International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 10 | Oct -2016 www.irjet.net p-ISSN: 2395-0072

Visual Enhancement of Undersea Images by ADCP Method

Jasneet Kaur Babool[1], Satbir Singh[2], Saurabh Mahajan[3]

[1]M.Tech Scholar, Dept. of ECE, GNDU, RC, Gurdaspur, Punjab, India
[2]Assistant Professor, Dept. of ECE, GNDU, RC, Gurdaspur, Punjab, India
[3]Assistant Professor, Dept. of ECE, BECT, Gurdaspur, Punjab, India

---***---

Abstract – We have Purposed ADCP method for assessing perceptual image quality is a usual effort to quantify the perceptibility of inaccuracy between a vague 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.

Key Words: **MSE, PSNR, Image Processing, MATLAB, CLAHE, ADCP**

1. INTRODUCTION

The extensive distortions during acquisition, processing, compression, storage, transmission and reproduction may result in a degradation of visual quality of the digital images. For applications in which images are ultimately to be viewed by human beings, the only "accurate" method of quantifying visual image quality is through special evaluation, but is usually too inconvenient, costly and time-consuming. An objective image quality metric can play a variety of roles in image processing applications [1]. The examination of mention image quality assessment is to develop quantitative measures that can automatically predict perceived image quality i.e. it can be used to dynamically monitor and adjust image quality.

Acquiring apparent images in undersea environments is a significant issue in ocean engineering. The quality of undersea images plays a pivotal role in scientific missions such as monitoring sea life, taking census of populations, and assessing geological or biological environments [2].

Undersea imaging is essential for scientific research and technology as well as for trendy activities, yet it is plagued by poor visibility environment. The most computer vision methods cannot be employed directly undersea [3]. This is due to the particularly challenging environmental conditions that complicate image matching and analysis. The optimization of undersea image system parameters predominantly focuses on maximizes signal strength and minimizes scattering effects. Obtaining satisfactory visibility of undersea objects has been historically difficult due to the absorptive and scattering properties of seawater. Mitigating these effects has been a long term research focus, but recent advancements in hardware, software, and algorithmic methods have led to noticeable improvement in system operational range.

Acquiring clear images in undersea environments is an important issue in ocean engineering [3]-[4]. The quality of undersea images plays a pivotal role in scientific missions such as monitoring sea life, taking census of populations, and assessing geological or biological environments.

The Color change and Light scattering are two main sources of deformation for undersea photography. The Color change corresponds to the varying degrees of attenuation encountered by light traveling in the sea with different wavelengths, rendering ambient undersea environments dominated by a bluish tone. The light incident on objects reflected and deflected several times by particles present in the water before getting the camera is due to light scattering [5]. This in turn lowers the visibility and contrast of the image captured. No existing undersea processing techniques can handle light scattering and color change distortions suffered by undersea images, and the possible presence of artificial lighting simultaneously. The Color change and Light scattering result in contrast loss and color deviation in images acquired undersea.

Capturing images undersea is challenging, mostly due to mist caused by light that is reflected, deflected and scattered by water. The color change is caused by varying degrees of light attenuation for different wavelengths. The smog is due to suspended particles such as algae, sand, minerals, and plankton that exist undersea. As light reflected from objects propagates toward the camera, a portion of the light meets these suspended particles. This in turn absorbs and scatters the light beam. In the absence of blackbody radiation [6], the multi-scattering process along the course of propagation further disperses the beam into homogeneous background light. Conventionally, the processing of undersea images focuses solely on compensating either light scattering or color change distortion. Techniques targeting on removal of light scattering distortion include exploiting the polarization effects to compensate for visibility degradation [7], using image de-hazing to restore the clarity of the undersea images and combining point spread functions and a modulation transfer function to reduce the blurring effect [8].

Although the aforementioned approaches can enhance scene contrast and increase visibility, distortion caused by the disparity in wavelength attenuation, i.e., color change, remains intact. On the other hand, color-change correction techniques estimate underwater environmental parameters by performing color registration with consideration of light attenuation [9], employing histogram equalization in both RGB and HSI color spaces to balance the luminance distributions of color [10], and dynamically mixing the illumination of an object in a distance-dependent way by using a controllable multicolor light source to compensate color loss [11]. Despite the improved color balance, these methods are ineffective in removing the image blurriness caused by light scattering. A systematic approach is needed to take all the factors concerning light scattering, color change, and possible presence of artificial light source into consideration.

The smog removal may be partition into two broad categories: image restoration and image enhancement. This process can enhance the contrast of smog image but loses some information regarding image. After watching the degradation style of smog, image will definitely be recognized. After that the degradation process is inverted to generate the smog free image without degradation. ADCP method was proposed to overcome the problem related to visibility of underwater images and have neglected the methods to reduce noise. The issue of uneven and also over illumination may also be an issue for smog removal methods. So new propose strategy may continue steadily to enhance image. This paper proposes a new method and results of this technique seems to be justifiable [12].

This section represents the literature survey done on the various haze and smog removal techniques. The literature review represents the work done by the various researchers and scholars in this direction which serves as an introduction to research further on various steps of fog removal [13]. The various research papers which have been referred during this research work are in reference. A novel defogging principle just based on a single image using dark channel prior as basics of principle. After experimental analysis about the dark channel prior Mist removal, they found that although dark channel prior reacts well in most situations, it also results in larger diffusion values in some specific situations. Targeting on these situations, they proposed an iterative principle to alter the color distortion effected by higher diffusion. This kind of global or local modification can be achieved by relatively ideal compromise between natural color and image definition [14]. The dark channel prior is a kind of data of outdoor Mist-free images. It is based on a key inspection that most local patches in outdoor Mist-free images include some pixels whose power is very low in at least one color channel. Using this prior with the Mist imaging representation, the thickness of the Mist is approximated and get better high-quality Mist-free image. We use the image Mist elimination of dark channel prior prone to color distortion occurrence for some large white bright area in the image. They presented an image Mist deduction of wiener filtering based on dark channel prior. The algorithm is mostly to approximate the median function in the use of the media filtering method based on the dark channel, to make the media function more exact and unite with the wiener filtering closer [15]. So that the fog image restoration problem is altered into an optimization problem, and by minimizing mean-square error a clearer, fog free image is finally obtained.

Experimental results show that the proposed algorithm can make the image more detailed, the contour smoother and the whole image clearer. In particular, this algorithm can recover the contrast of a large white area fog image [16].

The use of the lowest level channel is cut down from the dark channel prior. It is based on a key inspection that fog-free strength in a color image is usually the minimum value of dichromatic channels. To approximate the transmission model, the dark channel prior that performs as a min filter for the lowest concentration. However, the min filter results in halo artifacts, specifically for neighbors of edge pixels. As the light spreads from object to the observer, the color and strength is changed by the atmospheric particles.

2. UNDERWATER DARK CHANNEL PRIOR

In computer vision and computer graphics, the model widely used to describe the formation of a haze image is as follows [5, 18]:

$$\mathbf{I}(\mathbf{x}) = \mathbf{J}(\mathbf{x})t(\mathbf{x}) + \mathbf{A}(1 - t(\mathbf{x})), \quad (1)$$

Where, **I** is the observed intensity, **J** is the scene radiance, **A** is the global atmospheric light, and t is the medium transmission describing the portion of the light that is not scattered and reaches the camera. The goal of haze removal is to recover **J**, **A**, and t from **I**.

The first term $\mathbf{J}(\mathbf{x})t(\mathbf{x})$ on the right hand side of Equation (1) is called *direct attenuation*, and the second term $\mathbf{A}(1 - t(\mathbf{x}))$ is called *air light* [5,1]. Direct attenuation describes the scene radiance and its decay in the medium, while air light results from previously scattered light and leads to the shift of the scene color.

The traditional dark channel prior is based on the following observation on smog-free images: in most of the non-sky patches, at least one color channel has very low intensity at some pixels. It can be defined as:

$$J^{dark}(x) = \min_{c\in\{r,g,b\}} (\min_{y\in\Omega(x)} (J^c(y))) \quad (2)$$

Where Jc is a color channel of J and (x) is a local patch centered at x. According to the dark channel prior, except for the sky region, the intensity of the dark channel is low and tends to be zero [19]. Next, we will illustrate why the above dark channel prior does not apply to underwater images. According to He et al.'s theory, the intensity of the dark channel of a haze image is a rough approximation of the thickness of the haze.

It's the key to haze removal. But for undersea images, the traditional dark channel prior may fail at many cases. In order to facilitate the description, we define the single dark channel as:

$$I^{dark(c)}(x) = \min_{y\in\Omega(x)}(I^c(y)) \quad (3)$$

And the dark channel of I can be written as:

$$I^{dark}(x) = \min_{c\in\{r,g,b\}}(I^{dark(c)}(x)) \quad (4)$$

We find that for an image captured around deep-water area or under muddy water, due to the energy of red light being absorbed largely, the intensity of I dark(r) (x) is very low and tends to be zero, which causes the dark channel of the input undersea image to be prone to a zero[6]. As light attenuation in atmosphere and the attenuation of blue and green light in water almost share the same principle scattering, we could consider only the blue and green channels and redefine a new dark channel that fits the underwater image:

$$J^{uwdark}(x) = \min_{c\in\{g,b\}}(\min_{y\in\Omega(x)}(J^c(y))) \quad (5)$$

We call it the undersea dark channel of J. Similarly to the traditional dark channel prior, the intensity of the undersea dark channel should be low and tend to be zero [9]. Empirically, the backgrounds of undersea scenes tend to be blue (for seas and oceans) or green (for lakes). Due to the color shift caused by the background light, the intensities of blue or green channels of a captured undersea image should be larger than their true radiances. And the undersea dark channel of an undersea image will have higher intensity in regions farther from the camera. Consequently, the undersea dark channel can qualitatively reflect the undersea distance between the scene point and the camera [18].

3. PERFORMANCE RESULTS

The algorithm is applied using various performance indices Mean squared error (MSE), peak signal to noise ratio (PSNR), Geometric Accuracy (GA), Standard Deviation (SD) and Contrast Gain (CG). In order to implement the algorithm, design and implementation has been done in MATLAB R2010a version using image processing toolbox. The developed approach is compared against a well-known image de-hazing technique. We are comparing proposed approach using some performance metrics. Result shows that our approach gives better results than the existing technique.

As mean square error needs to be reduced therefore the 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. The method is tested on the number of images and in each case shows the better results than the existing method. For example in given table it is clearly shown that the 1,2,3,4 images have very much less MSE values so ADCP method work efficiently.

The 1st input image is evaluated by the proposed ADCP algorithm and other existing methods. The results of below image shows that round blocks are floating in sea and blue colour of water showing slightly green due to light reflection; soil is heaving its natural colour for ADCP method as comparative to other existing methods.

Fig3.1: (a)Round blocks(b)CLAHE(c)Base paper(d)ADCP result.

The Round blocks in water are clearly visible, the color of blue water and soil is more effectively preserve by proposed ADCP output image. The comparison table of parameter using different methods is given below.

Table 3.1: shows that proposed ADCP methods gives better result as compare to the other methods for every parameter. So, it could be concluded from the result of image (d) in fig 3.1 by advanced dark channel prior (ADCP) method is more effective as compare to other existing methods for same image (i.e. 1st Image).

Table 3.1: Comparison of parameters for 1st image using different methods

Parameters	**CLAHE**	**Base Paper**	**ADCP**
Mean Square Error	83	61	**53**
PSNR	20.8201	22.3417	**23.126**
Geometric Accuracy	89.7661	89.4163	**92.364**
Standard Deviation	0.0092	0.0084	**0.0084**
Contrast Gain	10.8392	9.9764	**13.338**

The 2nd input image is evaluated by the proposed ADCP algorithm and other existing methods. The results of input image shows that the girls are swimming in water and their body, clothes and water is having likely color for ADCP method as comparative to other existing methods.

Fig 3.2 :(a) Swimming (b)CLAHE(c)Base paper(d) ADCP result

The swimming girls in water are clearly visible, the color of their clothes and body is more effectively preserve by proposed ADCP output image. The comparison table of parameter using different methods is given below.

Table 3.2: shows that proposed ADCP methods gives Better result as compare to the other methods for every parameter. So, it could be concluded from the result of image (d) in fig 3.2 by advanced dark channel prior (ADCP) method is more effective as compare to other existing methods for same image (i.e. 2nd Image).

Table 3.2: Comparison of parameters for 2nd image using different methods

Parameters	CLAHE	Base Paper	ADCP
Mean Square Error	127	2000	**31**
PSNR	18.9910	17.3832	**26.6755**
Geometric Accuracy	87.0528	85.6792	**94.1222**
Standard Deviation	0.0085	0.0087	**0.0074**
Contrast Gain	7.8013	6.4307	**14.1275**

The 3rd input image is evaluated by the proposed ADCP algorithm and other existing methods. The results of input image are showing that the medicine (i.e. tablets and capsules) and algae in water is having natural color for ADCP method as comparative to other existing method.

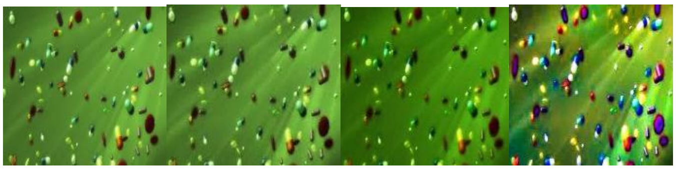

Fig3.3:(a)Tablets(b)CLAHE(c)Base Paper(d)ADCP Result

In ADCP output image result the medicine in water are clearly visible and retained image also showing natural color of algae. The comparison table of parameter using different methods is given below.

Table 3.3: Comparison of parameters for 3rd image using different methods

Parameters	CLAHE	Base Paper	ADCP
Mean Square Error	114	159	**81**
PSNR	19.4228	18.1583	**20.9585**
Geometric Accuracy	88.7536	85.1560	**89.3088**
Standard Deviation	0.0093	0.0089	**0.0087**
Contrast Gain	9.8306	5.8919	**10.3960**

Table 3.3: shows that proposed ADCP method gives better Result as compare to the other methods for every parameter. So, it could be concluded from the result of image (d) in fig 3.3 by advanced dark channel prior (ADCP) method is more effective as compare to other existing method for same image (i.e. 3rd Image).

The 4th input image is evaluated by the proposed ADCP algorithm and other existing methods. The results of input image shows that the turtle in water showing natural color for ADCP method as comparative to other existing methods.

Fig 3.4 : (a)Turtle(b)CLAHE(c)Base Paper(d) ADCP Result

In ADCP output image result the turtle in water is more effectively and clearly visible .The brightness of image also retained and showing black spots on turtle clarity. The comparison table of parameter using different methods is given below.

Table 3.4: Comparison of parameters for 4th image using different methods

Parameters	CLAHE	Base Paper	ADCP
Mean Square Error	245	70	**59**
PSNR	16.7319	21.6186	**22.5075**
Geometric Accuracy	84.3756	87.1218	**89.5496**
Standard Deviation	0.0092	0.0085	**0.0085**
Contrast Gain	5.1371	7.8740	**10.5400**

Table 3.4: shows that proposed ADCP method gives better result as compare to the other methods for every parameter. So, it could be concluded from the result of image (d) in fig 3.4 by advanced dark channel prior (ADCP) method is more effective as compare to other existing methods for same image (i.e. 4th Image).

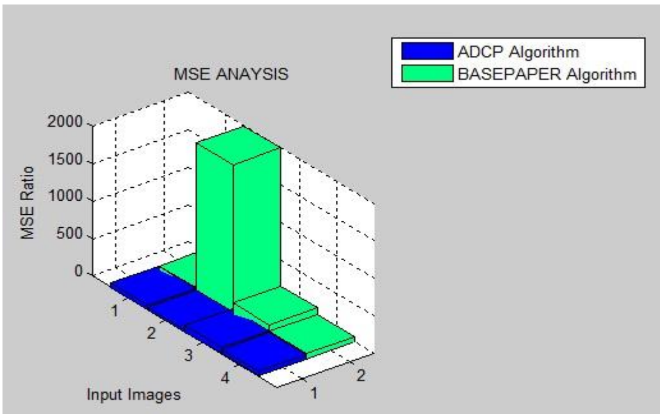

Fig 3.5 (a): MSE comparison of images for ADCP and Base paper methods

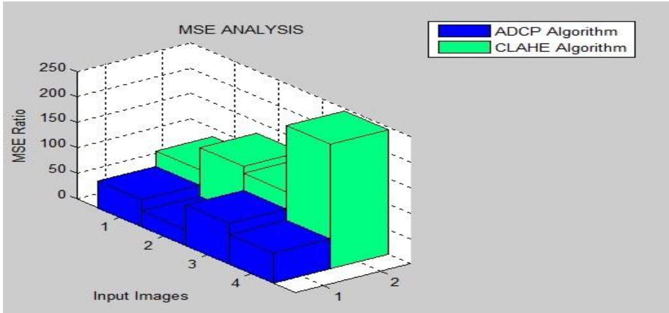

Fig 3.5 (b): MSE comparison of images for ADCP and CLAHE Methods

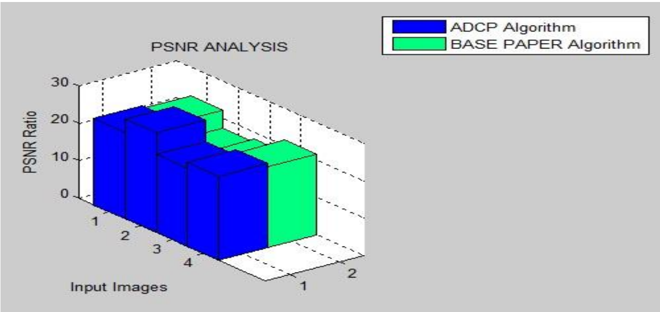

Fig 3.6(a): PSNR comparison of images for ADCP and Base paper methods

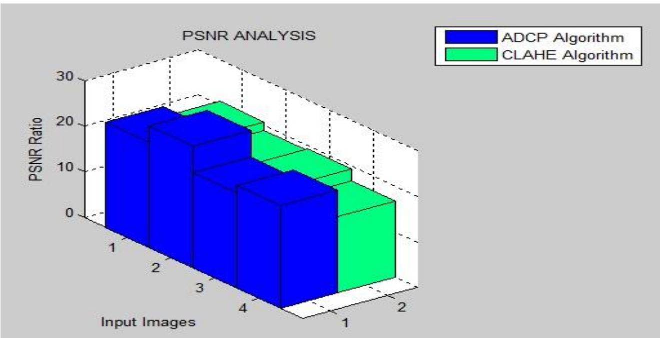

Fig 3.6(b): PSNR comparison of images for ADCP and CLAHE methods

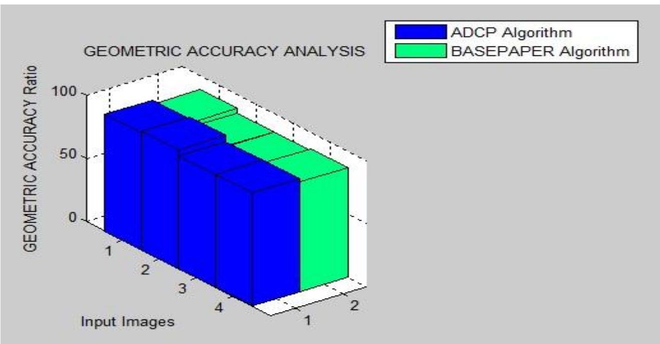

Fig 3.7(a): Geometric accuracy comparison of image for ADCP for Base Paper methods

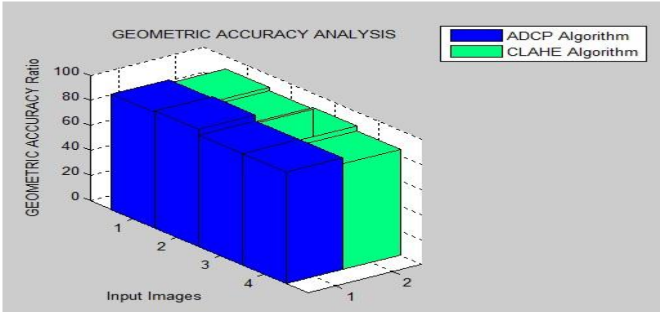

Fig 3.7(b): Geometric accuracy comparison of images for ADCP and CLAHE methods

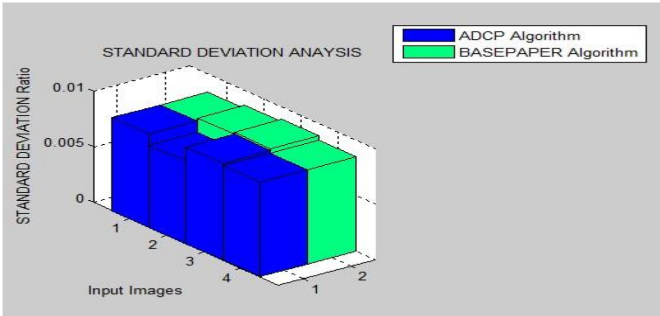

Fig 3.8(a): Standard deviation comparison of images for ADCP and Base Paper methods

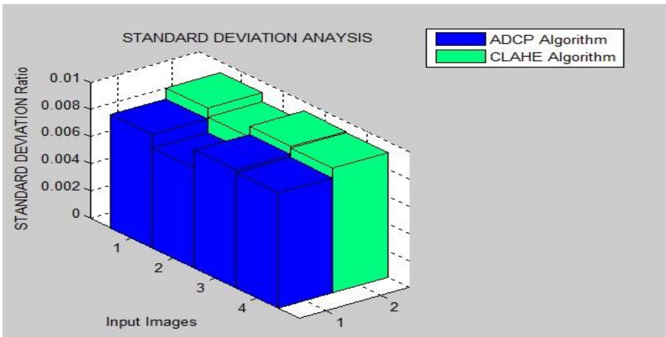

Fig 3.8(b): Standard deviation comparison of images for ADCP and CLAHE methods

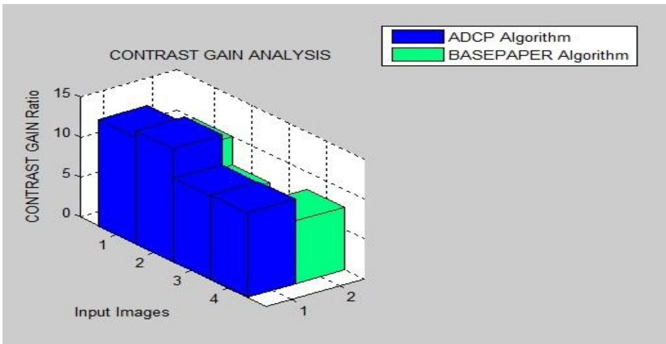

Fig 3.9(a): Contrast gain comparison of images for ADCP and Base Paper methods

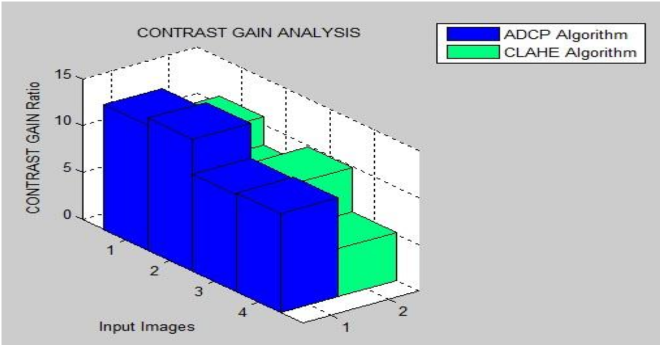

Fig 3.9(b): Contrast gain comparison of images for ADCP and CLAHE methods

4. CONCLUSIONS AND FUTURE SCOPE

In this paper, we have introduced ADCP a very simple but powerful prior, called dark channel prior, for single image smog removal. The dark channel prior is based on the statistics of the outdoor images. Applying the prior into the smog imaging model, single image smog removal becomes simpler and more effective.

Here, an effective undersea image enhancement algorithm is proposed. Since the dark channel prior is a kind of statistic, it may not work for some particular images. When the scene objects are inherently similar to the atmospheric light and no shadow is cast on them, the dark channel prior is invalid. Our work also shares the common limitation of most haze removal methods - the haze imaging model may be invalid. More advanced models can be use to describe complicated phenomena, such as the sun's influence on the sky region, and the bluefish hue near the horizon. Our algorithm is effective and physical valid, and can well handle deep-sea images and images captured from turbid waters. In future work, we will further improve the adaptability and flexibility of our algorithm. We intend to investigate haze removal based on these models in the future.

5. REFERENCES

[1] Guo, Fan, Cai Zixing, Xie Bin and Tang Zin, "Automatic Image Mist Removal Based on Luminance Component", Wireless Communications Networking and Mobile Computing (WiCOM), 2010 6th International Conference on. IEEE, 2010.

[2] B. Girod, "What's wrong with mean-squared error," in *Digital Images and Human Vision*, A. B. Watson, Ed. Cambridge, MA: MIT Press, 1993, pp. 207–220.

[3] Wei, Sun, and Han Long,"A New Fast Single-Image Defog Algorithm", Intelligent System Design and Engineering Applications (ISDEA), 2013 Third International Conference on. IEEE, 2013

[4] R. Fattal, "Single image dehazing," ACM Transactions on Graphics, vol. 27, no. 3, pp. 721-729, 2008.

[5] H. Yang, P. Chen, C. Huang, Y. Zhuang and Y. Shiau, "Low complexity underwater image enhancement based on dark channel prior," IBICA, pp.17-20, 2011.

[6] L. Chao and M. Wang, "Removal of water scattering," ICCET, vol. 2, pp. 35-39, 2010.

[7] Xu Haoran, Guo Jianming, Liu Xing and Ye Lingli, "Fast image dehazing using improved dark channel prior",Information Science and Technology (ICIST), 2012 International Conference on. IEEE, 2012.

[8] Xu, Zhiyuan, and Xiaoming Liu, "Bilinear interpolation dynamic histogram equalization for fog-degraded image enhancement", J Inf Comput Sci 7.8 (2010) 1727-1732.

[9] N. Carlevaris-Bianco, A. Mohan, and R. M. Eustice, "Initial results in underwater single image dehazing," OCEANS 2010, pp. 1-8, 2010.

[10] K. He, J. Sun and X. Tang, "Single image haze removal using dark channel prior," Proceedings of IEEE Conference on Computer Vision and Pattern Recognition Workshops 2009, pp. 1956-1963. 2009.

[11] Shuai, et al, "Image Mist removal of wiener filtering based on dark channel prior", Computational Intelligence and Security (CIS), 2012 Eighth International Conference on. IEEE, 2012.

[12] Huang, Darong, Zhou Fang, Ling Zhao, and Xiaoyan Chu. An improved image clearness algorithm based on dark channel prior. In Control Conference (CCC), 33rd Chinese, pp. 7350-7355. IEEE, 2014.

[13] Xu, Haoran, et al. Fast image dehazing using improved dark channel prior. International Conference on Information Science and Technology (ICIST), IEEE, 2012.

[14] Wang, Gangyi, Guanghui Ren, Lihui Jiang, and Taifan Quan, "Single Image Dehazing Algorithm Based on Sky Region Segmentation", Information Technology Journal 12.6, 2013.

[15] Hitam, M. S., W. N. J. H. W. Yussof, E. A. Awalludin, and Z. Bachok. Mixture contrast limited adaptive histogram equalization for underwater image enhancement. International Conference on, Computer Applications Technology (ICCAT), pp. 1-5. IEEE, 2013.

[16] Wang, Yan, and Bo Wu. Improved single image dehazing using dark channel prior. International Conference on Intelligent Computing and Intelligent Systems (ICIS), Vol. 2. IEEE, 2010.

[17] Shuai, Yanjuan, Rui Liu, and Wenzhang He.Image. Haze Removal of Wiener Filtering Based on Dark Channel Prior International Conference on Computational Intelligence and Security (CIS), Eighth IEEE, 2012.

[18] He, Kaiming, Jian Sun, and Xiaoou Tang, "Single image Mist removal using dark channel prior", Pattern Analysis and Machine Intelligence, IEEE Transactions on 33.12, pp. 2341-235, (2011).

[19] Tripathi A.K and S. Mukhopadhyay,"Single image fog removal using bilateral filter", Signal Processing, Computing and Control (ISPCC), 2012 International Conference on. IEEE, 2012.

[20] Wang, Jin-Bao, Ning He, Lu-Lu Zhang, and Ke Lu.Single image dehazing with a physical model and dark channel prior. Neurocomputing 149, pp. 718-728, 2015.