Underwater Image deblurring using Histogram Equalization

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Abstract

This project focuses its attention towards underwater image processing in order to improve the image quality. As most of the images of offshore installations, drinking water reservoir etc. are captured and inspected manually by divers. And manual intervention in this regard is dangerous, costly, time-consuming and yet does not often enable a full assessment. Hence camera based inspection is used to capture the images under water. Using cameras underwater poses major technological challenges. The objects in the underwater images are faint, difficult to view and analyze because the images of such environment loses the details of the object. The underwater images usually suffer from non-uniform lighting, low contrast, skew, blurs and diminished colors. And hence in this research work, a novel method has been proposed for handling underwater image skewing and blurring in case of unidirectional cyclic waves and circular ripples to enhance the visibility of underwater images. The geometric distortion such as skew is caused by the time variant refraction over the dynamic fluids. And this distortion is associated with motion blur depending on the exposure time of camera. The proposed work develops a mathematical model for image restoration from these distortions with good accuracy.

Keywords: Deblurring, Enhancement, Histogram Equalization

I. INTRODUCTION

Camera movements might result in motion blur in captured images. The blurred image is usually modeled as a convolution between the original image and a known point spread function (PSF). Image restoration techniques are used to remove or minimize known degradations in an image. There are several classical image restoration methods, such as the iterative Lucy–Richardson algorithm and the non-iterative Wiener algorithms [1–2]. Several complex methods such as the Bussgang algorithm [3] have also been proposed. In [4], an adaptive restoration method to adaptively correct retinal images is proposed. This is performed by using deconvolution to remove the residual wave-front aberrations and provide an improvement over the Wiener filter with respect to the quality of restoration. An efficient technique based on physical optics is presented in [5]. In this, space-variant blurs are restored by sectioning using modified Wiener filtering. In [6], an image reconstruction and restoration method using the simplified topological ε-algorithm is proposed. In [7], the generalized Hermitian and skew-Hermitian splitting (GHSS) iterative method is applied to the problem of image restoration.

This paper focuses its attention towards underwater image processing in order to improve the image quality. As most of the images of offshore installations, drinking water reservoir etc. are captured and inspected manually by divers. And manual intervention in this regard is dangerous, costly, time-consuming and yet does not often enable a full assessment. Hence camera based inspection is used to capture the images under water. Using cameras underwater poses major technological challenges. The objects in the underwater images are faint, difficult to view and analyze because the images of such environment loses the details of the object. The underwater images usually suffer from non-uniform lighting, low contrast, skew, blurs and diminished colors. And hence in this research work, a novel method has been proposed for handling underwater image skewing and blurring in case of unidirectional cyclic waves and circular ripples to enhance the visibility of underwater images. The geometric distortion such as skew is caused by the time variant refraction over the dynamic fluids. And this distortion is associated with motion blur depending on the exposure time of camera. The proposed work develops a mathematical model for image restoration from these distortions with good accuracy.

II. LITERATURE SURVEY

Quality evaluation of underwater images is a key goal of underwater video image retrieval and intelligent processing. To date, no metric has been proposed for underwater color image quality evaluation (UCIQE). The special absorption and scattering characteristics of the water medium do not allow direct application of natural color image quality metrics especially to different underwater environments. Based on these, a new UCIQE metric, which is a linear combination of chroma, saturation, and contrast, is proposed to quantify the nonuniform color cast, blurring, and low-contrast that characterize underwater engineering and monitoring images. Importantly, UCIQE is a simple and fast solution for real-time underwater video processing. This approach[1] extracts the most relevant statistical features that are representative for underwater image degradations such as colour cast, blurring and noise caused by attenuation, floating particles and lighting. This approach uses the following methods (i) defogging based algorithms – to enhance visibility (ii). contrast stretching methods and the newest image fusion enhancement.

By adopting image blurriness with the image formation model (IFM) [2], there is a way to estimate the distance between scene points and the camera and thereby recover and enhance underwater images. This paper used image blurriness to estimate the depth map for underwater image enhancement. It is based on the observation that objects farther from the camera are more blurry for underwater images.

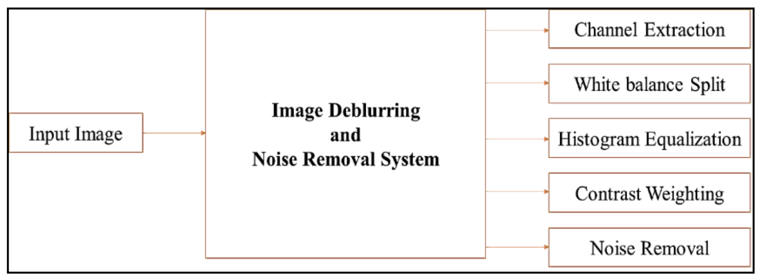
Blurring and low-contrast are the characteristics of underwater images, which are similar to haze images, is the main challenge in searching of fish from underwater images. To overcome the effects of blurring and low-contrast, apply the dark channel prior [3], which was proposed to remove haze from a single input image. Since the underwater images are similar with the haze images, this method mentioned can be also applied to underwater images. The dark channel prior is based on those most local patches in haze-free outdoor images containing some pixels, which have low intensities in at least one color channel. Using this prior with the hazeimaging model, a high quality haze-free image can be recovered. When the dark channel prior is applied to an underwater image, a clear image is generated.

Objects look very different in the underwater environment compared to their appearance in sunlight. High quality images with correct colouring simplify the detection of underwater objects and may allow the use of visual SLAM algorithms developed for land-based robots underwater. Hence, image processing is required to obtain images of high quality and correct colouring. Current algorithms focus on the colour reconstruction[4] of scenery at diving depth which has the advantage that a significant part of sunlight is still present and different colours can still be distinguished. At greater depth the filtering is much stronger such that this is no longer possible. In this study it is investigated whether machine learning can be used to transform image data. In order to obtain images under underwater lighting conditions in a controlled environment a special light source with a defined wavelength is used for illumination of test objects in a laboratory setup. The images are then fed through statistical learning algorithms with or without pre-filters. It is shown that k nearest neighbour and support vector machines are most suitable for the given task and yield excellent results.

Spatial and frequency domain filtering and linear filtering methods are conceptually pleasing and extremely useful in many applications [6]. The spatial filtering is used in spatial domain in the image plane by directly manipulating neighborhood pixels with the help of convolution kernels (Andrews, Hunt, 1987). In frequency domain filtering, if it neglects the presence of interference in the image and restoration is on the footing of the frequency response of correction filter, which was set up for the inverse of the frequency response [7]. This inverse filtering has developed in the frequency domain with the help of FFT. But image restoration by direct inversion was ill-posed owing to the presence of observation noise [8-9]. Direct inversion had caused oscillation due to noise amplification solution [10]. Stephen E. Reichenbach et al. has used corresponding spatial frequency-domain acquisition model.

III. PROPOSED DESIGN

- The system architecture of the proposed method describes the basic procedure for estimating the illumination directions of underwater images and cope with the problem of illumination by normalization. Secondly deblurring of the underwater image using histogram equalization algorithm and finally by fusing both the results the restored image is acquired.



Proposed System Architecture

Channel Extraction

The different channels from image needs to be extracted which can be used in the end to fuse the gray enhanced image with existing color panels. Display each color channel separately, along with the original RGB image. Notice that each separated color plane in the figure contains an area of white. The white corresponds to the highest values (purest shades) of each separate color. For example, in the Red Channel image, the white represents the highest concentration of pure red values. As red becomes mixed with green or blue, gray pixels appear. The black region in the image shows pixel values that contain no red values, i.e., R == 0.

White balancing

White color balance is the global adjustment of the intensities of the colors (typically red, green, and blue primary colors). An important goal of this adjustment is to render specific colors – particularly neutral colors – correctly. Hence, the general method is sometimes called gray balance, neutral balance, or white balance. Color balance changes the overall mixture of colors in an image and is used for color correction. Generalized versions of color balance are used to correct colors other than neutrals or to deliberately change them for effect. We have used color balancing on gray scale image to form various different color formations.

Histogram Equalization

Histogram equalization is used to enhance contrast. It is not necessary that contrast will always be increase in this. There may be some cases were histogram equalization can be worse. In that cases the contrast is decreased.

This method usually increases the global contrast of many images, especially when the usable data of the image is represented by close contrast values. Through this adjustment, the intensities can be better distributed on the histogram. This allows for areas of lower local contrast to gain a higher contrast. Histogram equalization accomplishes this by effectively spreading out the most frequent intensity values.

The method is useful in images with backgrounds and foregrounds that are both bright or both dark. In particular, the method can lead to better views of bone structure in x-ray images, and to better detail in photographs that are over or under-exposed. A key advantage of the method is that it is a fairly straightforward technique and an invertible operator. So in theory, if the histogram equalization function is known, then the original histogram can be recovered. The calculation is not computationally intensive. A disadvantage of the method is that it is indiscriminate. It may increase the contrast of background noise, while decreasing the usable signal.

In scientific imaging where spatial correlation is more important than intensity of signal (such as separating DNA fragments of quantized length), the small signal to noise ratio usually hampers visual detection.

Histogram equalization often produces unrealistic effects in photographs; however it is very useful for scientific images like thermal, satellite or x-ray images, often the same class of images to which one would apply false-color. Also histogram equalization can produce undesirable effects (like visible image gradient) when applied to images with low color depth. For example, if applied to 8-bit image displayed with 8-bit gray-scale palette it will further reduce color depth (number of unique shades of gray) of the image. Histogram equalization will work the best when applied to images with much higher color depth than palette size, like continuous data or 16-bit gray-scale images.

Fusion

Image fusion generally involves selecting the most informative areas from the source images and blending these local areas to get the fused output images. A straight forward approach is to fuse the input images as a weighted blending of the input images. The N input images can be fused by computing a weighted average along each pixel using weights computed from the quality metrics.

Fusion can be used to improve the deficiencies of some existing enhancement methods. There are various techniques for image fusion and the selection of a particular one depends upon the application. The problem of fusion is actually how to define the weights and the combination rules for the fusion process. A simple approach to fusion is to build a composite image as a weighted average of the source/input images. The weights are computed on the basis of salience dictated by the particular vision task.

IV. CONCLUSION AND FUTURE WORK

We have presented an alternative approach to enhance underwater videos and images. Our strategy builds on the fusion principle and does not require additional information than the single original image. We have shown in our experiments that our approach is able to enhance a wide range of underwater images (e.g. Different cameras, depths, light conditions) with high accuracy, being able to recover important faded features and edges. Moreover, for the first time, we demonstrate the utility and relevance of the proposed image enhancement technique for several challenging underwater computer vision applications. We have used histogram equalization as a core method to utilize contrast enhancement in images to improve the accuracy of image proved in above result analysis. Based on system results our proposed methodology can restore 79% of lost data happened to contrast issues in underwater images.

In future we plan to implement the system in video based system so as to improve the quality of HDR videos. Right now the system execution speed is not on par with the speed of frames in video so it will require time enhancement for HDR contrast enhancements.

V. REFERENCES

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