A SURVEY ON UNDERWATER IMAGE QUALITY AND ENHANCEMENT EVALUATION METRIC TECHNIQUES

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Abstract
The underwater images typically suffer from non-uniform lighting, near to the ground contrast, haze and reduced colors. This survey paper deals with the methods to improve underwater image enhancement techniques, the processing of underwater image captured is necessary because the quality of underwater images affect and these image leads some serious problems when compared to images from a clearer environment. Underwater images mainly suffer from the problem of very poor color contrast and low visibility. These problems happened due to the diffusion of light and refraction of light while inflowing from rarer to denser medium. Several techniques and methods are recognized by researchers to resolve the problem of underwater image enhancement. In this paper different underwater image enhancing techniques are reviewed and studied.

Key Words: Underwater, Contrast, Morphological Filter, Sift, HSV, Entropy.

Introduction

Establishing an effective and objective quality evaluation metric for images taken in underwater environments is a critical component in underwater image processing, classification and analysis [1]–[4], especially in underwater engineering and monitoring tasks. Subjective quality metrics are considered to give the most reliable results, but are expensive, time-consuming and impractical for real-time implementation and system integration. Objective Image Quality Evaluation (IQE) methods can be classified by whether a reference image, representing the original signal, exists. When such a reference is accessible, the evaluation is known as full-reference (FR) image quality assessment. Another IQE approach is the reduced-reference (RR) quality assessment, which assumes that partial information about the reference signal is available and used for quality evaluation. For underwater images where a reference image cannot be obtained, a no-reference, or blind, objective image quality metric is needed to measure the perceptual image quality. Such a measure should be capable of identifying the differences in distortied images; correlate with human perception; reliably benchmark image processing algorithms and assist in selecting the optimal operating parameters; have low computational complexity, and be implementable in real time.

Underwater (UW) imaging has been receiving considerable attention in the last few decades. A driving force behind advances in UW technologies has been the need to improve image quality. Underwater images can suffer from different types of degradations including color loss, noise due to floating particles, low contrast, skewing and blurring. The primary aim is to restore scenes captured through a dynamic refractive medium. Even though visibility is limited to few tens of meters inside water, imaging through dynamic water surface is important for coral reef monitoring, examining the contamination of shallow water, mapping the distribution of vegetation and seabed sediments etc. These capabilities find applications in commercial fishing zones as well as in boat safety. Thus, it is essential to develop image restoration schemes that can address the challenges that arise when imaging through flowing water.

Many studies have been made in the area of underwater colour image processing in recent years [1], [5], [6]. However most of the restoration and enhancement methods are for underwater photography. Also, there is no colour image quality metric that can be applied to judge and optimize these algorithms. While quality metrics for atmospheric colour images are available [7], they are not applicable to underwater images. Due to poor lighting conditions and the effect of serious absorption and scattering in turbid water, underwater monitoring and survey images suffer from the problems of limited visibility, low contrast, non-uniform illumination, blurring, non-uniform colour cast and complex noise.

Literature Survey

M. Yang and Z. Ji, [1] discussed an Underwater color image enhancement is an important issue in underwater vision field. The non-uniform brightness caused by illumination often severely affects the image enhancement effect in underwater image processing. In this paper, authors presented color fuzzy morphological sieves are first utilized to improve the non-uniform illumination condition. And then, the geometrical rotations in color space are computed with quaternion. By setting the background pixels of the water areas of the processed images to gray or low saturation colors while remaining the object pixel color unchanged, the difference between background and foreground colors of the image is increased.

M. Yang and C.-L. Gong [2] illustrated for the underwater degenerative image caused by obscure and noise, atmospheric turbulence model is utilized to construct the restoration model. By computing the underwater image quality function which is used to estimate the adaptive degradation model parameter, underwater image is restored through Wiener filters. The connection between image contrast and average gradients and model parameter is analyzed as well.

M. Yang and Z. Ji [3] proposed a Color morphological filters based on lexicographic order are typical applications. But they suffer from detail losing problems and it is the same with single-channel processing methods. A new kind of quaternion morphological filter based on traditional Lab space morphological filter is presented. The results show that compared with the traditional Lab morphological filters, the proposed approach, not only effectively preserves the details, but also provides better filtering performance.

R. Schettini and S. Corchs [4] discussed the underwater image processing area has received considerable attention within the last decades, showing important achievements. The authors reviewed some of the most recent methods that have been specifically developed for the underwater environment. These techniques are capable of extending the range of underwater imaging, improving image contrast and resolution. After considering the basic physics of the light propagation in the water medium, we focus on the different algorithms available in the literature. The conditions for which each of them have been originally developed are highlighted as well as the quality assessment methods used to evaluate their performance.

*R. A. Pramunendar*et al [5] proposed the absorption of the light by sea water and light scattering by small particles of underwater environment has become an obstacle of underwater vision researches with camera. It gives impact to the limitation of visibility distances camera in the sea water. The research of 3D reconstruction requires image matching technique to find out the keypoints of image pairs. SIFT is one of the image matching technique where the quality of image matching depends on the quality of the image. The research proposed HSV conversion image with auto level color correction to increase the number of SIFT image matching.

C. Ancuti et al[6] described a novel strategy to enhance underwater videos and images. Built on the fusion principles, our strategy derives the inputs and the weight measures only from the degraded version of the image. In order to overcome the limitations of the underwater medium we define two inputs that represent color corrected and contrast enhanced versions of the original underwater image/frame, but also four weight maps that aim to increase the visibility of the distant objects degraded due to the medium scattering and absorption. Our strategy is a single image approach that does not require specialized hardware or knowledge about the underwater conditions or scene structure. Our fusion framework also supports temporal coherence between adjacent frames by performing an effective edge preserving noise reduction strategy. The enhanced images and videos are characterized by reduced noise level, better exposed-ness of the dark regions, improved global contrast while the finest details and edges are enhanced significantly. In addition, the utility of our enhancing technique is proved for several challenging applications.

Z. Wang et al [7] authors discussed the methods for assessing perceptual image quality traditionally attempted to quantify the visibility of errors (differences) between a distorted image and a reference image using a variety of known properties of the human visual system. Under the assumption that human visual perception is highly adapted for extracting structural information from a scene, we introduce an alternative complementary framework for quality assessment based on the degradation of structural information. As a specific example of this concept, we develop a structural similarity index and demonstrate its promise through a set of intuitive examples, as well as comparison to both subjective ratings and state-of-the-art objective methods on a database of images compressed with JPEG and JPEG2000.

C. Gao, K. Panetta, and S. Agaian [8] introduced a new spatial domain color contrast enhancement algorithm based on the alpha weighted quadratic filter. The goal of this work is to utilize the characteristics of the nonlinear filter to enhance contrast while recovering the color information. Automatic parameter selection is also important for autonomous robot systems. Therefore, we also present a modified image contrast measure Global logAMEE to incorporate the global image information in regular logAMEE. The new measure helps to choose the optimal parameters and to demonstrate the effectiveness of the proposed method. Experimental results show that the proposed algorithm can enhance the contrast and color efficiently and effectively, even in the presence of noise. Thus, the algorithm is suitable for use in real time robotic applications.

Y. Wang, Q. Chen, and B. Zhang [9] presented the histogram equalization is a simple and effective image enhancing technique. But in some conditions, the luminance of an image may be changed significantly after the equalizing process, this is why it has never been utilized in a video system in the past. A novel histogram equalization technique, equal area dualistic sub-image histogram equalization, is put forward. First, the image is decomposed into two equal area sub-images based on its original probability density function. Then the two sub-images are equalized respectively. Finally, we obtain the results after the processed sub-images are composed into one image. The simulation results indicate that the algorithm can not only enhance the image information effectively but also preserve the original image luminance well enough to make it possible to be used in a video system directly.

M. Kim and M. Chung [10] proposed a new histogram equalization method, called RSWHE (recursively separated and weighted histogram equalization), for brightness preservation and image contrast enhancement. The essential idea of

RSWHE is to segment an input histogram into two or more sub-histograms recursively, to modify the sub-histograms by means of a weighting process based on a normalized power law function, and to perform histogram equalization on the weighted sub-histograms independently. RSIHE (recursive sub-image histogram equalization) and RMSHE (recursive mean separate histogram equalization) are some methods similar to RSWHE, but they do not carry out the above weighting process. We show that compared to other existent methods, RSWHE preserves the image brightness more accurately and produces images with better contrast enhancement.

S.-D. Chen and A. R. Ramli[11] discussed the histogram equalization (HE) is widely used for contrast enhancement. However, it tends to change the brightness of an image and hence, not suitable for consumer electronic products, where preserving the original brightness is essential to avoid annoying artifacts. Bi-histogram equalization (BBHE) has been proposed and analyzed mathematically that it can preserve the original brightness to a certain extends. However, there are still cases that are not handled well by BBHE, as they require higher degree of preservation. This paper proposes a novel extension of BBHE referred to as minimum mean brightness error bi-histogram equalization (MMBEBHE) to provide maximum brightness preservation. BBHE separates the input image's histogram into two based on input mean before equalizing them independently. This paper proposes to perform the separation based on the threshold level, which would yield minimum absolute mean brightness error (AMBE - the absolute difference between input and output mean). An efficient recursive integer-based computation for AMBE has been formulated to facilitate real time implementation.

C. Wang and Z. Ye [12] discussed the histogram equalization (HE) is a simple and effective image enhancing technique, however, it tends to change the mean brightness of the image to the middle level of the permitted range, and hence is not very suitable for consumer electronic products, where preserving the original brightness is essential to avoid annoying artifacts. This paper proposes a novel extension of histogram equalization, actually histogram specification, to overcome such drawback as HE. To maximize the entropy is the essential idea of HE to make the histogram as flat as possible. Following that, the essence of the proposed algorithm, named brightness preserving histogram equalization with maximum entropy (BPHEME), tries to find, by the variational approach, the target histogram that maximizes the entropy, under the constraints that the mean brightness is fixed, then transforms the original histogram to that target one using histogram specification. Comparing to the existing methods including HE, brightness preserving bi-histogram equalization (BBHE), equal area dualistic sub-image histogram equalization (DSIHE), and minimum mean brightness error bi-histogram equalization (MMBEBHE), experimental results show that BPHEME can not only enhance the image effectively, but also preserve the original brightness quite well, so that it is possible to be utilized in consumer electronic products.

K. Panetta, C. Gao, and S. Agaian[13] introduced the No-reference (NR) image quality assessment is essential in evaluating the performance of image enhancement and retrieval algorithms. Much effort has been made in recent years to develop objective NR grayscale and color image quality metrics that correlate with perceived quality evaluations. Unfortunately, only limited success has been achieved and most existing NR quality assessment is feasible only when prior knowledge about the types of image distortion is available. This paper present: a) a new NR contrast based grayscale image contrast measure: Root Mean Enhancement (RME); b) a NR color RME contrast measure CRME which explores the three dimensional contrast relationships of the RGB color channels; c) a NR color quality measure Color Quality Enhancement (CQE) which is based on the linear combination of colorfulness, sharpness and contrast. Computer simulations demonstrate that each measure has its own advantages: the CRME measure is fast and suitable for real time processing of low contrast images; the CQE measure can be used for a wider variety of distorted images.

Conclusion

In this review paper, we focused on a survey of different underwater image enhancement techniques are reviewed and studied. The previous methods have isolated the use of gamma correction and histogram stretching to decrease the noise problem which will be presented in the output image of the presented underwater removal algorithms. The equalization (HE) method not creates extra facts, but it can really improve the look of details by increasing small scale acutance and get the output image more improved by applying two stages of HE which will help to reduce complexity of the system and also addresses the problem of color levels. In future work the efficient contrast enhancement Turbulence Mitigation system could be an extra option for processing underwater images in digital cameras, or an enhancement option for image editing software.

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