Under Water Image Enhancement Using Discrete Cosine Transform

S.V.S.Sai.Sravya, B.Gopi Naik, P.Bhavani, G.Prathibha

***Abstract*— Numerous underwater image enhancement schemes are being used for improving an image, which includes gray scale manipulation, filtering and Histogram Equalisation. Histogram Equalisation has become a popular technique because this method is simple and effective. Another significant technique in underwater image enhancement is Discrete cosine transform. Discrete cosine transform is a fast transform that has excellent compaction for highly correlated data. DCT gives good compromise between information package ability and computational complexity. In this paper underwater image enhancement is proposed based on discrete cosine transform and Unsharp Mask Filtering, which gives the significant results as compared to previous techniques.**

***Index Terms*— Discrete Cosine Transform, Unsharp Mask Filtering.**

I. INTRODUCTION

Getting clear images in underwater environments is an important issue in Ocean engineering. Image enhancement is a process of changing an image so that the result is more suitable than the original image for a particular application. Image enhancement commonly used in computer graphics and it is the subarea of image processing. Image enhancement techniques can be divided into two broad categories: Spatial domain methods and Frequency domain methods. Spatial domain is the collection of pixels composing an image. Spatial domain techniques are procedures that work directly on the pixels. Spatial domain processing is denoted such as g(x, y) =T [f(x, y)]. Point processing is the processing of contrast enhancement. This process produces an image of higher contrast than the one by darkening a particular level. Hitam et al. (2013) [1] have discussed a new method specifically developed for enhancing the underwater images called mixture Contrast Limited Adaptive Histogram Equalization (CLAHE) color model. Galdran et al. 2014[2] proposed a Red Channel method, where colors associated to short wavelengths are recovered, as expected for underwater images. G.Padmavathi et al. 2010[3] have compared and evaluated three filters performance. These filters are homomorphic filter, anisotropic diffusion and wavelet denoising by average filter. All these filters are helpful in pre-processing of underwater image. Chiang et al. 2012[4] have proposed a fresh efficient approach based on dehazing algorithm, used to enhance underwater images. Erturk et al. 2012 [5] have presented a new algorithm based on an Empirical Mode Decomposition (EMD) which is used to improve visibility of underwater images. Sowmyashree et al. 2014[6] have presented a relative study of the different image enhancement methods used for enhancing images of the bodies under the water. Hung Yu Yang et al.2011 [7] worked on "Low complexity under water image enhancement based on dark channel prior”. bt.Shamsuddin et al. 2012[8] developed a technique on Significant level of image enhancement techniques for underwater images. Jinbo Chen et al. 2011[9] proposed A detection method based on sonar image for underwater pipeline tracker. Haochng Wen and Yonghong Tian (2013) [10] proposed a new underwater optical model which describe the formation of an underwater image in the true physical process.

S.V.S.Sai.Sravya, Final year B.Tech ECE Students, ANUCET, Acharya Nagarjuna University, Guntur, A.P. India
B.Gopi Naik, Final year B.Tech ECE Students, ANUCET, Acharya Nagarjuna University, Guntur, A.P. India
P.Bhavani, Final year B.Tech ECE Students, ANUCET, Acharya Nagarjuna University, Guntur, A.P. India
G.Prathibha, Assistant Professor, Dept of ECE, ANUCET, Acharya Nagarjuna University, Guntur, A.P. India

BASIC METHODOLOGY

Dark-channel prior method (a scene-depth derivation method) is used first to calculate the distances of the scene objects to the camera as shown in fig 1. First an image is kept in an array. Next it is compared to the image of the other camera by taking square regions of pixels and comparing the intensity between the two cameras images. Third the depth of a given pixel region is calculated and kept in an array. Finally this array of depths is changed into color for maximum clarity, with bright colors being closer and dull colors being more far. Large blocks of solid color will produce black or nearly indiscriminate results. Now the depth value (between 0 and 255) is converted to a colour to better show how far away the object is. Red is the closest in colour list to black as the furthest. The real depths these colours symbolize is dependent upon your cameras and their distance from each other.

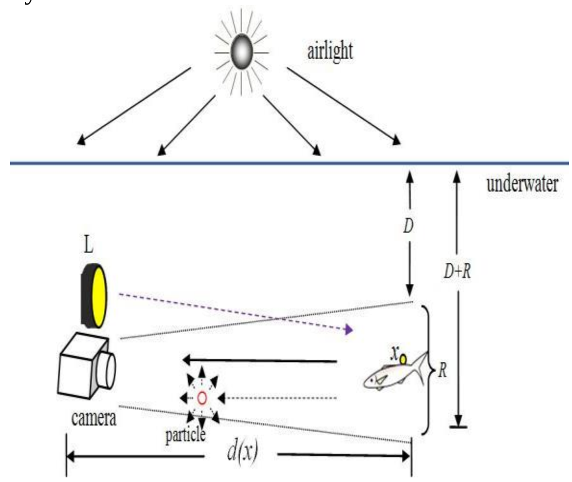

Fig.1. Natural light enters from air to an underwater scene point

BASIC ALGORITHM

The distance between object and camera is known and image segmentation is done based on the depth map as shown in fig.2. The foreground and background light intensities of the image are then compared, to determine an artificial light scattering effect is employed during the image acquiring process; the added luminance is to be eliminated by detecting the artificial light source. So that haze effect and color change along the underwater propogation path can be removed.

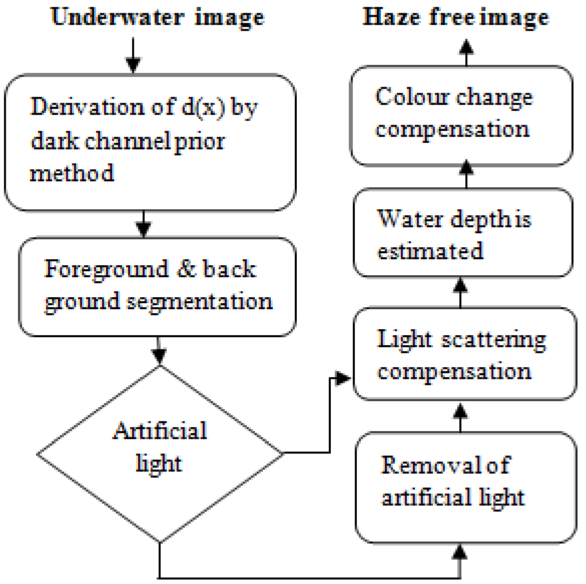

Fig.2. Algorithm of underwater image enhancement

II. OVERVIEW OF DCT

Transform coding as shown in fig.3 constitutes an integral component of contemporary image/video processing applications. Transform coding relies on the premise that pixels in an image exhibit a certain level of correlation with their neighbouring pixels. Similarly in a video transmission system, adjacent pixels in consecutive frames show very high correlation. Consequently, these correlations can be exploited to predict the value of a pixel from its respective neighbours. A transformation is therefore, defined to map this spatial (correlated) data into transformed (uncorrelated) coefficients. The objective of the source encoder is to exploit the redundancies in image data to provide compression. In other words, the source encoder reduces the entropy, which in our case means decrease in the average number of bits required to represent the image. Here transformation is a loseless operation; therefore, the inverse transformation renders a perfect reconstruction of the orginal image.

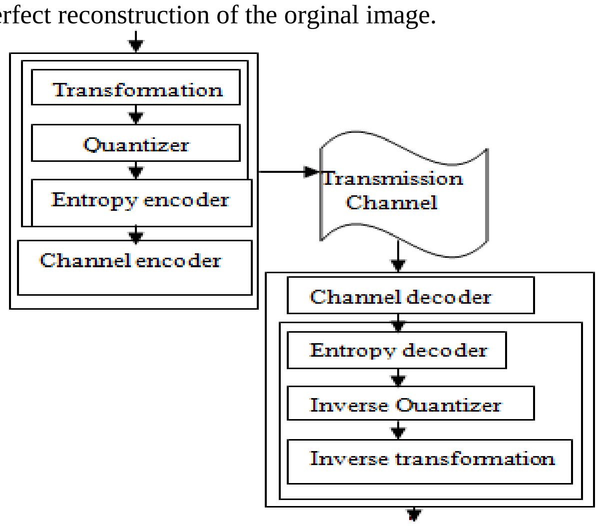

Fig.3.Block diagram of transformation system

The Discrete Cosine Transform

Like other transforms, the Discrete Cosine Transform (DCT) attempts to decorrelate the image data. After decorrelation each transform coefficient can be encoded independently without losing compression efficiency

The One-Dimensional DCT –

The most common DCT definition of a 1-D sequence of length N is

$$\mathbf{c(u) = a(u)\sum_{x=0}^{N-1} f(x)\cos[\pi(2x + 1/2N)]}$$

For u= 0, 1, 2 ..., N-1. Similarly, the inverse transformation is defined as

$$f(x) = \sum_{u=0}^{N-1} a(u)c(u)\cos[\pi(2x+1)u/2N]$$

For x= 0, 1, 2…, N −1

Note that these basis functions are orthogonal. Hence, multiplication of any waveform with another waveform followed by a summation over all sample points yields a zero (scalar) value, whereas multiplication of any waveform in with itself followed by a summation yields a constant (scalar) value. Orthogonal waveforms are independent, that is, none of the basic functions can be represented as a combination of other basis functions. Here, a very important point to note is that in each such computation the values of the basis function points will not change. Only the values of *f* (*x*) will change in each sub-sequence. This is a very important property, since it shows that the basic functions can be pre-computed offline and then multiplied with the sub-sequences. This reduces the number of mathematical operations (i.e., multiplications and additions) thereby rendering computation efficiency.

The Two-Dimensional DCT

The objective of this document is to study the efficiency of DCT on images. The 2-D DCT is a direct extension of the 1-D case and is given by

$$c(u,v) = a(u)a(v)\sum_{x=0}^{N-1}\sum_{y=0}^{N-1} f(x,y)\cos[\pi(2x+1)u/2N]\cos[\pi(2y+1)v/2N]$$

$$f(x,y) = \sum_{u=0}^{N-1}\sum_{v=0}^{N-1} a(u)a(v)c(u,v)\cos[\pi(2x+1)u/2N\cos[\pi(2y+1)v/2N]]$$

For *x*, *y* = 0, 1, 2…, *N* −1. The 2-D basis functions can be generated by multiplying the horizontally oriented 1-D basis function with vertically oriented set of the same functions.

III. METHODOLOGY

In the previous sections, some issues concerning underwater image enhancement techniques is discussed. It has been highlighted that researchers with in the field of underwater image enhancement research in general and computer science in particular are facing problems regarding the quality of the underwater images. The problems related the underwater images come from the light absorption and scattering effects by the open environment. To eliminate this problem, researchers are using state-of-the-art technology such as, sensors and optical cameras, and well programmed DSPs. However, the technology has not yet reached to the appropriate level of success. In order to address the issues discussed above, an approach based on under water image enhancement in DCT domain is proposed. Firstly, contrast stretching of RGB algorithm is used to equalize the color contrast in the images. Secondly, the saturation and intensity stretching of HSI is applied to increase the true color, Further the problem of lighting in the processed image can be removed by using Unsharp masking filtering (USM). The performance of Unsharp Masking is significantly improving the color quality of images distorted or affected.

IV. ALGORITHM

Image enhancement methods may be classified into those that enhance contrast directly and those that enhance contrast indirectly. Direct contrast enhancement methods measure the image contrast before enhancement. In this paper, a new direct contrast enhancement method based on a definition of image contrast in the DCT domain is introduced.

The proposed algorithm contains the following stages:
1. Dividing the input image into no overlapping M blocks of (8X8) pixels.
2. Computing enhancement factor.
3. Computing DCT coefficients of all blocks.
4. Applying the Enhancement algorithm.
5. Computing inverse DCT of all blocks to form the enhanced image.

Computing the Enhancement Factor

The resultant image is depending upon the enhancement factor. It is noted that it is difficult to select appropriate enhancement factor, so it is required to repeat the experiment many times to get the desired or enhanced image. Also, for the image with darkened areas, the resultant images is blurred, therefore several experiments are done to select appropriate function that used to compute the enhancement factor, which is varied according to the lightness of the blocks and don't remain constant for the whole image, and also make it flexible for a wide bands of images

Computing DCT Coefficients

The DCT coefficients represent the spatial frequency content of the image in a similar way to the coefficients in one quadrant of the 2-D Fourier domain. The coefficients at location (0, 0) represent the DC level of the block, and the other coefficients represent spatial frequencies that increase with their distance from the DC level.

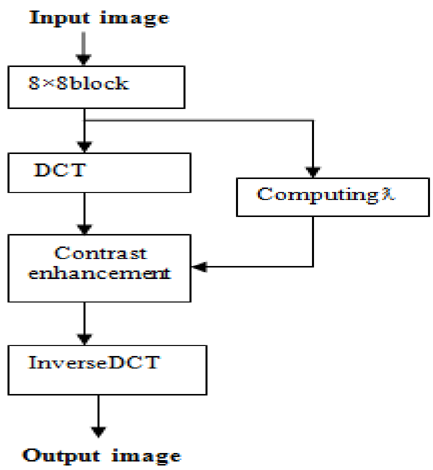

Fig.4. Dct algorithm

V. EXPERIMENTAL RESULTS

Fig.5. Original image

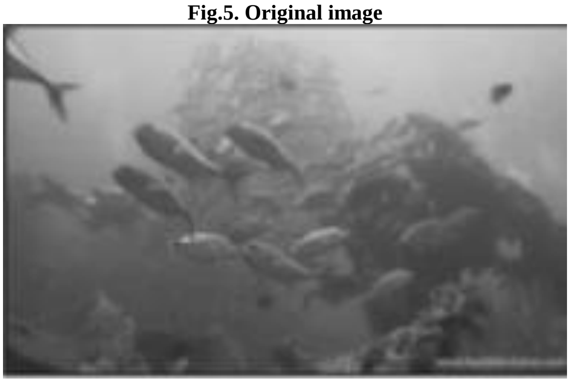

Fig.6. Dct enhancement image

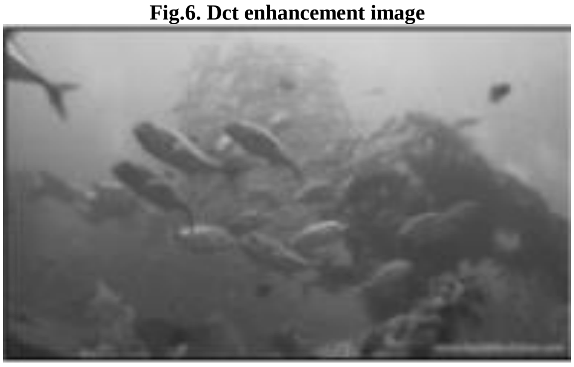

Fig.7. Dct balanced image

VI. CONCLUSION

From the result, it is clear that proposed system gives properly enhanced under water image output with less processing time. In addition, a simple noise estimation and reduction scheme directly in the DCT domain can be introduced for a robust enhancement algorithm. The experiment results showed that proposed algorithm improved the image colour levels and contrast effectively with out causing block artifacts and boosting noisy information less. It works well with most of natural images. However the image with very high frequency components may be blurred. Nevertheless, the proposed algorithm can be used as a significant tool to improve the dynamic range.

REFERENCES

[1] Hitam, M. S., W. N. J. H. W. Yusuf, E. A. Awalludin, and Z. Bachok. "Mixture contrast limited adaptive Histogram Equalisation for under water image enhancement". IEEE, 2013.
[2] Adrian Galdran, David Pardo, ArtzaiPicón and Aitor Alvarez-Gila" Automatic Red-Channel underwater image restoration" Elsevier, 2014.

[3] Dr.G.Padmavathi, Dr.P.Subhashini, Mr.M.Muthu Kumar and Suresh kumar Thakur. “Comparison of Filters used for Underwater Image Pre-Processing” IJCSNS, 2010.

[4] John Y. Chiang and Ying-Ching Chen. “Under water Image Enhancement by Wavelength Compensation and Dehazing” IEEE, 2012.

[5] AysunTas_yapıCelebi and SarpErturk. “Visual enhancement of underwater images using Empirical Mode Decomposition” Elsevier, 2011.

[6] Sowmyashree M. S., Sukrita K. Bekal, R. Sneha, and N. Priyanka. "A Survey on the various underwater image enhancement techniques." International Journal of Engineering Science Invention, 2014.

[7] Hung-Yu Yang; Pei-Yin Chen; Chien-Chuan Huang; Ya-Zhu Zhuang; Yeu-HorngShiau, "Low Complexity Underwater Image Enhancement Based on Dark Channel Prior," Innovations in Bio-inspired Computing and Applications (IBICA), 2011 Second International Conference on , vol., no., pp.17,20, 16-18 Dec. 2011.

[8] bt.Shamsuddin, N.; bt. Wan Ahmad, W.F.; Baharudin, B.B.; Kushairi, M.; Rajuddin, M.; bt.Mohd, F., "Significance level of image enhancement techniques for underwater images," Computer & Information Science (ICCIS), 2012 International Conference on , vol.1, no., pp.490,494, 12-14 June 2012.

[9] Jinbo Chen; Zhenbang Gong; Hengyu Li; ShaorongXie, "A detection method based on sonar image for underwater pipeline tracker," Mechanic Automation and Control Engineering (MACE), 2011 Second International Conference on , vol., no., pp.3766,3769, 15-17 July 2011.

[10] Balvant Singh, Ravi Shankar Mishra, PuranGour. “Analysis of contrast Enhancement Techniques for Under water image “IJCTEE, 2012.

[11] Kashif Iqbal, Rosalina Abdul Salam, Azam Osman and Abdullah Zawawi Tallib. “Under water Image Enhancement using an Integrated Colour Model” IJCS, 2007.

[12] Rafael Garcia, Tudor Nicosevici and Xevicuff. “On the way to solve lighting problems in under water imaging” IEEE, 2002.

[13] Shelda Mohan and T.R.Mahesh. “Particle Swarm Optimisation based Contrast Limited enhancement for mammogram images”. IEEE, 2013.

[14] Neethu M.Sasi and V.K.Jayasree. “Contrast Limited Adaptive Histogram Equalisation for Qualitative Enhancement of Myocardial Perfusion Images” Scientific research, 2013.

[15] Navpreet Saroya, Prabpreet Kaur “Analysis of IMAGE COMPRESSION Algorithm using DCT and DWT transforms” International Journal of Advanced Research in Computer Science and Software Engineering, Volume 4, Issue 2,February 2014.

BIBLOGRAPHY

S.V.S.Sai.Sravya studying final year B.Tech in Electronics and Communication Engineering at Acharya Nagarjuna University College of Engineering and Technology, Guntur, India. Her areas of interest are Digital and Image processing.

B.Gopi Naik studying final year B.Tech in Electronics and Communication Engineering at Acharya Nagarjuna University College of Engineering and Technology, Guntur, India. His areas of interest are Digital and Image processing

P.Bhavani studying final year B.Tech in Electronics and Communication Engineering at Acharya Nagarjuna University College of Engineering and Technology, Guntur, India. Her areas of interest are Digital and Image processing.

G.Prathibha currently working as an Assistant professor in Electronics and Communication Engineering at Acharya Nagarjuna University College of Engineering and Technology, Guntur, India. Her areas of interest are Image processing, Signal processing and Recognisation of pattern diagrams