formation model.

Two level contourlet deterioration with four directional sub bands of LR test image of size MxM and three level deterioration of all HR training images each have a size of 2Mx2M.

Considering the contourlet coefficients in sub bands I-IV and comparing 2x2 blocks in VVIII of LR and HR image, obtain the total of absolute contrast between the contourlet coefficients in the LR image and all the coefficients for each of training image. Locate the best match.

If MAD < threshold, obtain the high resolution contourlet coefficients (4x4 block) from the training image of sun bands IX-XII to LR test image, otherwise set the sub bands IX-XII of LR test image to zeros.

Repeat steps (3-4) for each contourlet coefficient in bands I-IV of low resolution image.

Perform inverse contourlet transform to acquire the high- resolution image of the given test image.

Kmeans Segmentation

Image segmentation is the classification of an image into different groups. Given a vector of N measurements describing every pixel or group of pixels (i.e., region) in an image, a comparability of the measurement vectors and hence their segmentation in the N-dimensional measurement space suggests similarity of the relating pixels or pixel groups. Therefore, clustering in measurement space may be a marker of similarity of image regions, and may be utilized for segmentation purposes.

The vector of estimations depicts some useful image features and thus is also called as a feature vector. Similarity between image regions or pixels suggests clustering (small separation distances) in the feature space. Segmentation strategies were some of the earliest data segmentation methods to be created.

K-means clustering creates a particular number of disjoint, flat (non-hierarchical) clusters. It is appropriate to create globular clusters. The K-means strategy is numerical, unsupervised, non-deterministic and iterative.

- The dataset is segmented into K clusters and the data points are randomly assigned to the clusters resulting in clusters that have generally a similar number of data points.
- For each data point:
- Calculate the separation (Mahalanobis or Euclidean) from the data point to every cluster.

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- If the data point is nearest to its own cluster, leave it where it is. If the data point is not nearest to its own cluster, move it into the nearest cluster.
- Repeat the above step until a complete go through every data points' outcomes in no data point moving starting with one group then onto the next. Now the groups are steady and the clustering procedure ends.

  The choice of initial segment can significantly influence the final clusters that result, in terms of inter-cluster and intra-cluster distances and cohesion.

GLCM Feature Extraction

GLCM- Gray Level Co-occurrence Matrix is used to extract the statistical texture features. Attaining the histogram details will only give us details about the texture whereas the GLCM calculates the relative position of the pixels in relative to its texture. This statistical approach gives a lot of information about the relative position of the neighboring pixels in an image.

GLCM is a spatial domain technique which tabulates the difference in combination of pixel brightness in the image. The features involved in feature estimation are divided into few steps: First four co-occurrence matrices are calculated from the gray scale image. It considers the distance between the pixels to be 1 and the four directions as 0o, 45o, 90o and 135o. So the co-occurence matrix is computed at 00.

There are four features in every computed matrix namely correlation, contrast, energy and homogeneity.

Hence the feature vector will be of size 16.

After the calculation of GLCM for all the four directions 0, 45, 90, 135 degrees, contrast, feature energy, homogeneity and correlation are calculated as below.

$$\text{Energy} = \sum_{i,j=0}^{N-1} (P_{i,j})^2 \qquad (4)$$

$$\text{Contrast} = \sum_{i,j=0}^{N-1} P_{i,j}(i-j)^2 \qquad (5)$$

$$\text{Homogeneity} = \sum_{i,j=0}^{N-1} \frac{P_{ij}}{1+(i-j)^2} \qquad (6)$$

$$\text{Correlation} = \sum_{i=1}^{N} \sum_{j=1}^{N} \frac{(i-m_r)(j-m_c)P_{ij}}{\sigma_r \sigma_c} \qquad (7)$$

$$m_r = \sum_{i=1}^{N} i \sum_{j=1}^{N} P_{ij} \qquad m_c = \sum_{j=1}^{N} j \sum_{i=1}^{N} P_{ij}$$

$$\sigma_r = \left(\sum_{i=1}^{N} (i-m_r)^2 \sum_{j=1}^{N} P_{ij} \right)^{1/2} \qquad \sigma_c = \left(\sum_{j=1}^{N} (j-m_c)^2 \sum_{i=1}^{N} P_{ij} \right)^{1/2}$$

In the above equation, N represents the number of rows and columns of image matrix Q.Pij are the probability that a pair in the Q has values (ni, Nj) and they represent the rows and columns respectively. They are the standard deviation of rows and columns respectively.

Angular Second Moment also called as the Uniformity or energy. It is calculated by taking the sum of squares of entries in the GLCM

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angular second moment measures the image homogeneity. This value is high when the image has good homogeneity and even when pixels are similar.

The inverse difference moment (IDM) represents the local homogeneity and it said to be high if the local gray level is evenly distributed and inverse GLCM is high.

Entropy helps to decide on the amount of information required to define an image for image compression.

Correlation calculates the linear dependency of gray levels of neighboring pixels. Correlation is used to measure displacement, deformation, optical flow and deformation. On a very common note it is used for measuring motion of optical mouse.

The above four image features are extracted using Matlab. GLCM is calculated using Matlab because a raw image cannot be given as input to implement FPGA. All the text features derived are in the form of real numbers and is projected in form of bits as output.

SVM Classification

The process of learning the pattern or the similarities between the data and recognizing the structure from a large set of data is required to systemize the storage. Several classifiers like neural networks (NN) and Bayesian classifiers are used to learn an organization. Support Vector Machine (SVM) is an advanced approach for classification when considering its former methods. It is purely based on a strong foundation and uses the statistical learning theory [4] . As it was invented in the 90s its application is wide; it is applied in pattern recognition, image classification, handwritten character recognition, financial time series prediction, bioinformatics, face detection, biomedical signal analysis, data mining and medical diagnostics. It has been the choice of many researches and practitioners for several years around the world. It is due to its capability to generalize a set of data with several other added advantages like:

- It has a less complex computation process.
- It results well even with high dimensional spaces.
- Lack of training is not an issue.
- It is based on reducing the estimate test error rather than the training error.
- It is robust even with noisy data.
- Dimensions do not affect the performance of the method.
- It is powerful than other classifiers.

SVM has an unique approach to find the optimal hyper plane. It is said that the data points which lie in two different groups have a marginal

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difference between them. SVM works to maximize this marginal difference using the approach of quadratic programming problem where mathematical formulas and equations are used to derive a solution.

FCM Algorithm

Clustering of data is the basic classification performed to identify groups of similar characteristics. The main advantage of applying clustering is to split large data set into small groups of similar characteristics which represents systems behaviour. FCM is one of the clustering methods to group the datasets into clusters where every data resembles the cluster to certain degree. This is simply analyzed by taking a data point which lies close to the center of the cluster. This data point will have high degree of similarity to the cluster, wherein a data point chosen far away from the center of the cluster will have less resemblance to the cluster. Initially the center of the cluster is chosen at random and is incorrect during the initial stages. The FCM assigns a grade for every data point in the cluster. Several iterations are performed by updating the cluster centers and the grades of the members. Finally FCM will be able to achieve its right center after several iterations performed. The number of iteration depends on reducing the objective function which represents the distance from any data point to the cluster center weighted by the data point's membership grade. Image segmentation is done to separate the disjoint regions from the image based on uniform and homogeneous attributes like the tone or texture, color, intensity, etc. There are several segmentation processes discussed and detailed surveys are found in the reference. The segmentation process is divided into four categories namely, clustering, region extraction, edge detection and thresholding. Clustering is classifying the objects in a way where the samples in the group hold similarity than the samples in the other groups. For clustering we have the fuzzy clustering technique and hard clustering scheme. FCM is chosen upon hard clustering because it is more robust and has the ability to retain more information than the hard segmentation methods.

Results

Fig 1 PSNR values of the proposed and the existing methods.

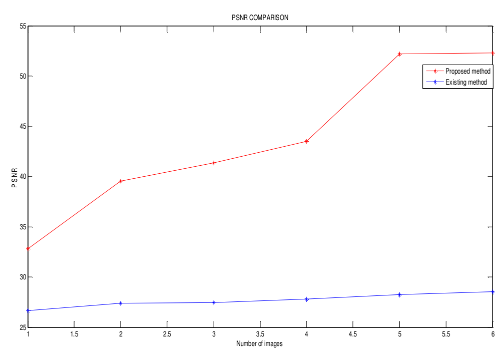

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Fig 1 PSNR Comparison

Figure A2.1: Input image

Figure A2.2 :Gaussian Filter

A2.3 :Bilateral Filter

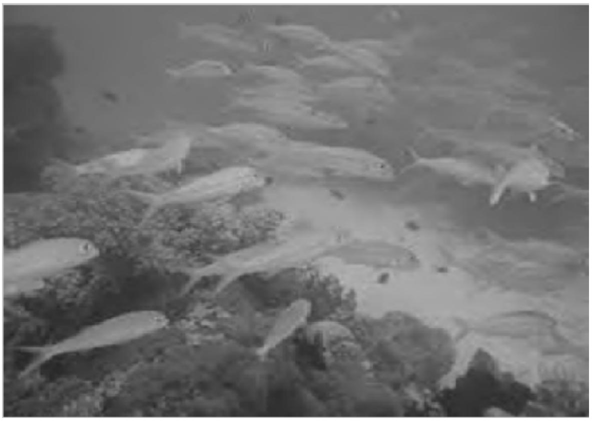

Figure A2.4: Contourlet Transform

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Figure A2.5 : Wavelet Transform

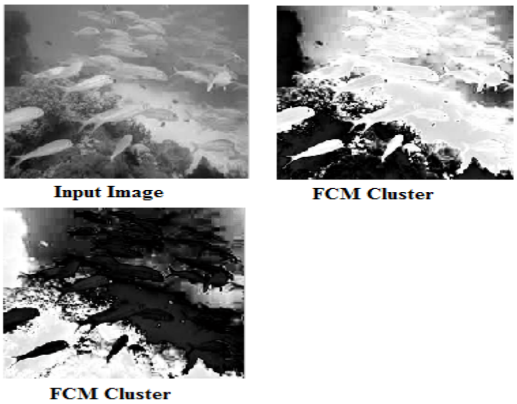

Figure A2.6: FCM

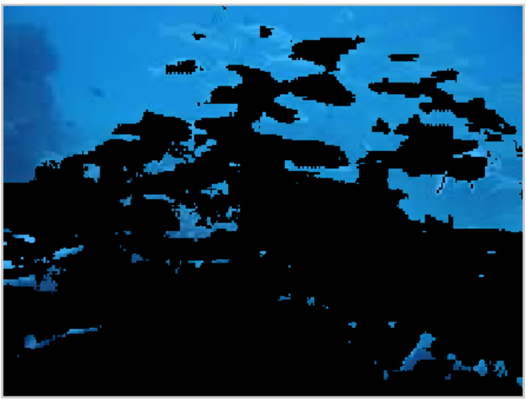

Figure A2.7 : K-Means Segmentation

Conclusion

It is highly essential to consider denoising and image enhancement for underwater images. The underwater exploration is used on several studies and researches to study about biological environment, conducting underwater living organism's analysis, exploring mineral, etc. Due to obstacles like scattering of light, light absorption, light reflection, bending of light and poor visibility of underwater images there is an urge to enhance the image quality. This research is proposed to duly study all the available underwater image enhancement methods. We have proposed a method using bilateral filter, segmentation kmeans, fcm and contourlet transform algorithm. Finally GLCM and SVM are used.

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