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FFTMI: Features Fusion for natural tone-mapped images quality evaluation

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Abstract:
We introduce an effective technique to enhance theimages captured underwater and degraded due to the medium scattering and absorption. Our method is a single image approach that does not require specialized hardware or knowledge about the underwater conditions or scene structure. It builds on the blending of two images that are directly derived from a colour compensated and white-balanced version of the original degraded image. The two images to fusion, as well as their associated weight maps, are defined to promote the transfer of edges and colour contrast to the output image. To avoid that the sharp weight map transitions create artefacts in the low frequency components of the reconstructed image, we also adapt a multiscale fusion strategy. Our extensive qualitative and quantitative evaluation reveals that our enhanced images and videos are characterized by better exposedness of the dark regions, improved global contrast, and edges sharpness. Our validation also proves that our algorithm is reasonably independent of the camera settings, and improves the accuracy of several image processing applications, such as image segmentation and keypoint matching.

I. INTRODUCTION

With the fast advance of technologies and the prevalence of imaging devices, billions of digital images are being created every day. Due to undesirable light source, unfavourable weather or failure of the imaging device itself, the contrast and tone of the captured image may not always be satisfactory. In fact, image enhancement algorithms have already been widely applied in imaging devices for tone mapping. For example, in a typical digital camera, the CCD (Charge Coupled Device) or CMOS (Complementary Metal Oxide Semiconductor) array receives the photons passing through lens and then the charge levels are transformed to the original image. Usually, the original image is stored in raw format, with a bit length too big for normal displays. An underwater image bears poor quality of images due to the nature of the light. When light enters the water it gets refracted, absorbed and scattered in different directions. Scattering causes the blurring of light and reduces the color contrast. These effects on underwater images are due to the nature of the water. So, image enhancement is the mechanism to process the input image to make it clearly visible as this image enhancement improves the information content and alters the visual impact.

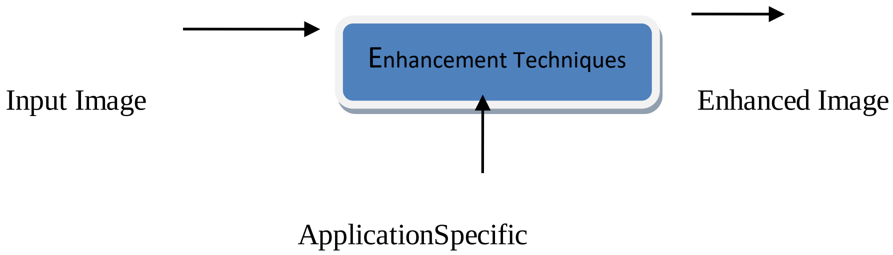
Because of the undesirable illuminance or the physical limitations of inexpensive imaging sensors, the captured image may carry obvious color bias. To calibrate the color bias of image, we need to estimate the value of light source, the problem of which called color constancy. Using a suitable

physical imaging model, one can get an approximated illuminance, and then a linear transform can be applied to map the original image into an ideal one.
White balance determines color rendition of digital photography's, here it is a typical example for the effect of different white balance settings show in the below Figure 1.3.1.White-balance is an aspect of photography that many digital camera owners don't understand, so for those of you have been avoiding white balancing.

Color cast Daylight white balance

Figure 1.3.1.White Balance Image

Different digital cameras have different ways of adjusting white balance. Many digital cameras have automatic and semi-automatic modes to help you make the adjustments. White balance basically means color balance. It is a function which gives the camera a reference to "true white". It tells the camera what the color white looks like, so the camera will record it correctly.
Image fusion is a procedure of fusing two or more images of same scene to form single fused image which displays vital information in the fused image. Image fusion technique is used for removing noise from images. The advantages of image fusion includes image sharpening and feature enhancement. Image Enhancement is one of the most important and difficult techniques in image research. The aim of image enhancement is to improve the visual appearance of an image, or to provide a "better transform representation for future automated image processing. Many images like medical images, satellite images, aerial images and even real life photographs suffer from poor contrast and noise. It is necessary to enhance the contrast and remove the noise to increase image quality. One of the most important stages in medical images detection and analysis is Image Enhancement techniques which improves the quality (clarity) of images for human viewing, removing blurring and noise, increasing contrast, and revealing details are examples of enhancement operations.



II. LITERATURE SURVEY

2.1) Topic: A nonnegative factor model with optimal utilization of error estimates of data values.
Author: P. Paatero and U. Tapper

The fundamental principle of source/receptor relationships is that mass conservation can be assumed and a mass balance analysis can be used to identify and apportion sources of airborne particulate matter in the atmosphere. This methodology has generally been referred to within the air pollution research community as receptor modelling [Hopke, 1985; 1991]. The approach to obtaining a data set for receptor modelling is to determine a large number of chemical constituents such as elemental concentrations in a number of samples. Alternatively, automated electron microscopy can be used to characterize the composition and shape of particles in a series of particle samples.

2.2) Topic: "Underwater image processing: state of the art of restoration and image enhancement methods.

Author: R. Schettini and S. Corchs

The authors provide an overview of state-of-the-art image enhancement and restoration techniques for underwater images. Underwater imaging is one of the challenging tasks in the field of image processing and computer vision. Usually, underwater images suffer from non-uniform lighting, low contrast, diminished color, and blurring due to attenuation and scattering of light in the underwater environment. It is necessary to pre-process these images before applying computer vision techniquesOver the last few decades, many researchers have developed various image enhancement and restoration algorithms for enhancing the quality of images captured in underwater environments. The authors introduce a brief survey on image enhancement and restoration algorithms for underwater images. At the end of the chapter, we present an overview of our approach, which is well accepted by the image processing community to enhance the quality of underwater images. Our technique consists of filtering techniques such as homomorphic filtering, wavelet-based image denoising, bilateral filtering, and contrast equalization, which are applied sequentially. The proposed method increases better image visualization of objects which are captured in underwater environment compared to other existing methods.

2.3) Topic: "Underwater image super-resolution by descattering and fusion.

Author: H. Lu, Y. Li, S. Nakashima, H. Kim, and S. Serikawa

Underwater images are degraded due to scatters and absorption, resulting in low contrast and color distortion. In this paper, a novel self-similarity-based method for descattering and super resolution (SR) of underwater images is proposed. The traditional approach of pre-processing the image using a descattering algorithm, followed by application of an SR method, has the limitation that most of the high-frequency information is lost during descattering. Consequently, we propose a novel high turbidity underwater image SR algorithm. We first obtain a high resolution (HR) image of scattered and bespattered images by using a self-similarity-based SR algorithm. Next, we apply a convex fusion rule for recovering the final HR image. The super-resolved images have a reasonable noise level after descattering and demonstrate visually more pleasing results than conventional approaches. Furthermore, numerical metrics demonstrate that the proposed algorithm shows a consistent improvement and that edges are significantly enhanced.

2. 4) Topic: "Color constancy using natural image statistics and scene semantics.

Author: A. Gijsenij and T. Gevers

Existing color constancy methods are all based on specific assumptions such as the spatial and spectral characteristics of images. As a consequence, no algorithm can be considered as universal. However, with the large variety of available methods, the question is how to select the method that performs best for a specific image. To achieve selection and combining of color constancy algorithms, in this paper natural image statistics are used to identify the most important characteristics of color images. To capture the image characteristics, the Weibull parameterization (e.g., grain size and contrast) is used. It is shown that the Weibull parameterization is related to the image attributes to which the used color constancy methods are sensitive. AMoG-classifier is used to learn the correlation and weighting between the Weibull-parameters and the image attributes (number of edges, amount of texture, and SNR). The output of the classifier is the selection of the best performing color constancy method for a certain image. On a data set consisting of more than 11,000 images, an increase in color constancy performance up to 20 percent (median angular error) can be obtained compared to the best-performing single algorithm. Further, it is shown that for certain scene categories, one specific color constancy algorithm can be used instead of the classifier considering several algorithms.

III. EXISTING SYSTEM

3.1 Basic Steps of Image Enhancement

Figure 3.2.1.shows that the basic steps of image enhancement, if we are taking the any input image, the image is then specify application pre-processing method will be performed on those image after this method the image quality is increased.

1. **Input Image:** In this first an image will be taken as an input. These images can be medical images, blur images, remote sensing images machine vision, the military applications etc.
2. **Perform Pre-processing on the Image:** Images that will be taken as input can be blur image or noisy image so the various pre-processing methods will be performed on those images before applying enhancement technique.
3. **Applying Domain Techniques:** After applying pre-processing method on input images then image quality will be enhanced by using Image enhancement domain techniques such as spatial or transformation.
4. **Output Enhanced Image:** In this the output image will be get which is anenhanced image.

3.2.. Enhancement Methods

Spatial domain techniques are performed to the image plane itself and they are based on direct manipulation of pixels in an image. Then the 3*3 neighbourhood of a point (x, y) as the pixel represented by spatial domain in Figure 3.2.2. (a).

The operation can be formulated as in Eq. 1.

3.3 Image Negative

The negative of image with intensity level in the range 0 to L-1 is obtained by using the negative transformation which is given by in Eq. 2.

$$S=L-1-r \longrightarrow \textbf{... (Eq.2)}$$

Reversing the intensity level in an image in this manner produces the equalent of a photographic negative. This type of processing is particularly suited for enhancing white or gray detail, embedded in dark regions of an image.

3.4 Log Transformation

Log transformation is one of the elementary image enhancement techniques of the spatial domain that can be effectively used for contrast enhancements of dark images. The log transform is essentially a grey level transform which means that the grey levels of image pixels are altered. The general form of the log transformation can be mathematically represented as below in Eq. 3.

$$S=c*\log(1+r) \longrightarrow \textbf{(Eq.3)}$$

Where, sis the output grey level, r is the input grey level and c is a constant. It is assumed that $r \geq 0$.

3.5 Power-Law (or) Gamma Transformation

The nth power and nth root curves shown in Figure 3.2.2.(b). A can be given by the expression; this transformation function is also called as gamma correction. The combination of input and output pixel is given in Eq. 4.

$S = Z^{\gamma}$ Gamma … **(Eq.4)**

Output PixelInput Pixel

For various values of γ different levels of enhancements can be obtained. This technique is quite commonly called as Gamma Correction. If you notice, different displaymonitors display images at different intensities and clarity the difference between the log transformation function and the power-law functions is that using the power-law function a family of possible transformation curves as shown in Figure 3.2.2. (b). can be obtained just by varying the λ.

3.6 Piece-Wise Linear Transformation

The principal advantage of piecewise linear functions over the types of functions we have discussed thus far is that the form of piecewise functions can be arbitrarily complex. In fact, as we will see shortly, a practical implementation of some important transformations can be formulated only as piecewise functions. The principal disadvantage of piecewise functions is that their specification requires considerably more user input. There are four types

1. Contrast stretching
2. Thresholding
3. Gray level slicing
4. Bit plane slicing

3.7 Contrast stretching

Low-contrast images can result from poor illumination, lack of dynamic range in the image sensor, or even wrong setting of a lens aperture during image acquisition. The idea behind contrast stretching in Figure 3.2.2. (c)is to increase the dynamic range of the gray levels in the image being processed. Suppose if the image is taken compare than the image is increase then brightness is increase and then decrease image brightness is called contrast stretching. The binary image as intensity value is a 1 and 0. 1 is a white colour image and 0 require black image.

Original image processed image

Figure 3.2.2. (c). Contrast Image

3.8 Thresholding

Image Thresholding transformation in which let rth be a threshold value in f(x, y). Image thresholding can be achieved as in a normalized gray scale As pixel values of threshold image are either 0‟s or 1‟s, g(x, y) is also named as binary image. These are particularly useful in image segmentation to isolate an image of interest from background.

3.9 Intensity level (or) Gray level slicing

Highlight a specific range of intensities in an image is called as gray level or intensity level slicing. It is having two approaches one is display in one value i.e. on the values in the range of interest, and change the black everything else second certain approaches desired range of intensities leaving or other intensity levels are unchanged.

3.10 Bit Plane Slicing

In this procedure the pixels are represented in the form of the bits, most changes can be captured in significant bits. In this bit plane slicing we may not be able to for see manure changes reflected in low bits. Instead of highlighting gray-level ranges, highlighting the contribution made to total image appearance by specific bits might be desired.

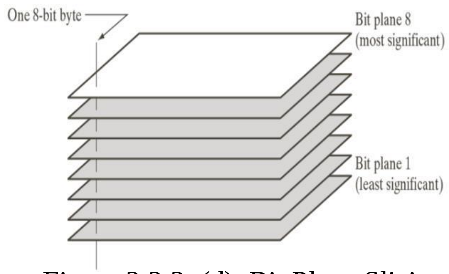


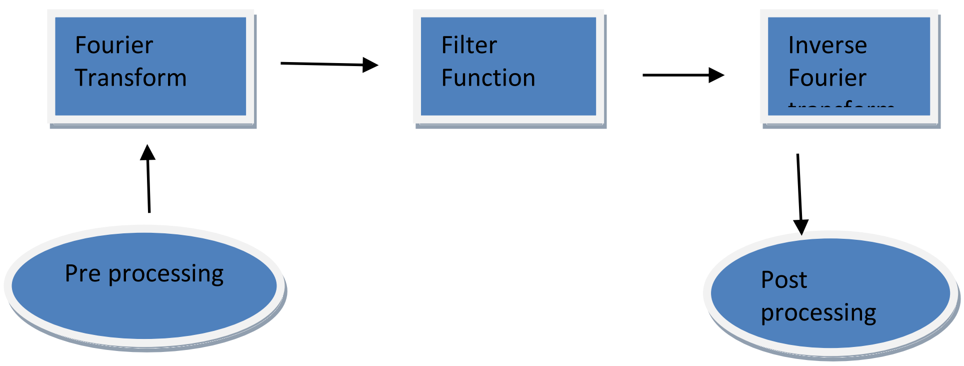
Figure 3.2.2. (d). Bit Plane Slicing

In terms of bit-plane extraction for an 8-bit image, it is not difficult to show that the (binary) image for bit-plane 7 can be obtained by processing the input image with a thresholding gray-level transformation function that maps all levels in the image between0 and 127 to one level (for example, 0); and (2) maps all levels between 129 and 255 to another (for example, 255).The binary image for bit-plane 7 in Figure 3.2.2.(d).

3.11 Frequency Domain Method

The transform domain enables operation on the frequency content of the image, and therefore high frequency content such as edges and other subtle information can easily be enhanced. Frequency domain which operate on the Fourier transform of an image. The basic frequency functions as in Figure 3.2.2(e).Edges and sharp transitions (e.g. noise) in an image contribute significantly to high frequency content of Fourier transform. Low frequency contents in the Fourier transform are responsible to the general appearance of the image over smooth areas.

1. **Image sharpening:** The main aim in image sharpening is to highlight find detail in the image, or to enhance detail that has been blurred.



PROPOSED SYSTEM

Underwater environment offers many rare attractions such as marine animals and fishes, Different from common images, underwater images suffer from poor visibility resulting from the attenuation of the propagated light, mainly due to absorption and scattering effects. The absorption substantially reduces the light energy, while the scattering causes changes in the light propagation direction. They result in foggy appearance and contrast degradation making distant objects misty. Practically, in common sea water images, the objects at a distance of more than 10 meters are almost unperceivable, and the colors are faded because their composing wavelengths are cut according to the water depth.

3.12 Underwater White Balance

In our approach, white balancing aims at compensating for the color cast caused bythe selective absorption of colors with depth, while image fusion is considered to enhance the edges and details of the scene, to mitigate the loss of contrast resulting from back-scattering. We now focus on the white-balancing stage.

White-balancing aims at improving the image aspect, primarily by removing the undesired color castings due to various illumination or medium attenuation properties. In underwater,the perception of color is highly correlated with the depth, and an important problem is the green-bluish appearance that needs to be rectified. Since the scattering attenuates more the long wavelengths than the short ones, the color perception is affected as we go down in deeper water.

The compensation should be proportional to the difference between the mean green and the mean red values because, under the Gray world assumption (all channels have the same mean value before attenuation), this difference reflects the disparity/unbalance between red and green attenuation.

The sharpening method defined is referred to as normalized unsharp maskingprocess in the following. It hasthe advantage to not require any parameter tuning, and appears to be effective in terms of sharpening. This second input primarily helps in reducing the degradation caused by scattering. Since the difference between white balanced image and its Gaussian filtered version is a high pass signal that approximates the opposite of Laplacian, this operation has the inconvenient to magnify the high-frequency noise, thereby generating undesired artifacts in the second input.

3.13 BLOCK DIAGRAM OF PROJECT:

In this project, two images are derived from a white-balanced version of the single input and are merged based on a multi-scale fusion algorithm. Block diagram is shown in the Figure 4.3.

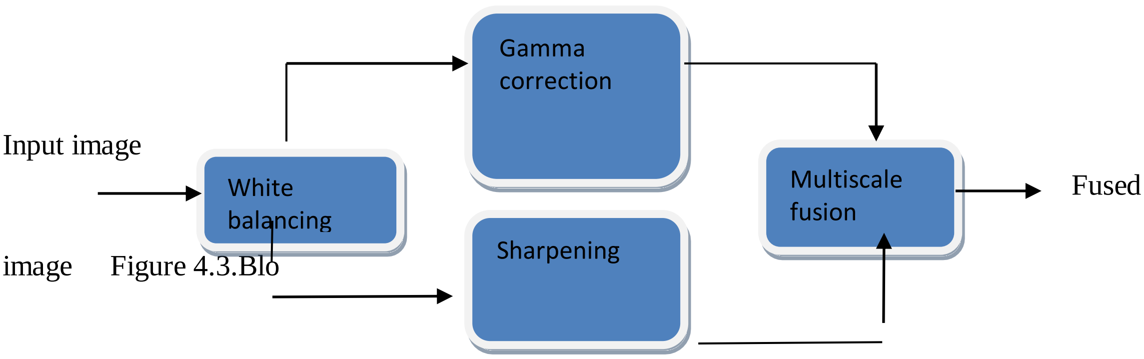


Figure 4.3.Blo

Image enhancement approach adopts a two step strategy, combining white-balancing and image fusion. White-balancing aims at compensating for the color cast caused by the selective absorption of color with depth, while image fusion is considered to enhance the edges and details of the scene.Color correction is critical inunderwater so first we apply white balancing technique to the original image. This step aims to enhance the im

3.14 DESIGN AND IMPLEMENTATION

In this project our white-balancing aim at compensating for the color cast caused by selective absorption of color with depth. Primarily by removing the undesired color casting due to various illumination or medium attenuation properties. Image fusion is to improve underwater images without restoring. Here the results are executed in MATLAB software .Image processing toolbox is used to perform analysis and algorithm development which perform image segmentation, image enhancement and noise reduction. In this project a single image is given as input image and our white-balancing approach derived into two images one is the input 1 and input 2 as shown in the Figure using gamma correction and edge sharpening and the two input images are used as inputs of the fusion process. Multi-scale fusion approach is here to examine with three levels by weight maps calculation.

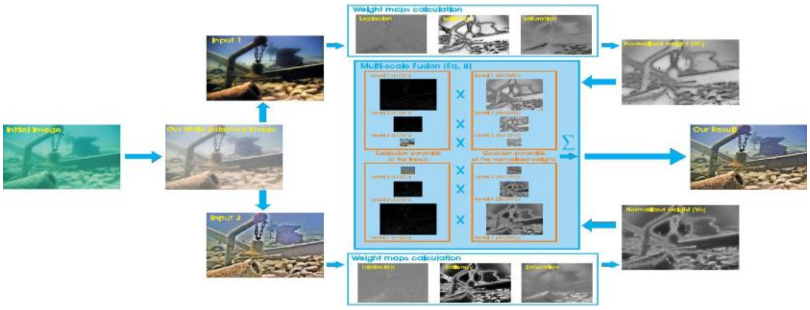


Figure 5.2.System Architecture Diagram

IV. RESULTS

As shown in the Figure 6.1. (f)fused image builds on the set of inputs and weight maps derived from single image. This fused image is defined based on number of local image quality. In this Figure we can see the difference between the input image and fused image as the fused image is clear with color and quality of the image.Finally we calculate and get the values of MSE and psnr to know the quality of the image.

V. CONCLUSION

We presented a new full reference metric named LSHS to assess the quality of tone-mapped images. LHSH quantifies the loss of image quality considering 16 different low-level features and assigns a single score to the tone-mapped image. The features are extracted in the HSV color space – five from the lightness, hue, and saturation channels each, and one giving the structural fidelity. Experimental results showed that these features are quite effective in detecting and penalizing diverse types of distortions and assigning an appropriate score to the image's quality. The performance of an objective metric can be evaluated based on the correlation of its scores with the scores obtained through a subjective study. For this purpose, a widely used labeled dataset is TMID. In this paper, a new labeled dataset was proposed that contains a larger number of images and a variety of scenes. The proposed LSHS algorithm outperformed 24 existing state-of-the-art metrics on both datasets. Some existing metrics, which were fine-tuned for optimal performance on the TMID, failed on the new dataset, whereas the performance of LSHS stayed consistently better across both datasets. The proposed metric was also evaluated on standard LDR images (not obtained through tone-mapping of HDR images) using the TID2013 dataset of 3000 distorted images. Although the features used by our metric are defined for tone-mapped images, it still performed well, remaining in the second position among 25 metrics, including some state-of-the-art metrics designed explicitly for traditional images.

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