Application of Different Techniques for Underwater Image Processing- A Systematic Review

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Abstract. The area of underwater image processing has gained huge attention among the researchers because of its wide application. Image processing is the approach of developing the input image quality so that it would be understood easily by users in future. Image processing develops the data content of image and changes the images visual impact on the observer. Image processing intensifies the image features and accentuates the features of image like corners, contrast to enhance the photographs display which is much helpful for study and examination. Several methods and techniques have been used by researchers worldwide in order to resolve the underwater image processing issues. This paper reviews different techniques of underwater image processing and also compares the techniques among each other. This paper discusses about the filtering method, histogram-based equalization method and particle swarm optimization techniques and compares them with their advantages.

Keywords: Filtering Method, Histogram Based Method, Particle Swarm Optimization, Underwater Image Processing.

1. Introduction

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1.1. LNCS Online

In electromagnetic radiation, water is seen as a robust attenuator, thus satellites could connect whole planets from space with ranging of laser and cameras, vehicles in underwater has to bewithin100 meters for best optical sensors. Mechanical waves penetrate within the water, thus some realistic trade-offs are there between frequency, strength of source and distance speed. Sonar’s are integral on ship adapt lesser frequencies for reaching the bottom, whereas these adapt lengthy wavelengths that move towards the cost of minimized resolution. For mapping fine-scale types are related to most of practical applications, acoustic and optical imaging stages have to perform relatively near to seafloor. For overcoming these issues, image processing is adopted (Dhanigaivel et al, 2019). There are many researchers and investigators who focused on studying about image processing in underwater (Peng and Cosman, 2017, Galdran et al, 2015, Sowmyashree et al, 2014, and Senthilkumaran and Thimmajaraja, 2014, Lu et al,
2015, Sathya and Bharathi, 2015, Roser et al, 2014, Panetta et al, 2016, Kaur et al, 2014, Wang et al, 2015, Qing et al, 2015, Alharbi et al, 2014 and Galdran et al, 2014). Underwater imaging plays a vital role in research of computer graphics and ocean engineering. Removal techniques for underwater haze have become very famous since adoption of different applications in image underwater. Underwater videos and images are captured for showing underwater to the world. Haze is usual observable fact that minimizes the clear view of underwater images. Additionally, haze minimizes the contrast of scene which would fade the colours. Thus eliminating the haze is challenging and difficult task. There are different methods and techniques developed for removing the haze and quality of the image is improved from underwater images as mentioned by Pati et al (2018).

Underwater images are distorted because of amalgamation and distributed. Captured images from underwater have poor visibility. Due to sea water’s dispersion and absorptive nature, it is tough to obtain visible and satisfying images at short or long paths. Noises minimize the details which involve main information. Therefore, best resolving speckled images in underwater are significant for observing in ocean. Such images mostly suffer from distortion of colour and low contrast since minimizing distance of spread light from camera particularly outcome from effects of scattering absorption (Natarajan, 2017).

**Figure 1.** Effects of Water Surface (Source: Raj et al, 2016)

Fig 1 depicts effects of water surface. Several portions of incident light travel through the water as well as other portion of light are replicated at surface. Because of choosy absorption characteristics, light component in red colour suffers severe reduction from the surface. Thus light passes profoundly to water mostly involve components of green and blue colour. Diffusion light denotes the light that passes all through the medium of water by scattering (Raj et al, 2016).

**Figure 2.** Image about absorption of light in water (Source: Bharal, 2015)
Fig 2 illustrates image about absorption of light in water. In the image, with every 10m intensification of the sunlight, the brightness is reduced by half. More or less all red coloured light minimized to 50 percent from surface. At the same time, blue coloured light continues to go profound in the ocean since blue colour have smallest wavelength thus it passes through the greatest distance in water. Due to this, underwater images are based on green and blue colour (Bharal, 2015). Quantity of sunlight minimizes as it moves profound under water. As an outcome, underwater images seem to be dim. Objects will reach the camera only through part of light and other part of light gets scattered while penetrating through the distance through medium of water. Therefore, underwater images could be captured by camera affect from uneven illumination, visibility degradation, imbalance in the colour, blurring and so on (Raj et al, 2016). Resolution of image and enhancement of image are very important in most of remote sensing applications in image processing like hyper-spectral extraction of data feature (Wang et al, 2015a), segmentation (Zhang et al, 2015 and Shang et al, 2017) and classification (Isikdogan et al, 2017 and Yuan et al, 2015), detecting the cloud (Xie et al, 2017) measurements in remote sensing (Ning et al, 2017 and Martins et al, 2017). Thus, it can be inferred that the enhanced images offer much visibility, interpretability and are good in terms of clarity and colour.

2. Literature review

2.1. Different Techniques of Underwater Image Processing

Sudhakar and Meena (2019) have stated that underwater images are hampered by bad contrast, change in colour, floating and suspended particles. Specifically, with cameras places on AUV and ROV systems has vast spread in military and civil applications. The analysis and processing of underwater images is non-trivial in ocean engineering and several other scientific applications. The main problem in ocean engineering is to capture clear and perfect images in underwater surroundings. Image enhancement is a technique utilized to enhance the underwater image quality by increasing the levels of intensity of the image or image parts so that the output image must be clear compared to the captured underwater image and hence it is utilized for display or for further examination of image. This method will not enhance the intrinsic data of underwater image. This involves manipulation in contrast and grey level, noise removal, sharpening the regions of object, colour correction and filtering and so on. Thakare and Sahu (2014) have stated that the techniques of Underwater Image Enhancement offer a way to enhance the identification of object in underwater surroundings. In underwater surroundings the images get dull due to bad conditions of visibility and impacts like light reflection, light absorption, light bending, light scattering, denser medium, etc. These are the essential factors which causes underwater image degradation. Two techniques are there to address image processing namely restoration of image and enhancement of image (Pati et al, 2018 and Prabu et al, 2019). There are numerous researchers examined about methods for restoring the image (Galdran et al, 2015, Drews et al, 2016, Li et al, 2016a, Peng and Cosman, 2017, Li et al, 2016b, Li et al, 2017 and Peng et al, 2018). Further authors also focused on enhancing the underwater image (Serikawa and Lu, 2014, Fu et al, 2014, Trehan et al, 2016; Sohal and Singh, 2015and Bianco et al, 2015). Enhancing the image is a process adopted for improving the image quality by enhancing its properties. Therefore, it is probable to maximize the objects’ visibility and image quality (Kaur and Sidhu, 2015, AbuNaser et al, 2014, Guraksin et al, 2016 and Lakshmi and Loganathan, 2015).

Algorithms for image processing in underwater are categorized as enhancement, restoration or correction in colour and illumination of approaches based on normalization and range from medium computational to high and structural difficulty. Further algorithms based on restoration include de-hazing and de-blurring processes (Dhanigaivel et al, 2019 and Zhao et al, 2015) using DCP (dark channel prior) based techniques or Weiner de-convolution. Many researchers studied about restoration based algorithms. Algorithms based on enhancement do not involve any models which derive from previous picture information or physical phenomena. They adopt histogram or statistical oriented or logarithmic contrast stretching or enhancement and techniques for correcting the colour in their formulation (Ghani and Isa, 2015, Lu et al, 2015). Gradient and entropy optimized algorithms for image processing in
underwater was developed based on partial differential equations and they resulted in automated and efficient enhancement, better outcomes from prior algorithm (Nnolim, 2017 and Nnolim, 2017a). The below Table 1 shows the various algorithms used for underwater image enhancement:

| Algorithm | Benefit | Author |
|-----------|---------|--------|
| WCID Algorithm | Removes artificial lighting and Maintain image quality | Pati et al, 2018 |
| Red Channel Method | Manages artificially illuminated regions gracefully and accomplishes correction of natural colour and equivalent or superior visibility growth compared to other state of art approaches | Galdran et al, 2015 |
| UDCP (Underwater Dark Channel Prior) | Offers better restoration and depth evaluation | Drews et al, 2016; Peng et al, 2018 |
| Underwater image dehazing algorithm and a contrast enhancement algorithm | Dehazing algorithm reduces the loss of information of enhanced UI based on the principle of minimum information loss and underwater imaging optical properties | Li and Guo, 2015; Li et al, 2016a; Dhanigaivel et al, 2019 |
| Depth estimation Method | Enhance and restore underwater images and estimates the depth of underwater scene much accurately. | Peng and Cosman, 2017; |

2.2. Different Techniques of Underwater Image Processing
Li and Guo (2015) developed an approach based on colour correction and dehazing algorithms for enhancing the underwater image. First and foremost, dehazing algorithm was utilized for removing the impacts of haze in underwater picture. Secondly intensity stretching, saturation, HE and compensation of colour are adopted for improving the visibility, colour, brightness and contrast of underwater picture. Apart from these, this research also adopted bilateral filtering is adopted for addressing the issue of noise occurred due to medium physical properties and Histogram Equalization algorithm. The proposed method maximized brightness, contrast, genuine colour, better visibility and minimized noise level.
Swarna Lakshmi and Loganathan (2015) study presents a comparative analysis of different techniques of image enhancement used for improving underwater images. The underwater images quality is bad because of particular light propagation properties in water. When capturing such images reduce due to several factors namely water ripple, lack of light organic matter availability dissolved in water and also captured images from little distance must be pre-processed before applying any type of operation on these images various techniques of filtering are feasible for pre-processing underwater images. Usually the filters are used to enhance the quality of image, suppress the noise preserve the corner in an image, smoothen and enhance the image properly.

In the study of Banerjee et al (2017) the proposed method processing sequence involves removal of noise using non-linear and linear filters followed by adaptive contrast correction in YCbCr and RGB planes of colour. The proposed method output has been calculated and compared with three major approaches called UCM (UnSupervised Color correction Process), namely WP (with white patch), GW (Gray World) and APE (Adobe Photoshop Equalization).

The Lu et al (2016) research offers a new solution to optimizing optical photos by utilizing a wavy driven trigonometric filter and the camera’s spectral properties in turbid mud. The three major issues of distortion in the optical photography of the underwater include reflection, artificial light and absorption. A new, deep-sea imaging technique that balances variations in attenuation along the direction of diffusion and an effective underwater scenario creation scheme is provided. The input of the report.

In the study of Rai and Bhalla (2016) the pre-processing is undertaken by image denoising. In order to accomplish this the integration of algorithms of image denoising namely KarhunenLoeve Transform (KLT) and Wavelet Transform (WT) and an adaptive filter are used on images to eliminate noise that are either existing in image during injecting or capturing into image during transmission. The wavelet transform has an outstanding performance in the field of denoising while KarhunenLoeve Transform reveals a better performance in signal rebuilt ability and adaptive filter can enhance the image by filtering out the noise of Gaussian.

Thakur and Dutta (2016) developed the pre-processing technique to enhance the quality of degraded pictures in the underwater. Three edge preventing filters considered for the research are wavelet denoising based on average filter, anisotropic filter and homo-morphic filter. Picture in underwater suffers from transmitting properties of water, lightening disturbance, transmitting limited light range, blurring and low contrast of image, diminishing colour at the time of image capture. Speckle decrease by anisotropic filter enhances the quality of the picture, prevents the edges in picture, restrained the noise, smoothen and enhance the picture. Homomorphic filtering is adopted for correcting non-uniform illumination and for enhancing image contrast.

Pan et al (2018) have proposed a novel approach to enhance underwater images. Firstly, a CNN is trained end to end to evaluate the transmission map. Similarly, the adaptive bilateral filter is used to refine the map of transmission. Secondly a strategy based on white balance is proposed to eliminate the deviation of colour. Laplace pyramid fusion is used to acquire the fusion output of colour corrected and haze free image. Lastly the resultant image is transformed into HWD (Hybrid Wavelets and Directional Filter Banks) domain for edge enhancing and denoising.

The below Table 2 shows the reviews on the filtering techniques used in underwater image processing:
### Table 2. Review on the Filtering Techniques Applied for Underwater Image Enhancement

| Author                                      | Filtering Technique                                         | Advantages                                                                 |
|----------------------------------------------|------------------------------------------------------------|----------------------------------------------------------------------------|
| Liu and Guo, 2015                           | Bilateral Filtering                                       | Resolves the noise issue occurred due to medium physical properties       |
| Swarnalakshmi and Loganathan, 2015;          | Homomorphic filter, Wavelet filter, Bilateral filter and   | Improves the quality of image, suppress the noise in image, preserve the  |
| Madhumatke and Agarwal, 2017; Srividhya and | Anisotropic filter                                         | image edges, smoothen and enhance the underwater image effectively         |
| Ramya, 2015                                  |                                                            |                                                                           |
| Banerjee et al, 2016                        | Linear and Non-linear filters                             | Reduces noise of underwater image                                         |
| Lu et al, 2016                               | Guided Trigonometric filter                               | Refine the map of coarse depth transmission                               |
| Rai and Bhalla, 2016                        | Adaptive filter                                            | Enhance the image by filtering out the noise of Gaussian                  |

#### 2.3. Histogram Based Algorithm

Ashwin et al (2014) combined contrast limited adaptive Histogram Equalization (CLAHE) and dark channel prior techniques for better image quality. Developed method is appropriate to enhance the underwater images quality than existing methods. Jayasree and Thavaseelan (2014) developed HE and algorithm of contrast stretching for improving the quality of underwater picture. Kuber and Dixit (2014) reviewed about modified application in enhancing the image. Enhancing the image is given better input to enhance the perception or interpretability of details in images for person to view with automated techniques in image processing. Different HE techniques such as Global HE, Clipped HE, Bi-histogram equalization, recursive mean-separate HE, dualistic sub image HE and multi-HE techniques are adopted for processing the input image for enhancing its output. This research modifies the brightness preserving dynamic HE (BPDHE) technique for enhancing its abilities in contrast enhancement and brightness preserving whereas it minimizes the computational complexity. There are many modified techniques associated with BPDHE which adopts data of digital images for processing and representation. For representing and processing the images in spatial area allow the method to handle the uncertainty in levels of grey values in a better way and result in enhanced performance.

Brindha and Vijayakumar (2017) stated that images in underwater have poor contrast and colour. Process of enhancing the image is needed for better look. Good enhancement of image for images in underwater is auto level method. Such method maximizes the contrast channel of every colour. This research balances the colour based on each channel distribution namely R, G and B depends on its histogram. Developed method adopts adjusted value for stretching right and left image boundary in
histogram relies on distribution. Developed methods illustrate the main enhancement in auto level for image in the underwater. Thus, many objects look clearer in the underwater images. Chen and Wu (2017) developed another HE-based estimation enhance image by distinguishing the suspicious vision of best entropy for keeping up various highlights in quality of image. Exploratory result verified the developed estimation is best to create enhanced images based on subjective human visual estimation and quantitative investigation. Lee and Tseng (2017) introduced an up-gradation technique of colour picture by adapting HE approach without modifying immersion and tint in HSI (hue, saturation and intensity) shading space. Developed method has suitable optical vision over ordinary HE approach because immersion and tint are saved in upgraded method. Picture of backdrop illumination and picture during evening time are adapted for exhibiting the feasibility of developed technique of colour enhancement.

Deperlioglu et al (2018) enhanced the images with HE, HSV (Hue saturation value color space) and V transform algorithm. Shaik et al (2018) applied various histogram based techniques on various images in underwater. This research has provided substitute approach for enhancing the images in the underwater. This strategy develops the principle of white balance and do not need extra data instead of single original image. Apart from these, it was confirmed that method of white balance gives better outcomes when compared with HE (histogram equalization), adaptive HE (AHE) and contrast limited AHE.

The below table 3 shows the reviews on the use of histogram-based algorithm in underwater image processing:

**Table 3. Review on the Histogram based algorithm Applied for Underwater Image Enhancement**

| Author         | Histogram Technique                             | Advantages                                                                 |
|----------------|-----------------------------------------------|----------------------------------------------------------------------------|
| Ashwin et al   | Contrast Limited Adaptive Histogram Equalization | Improves the intensity and contrast of underwater images                   |
| 2014           |                                               |                                                                            |
| Jayasree and Thavaseelan | Histogram Equalization and Contrast Stretching Algorithm               | Enhances the quality of underwater image                                  |
| 2014           |                                               |                                                                            |
| Kuber and Dixit| Brightness Preserving Dynamic Histogram Equalization Technique         | Improves the contrast enhancement and brightness preserving capabilities while decreasing its complexity of computation |
| 2014           |                                               |                                                                            |
| Brindha and Vijayakumar | Histogram Method                             | Improves the auto level for underwater image                              |
| 2017           |                                               |                                                                            |
| Chen and Wu    | Histogram Equalization based Algorithm         | Enhances the contrast of underwater image based on maximum entropy to     |
| 2017           |                                               |                                                                            |
manage image quality features

| Author         | Method                                                        | Description                                                                 |
|----------------|---------------------------------------------------------------|-----------------------------------------------------------------------------|
| Lee and Tseng  | Intensity Histogram Equalization Method                      | Good visual colourfulness in histogram and the saturation and hue are preserved in the process of enhancement |
| Deperlioglu    | Histogram Equalization Techniques                            | Improves the R, G and B components of underwater images                      |
| Shaik et al    | Histogram Equalization, Adaptive Histogram Equalization and Contrast Limited Adaptive Histogram Equalization | Improves the contrast and colour of underwater images                        |

### 2.4. Particle Swarm Optimization

AbuNaser et al (2014) introduced a framework to enhance pictures in underwater image using algorithm of PSO (particle swarm optimization). A pre-processing step was initiated for reducing the scattering and absorbing impacts of water prior adopting a filter based on proposed method for enhancing the picture. Enhanced images quality is numerically measured by adopting proposed method on dataset of underwater pictures. Acquired outcomes illustrate a significant enhancement.

Ye et al (2015) developed a cuckoo-search-PSO based technique for enhancing the images for grey-level pictures is developed and new norm to measure the enhanced picture quality. Developed method improves the image contrast and gives a high-quality base for next image processing. Outcomes of the developed technique are compared with prior techniques of image enhancements and found out developed method stably and rapidly unite to best solution as well as objective function was favourable when compared with other methods.

Chelva et al (2017) devised an algorithm to enhance the image’s visual appearance catches by camera in embedded systems based on microcontroller. This study developed a new approach to improve the grey-scale picture quality using PSO algorithm. From the findings of the simulation outcomes, it was found that developed algorithm provide acceptable outcome namely quality of the image and speed than prior methods. Singh et al (2017) adopted grey-levels image technique for enhancing contrast using PSO was found to favourable fit for human interpreter demands.

Zhou et al (2017) found that developed method could efficiently enhance the contrast of pictures using algorithm of multi-scale retinex and nonlinear transformation and their parameters for optimization were chosen automatically with the help of PSO algorithm. When developed method was compared with other classical algorithms for enhancement indicated that developed method efficiently minimizes the impact of uneven and low illumination on next recognition outcomes.

The below table 4 shows the reviews on the use of PSO algorithm in underwater image processing:
Table 4. Review on the PSO techniques Applied for Underwater Image Enhancement

| Author                        | PSO Technique                          | Advantages                                                                 |
|-------------------------------|----------------------------------------|-----------------------------------------------------------------------------|
| AbuNaser et al; 2014; Alshawatnawi et al, 2015 | Particle Swarm Optimization            | Increases the visibility, Enhance the brightness and Enhance the contrast of UW image |
| Ye et al, 2015;                | Cuckoo Search Particle Swarm Optimization Algorithm | Robust and Adaptive and Enhance the contrast of underwater image effectively |
| Chelva et al, 2017;            | Particle Swarm Optimization            | Reduce the number of particles and reduce the maximum iteration number and also enhances the quality and speed of underwater image |
| Singh et al, 2017;             | Particle Swarm Optimization            | Optimize the parameters used in transformation function                      |
| Zhou et al, 2017;              | Particle Swarm Optimization            | minimizes the impact of uneven and low illumination on next recognition outcomes |

2.5. Dark Channel Prior Method

Sathya et al (2015) has mentioned in their study that colour change and scattering of light are two major issues in underwater images. The light dispersal deflects the incident light which removes the objects in the atmosphere on several occasions. It rising the underwater image's brightness and clarity. Dark channel approach is used to eliminate haze from the underwater image. This is based on a crucial discovery that some local patches include several pixels of diminished strength on a canal of color in haze-free underwater pictures. For this preceding technique utilizing the haze imaging model the intensity of the haze is measured and a good resolution haze free underwater image can be obtained.

The study of Mallik et al (2016) focused on UW techniques of image enhancement which is needed mainly for navigation and exploration of sea floor, monitoring of underwater environment, predicting possibilities for coral reefs assessment and civil engineering. An approach which comprises an algorithm of haze removal followed by a CLAHE colour structure has been established. This study focuses on enhancement of underwater image through algorithm of haze removal by dark channel prior technique. But it has the capability to darken the underwater image in certain circumstance but it reveals a better outcome by reducing the effect of noise and haze. In order to develop the result of dehazing a HE
technique has been considered. CLAHE on the model of RGB has been followed in this study to alter the contrast level and dehaze image intensity.

Guo et al (2017) proposed an ISDCP (Improved Segmentation Dark Channel Prior) defogging method to resolve the fog impacts caused by water physical properties and also resolves the issues of underwater imaging colour cast and fog impact. Due to the mass light refraction in underwater imaging process the impacts of fog could lead to blurring of image. The colour cast is associated closely to varied attenuation ratio while light with varied wavelengths is passing in water. The proposed approach combines the quantitative histogram stretching and Improved Segmentation DCP techniques in to the process of image enhancement.

The UW photos were impaired owing to impacts of dispersion and absorption by Powar and Wagdikar (2017). UW imaging is essential to anticipate artifacts such as tiny organisms, fish and algae in present techniques. Color shift and dispersion of light are two dominant sources of distortion in UW imaging which reduce the contrast and visibility of the images captured. The suggested method thus describes a modern approach to boost UW photos with distance factors and histogram equalization and dehazing algorithms through remote factor estimation. Before the noise particles are eliminated, the distance factor dependent on specific color channel intensities with gamma correction is applied to improve the dimmed picture luminosity. The DCP removes noise and a haze effect and provides good visual quality with adaptive exposure map displaying to change the UW picture areas too light and too dark.

Swetha and Joan (2018) has proposed Dark Channel Prior based on the observation that most local patches in outdoor haze free underwater images comprises certain pixels whose intensity is very small in a colour channel. With Dark Channel Prior essentially superior colour fidelity and enhanced visibility of UW images are obtained and it decreases the complexity of computation and enhances the effectiveness in dehazing effect terms. The below table 5 shows the reviews on the use of DCP algorithm in underwater image processing:

| Author | DCP Technique | Advantages |
|--------|---------------|------------|
| Sathya et al, 2015; Amer et al, 2018; Venkateswararao and Rao, 2018 | Dark Channel Prior Method | Dark Channel Prior method is good compared to image processing using HE |
| Mallik et al, 2016; Gao et al, 2016; Kaur and Mahajan, 2014; Badhe and Ramteke, 2018 | Dark channel Prior and Histogram Equalization | Improves the underwater images quality quantifiably and visually by enhancing the underwater image contrast and reduces artefacts as well as noise in image |
| Guo et al, 2017; Pramunendar et al, 2018 | Improved Segmentation DCP and Quantitative Histogram Stretching | Reduces the complexity of computation and enhances the efficiency in defogging impact terms to meet the real time needs |
Powar and Wagdarikar, 2017; Han and Chen, 2016; Dark Channel Prior with Gamma Correction

Improves the brightness of dimmed images and also improves output by removing the impact of scattering and absorption components avoiding too bright and too dark areas using adaptive exposure map.

Swetha and Joan 2018; Khandelwal et al, 2018; Łuczyński and Birk, 2018

DCP method

Enhances superior fidelity of colour and visibility of underwater image and also reduces the complexity of computation and increases the effectiveness in dehazing effect terms.

3. Findings and discussion

3.1. Performance Characteristics

This study focused on the review of various techniques of underwater image processing to improve the underwater images quality. The below Table 6 compares the different techniques available for processing underwater images:

| Author                  | Year                  | Technique                                                | Results/Outcome                                                                 |
|-------------------------|-----------------------|----------------------------------------------------------|---------------------------------------------------------------------------------|
| Banerjee et al; Lu et al; Rai and Bhalla et al | 2016                  | Linear and Nonlinear filters, Guided Trigonometric filter and Adaptive Filter | Reduces the UW image noise, Refine the coarse depth transmission map and enhance the UW image by filtering out the Gaussian noise |
| Brindha and Vijayakumar; Chen and Wu; and Lee and Tseng | 2017                  | Histogram Equalization and Intensity Histogram Equalization | Enhances the UW image contrast based on maximum entropy and improves the automatic level of UW image and better visual colourfulness in histogram |
| Year | Authors                        | Method                                     | Description                                                                 |
|------|-------------------------------|--------------------------------------------|-----------------------------------------------------------------------------|
| 2017 | Chelva et al; Ye et al; and Zhou et al | Particle Swarm Optimization               | Reduce the maximum iteration number and enhance the speed and quality of UW image |
| 2017 | Guo et al; Powar and Wagdarikar | Dark Channel Prior Method                  | Reduces the complexity of computation and improves the brightness of dull images |

4. Conclusion
Underwater image enhancement is the area of image processing and it is considered as a dynamic sector. Obtaining the objects visibility at short or long distance in underwater scenes is very challenging and a difficult task. The atmospheric light is the main hurdle to process the UW images from bad conditions of visibility under the water, light attenuation and light scattering due to entire reasons which the UW images faces a lot and influence their contrast and visibility which they comprise originally. This review paper has examined different techniques applied for underwater image processing and explained how they enhance the quality of the underwater image. The paper could be extended in future by implementing the reviewed techniques on a real time basis and comparing their performances using appropriate evaluation strategies.

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