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DESIGN OF FEATURE EXTRACTION TECHNIQUE FOR UNDERWATER IMAGE FUSION

A DISSERTATION

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF

MASTER OF TECHNOLOGY
IN
SIGNAL PROCESSING AND DIGITAL DESIGN

Submitted by:

NITANT KHULLAR

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JULY 2020

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CANDIDATE'S DECLARATION

I NITANT KHULLAR, 2K18/SPD/04, student of M.Tech (Signal Processing and Digital Design), hereby declare that the project Dissertation titled "DESIGN OF FEATURE EXTRACTION TECHNIQUE FOR UNDERWATER IMAGE FUSION" which is submitted by me to the Department of Electronics and Communication Engineering, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Technology, is original and not copied from any source without proper citation. This work has not previously formed the basis for the award of any Degree, Diploma Associateship, Fellowship or other similar title or recognition.

Place: Delhi **NITANT KHULLAR**

Date: 16th October, 2020

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CERTIFICATE

I hereby certify that the Project Dissertation titled "DESIGN OF FEATURE EXTRACTION TECHNIQUE FOR UNDERWATER IMAGE FUSION" which is submitted by NITANT KHULLAR, Roll No 2K18/SPD/04, Electronics and Communication Engineering, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Technology, is a record of the project work carried out by the students under my supervision. To the best of my knowledge this work has not been submitted in part or full for any Degree or Diploma to this University or elsewhere.

Place: Delhi

Date: 16th October, 2020

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ABSTRACT

Submerged pictures typically need differentiate and experience the ill effects of shading mutilation because of light bar dissipating and lessening. Light dispersing is because of the presence of suspended particles in water in type of both natural and inorganic material which mirrors and diverts the light in a capricious way before it arrives at the sensor and results in a picture which is low conversely. Water as a medium promptly retains light, and in addition various frequencies of light as ingests at various rates. Moreover, the more extended frequency is assimilated first and it brings about the submerged climate with a prevailing green-somewhat blue tone. Our examination has brought about progress upon the entrenched submerged picture combination technique. Our submerged picture upgrade framework can comprehensively be separated in three significant segments; parting of the first picture into illuminance and reflectance cuts, applying a straight piecewise shading amendment calculation on the reflectance cut and agreement improving methods on the illuminance part. At last, to remake the yield picture we apply the multi stage combination strategy which depends on SIFT and HOG. Exploratory outcomes show an enhancement for the effectively accessible combination based methods. Additionally we furnish an examination with two different strategies. The performance of the proposed method is compared with an existing method in terms of Mean Square Error and Peak Signal to Noise Ratio, which indicates that the proposed method is better than the existing method.

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LIST OF SYMBOLS AND ABBREVIATION

WT: Wavelet transform.

HOG: Histogram of oriented gradients.

SIFT: Scale invariant feature transform.

SD: Sparse Decomposition.

IHS: Intensity Hue Saturation.

NSCT: Non-Sub sampled Contour let transform.

GFF: Guided Filtering Fusion.

HSaLS: High-Spatial-and-Low-Spectral.

LSaHS: Low-Spatial-and-High-Spectral.

LSTM: Long Short-term memory network.

CHAPTER 1

INTRODUCTION

Like light going noticeable all around, the submerged light engendering experiences dispersing and retention. Regardless, the size of assimilation and dissipating is tremendous. While the light weakening coefficients noticeable all around are estimated in backwards kilometers for a submerged climate it is in reverse meters. Such extreme debasement of light stances genuine difficulties for imaging sensors to catch the data of the submerged zone of intrigue. In contrast to air, water is just straightforward to the noticeable aspect of the electromagnetic range and dark to every other frequency. Besides, the constituent frequencies of the noticeable range are caught up in various rates with longer frequencies are retained all the more quickly. The rot of light energy in water is really momentous. In the gem frees waters from the center seas under 1% of light energy stay by the profundity of 150m. Henceforth the perceivability corruption is with the end goal that the article is more diligently to see past the 20m territory and in turbid waterfront waters the perceivability falls beneath the 5m mark. Likewise no characteristic light from sun comes to beneath 1km of ocean. Henceforth, the measure of light with in water is in every case not exactly the measure of light over the outside of water. Accordingly pictures acquired submerged for the most part have low visual quality. The shortage of light submerged is generally a direct result of two unavoidable realities. One, the light submerged is loses its actual power, and second the odds for dispersing of light inside water is very high. The quick effect of this insufficient measure of light is the shading twisting and brightening of the submerged scene perceivability. Two of the most weakening impact on submerged picture quality are the assimilation of light energy and arbitrary way change of the light pillars and at movement in water medium loaded up with suspended particles. The piece of light energy which enters the water is quickly consumed and changed over into different types of energy like warmth which in returns causes the water particles to get empowered and get hotter and will in general vanish. Likewise a portion of the light energy is spent by the small plants based creature which use it for photosynthesis. This assimilation corrupts the genuine nature power of the submerged items. As clarified in the past passage some portion of light which isn't consumed by the water particles may not go in straight line yet follows an arbitrary Brownian movement. Presence of suspended issue in water is liable for this. Water, especially the ocean water contains broke up salts and both natural and inorganic issue which mirrors and diverts the light pillar in new ways and it might likewise leave the water surface and rot back in air. Light dispersing of light in water medium is additionally partitioned into two classifications. The forward dissipating; which is the light shaft avoided subsequent to hitting the object of intrigue and arriving at the picture sensor. This sort of dissipating as a rule causes a picture to show up obscure. The other kind of dispersing is the back-dissipating which is the light pillar hitting the picture sensor without first reflecting back from the article. It might be said this the light energy which isn't conveying any data about the item. It just adds to corrupted differentiation of a picture. One method of improving the perceivability submerged is by presenting the counterfeit light source, despite the fact that it adds its own flavor to the issue. Aside from the issue referenced above like dispersing and lessening of light, fake light will in general enlighten the area of enthusiasm for a non-uniform way and as a rule produce a splendid spotting at the focal point of and picture with hazier shades around it. Notwithstanding this the lighting gear is hefty and expensive. Additionally they required steady gracefully of power either in type of batteries or wired from the surface boat.

From this time forward, the submerged imaging framework not just influenced with the low light conditions, seriously debased perceivability, lessening contrast, beefiness, light curios yet in addition confine shading reach and arbitrary clamor. Therefore, the standard picture handling procedures which work well for us for earthbound imaging improvement should be adjusted or plentiful totally and we have to concoct new arrangements. Furthermore, by improving the nature of submerged pictures can prompt better picture division, an improved component extraction and better submerged route calculations to control independent submerged vehicles. Additionally seaward boring stages may likewise profit by the more clear symbolism for evaluating the auxiliary quality of the submerged aspect of their apparatuses.

1.1 Characteristics of Underwater Images

Dissimilar to regular imaging taken above ocean in outdoors, submerged photography shows a solid predominance of somewhat blue and greenish tones. Then again, the solid constriction of light in the water concerning the air and a more noteworthy dispersion of the occurrence light have the result of significantly diminishing the perceivability. Subsequently, objects at far off good ways from the procurement framework or the eyewitness yet in addition at medium separations, or even moderately short now and again, are not really obvious and inadequately appeared differently in relation to regard to their current circumstance. Furthermore, within the sight of particles suspended in water (sand, microscopic fish, green growth, and so forth.), the occurrence light is reflected by these particles and structures a sort of inhomogeneous fog that adds to the scene watched. This turbidity of the water, regularly white, likewise influences the perceivability yet in addition the shading elements of the articles contained in the picture by discoloring or veiling them. Then again, the development of a submerged picture is profoundly subject to the idea of the water in which it was procured. Regular waters can have fluctuated constitutions regarding plants or minerals disintegrated or suspended in water. The conduct of the proliferation of light in such a medium is emphatically administered by this factor.

1.1.1 Bio-optical Properties of Natural Waters

Normal waters and their IOPs rely upon the different components that go into their organizations. While clear waters will generally diffuse blue light, natural rich waters will emanate a greener, here and there even yellow. Various estimations have been made which have made it conceivable to set up a connection between the optical properties of retention and dissemination and the compound idea of the principle segments of the water.

A subsequent part comparing to Dissolved Organic Matter, or yellow substance, was included later improving the model. From optical estimations and substance estimations, ghostly weakening bends for various focuses were gotten. A lessening model was then settled by relapse of these information, making it conceivable to characterize a capacity communicating the weakening coefficient legitimately from the fixations.

1.1.2 Components and Mitigation by Water

The primary part of regular waters is simply the water atom. On the off chance that we think about the complete weakening coefficient, it is conceivable to break down this term into a few segments comparing separately to lessening by unadulterated water and to various kinds of particles. Indeed, the parts that most influence constriction in characteristic waters are individually the chlorophyll-based shades present in some living cell creatures in suspension and the broke up natural issue. In ordinary cameras the stenop'e gap is supplanted by a focal point which, on account of a bigger surface region and its light-centering property, permits the focal point to be lit up. Get a more splendid picture and have a superior clean. The components that make up a fundamental camera are the accompanying: at least one focal points, the picture plane (film, CCD, CMOS), a centering gadget that makes it conceivable to move the focal point as for the picture plane, the stomach that controls the measure of light got by the focal point and the shade that controls the opening season of the stomach. The nature of the picture watched will rely upon sensor optics, gadgets (enhancement, evaluation and examining) just as the climate in which the light will spread before arriving at the target and lighting conditions.

1.2 Mathematical Model for Underwater Images

There are a few numerical models to depict the development of a picture submerged. For this proposition the mathematical model we utilized is depicted beneath. It establish the summation of parts:

$$E_T = E_d + E_f + E_b \qquad (1.1)$$

E_T is the absolute light energy falls on the picture sensor which shapes the picture. The primary variable on the correct side of the condition is the immediate transmission E_d of the energy of the outside of an item E_o. The E_f is the forward dispersed light which albeit reflected of the object however experience the ill effects of diversions before entering the sensor. E_b is back-dissipated light which falls on the sensor however conveys no picture data. The light pillar in the wake of reflecting of the item is additionally lessened and as clarified before the assimilation is relied on the frequency of light. Also, subsequently makes a bogus shading map for the item under perception. Numerically the intelligent segment can be depicted as:

$$E_d = E_{o*}e^{-c\lambda r} \qquad (1.2)$$

1.3 Motivation

Programming based submerged picture upgrade strategies are normally work by controlling some part of the numerical model of submerged to make up for the debasing impacts presented by the water's light ingestion and the presence of natural and inorganic particles in water. Current best in class technique for submerged picture rebuilding are regularly intended for a solitary picture contribution as utilizing numerous pictures for the preparing as a rule require more computational assets and may not be reasonable for the continuous applications. Among the single picture upgrades technique, those dependent on the picture combination strategies shows the most encouraging outcomes. The overall rule followed by combination based strategies is parting the info picture into two, preparing the split pictures independently figuring the loads dependent on the highlights of each picture lastly utilizing the determined loads to intertwine the pictures into a conclusive outcome. In spite of the fact that this calculation delivers great outcomes for the majority of the cases, it experiences over remuneration of the shading and at some point twist the differentiation in a negative manner. Various varieties of this methods exists and there is opportunity to get better. In particular, improving the shading debasement some portion of the technique can utilize the direct capacity. In this way consolidating the shading improvement calculation with the picture combination guideline could improve the general nature of the upgraded picture considerably more.

Objectives

The destinations of this exploration is to build up an improved single picture upgrade method with can work under an assortment of conditions and utilizing a standard definition for evaluation of submerged picture quality. In particular, the objectives of this exploration are as per the following.

- Investigate and study the consequences for light spread submerged and its effect on the corruption on picture quality.
- Examining the deterioration of a solitary corrupted submerged picture into its constituent parts for free preparing to improve shading and upgrade contrast lastly combining the handled pictures into a solitary yield picture with better visual characteristics.

Comparing the results of the proposed solution using established techniques with other state of the art solutions to the problem of enhancing underwater images.

CHAPTER 2

LITERATURE REVIEW

Jiaxuan Jiang, et.al (2019) performed analysis of X-ray backscattered image and Holographic Subsurface Radar image on the basis of their features [15]. This work evaluated various fusion techniques in virtue of Shear let transform, Weighted Fusion algorithmic approach, WT (Wavelet transform), NSCT (Non-Sub sampled Contour let transform), GFF (Guided Filtering Fusion) etc. On the X-ray backscattered images, this work implemented non-local mean filtering approach and PCA algorithm. Also, the region of interest was extracted automatically by applying Otsu's algorithm. The tested outcomes based on image quality revealed that Shear let transform fusion approach distinctly outperformed its counterparts in regard to improved image readability, improved color fidelity, and lesser fake content.

Mohammad Mahdi Sayadi, et.al (2020) performed the fusion of PET and MRI images by combining retina-inspired model and Non-Sub sampled shear let transform together [16]. Initially, the shear let transform was applied to the MRI image to obtain the high-frequency element. This process created sub-images in different scales and directions. Further, a single edge image was recreated by the merger of all created images. Next, the transferring of PET image had been carried out from RGB to IHS color space. Moreover, a Gaussian low pass filtering approach had been applied to the luminance medium of the PET image for generating an element of low frequency. Finally, in order to get fused picture, high and low frequency elements were combined together and obtained outcomes were transferred from IHS colour space to RGB colour space.

Simone Parisotto, et.al (2020) presented a novel osmosis energy based variation model to perform the fusion of non-linear images [17]. The visually credible image data fusion, unvarying to multiplying brightness variations had been realized by minimizing the presented non-convex energy. Practically, the new model needed minimum control and parameter tuning. This model was capable to encrypt past data on the edifice of the images selected for fusion. This work devised a primal-dual algorithmic approach to solve presented model numerically. This work also provided solution of multi-modal face fusion, color transfer and cultural heritage preservation issues by applying the subsequent minimization approach. The new approach was compared against other existing approaches in terms of different metrics and it proved to be the most flexible.

Carlos A. Theran, et.al (2019) devised a multi scale deep learning model for fusing multispectral data using HSaLS (High-Spatial-and-Low-Spectral) resolution and hyper spectral data using LSaHS (Low-Spatial-and-High-Spectral) resolution [18]. It was possible to get a HSaHS image as an outcome of the fusion method. This result had been accomplished by developing a new scalable high spatial resolution scheme. This scheme explained the process of transiting low spatial resolution to an intermediary spatial resolution level and eventually provided an image of HSS (High Spatial-Spectral) resolution. This gradual process saved vital part of spatial information to be lost. The obtained outcomes proved the superiority of the new approach in regard to two metrics including SNR and SSI (Structural Similarity Index).

Fahim Shabanzade, et.al (2019) fused MRI and PET images together by designing a new approach based on PDE (Partial Differential Equation) and SD (Sparse Decomposition). Initially, a multi-scale depiction of MRI image had been produced by applying a group of PDE filters to the MR image [19]. After this, multi-scale depiction of the MR image possessing the key features of the image were used to find out various principal dictionaries. Eventually, these primary dictionaries were used to create a new dictionary. The new dictionary was further used to estimate the high frequency patch. This work used a weighted averaging algorithm for the patches of low frequency. The tested outcomes depicted that proposed approach performed better in terms of visual quality and quantitative evaluation.

Meimei Chen, et.al (2015) proposed one underwater image stitching model combined with the Scale Invariant Feature Transform (SIFT) and the wavelet fusion. Poor visibility in the sea and the variations in the illumination, viewpoints, etc., have been comprehensively taken into consideration for image matching [20]. Wavelet fusion is then made full use of to undertake the underwater image mosaic. It is shown in the simulation experiment that the proposed approach could achieve great performances in both robustness and effectiveness, with good behaviors in the vision effects and matching precision for the underwater images.

Cosmin Ancuti, et.al (2012) proposed a novel strategy to enhance underwater videos and images. Built on the fusion principles, our strategy derives the inputs and the weight measures only from the degraded version of the image [21]. In order to overcome the limitations of the underwater medium we define two inputs that represent color corrected and contrast enhanced versions of the original underwater image/frame, but also four weight maps that aim to increase the visibility of the distant objects degraded due to the medium scattering and absorption. Our strategy is a single image approach that does not require specialized hardware or knowledge about the underwater conditions or scene structure. The enhanced images and videos are characterized by reduced noise level, better exposedness of the dark regions, improved global contrast while the finest details and edges are enhanced significantly. In addition, the utility of our enhancing technique is proved for several challenging applications.

Amjad Khan, et.al (2016) proposed a wavelet-based fusion technique for enhancing the foggy underwater images. The main objective of proposed approach was to remove the low contrast and color variation problems [22]. Some state of the art techniques were used to enhance and analyze the openly existing foggy underwater images in qualitative way. The improved results were depicted by the quantitative scrutiny of image quality. The quality of the foggy underwater images was improved by the proposed technique as per the qualitative outcomes. The quantitative scrutiny showed that the quality of the image was also maintained by the proposed technique. A complete relative analysis will be carried out on the state of the art techniques for quantitative study along with the proposed technique in the nearby future.

Ritu Singh, et.al (2017) stated that the images clicked in underwater environment were corrupted due to the scattering and absorption of light [23]. Less colors, low intensity and undetectable objects within the image were included in this image dilapidation. In this work, a fusion relied underwater image improvement method was proposed for improving the quality of these corrupted images. With the help of contrast enlarging and auto white balance, the proposed technique gave attention to improve the contrast and color of underwater images. The proposed technique was extremely easy and uncomplicated. Therefore, this technique increased the visibility of underwater images up to a great extent.

Amjad Khan, et.al (2016) proposed a wavelet-based fusion technique for enhancing and de hazing the underwater foggy images of rotten tube [24]. The main objective of this work was to examine the underwater pipelines to predict decomposition. The proposed technique involved three major phases. Initially, the color contrast and the color profiles of foggy underwater image were adjusted to improve the image of decomposed pipeline. The improved adaptations were fused into a non-hazy image by performing the wavelet-based decomposition and inverse composition in the second phase. The decomposition on the surface of the pipeline was predicted in the last phase. The deterioration was predicted in both hazy and non-hazy image for verifying the performance of proposed technique. On the other hand, a strategy was made to generate the ground reality from the actual image for verifying the prediction of deterioration. Therefore, the obtained results will be compared with ground reality in the nearby future for verifying the anticipated level of decomposition.

Zhigang Zhang, et.al (2016) presented a sonar image fusion technique for underwater images. The proposed technique was based on the directional filters banks and morphological wavelets. The characteristics of multi resolution wavelet scrutiny and nonlinear filters were combined by these approaches [25]. Initially, the noisy sonar images were converted into the morphological wavelet field. This was done to reduce the image noise in an efficient manner. Further, the high frequencies of the original pictures were inserted into a directional filters bank. The directional decomposition technique was employed by the filter bank for providing accurate information about the image by maintaining the untransformed low frequency substance. Lastly, the multi-scale and directions regions were fused into the changing field. This resulted in the regeneration of fusion picture. The effect of implementing this technique to a series of sonar images from multi-views indicated that the additional elements in source images could be described by the fusion image in an effective way. These elements were described in terms of multi-resolution and direction. The proposed technique showed good performance in noise suppression, particularly for images with a bigger noise amount. Several tests and real data were compared and supported the conclusions of biased and unbiased assessment. These comparative results indicated results that the proposed technique efficiently mended the parts within the fused images. The proposed technique enhanced the quality of the image as well.

Codruta Orniana Ancuti, et.al (2011) introduced a new technique to improve the clarity of underwater images in effective manner [26]. The proposed technique was based on the fusion approach. This fusion approach derived a series of inputs from the original image. Basically, the main objective of fusion-based technique was to produce an ultimate image for removing overcomes the issues occurring in the corrupted input images. For this purpose, the proposed technique used several weight maps. These weights differentiated the parts typified by the meager clarity. The wide spread tests depicted the usefulness of proposed technique. The proposed technique considerably improved the clarity level of the underwater images by enhancing both the image contrast and the color form.

Huimin Lu, et.al (2017) proposed a new self-similarity-based technique for de scattering and super resolution (SR) of underwater clicked images [27]. A de scattering algorithm was used by the conventional technique of image processing along with the application of an SR technique. The conventional approach had the major drawback that most of the high-frequency data was vanished in de scattering. Accordingly, a new high turbidity underwater image SR algorithm was proposed in this work. At first, a self-similarity-based SR algorithm was employed to attain the high resolution image of scattered and de scattered images. After that, in order to recover the ultimate high resolution image, a convex fusion rule was applied. After de scattering, the super-resolved images showed practical noise intensity. These images also depicted more clear satisfying outcomes as compared to the traditional techniques. In addition, statistical parameters demonstrated that the steady improvement was shown by the proposed approach. The proposed algorithm also improved the boundaries in significant manner.

Pooja Honnutagi, et.al (2018) presented a review of image improvement structure and fusion for underwater images [28]. In underwater environment, the objects located near or far could be viewed clearly. Furthermore, the fusion of underwater images was an extremely difficult job. After that, atmospheric luminosity was the major issue in the processing of underwater imagery. These images obtained from poor visibility circumstances of underwater. The underwater images suffered from various problems such as light reduction and light distribution. These factors affected the clearness and contrast of underwater images. Therefore, improved imagery was clearer and enhanced color clearness as well.

Yafei Wang, et.al (2017) proposed a novel fusion-based approach for achieving the improvement in underwater imagery. The proposed approach was implemented to the frequency domain. There were two inputs involved in the presented fusion procedure [29]. These inputs were characterized as color accurate and contrast improved images. These inputs were retrieved from the actual underwater imagery. The three-scale wavelet operator decomposed the color accurate and contrast improved images into low frequency and high frequency artifacts. A multi-scale fusion procedure was applied to fuse the low frequency and high frequency artifacts. The weighted average was used for the fusing of low frequency objects while the high frequency components were fused via local variance. These fused low frequency and high frequency components could be rebuilt as ultimate improved imagery. The tested outcomes depicted that the proposed approach could enhance the clarity of underwater imagery considerably. Moreover, a good result was shown by the proposed algorithm for the identification of image feature points and matching in underwater scenarios.

Wen Zou, et.al (2016) proposed a new underwater image fusion technique for obtaining an accurate visualization of the underwater atmosphere [30]. In order to obtain a suite of finest images from the input images, the dark channel prior hypothesis and histogram equalization was used in this work. The image fusion algorithm was applied for conserving the finest element of every image using some particular weight evaluation matrix. In order to generate the optimum metrics of underwater dark channel preceding model mechanically, the downhill simplex algorithm was applied. This model was developed from the original metrics set by modifying the quality standard relied on image entropy. In the meantime, this optimum process could guarantee the attainment of the contrast improved image in diverse underwater situations concurrently. A lot of tests were conducted for verifying the effects of this technique. The tested outcomes depicted that the proposed algorithm was able to improve the clarity and recovered image color for getting an improved visualization of underwater views than other state-of-the-art techniques.

M. Shanmugasundaram, et.al (2013) proposed a new image de-noising algorithm. The proposed algorithm used the effectual merits of curvelet and fusion methods for improving the quality of underwater clicked imagery [31]. The de-noised image was achieved by fusing two intermediary images using the proposed algorithm. At the same time, the input noise image was inserted into the Gaussian filter and curve let transform in this system. The image filtered using Gaussian filter gave the first output image. In order to get the second output image, the curvelet transform was employed for the denoising of first input image. The tested outcomes depicted that the proposed algorithm enhanced the ratio of PSNR and MSE significantly. The proposed algorithm also proved its efficiency by saving the edges and textures in underwater imagery during denoising process.

Naveen Kumar, et.al (2015) Detecting and classifying objects in side scan sonar images is an important underwater application with relevance to naval transportation and defense [32]. Properties of the imaging modality, in this case, often introduce large intra class variability's reducing the discriminative power of any classification algorithm and limiting the possibilities of improving classification accuracy by advances in pattern recognition only. In this work, we investigate the role of an ancillary feature set computed on object shadows and propose a scheme for exploiting this useful, but variedly reliable information for object classification. A mean-shift-clustering-based segmentation technique is used for isolating highlight and shadow segments from the images. We show the results of reliability-aware fusion of features computed on highlight and shadows on three different data sets of side scan sonar images, to illustrate under what conditions such information might be useful

Ahmad Shahrizan Abdul Ghani, et.al (2018) proposed a novel strategy to enhance the underwater imagery. The proposed approach included the three major steps [33]. These steps were called homomorphic filtering, recursive-overlapped CLAHS and dual-image wavelet fusion. In this way, the proposed approach increased the clarity of deep underwater images and extracted the valuable information. In addition, this strategy applied homomorphic filtering for providing homogeneity in the lighting of the overall image for ensuing procedures. The recursive procedure of overlapped tiles of alienated image channel was called Recursive-overlapped CLAHS. In this phenomenon, the processing of half of a tile was done two times along with a nearby tile. The tile was partially overlapped with its subsequent nearby tile. The combination of upper- and lower-stretched histograms provided the dual-image wavelet fusion. This fusion was obtained by fusing two images. These histograms were implemented with discrete wavelet transformation prior to the execution of major process of wavelet fusion. The proposed algorithm showed better performance as compared to the current state-of-the-art techniques as per the obtained qualitative and quantitative results.

M. N. V. S. S. Kumar, et.al (2016) introduced two novel algorithms due to the non-occurrence of a universal solution of the image segmentation issue in the processing of underwater imagery [34]. Generally, the earlier methods were fused with field information for providing an effective solution of underwater image segmentation issue for a particular application. The first algorithm fused the segmented images into a solo image. This process was termed as image fusion. The image fusion process retained the main attributes of the imagery from signal segmented imagery. The image processing was done with the help of this method for identifying its likely components. However, few edges of the target could not be retained by this technique. The probability maximization method was implemented to the segmentation techniques in the second algorithm. This approach showed improved performance to maintain the boundaries of the targets. The tested outcomes depicted that the both proposed algorithms successfully achieved the high values of PSNRs.

Rashid Khan, et.al (2015) proposed a new approach for the restoring of underwater imagery. The proposed approach employed fusion and wavelet Transform [35]. The proposed approach derived the inputs and measured weights just from the corrupted adaptation of the image on the basis of fusion rules. Two inputs were defined in this work for removing the limits of the underwater channel. These inputs were called as represent color corrected and contrast enhanced adaptations of the actual underwater image or edge. In this work, four weight maps were represented as well. The main purpose of these maps was to improve the clarity of the far-away objects. The visibility of these objects was corrupted due to the channel dispersion and absorption. The proposed approach was considered as a single image strategy. The proposed approach did not need concentrated hardware or information about the underwater scenarios or sight configuration. The fusion structure long with wavelet transform also provided support to sequential consistency among neighboring frames by applying an effectual border maintaining noise lessening approach. The decreased level of noise, improved depiction of the dim sections, better overall contrast, enhanced optimum particulars and edges considerably characterize the enhanced images. Also, the effectiveness of proposed improved system was validated for various complex applications.

Wei Mu, et.al (2014) stated that PET and CT image fusion was come out as a novel and bright research domain in the last few years [36].The fine anatomical configuration was frequently blurred by the Alpha-blending which was the existing standard technique of PET and CT fusion. A novel fusion technique was proposed in this work. The proposed technique was based on the Pan sharp model. The proposed technique initially scaled the PET image into the resolution of the CT data using bilinear interpolation and registered them with common data. Afterward, this technique integrated the anatomical information into the genuine PET image and converted this image into a multi-channel RGB image with the help of a color table. Further, the multiple regression scrutiny was carried out for the simulation of panchromatic image. At the last, the fused image was obtained based on the Pan sharp model. Forty-five real data sets were employed for validating the proposed technique. The results obtained from both qualitative and quantitative scrutiny proved the efficiency and strength of the proposed technique.

Myung-Won Lee, et.al (2017) compared the performances of image fusion techniques using infrared and visible images [37]. Initially, intensity-based registration technique was applied in this work. This method aligned the image on the basis of comparative intensity samples for image registration. With the help of OSU color-thermal database, the performances of Sparse Representation (SR)-based and Multi scale Transform (MST)-based image fusion algorithms were compared as well. At last, the common data and entropy from ultimate fusion imagery were used for evaluating the performance index. The comparative results depicted that the high-quality performance was shown by the provided image registration and fusion techniques.

Liu Jiahuan, et.al (2018) stated that the main objective of distant sensing imagery fusion was to develop a fused image [38].As compared to the single image, the fused image contained more obvious, correct and inclusive information. In this work, an image fusion algorithm integrating gamma-corrected was proposed. The proposed image fusion algorithm was based on non-sub sampled Contour let transform (NSCT). Initially, the conversion of multispectral image was done into an intensity-hue-saturation (IHS) system. The non-sub sampled Contour let transform (NSCT) decomposed the panchromatic image and the element strength of the multispectral image in the second step. After this, the different principals were applied to fuse the non-sub-sampled Contour let transform coefficients into high and low frequency sub-bands in respective manner. An adaptive gamma correction was utilized for the low frequency sub bands. For the weighted coefficient fusion, the common information was used as the threshold. In order to fuse the high frequency coefficients, the max-abs-based fusion rule was employed. At last, the inverse NSCT and inverse IHS transform were used to obtain image fusion. The tested results depicted that the abundant detailed contents were included in the fused image. These contents preserved the saliency configuration. The proposed technique achieved superior illustration quality as compared to the other existing techniques.

Yang Juan, et.al (2013) proposed adaptive multi-feature fusion algorithm for the classification of the divers, underwater automobiles and other identical targets [39]. This method generally used target features. These features included image feature, instant feature and high resolution range profile features. An adaptive feature fusion technique was used to select the high resolution range profile features. The proposed algorithm processed the sea test data gathered in Sanya in January 2009. The tested results obtained after the processing of real data depicted that the proposed algorithm was able to decrease the likelihood of errors efficiently.

Yang Luo, et.al (2017) presented a new underwater localization algorithm. The proposed algorithm fused the Attitude and Heading Reference System (AHRS) with underwater altimeter [40]. In the spent fuel pool of the nuclear power station, the fusing was done for localizing the underwater welding vehicles (UWV). Based on the behavior of the UWV, the SFP was separated into various regions. The equivalent technique computed the coordinate of the UWV in all regions. In addition, to verify the precision of the proposed algorithm, the simulation of the three different motion trails of UWV localization was done. The satisfied accuracy level was shown by the obtained results. In future, the proposed localization algorithm will provided definite hypothetical base to localize the restricted water region.

Shaokang Zhang, et.la (2018) proposed a target recognition technique on the basis of Long Short-term memory network (LSTM). The proposed method fused multiple feature data and had a definite level of intelligence skill [41]. In this method, the different types of underwater audio target noise feature data was generated by the Long Short-term memory network (LSTM). The multi- feature was fused using a classifier called soft max. This classifier classified the targets. Finally, the time domain data, frequency data and Mel cestrum data were used as input data for model validation. The identification outcomes showed that the model fusing three types of input data showed better performance as compared to those methods that fused just two types of feature data. Thus, the proposed method fulfilled the smart needs of underwater acoustic target identification to a definite level.

Lixin Liu, et.al (2013) proposed an effective multi-focus image fusion algorithm. The proposed scheme was based on the lifting idea of wavelets. Initially, the wavelet lifting method was used into four sub bands to decompose the pending images [42].These sub bands were identified as LL, LH, HL and HH. After this, the sub bands called LH, HL, and HH were synthesized for obtaining the three directions of high-frequency particulars of the imagery. On the basis of high-frequency details, the Gaussian kernel computed the local luminance contrast. The weighted region energies represented this contrast. Therefore, the energy-based image fusion strategy was implemented to obtain a binary map. For this purpose, the maximal energy between images was selected. Using different function assessment criterion, the performance of the proposed scheme was compared with the current techniques. The tested outcomes depicted that the proposed algorithm showed a noteworthy enhancement in the fused image without any blocking effect. The proposed technique outperformed the other existing traditional techniques in terms of the speed of image processing and the quality of fused image.

Mingjun Zhang, et.al (2009) analyzed the monocular vision locating technique for underwater targets. The main aim of this technique was to remove the drawbacks of secondary focus technique and template calibrating technique [43]. In this work, a 3D locating method was fused with linear laser emitter and underwater camera. This combination computed the three dimensional coordinates of underwater targets precisely on the basis of coordinates' value in image plane of underwater targets and holistic fabric metrics. The locating precision of this combined method was bigger as compared to the normal secondary focus technique. The refraction effect on underwater image was optimized by considering the individuality of underwater imaging. This method also avoided the false issue of underwater imaging produced by image corruption. It was identified that the increasing distance between the image center and the edge increased the radial aberrance. The radial aberrance was initiated after the projection of calibrating camera parameters and a calibrating technique. This calibrating technique was used for fabric parameters of hardware flat. The comparative results of camera calibration and refraction optimization validated that the technique of revising camera aberrance and underwater image modification showed better performance for improving the locating accuracy. The technique based on sensors fusion showed better accuracy as compared to the secondary focus technique.

CHAPTER 3

PROPOSED SYSTEM AND IMPLEMENTATION DETAILS

3.1 Proposed System

In this proposed framework an improved submerged picture upgrade strategy is introduced which is an improvement upon the picture fusioning method. Beginning from only a solitary picture as information, it is first disintegrated into two parts the Reflective and Illuminance. At this stage a linear piece-wise capacity is applied to the Reflective segment of the first picture. This application results a picture with improved tones. For the component extraction calculation SIFT and HOG are utilized. Loads of every segment are determined independently and a multi-stage combination measure is followed to yield a solitary improved picture is delivered with better tones and less fogginess.

3.2 Technology Used

For design our system we used MATLAB for development. MATLAB is best suited for our proposed method due to these concern:

MATLAB

The significance of matlab is grid lab. Today we need a domain, wherein we have to evaluate number juggling estimation, plan and visual designs. For that reason we need a language that serve abnormal state programming with the fourth era innovation. Mathswork build up the matlab. In math's work treatment of lattice is permitted; we can actualize calculation; information and capacity plotting; improvement of calculations; UI can be structured; programs that are written in other language can be blend, these dialects incorporate FORTRAN, C++, Java and C; it can likewise break down the information; and making various applications and models. It contains such a large number of implicit directions and usefulness of science which will help us in counts of numerical projects, plot age and number-crunching techniques can be performed. It is the valuable apparatus for calculation of the numerical projects.

There are several basic features in the MATLAB:

- For arithmetic calculations, creation of applications and resolution it is used.
- It provides collective environment in which the solving of problems, designing and repetitive study take place.
- Statistics, filtering, arithmetic unification, linear algebra, ordinary differential equations and solving optimizations all these mathematical functions are provided by it in its library and also provide built in tools for graphical visualization of data and also provide tool for custom plots.
- It is very efficient tool for the development of quality of codes and increasing the presentation of the interface. For graphical interface it provide in built tools.
- It also provide tools for integrating the other language applications with the matlab based algorithms like Microsoft Excel, .Net, java and C.

- It also used a large variety of applications like:

  - Signal processing and Communications.
  - Image and Video Processing.
  - Control Systems.
  - Test and Measurement.
  - Computational Finance.
  - Computational Biology.

For the arithmetic calculations and visualization of data it provides a program called commands matlab. In the command window you can simply write the command with the prompt like '>>'. There are some common commands that are generally used by the users. There is a table listed below that give such commands:

Command	Purpose
clc	Clears command window.
clear	Removes variables from memory.
exist	Checks for existence of file or variable.
global	Declares variables to be global.
help	Searches for a help topic.
lookfor	Searches help entries for a keyword.
Quit	Stops MATLAB.
Who	Lists current variables.
Whos	Lists current variables (long display).

Fig 3.1: Describes Matlab simple command and purpose.

M files

For the estimations, nature of matlab is utilized as adding machine. It is one of the ground-breaking dialects for programming and furthermore give associated condition to calculation. Beforehand we examine about how direction enter in the order brief of the matlab. We additionally talk about how to composes different direction in a solitary record and how this single is executed. This resembles composing capacity into a record and afterward calling it.

The program document is of two kinds in the matlab M records:

Contents the program document which has .m augmentation is one sort of content record. In which we can compose numerous sorts of directions, these directions can be executed at the same time. These content records have a few confinements like information don't acknowledged and nothing will be return as the yield. They are utilizing workspace for doing any task.

Capacities - the program record which has .m augmentation is another sort of document called capacity record. Capacities are those factors which acknowledge the info and consequently produce some yield. All the inside characterize variable resemble neighborhood to that capacity record. For the formation of subterranean insect .m record the matlab manager can be utilized or we can utilize word processor moreover. This area is about the content documents. Content documents are those records which call numerous capacities and matlab directions in consecutive line. There is a basic method to run a content record by simply its name which will be type on the direction line. Word processor is utilized to make a content document. There are two different ways for the opening of the matlab manager:

- By the use of the command prompt.
- By the use of the IDE.

Data Types

There is no need of declaration any dimensions or data type with the statement. When the new variable is declared, it can be encountered easily and the appropriate space is allocated to it and variable is also created. In case that variable exists already then the original variable is replaced with the new one and its content is also replaced and for storage new space is also allocated if it is required.

There are 15 types of data types which are provided by this language. Every data types have some common functionality like the array or matrix type data is stored by these data types. The advantage of these data types is that they can store the array or matrix is of any length and minimum of 0 by 0. There is a table which represents the data types that are very commonly used in matlab:

Data Type	Description
int8	8-bit signed integer
uint8	8-bit unsigned integer
int16	16-bit signed integer
uint16	16-bit unsigned integer
int32	32-bit signed integer
uint32	32-bit unsigned integer
int64	64-bit signed integer
uint64	64-bit unsigned integer

Fig 3.2: Describes some Data types and their description.

Operators – from the name itself it suggest to do some operation, for logical calculations or perform mathematical operations this symbol is used which gives orders to the compiler to compile them. The basic designing of matlab is to operate the arrays or matrices primarily. Both non scalar and scalar data are operated by these operators. There are different types of operators in Matlab which are:

- Relational Operators.
- Logical Operators.
- Bitwise Operators.
- Set Operators.
- Arithmetic Operators.

Matlab allows two different types of arithmetic operations:

- Matrix Arithmetic Operations.
- Array Arithmetic Operations.

Vectors

One dimensional cluster is called vectors of numbers. There are two sorts of vectors in matlab:

- Row Vectors.
- Column Vectors.

Line Vectors: This kind of vector is made when the arrangement of information or component are bound by square sections, for boundless components we are utilizing comma or space.

Section Vectors: This kind of vector is made when the arrangement of information or component are bound by square sections, for boundless components we are utilizing semicolon.

Plotting

For crating the graph in the matlab we need to follow some steps:

1. Define the range of x variable and also define for which function we values f(x) are plotted.

2. Function y is also defined.

3. There is a command called plot, call as plot (x,y).

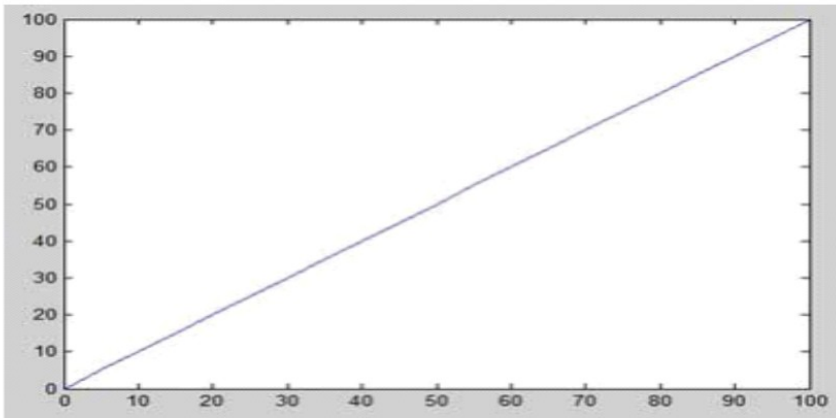


Fig 3.3: Graph plot on Matlab.

There are so many things we can do with this graph like adding title, giving name to x-axis and y-axis, form grid lines between the graph plot areas and we can also adjust the axes of the graph.

CHAPTER 4

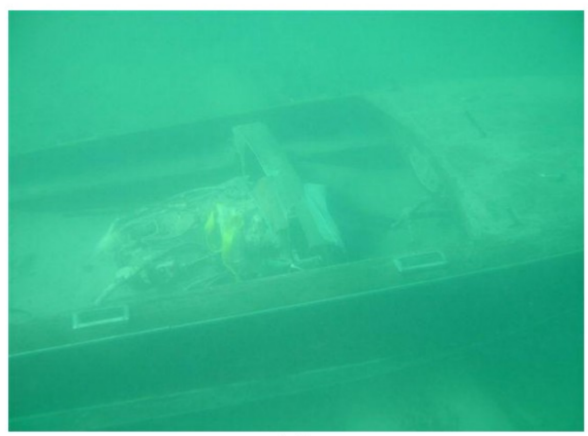
RESULT ANALYSIS

The method is implemented in MATLAB. The HOG and SIFT transformation method is applied for the underwater image fusion and we analyze performance of the method in terms of PSNR and MSE and compare it with those of the existing method [44].

(a)

(b)

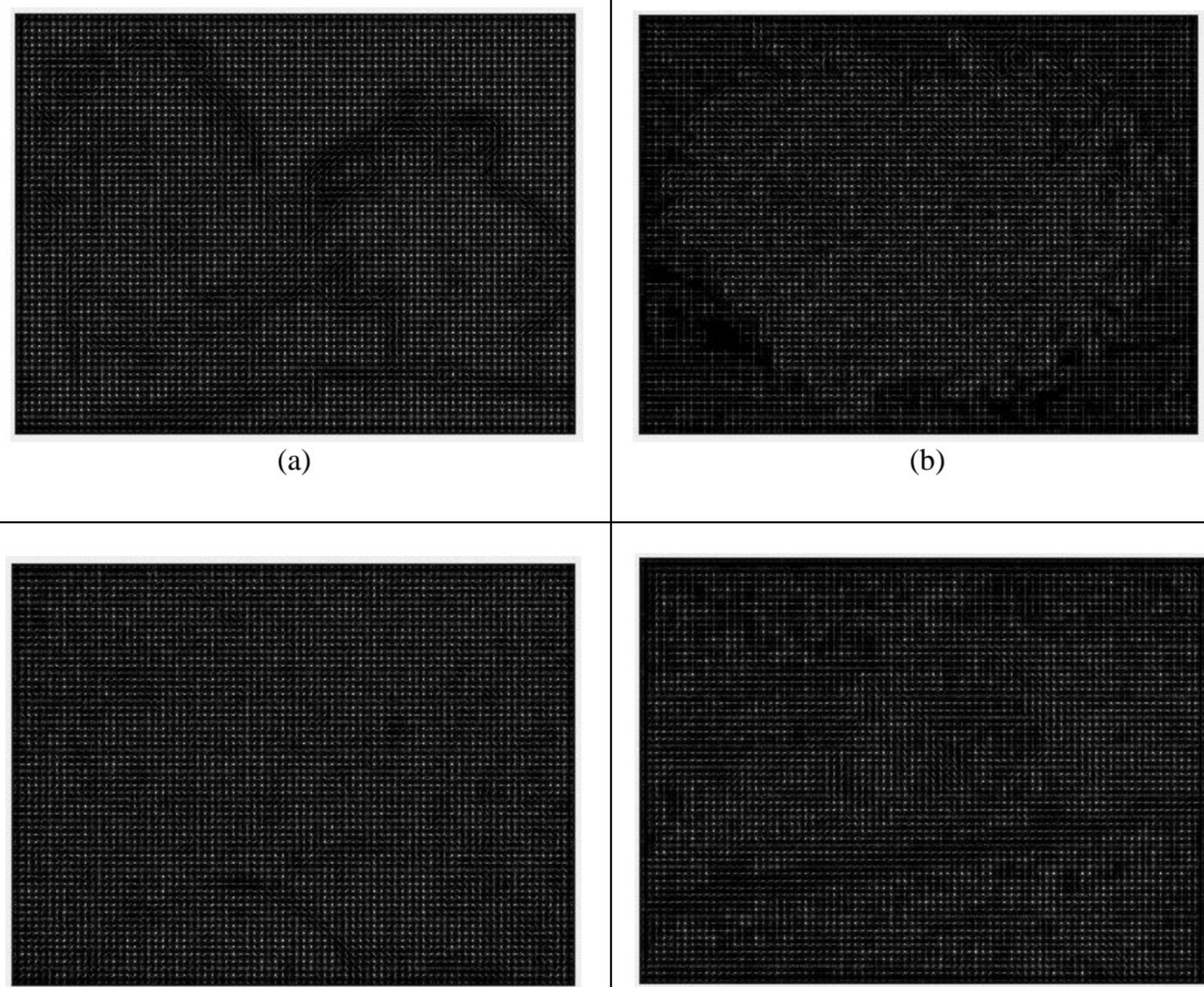
(c)



(d)

Fig. 4.1 (a), (b), (c), (d): Different types of Underwater Images taken as Input

As shown in figure 4.1, we take different set of underwater images as input images for our method.



(a) (b) (c) (d)

Fig. 4.2 (a), (b), (c), (d): HOG Transform for the corresponding sets of input as given in Fig. 4.1

As shown in figure 4.2, HOG Transform is computed which will be further used for the fusion process.

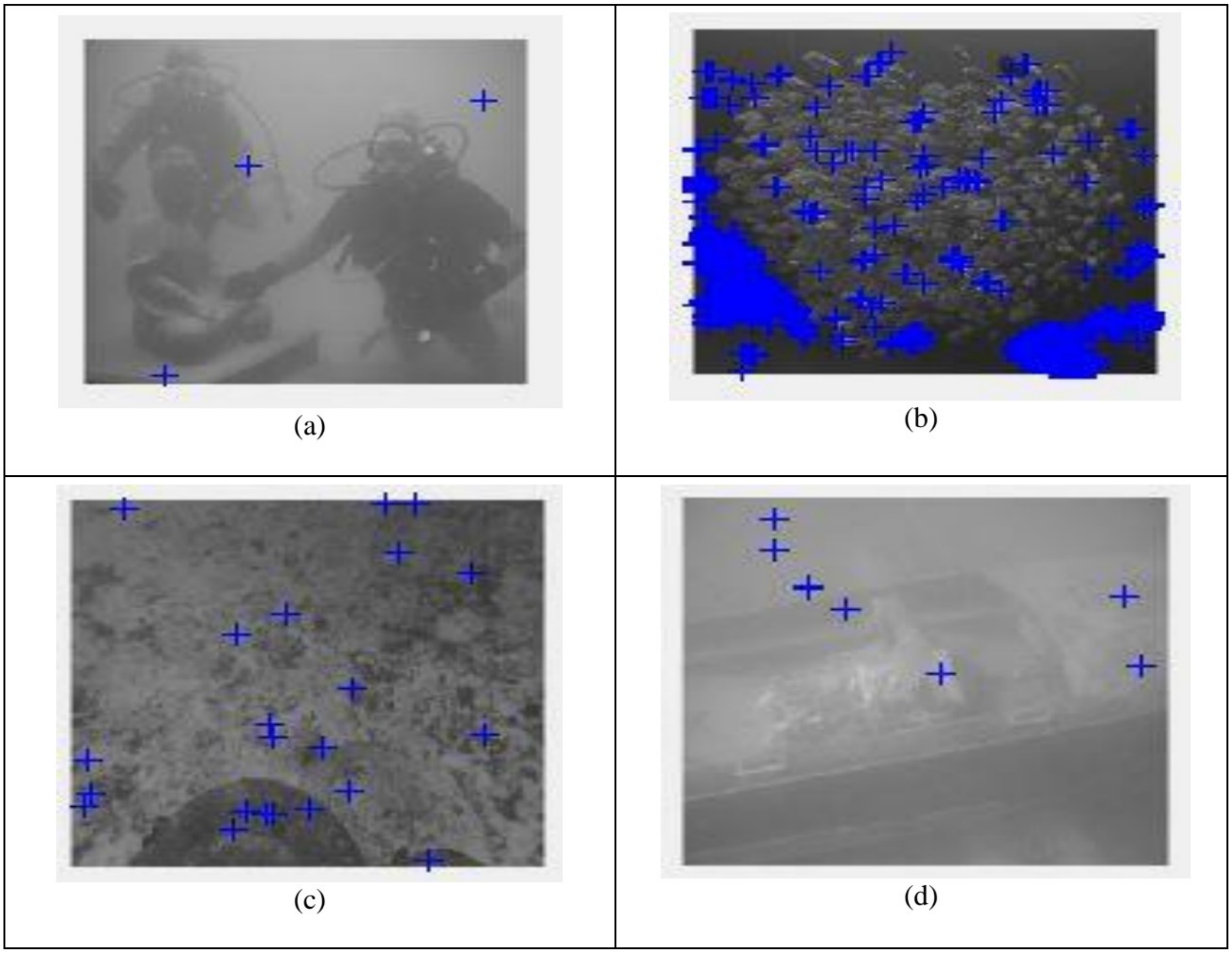


Fig. 4.3 (a), (b), (c), (d): SIFT Output for the corresponding set of input as given in Fig. 4.1

As shown in figure 4.3, output of Scale Invariant Feature Transform is generated for the corresponding set of input images which are given in figure 4.1.

(a)

(b)

(c)

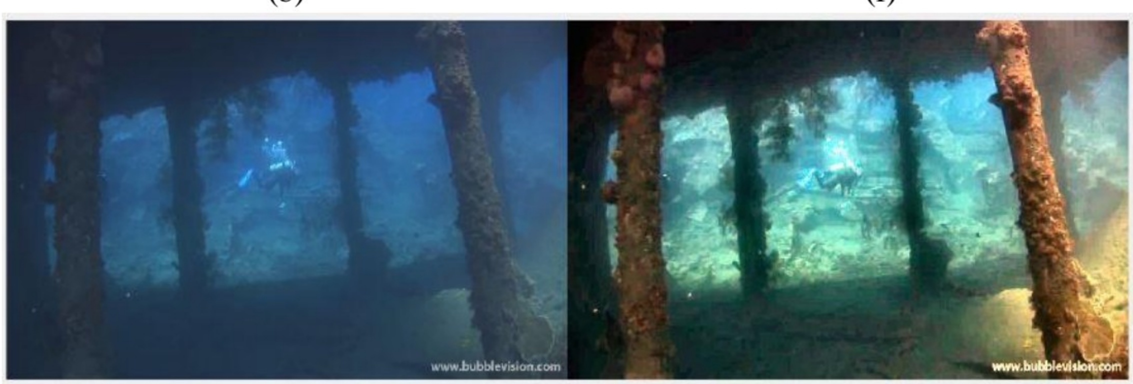
(d)

Fig. 4.4 (a), (b), (c), (d): Final output generation for corresponding set of input given in Fig. 4.1.

As shown in figure fig 4.4, we generate the final output of our method. The final output generated has improved the overall quality of the image.

(a) (e)

(b) (f)



(c) (g)

(d) (h)

Fig 4.5 (a), (b), (c), (d): Some more underwater input images.

Fig 4.5 (e), (f), (g), (h): Corresponding output images for input images in Fig 4.5 (a), (b), (c), (d).

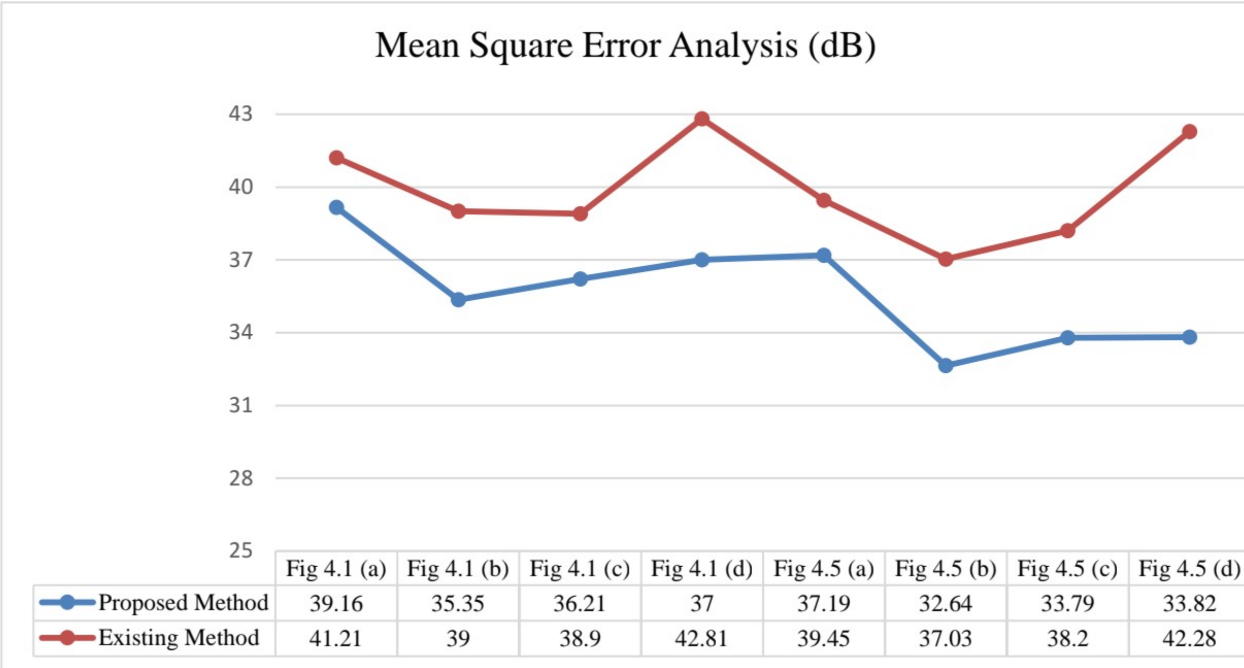


	Fig 4.1 (a)	Fig 4.1 (b)	Fig 4.1 (c)	Fig 4.1 (d)	Fig 4.5 (a)	Fig 4.5 (b)	Fig 4.5 (c)	Fig 4.5 (d)
Proposed Method	39.16	35.35	36.21	37	37.19	32.64	33.79	33.82
Existing Method	41.21	39	38.9	42.81	39.45	37.03	38.2	42.28

Fig. 4.6: Mean Square Error Analysis for Proposed Method and Existing Method.

As shown in Fig 4.6, the Mean Square Error value of the existing algorithm is compared with the proposed algorithm. The MSE value of the proposed algorithm is less as compared with the existing algorithm.

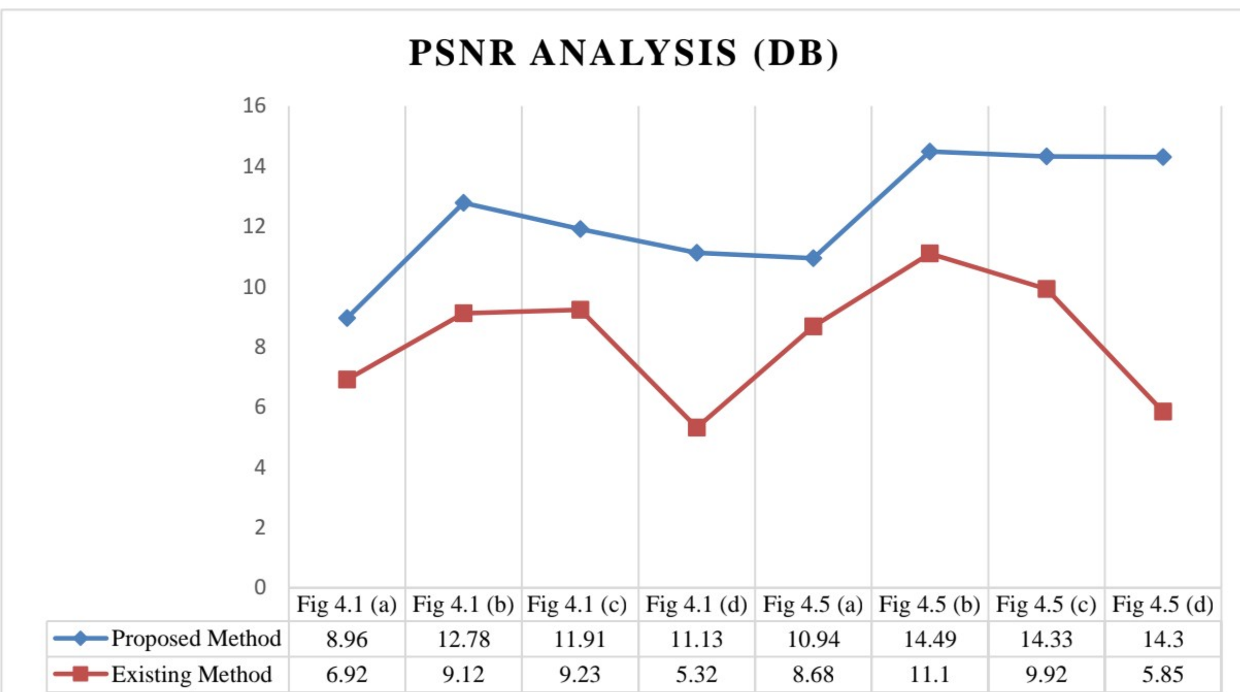


	Fig 4.1 (a)	Fig 4.1 (b)	Fig 4.1 (c)	Fig 4.1 (d)	Fig 4.5 (a)	Fig 4.5 (b)	Fig 4.5 (c)	Fig 4.5 (d)
Proposed Method	8.96	12.78	11.91	11.13	10.94	14.49	14.33	14.3
Existing Method	6.92	9.12	9.23	5.32	8.68	11.1	9.92	5.85

Fig. 4.7: PSNR Analysis for Proposed Method and Existing Method.

As shown in Fig. 4.7, the PSNR value of the proposed and existing algorithm is analyzed for the performance. The PSNR value of the proposed algorithm is high as compared to existing algorithm.

CHAPTER 5

CONCLUSION

An improved combination based procedure for upgrade of submerged pictures is introduced here. Contrasting with other combination based procedures it is uncovered that our strategies improved the submerged pictures. The method is basic yet hearty. It requires just one picture as info. Likewise the numerical model of submerged picture development is concentrated in incredible detail and it is uncovered that the light weakening in water and veiling light has the most impact on the submerged picture quality. For combination inputs the first picture is decayed into two constituent segments in particular the intelligent and illuminance parts. The two segments are handled freely and subsequent to computing the loads for the combination, the two pictures are converged once more into a solitary picture as yield.

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