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TO STUDY THE HYBRID UNDERWATER IMAGE CRYPTOSYSTEM

Jetendra Ivaturi
Research Scholar, Dept of Computer Science,
Maharaja Agrasen Himalayan Garhwal University, Uttarakhand

Dr Ajay Kumar Chaurasia
Associate Professor, Dept of Computer Science,
Maharaja Agrasen Himalayan Garhwal University, Uttarakhand

ABSTRACT

Underwater photographs of high quality are critical in a range of applications, including robotics, rescue missions, underwater military operations, and real-time navigation. Underwater images are playing an increasingly important role in ocean exploration and scattering in the aqueous medium, thanks to advances in technology and innovation in the field of marine exploration. This section proposes a novel technique for improving underwater image quality. The proposed method employs an upgraded version of a block-based strategy that employs a hybrid of DCT and a tuned tri-threshold Fuzzy intensification operator for underwater photos. The DCT technique is used to detect the background picture in underwater photos. Following that, picture improvement is performed utilizing Weber's law and a tailored tri-threshold fuzzy intensification operator. The proposed technique is tested on a variety of underwater photographs obtained from the internet and compared to the previous block-based scheme. In comparison to the original block-based scheme, the new result shows that the proposed method has improved the results.

KEY WORDS: Hybrid, Underwater, Image, Cryptosystem, Wavelength-Dependent.

INTRODUCTION

The data acquired by computer systems is continually expanding as computer and Internet proliferation encompasses every element of human existence. Because traditional data access methods are inefficient when dealing with enormous amounts of data, data mining is one of the most sought-after fields of research in computer science. Wavelength-dependent light absorption and scattering reduce image vision underwater, resulting in low contrast and distorted color casts. Recently, underwater research was conducted to learn more about unknown things deposited in the deep sea and to pinpoint the best location for a natural catastrophe detective system. It's simple if the correct location is determined by collecting a picture with a camera-mounted vehicle in a long depth area. However, there is a lack of brightness in the seafloor region, resulting in a low-quality image that conveys fewer critical details about the area. Meanwhile, the digital transfer of multimedia (picture, video, audio, and text) data over the underwater environment is fraught with security concerns. This may cause the researcher's attitude to deteriorate in the course of their study. Secure image transmission and enhancement techniques, on the other hand, will aid them in continuing to analyze the undersea region from the collected image. A hybrid underwater image cryptosystem is suggested in this chapter, which combines proposed image enhancement (DHET) and the secure force method (96-bit symmetric key generation). It is designed specifically for distorted underwater photographs and performs visual quality restoration, dynamic interference removal, appropriate image reconstruction, safe data exchange between vehicle nodes, and protects the encrypted image from third-party intrusions. It uses a combination of DCT and a tailored tri-threshold fuzzy intensification operator to improve the contrast of underwater photos. To begin, DCT is used to detect the backdrop of an underwater image, then fuzzy intensification and Weber's law are used to increase visual quality. As a result, bring forth image contrast improvement and dynamic interference reduction. Finally, the new approach is compared to the original block-based scheme by comparing test results of a sample picture collection. The suggested approach achieves improved contrast enhancement and reconstruction of underwater images after modeling and tests.

DYNAMIC HISTOGRAM ENHANCEMENT TECHNIQUE

This section explains how to use the dynamic histogram technique to improve the distribution of pixel intensity values in an underwater photograph. It is divided into three phases: the block phase, the DCT phase, and the tuned tri-threshold intensification operator phase. The input color image (RGB) is converted to a (YCbCr) image in the first phase, and a number of blocks (n n) is created. It devotes additional time to each block in order to improve the image acquisition system. In the second step, each block is subjected to feature extraction by DCT, which results in significant object detailing when all of the blocks are integrated into one image. In the third phase, the color contracting problem is minimized by using a tailored tri-threshold intensification operator with equal intensity scaling at each block. It's feasible thanks to the major fine-tuning parameter (Zeta), which reduces color contrast and improves image color accuracy. The image was then separated into three distinct channels (R, G and B). Estimate the importance of intensification operators such as Tau () assessment and membership functions at this time. To

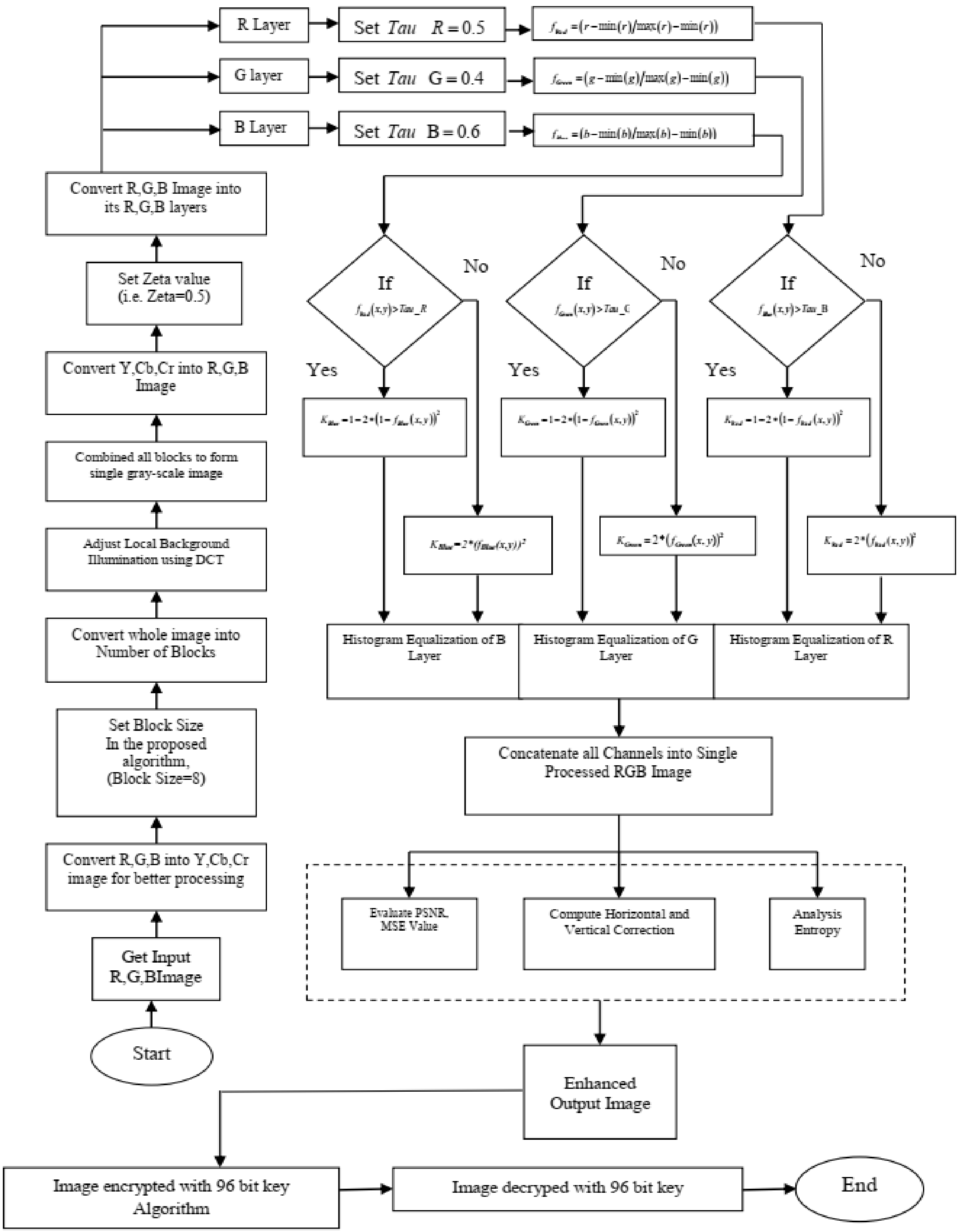


Figure 1 Shows The Flow Chart of Implemented Image Enhancement AlgorithmThe pseudo-code of proposed algorithms is as follow:

Parameter Initialization

#1 **Get** the input color image (preferable format.jpg)

#2 Convert color image into grey-scale image (i.e. RGB into YCbCr)#3 **Set** the block size (preferable block size is 8X8)

#4 Divide image into blocks of length $\square n \square n \square$

Interference Removal

#5 **for** Iteration starts <= last block

#6 Adjust background illustration DCT#7 **end for**

#8 Combined all blocks to form single gray-scale image

#9 Again, convert grey-scale image into color image (i.e. YCbCr into RGB)#10 **Set** the value of zeta =0.5

#11 Split image into R, G, & B component

#12 **Set** threshold values $Tau\_R \square 0.5; Tau\_G \square 0.5 \& Tau\_B \square 0.6$

#13 Compute membership functions for every component

$$f_{Red} = \left(r - \min(r) / \max(r) - \min(r)\right)$$

$$f_{Green} = \left(g - \min(g) / \max(g) - \min(g)\right)$$

$$f_{Blue} = \left(b - \min(b) / \max(b) - \min(b)\right)$$

determine the value of the intensification operator, two elements must be considered: the value of Tau () and the membership function. Tau () is the operator's threshold value, which computes between 0 and 1. Where fRed, fGreen, and fBlue are the outputs of the membership function for the red, green, and blue channels, respectively. It may obtain the input channels' maximum and minimum pixel values (max, min). The pixel intensity is equally distributed in each channel before being integrated into a single image, which is then used to calculate PSNR, MSE, Horizontal, Vertical correlation, and Entropy. The flow chart of the suggested image enhancement algorithm is shown in Figure .1.

Intensification Operator

#14 **if** $f_{Red}(x,y) > Tau\_R$,True: $K_{Red} = 2*(1 - f_{Red}(x,y))^2$, False: $K_{Red} = 2*(f_{Red}(x,y))^2$

#15 Histogram Equalization of R component

#16 **if** $f_{Green}(x,y) > Tau\_G$, True: $K_{Green} = 1 - 2*(1 - f_{Green}(x,y))^2$, False: $K_{Green} = 2*(f_{Green}(x,y))^2$

#17 Histogram Equalization of G component

#18 **if** $f_{Blue}(x,y) > Tau\_B$,True: $K_{Blue} = 1 - 2*(1 - f_{Blue}(x,y))^2$, False: $K_{Blue} = 2*(f_{Blue}(x,y))^2$

#19 Histogram Equalization of B component

#20 Concatenate R, G, B component to make a single processed RGB image

#21 Evaluate PSNR and MSE

#22 Compute Horizontal and Vertical Correlation

#23 Analysis Entropy

#24 Histogram #25Enhanced output image

#26 **end if**

#27 **end if**

#28 **end if**

#Encryption :96 bit key#Decryption:96 bit key #END

EVALUATION PARAMETERS FOR UNDERWATER IMAGE ENHANCEMENT

This section evaluates the parameters listed below to determine the processing efficiency of the proposed method.

PEAK SIGNAL TO NOISE RATIO AND MEAN SQUARE ERROR

The incidence of superfluous color items and object visual demand have been assessed as quality features of an improved image. Because these difficulties constantly occur in underwater collected images, the suggested dynamic histogram augmentation technique could be used to recover distorted object details. An objective statistic compares the processed image to the original image to determine the extent of noise reduction. To put it another way, the Peak Signal to Noise Ratio (PSNR) and Mean Square Error (MSE) are used to determine how successful improved images are (Qiao et al., 2017). MSE is usually computed first, followed by the PSNR value. MSE calculates the percentage of difference between the improved and original image. Along with the precise feature, it can compute the variation between values slanting by an approximation. As a result, the following instant of mistake is calculated by assigning the approximation and partiality equal incorporate.

The quantitative improvement of an image's visual feature is a subjective topic because it might vary from person to person. Set up a numerical confirmation and suggested over achieved value for picture enhancement during quantitative measurements. It is, nevertheless, difficult to forecast because it necessitates an appropriate standard, as well as the presentation of enhancement techniques using quality measurements such as PSNR values. That is, if it is too high beyond the threshold values, the enhanced image's visual quality has improved (Joseph et al., 2017). Following the use of enhancement techniques, discrete statistical data of PSNR for each image is generated. As a result of the statistical end result, present approaches with the highest PSNR in the majority of the items. As a result, in such scenario, the proposed technique performs exceptionally well. In other words, PSNR is a trade term for the ratio of a signal's greatest achievable power to the power of corrupting noise, with the goal of determining the authenticity of its display.

The decibel scale is commonly used to express it. Because many signals have a wide active range, they are usually described in logarithmic decibel scales, with the proposed algorithms' performance measured in terms of visual quality upgrading. The difference between the original image and the improved image can be used to calculate the process deviation. The Mean Square Error (MSE) and the corresponding distortion metric are used to define it. Otherwise, it refers to the difference in squared errors between the enhanced and original images. The following example demonstrates how to calculate the PSNR value for a given gray image. MAXi is the image's maximum potential pixel value. MAXi is 255, but the pixels are represented using 8 bits each sample. Furthermore, 2B1 is MAXi and Mean Square Error is MSE between the filtered picture and the original image where samples represent B bits per sample. With greater PSNR values and lower MSE, the high-quality technique determination generates lower MSE. In general, a high PSNR value is desirable since a higher PSNR point corresponds to a lower quantity of noise level, resulting in a process image that is minimally degraded when compared to the original input image.

ENTROPY

Entropy is a statistical measure that determines where randomness appears within the texture of an image. The color cast problem causes randomness in intensity, which is not a property of an underwater image. That is to say, if the occurrence is more random, the entropy purpose will be higher. Otherwise, less entropy is generated. Poor entropy during image processing indicates that the image has low contrast. Intuitively, when underwater photos are improved, intensity variation increases, resulting in more average information. Entropy validation can be used to validate that the average information attribute of an underwater image is accurate.

So, in the proposed situation, too, performance is better than others, if the color contrast of the augmented image is given importance. Based on Shannon theory, entropy is an effective way to calculate the information in an image. According to this idea, the higher the entropy value, the more information there is in the image.

HORIZONTAL AND VERTICAL CORRELATIONS ARE TWO TYPES OF CORRELATIONS.

The two-pixel intensity is compared to each other in order to compute the performance validation. p mi is the performance validation. In fact, if there is minimal process variation between photos, the mean square error value is minimized. Ranking is assigned based on that high priority, and its value is tracked for future pixel rank updates. It is represented by the number 2 (chi-square), which can be used to calculate the degree of association between two images. The Correlation Coefficient approach is used to find the input and output photos with the least amount of fluctuation. It is mostly used in applications that compare images statically, such as pattern recognition and video surveillance. Correlation coefficient values range from 0 to 1. That is, if "r = 0.00," this means there is no difference between the original image pixel value and the enhanced image pixel value. On the other hand, (say r=0.990067), which denotes a high degree of similarity or variance between the original image pixel value and the enhanced image pixel value. If the Correlation is somewhat higher than 0.5 (for example, r=0.6660), then there is a lot of similarity or variance between the original image pixel value and the enhanced image pixel value. Similarly, if it is less than 0.5 (for example, r=0.2660), it shows a lack of unity between the original image pixel value and the enhanced image pixel value. It is a single abstract figure used to determine whether there is a connection between two image pixels, how well-built that correlation is, and whether the correlation is positive or negative. The dissimilarity between the input and output image is measured using normalized cross-correlation. The dissimilarity between two variables is defined by the correlation coefficient. It forecasts the change in a single variable with relation to another variable. In most cases, correlation coefficient values range from +1 to +2.

NPCR AND UACI

Encrypted images are characterized by their ability to respond to tiny changes within a plain image (e.g. change just single pixel). Challenger has the ability to make a small adjustment in the input image that results in a huge change in the outcome.

The significant connection between the original image and the cipher image can be established using this technique, but one small change in the plain-image can cause a significant change in the cipher-image, leading to diffusion and confusion. As a result, the differential attack will be unable to find its effectiveness and will become nearly ineffective. Within those two photos, the NPCR (Sharma et al.,2019) calculates the percentage of distinct pixels to the total number of pixels. The average pixel intensity difference between two images is calculated by UACI. NPCR, like UACI, has a high value because of its better encryption. Assume that two cipher-pictures, C1 and C2, which are equal to plain images, differ by one pixel.

KEY SENSITIVITY ANALYSIS

The total amount of possible keys that can be utilized in cryptography is referred to as key space size. All secret keys are completely vulnerable to the cryptosystem. Not only should a good encryption algorithm be sensitive to the cipher key. Due to a minor key difference, the decrypted image differs significantly from the original image. As a result, a brute force attack on the security system is extremely tough. Figure 2 depicts the improper decryption of the cipher-image using keys that have a slight modification (LSB bit).

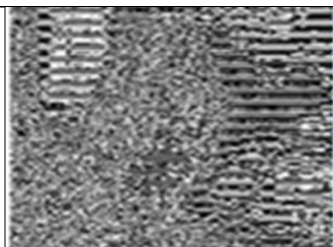
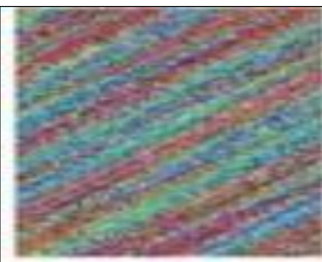
		
Image	Image Encrypted	Image Decrypted
Lion	**01234567890123456789 0123**	**01234567890123456789 0124**

Figure 2 Key Sensitivity analysis of Underwater Image Lion

HISTOGRAM ANALYSIS

Statistical metrics from an image's histogram are a technique for comparing the tonal distribution of original and improved images to evaluate the performance of an enhancement process. A broader histogram is traditionally associated with a high-quality photograph. The following dataset is used to verify the performance efficiency of the proposed approach; it can be accessed on the internet at (https://li-chongyi.github.io/proj benchmark.html).

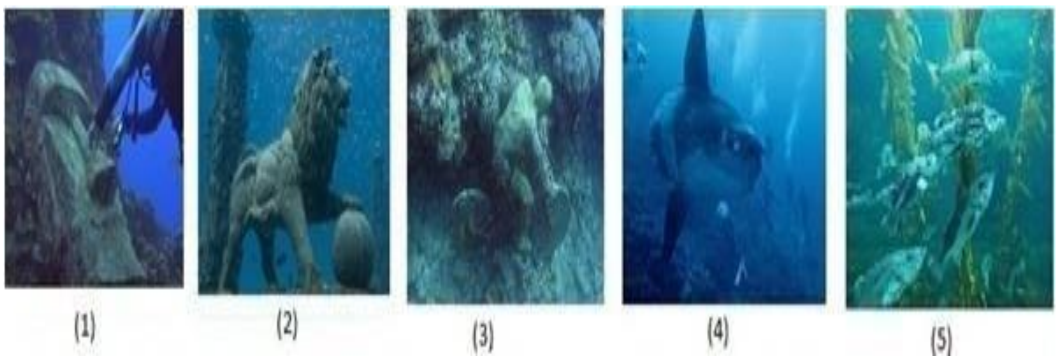
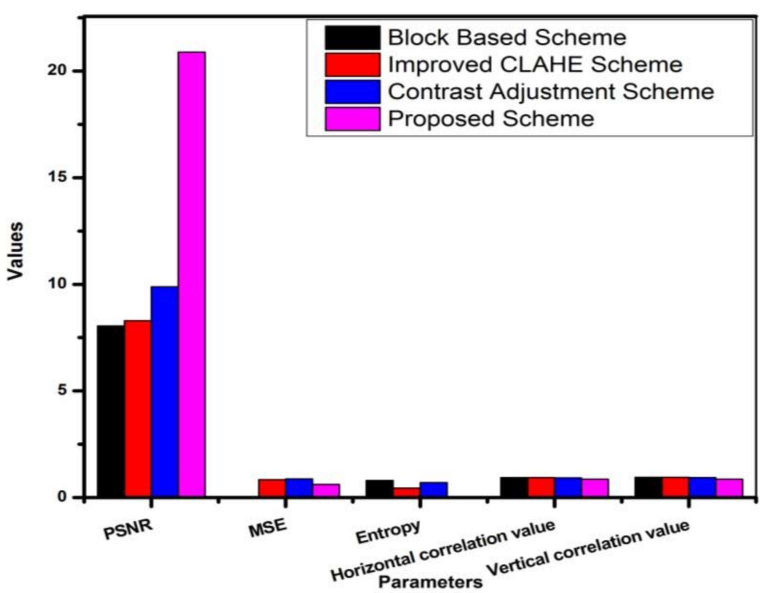


Figure 3 Dataset of underwater images

The incidence of unwanted color artifacts and object visual demand have been assessed as quality features of an augmented image. Because these difficulties constantly occur in underwater collected images, the suggested dynamic histogram augmentation technique could be used to recover distorted object details. The statistics compares the treated image against the original image to see how much noise is reduced. The Peak Signal to Noise Ratio (PSNR) and Mean Square Error (MSE) are used to calculate the augmented image's efficacy. MSE is usually calculated first, followed by PSNR. MSE calculates the percentage of difference between the improved and original image. Along with the precise feature, it can compute the variation between values slanting by an approximation. As a result, the following instant of error is calculated by giving the approximation's equal integrate and partiality. The results of a comparison of PSNR, MSE, and Entropy of test sample images. The quantitative improvement of an image's visual feature is a subjective topic because it might vary from person to person. To set up quantitative measures, a numerical confirmation and suggestive value for picture enhancement is acquired. It is, nevertheless, difficult to forecast because it requires an appropriate standard, as well as the presentation of enhancement techniques using quality measurements such as PSNR values. That is, if it is too high beyond the threshold values, the enhanced image's visual quality has improved.

Table 1 Shows The Effectiveness of Proposed Scheme with Existing Schemes onInput Image1

Parameters	hadoriya etal.,2019)	Mishra etal., 2018)	(Gupta etal., 2018)	ProposedScheme
PSNR	8.050	8.301	9.887	20.896
MSE	0.00001	0.836356	0.869091	0.615481
Entropy	0.796682	0.442682	0.702905	0.035022 2
Horizontal correlation value	0.940658	0.936034	0.929246	0.868089
l correlationvalue	0.954803	0.951671	0.941855	0.859227



al Representation Proposed Scheme with Existing Schemeson Input Image1

Table -2: Shows The Effectiveness of Proposed hybrid cryptosystem

Performance analysis of the proposed hybrid cryptosystem using 32-bit key				
Images	**NPCR**	**UACI**	**MAE**	**Correlation**
Image(1)	0.995	0.350702	35.2078	0.0956053
Image(2)	0.996	0.345835	34.7191	0.0964905
Image(3)	0.995	0.356831	35.823	0.0792723
Image(4)	0.996	0.331194	33.2493	0.1344840
Image(5)	0.995	0.325613	32.689	0.1282290
Performance analysis of the proposed hybrid cryptosystem using 64-bit key				
Image(1)	0.995	0.391381	39.2916	-0.0358969
Image(2)	0.995	0.383006	38.4507	-0.0286331
Image(3)	0.995	0.394198	39.5744	-0.0478051
Image(4)	0.996	0.381268	38.2763	-0.0255326
Image(5)	0.995	0.377919	37.9401	-0.0569214
Performance analysis of the proposed hybrid cryptosystem using 96-bit key				
Image(1)	0.995	0.378751	38.0237	-0.0007952
Image(2)	0.996	0.370043	37.1494	-0.0074844
Image(3)	0.996	0.382426	38.3925	-0.0245261
Image(4)	0.996	0.358479	35.9885	0.0114240

Image(5)	0.996	0.359629	36.1039	-0.0100232

CONCLUSION

This suggested paradigm includes enhancements and encryption for image communication. The proposed model transmits an image in a quick, cost-effective, and secure manner. The security of a cryptosystem is determined by the key, which is the most important design consideration. A hybrid underwater image cryptosystem was proposed, combining proposed image enhancement (DHET) and the secure force method (96-bit symmetric key generation). For distorted underwater photos, the suggested model uses a DHET that conducts visual quality restoration, dynamic interference reduction, and correct image reconstruction. It uses a combination of DCT and a tailored tri-threshold fuzzy intensification operator to improve the contrast of underwater photos. To begin, DCT is used to detect the backdrop of an underwater image, and the visual quality is increased utilizing the tuned tri-threshold fuzzy intensification operator and Weber's law. As a result, image contrast improvement and dynamic interference reduction are achieved. Second, for underwater image security, an enhanced secure force algorithm based on a 96-bit symmetric key was developed. It's a symmetric cryptographic technique that performs encryption and decryption using fundamental arithmetic operations. As a result, it has a feistel structure for analyzing security inefficiencies in image recorded vehicles systems. Logic operations (AND, OR, XOR, XNOR), swapping, and left and right shifting functions are all common. As a result, the encoder's minimum interoperability function is induced, resulting in well-optimized picture encryption and the influence of secure transmission in the deep underwater. The performance evaluation metrics of entropy, NPCR, UACI, MAE, encoded time, decoded time, and correlation coefficients were applied to standard existing methods and our suggested algorithm, with the results demonstrating that our proposed algorithm outperforms them. To date, underwater photos have become an essential and fundamental part of any valuable data, and they are widely employed in a variety of applications. As of now, underwater images are an intrinsic and frequently used component of any relevant data, such as military image databases and message communication, marine position, underwater mine position, underwater surveillance system, and online underwater picture identification and authentication. As a result, the proposed model can be used in a variety of applications.

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