An Image Enhancement Algorithm for Autonomous Underwater Vehicles: A Novel Approach

Mahfuzul Huda, Kumar Rohit, Bikramjit Sarkar, and Souvik Pal

Abstract An imaginative technique is proposed that addresses the nature of underwater images by eliminating shadows and poorly differentiated relics that are normally tracked in them. The most common methods of capturing underwater images, resolution, reflection, and capture are affected by various effects of light. These effects can make your photo weaker or covertly louder. Improvement strategies are needed to overcome these degrading factors. This post presents a procedure with example calculations to handle the nature of submerged images, a generic histogram with limited contrast. The purpose of this document is to provide a minimum effort plan for underwater vehicles that can be used with simple electricity collection. The submerged vehicle is created using a smaller PC SOC known as the Raspberry Pi. This paper proposes computations that can be used to improve images captured by submerged vehicles. The sensor is also connected to the device using some GPIO pins to measure depth and detect hooks. Various techniques using Python 3 have been tried to improve the image. The aftermath of these tests was then analyzed. Three bounds, specifically PSNR, root-mean-square error, and entropy were examined to describe the impact of the proposed strategy using state-of-the-art methods. The proposed framework is compared to current strategies for editing underwater images.

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1 Introduction

While taking submerged pictures, the light that raises a ruckus around town can make corruption and loss of its frequency due to dispersing. While scattering is achieved by particles in the water, the light coming from the camera can in like manner cause a deficiency of its recurrence as it goes additionally lowered [1, 2]. Red light got held first, and blue light can go much further. Because of these variables, pictures taken submerged may have inferior quality. They can likewise influence the usefulness of submerged cameras. Backscattering, light assimilation, and forward dissipation are a portion of the variables that can influence the nature of pictures caught submerged. To improve the nature of pictures caught submerged, specialists have been creating different strategies that can be utilized to send pictures and recordings to the base PC. This is done by utilizing an umbilical string, which is a kind of electrical gadget that conveys both power and sign [1]. At the point when the base PC gets a picture or video, it then, at that point, conveys the message to the subsequent stage. Nonetheless, this cycle can be extremely tedious and limits the usefulness of UUV. In this paper, we introduced a strategy that includes an electrical get-together that can perform different undertakings, for example, upgrading the nature of pictures caught submerged. Besides improving the nature of pictures, this gathering can likewise be utilized to gather other data like temperature and profundity. To play out these undertakings, a gadget known as the Raspberry Pi 3B was proposed. The gadget, which is smaller than the expected PC, is fueled by a 1.2 GHz processor and 1 GB of Smash. It runs on the Linux working framework known as Raspbian. Other outsider applications, for example, the Ubuntu MATE can also be used to run the device [3, 4]. The device has four USB ports, which can be used to connect various peripherals such as sensors and cameras. It also has a pair of general-purpose pins that can be used to connect sensors. The camera attached to the device is used to take images and videos. It then processes the captured images and based on the data collected, the device can control the propellers. The device also comes with a pair of external modules in build, namely a Wi-Fi module and a Bluetooth module. These allow the device to send enhanced videos to the base computer. The remaining section of the paper is arranged as follows. The second section of the paper talks about the various techniques involved in underwater image enhancement, i.e., Literature Survey. The third section covers the aspects related to the proposed algorithm and flowchart, the fourth section discusses the implementation details regarding hardware aspects, sensors, and Raspberry Pi, the fifth section discusses the experimentation results, and the final section concludes the paper [5].

2 Shallow Water Image Enhancement Method

A variation of the versatile histogram that considers the over-intensification of the difference is known as CLAHE. Rather than the whole picture, CLAHE centers around the little locales in the picture that are called tiles. Rather than the entire picture, CLAHE centers around the little locales inside it. Adapthisteq considers the tile's differentiation change capability and processes the ideal incentive for each tile inside pictures. The difference of each tile is improved, so that its result locale matches the histogram indicated by the "Appropriation" esteem. Bilinear introduction is utilized to wipe out the fake limits between the adjoining tiles [6, 7]. The subsequent differentiation can be acclimated to try not to enhance the commotion in the picture. While Applying CLAHE, there are two boundaries to be recollected: Clip limit and the network size (Fig. 1).

This sets the quantity of tiles in the line and section. Naturally, this is 8 × 8. It's utilized while the picture is separated into tiles for applying CLAHE. Properties of Versatile Histogram Evening out incorporate the size of a local district is a boundary that influences the difference of the picture. It is a trademark length scale that takes into consideration upgraded contrast at more limited sizes and decreased contrast

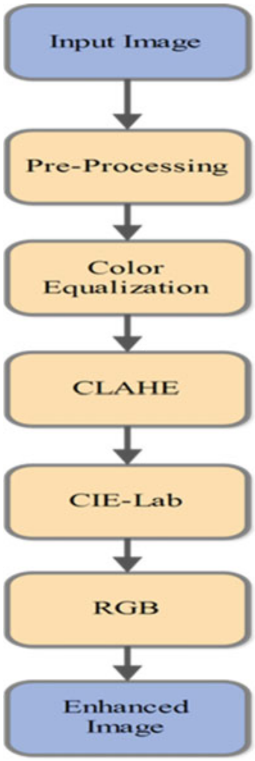

Fig. 1 Image enhancement process

at bigger ones. The outcome worth of a pixel is figured by considering its position among the adjoining pixels. This technique can be utilized to contrast the middle pixel and the other closeby pixels. Normalized result values can be registered by adding 2 for every pixel with a more modest worth than the middle pixel, and adding 1 for every pixel with equivalent worth. At the point when the picture district containing a solitary pixel's area is generally homogeneous, its histogram will be sufficiently able to top, and its change capability will plan the locale's pixel values to the entire reach. This outcome can make AHE overproduce a little clamor in the picture [8]. The subsequent picture is then reproduced to the RGB variety space and the result picture is a high goal upgraded picture. A variety of revised and contrast-upgraded yield pictures can be produced, which can be noticeable in the last result picture.

3 The Compute Module

The register module is a little structure factor gadget that can be utilized in modern applications. It includes the accompanying parts: the BCM2835, 512 MB of DDR3, and 4 GB eMMC streak memory. The gadget can be associated with a baseboard utilizing a 200-pin DDR2 equal port. It ought to be noticed that this isn't viable with standard SODIMMs. The gadget's different highlights can be gotten by utilizing the gadget's double-channel SODIMM connectors. The B/B + and A/B just have one of these. The register module is usually utilized by organizations to rapidly foster new items by giving them a total bundle that incorporates a central processor, memory, and capacity [5]. This kills the requirement for extra peripherals and permits them to zero in on the advancement of their new item.

4 BCM2835

The chip utilized in the well-known Raspberry Pi models A, B, and B + is the Broadcom BCM2835. It is an expensive upgraded, full HD mixed media application processor that can deal with most requested installed and versatile applications. The BCM2835 is an expense-enhanced, full HD mixed media applications processor that can deal with most requesting implanted and versatile applications [6]. It includes the organization's Video Core IV innovation, which empowers different applications like 3D gaming and media playback.

The Independent Submerged Vehicle is fueled by the Raspberry Pi, which has a 1.2 GHz Quad Center central processor and 1 GB of Slam. It likewise accompanies an SD card that can be utilized as a stockpiling medium. There are 40 pins in the gadget, which incorporate 5 V, 3 V, and rationale pins. The Raspbian Linux working framework was additionally introduced on a similar card. The 40 pins of the Raspberry module can be utilized to control the speed and course of the engines utilizing visual and sensor inputs [6]. The Raspberry was fueled by the 5 V interfacing with the power bank. Figure 2 shows the proposed circuit chart of the gadget. It demonstrates the way that our proposed module can be utilized as a working module for the UUV. The Raspberry can be utilized to control different engines and gadgets utilizing visual sources of info. For example, it tends to be utilized to identify objects submerged. This component was shown by utilizing the gadget's 40 pins to control the bearing and speed of the engines when the UUV goes through it. This Raspberry Pi elements can be utilized to identify and move toward target applications. We used bilge directs to control the UUV during this appearance. The contraption had the choice to achieve its goal by controlling the speed and heading of the propellers which are made of steel (Fig. 3).

The siphon, which is fueled by 12 V, is equipped for moving 1100 gallons of water at a time. The details of the propellers are as per the following: Sharp edge width: 31.2 mm; Opening: 2 mm, and viable with 2 mm shaft engines. Four engine controlling modules, in particular XY-15AS, were utilized to control the speed of the propellers. These modules can convey a current of up to 15 Amps. Subsequent to

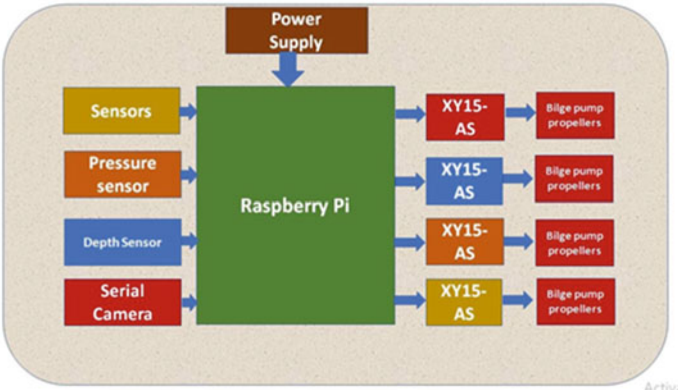

Fig. 2 Block diagram of the autonomous underwater vehicle system

Fig. 3 Practical implementation of the underwater vehicle

controlling the propellers utilizing 12 V Li-particle batteries, they were at long last all set [5]. The trial of the engines was performed on the outer layer of the gadget. The speed and bearing of the propellers were checked and constrained by Raspberry Pi.

5 Experimentation Results

Dissimilar to the general picture quality strategy, submerged pictures can't give a genuine colorless picture of an objective scene. Because of the absence of reference norms for submerged pictures, a great many strategies and procedures for emotional and objective assessment are utilized to assess and examine these pictures. The picture displayed in Fig. 5 is the first submerged picture that will be handled. The strategies that are utilized to further develop the picture are the CLAHE calculation, holomorphic sifting calculation, and the last figure shows the proposed calculation. The measures of all submerged pictures are 450*338. The CLAHE calculation in Fig. 1 can work on the picture's dynamic reach and feature subtleties, yet it can't take out the lopsided brightening. The holomorphic separating process in Fig. 1 can further develop the picture's variety cast by lessening the quantity of subtleties and working on its brilliance. Notwithstanding, it can't fundamentally improve the differentiation. The aftereffects of the concentrate in Fig. 1 demonstrate the way that the strategy can further develop the picture quality in turbid water by diminishing the commotion focuses in the picture. It can likewise feature the water bodies and far-off reef in the first picture. The regular condition of the light and shadow in the picture can likewise work on its lucidity. This can likewise help feature the details of marine life (Fig. 4).

The table beneath shows the different highlights of the picture that are connected with the pinnacle signal-to-commotion proportion, mean squared mistake, and data entropy. These are likewise considered after the dull channel earlier upgrade and holomorphic separating procedures and the proposed strategy. The more modest the MSE after picture handling implies the better the handling impact. Then again, the higher the PSNR, the better the picture's handling impact. The bigger the data entropy, the more prominent the problem of the data it contains. The consequences of this study show that the DCP calculation has the best exhibition with regards to picture handling. It has a bigger PSNR esteem and the littlest MSE. Albeit, the DCP calculation is fit for taking care of the majority of the picture-handling undertakings; it can't as expected manage the issues of lopsided enlightenment and variety cast in submerged pictures. The presentation of the holomorphic sifting calculation is impacted by the various upsides of the PSNR and the MSE. Notwithstanding, it can in any case perform better compared to different strategies with regards to managing the issues of variety cast and lopsided brightening in submerged pictures. The exhibition of the proposed calculation is likewise higher contrasted with that of the holomorphic separating technique and DCP strategy. It has higher objective evaluation indexes, and the information entropy is also higher. The contrast between the proposed strategies

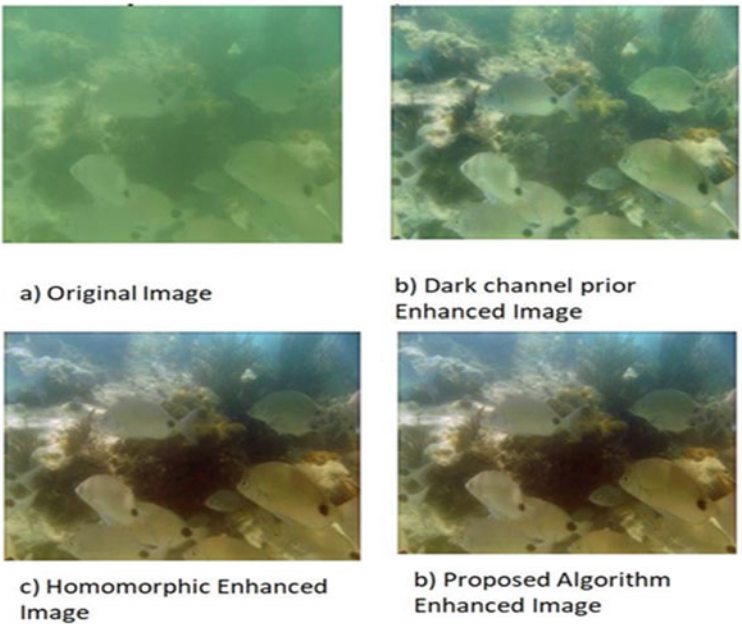

Fig. 4 Comparison images of proposed algorithm with traditional algorithms

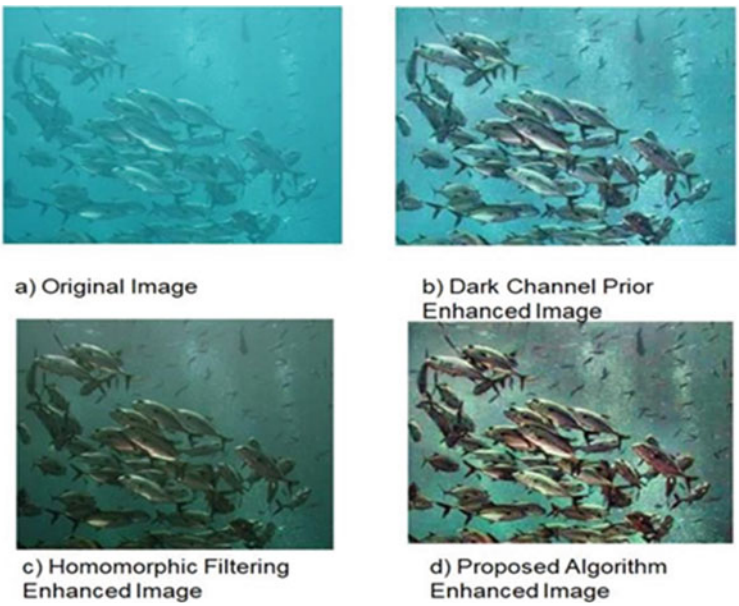

Fig. 5 Comparison images of proposed algorithm and traditional algorithms

and the customary techniques can be credited to the better acknowledgment of the inner surface and outside forms of the picture. As far as both execution and abstract outcomes are considered, the proposed calculation is plainly better compared to the aftereffects of the past two techniques.

6 Quantitative Evaluation

In Fig. 2, the information showing the different advances associated with the handling of a submerged picture is shown. The first Fig. 2 shows the first submerged picture with goal 367*305, while the second one Fig. 2b shows the consequences of the DCP calculation that is utilized to improve the picture, while Fig. 2c shows the consequences of holomorphic separating calculation and Fig. 2d portrays results subsequent to handling through the proposed calculation. The turbid water body of the fish is typically blue in variety, making it hard to see its subtleties. In the wake of handling utilizing proposed calculation, the fish can be plainly seen its shape, appearance, surface, and the emotional appearance of the picture is more normal. The progressions in the water brought about by the light can be noticed, and the differentiation between the articles in the water and the fish can be reestablished.

Table 1 relates to the pinnacle PSNR, MSE, and data entropy of the first submerged picture in Fig. 5 after DCP improvement, holomorphic sifting upgrade, and proposed calculation in this paper. The outcomes likewise show that the strategy proposed in this paper is fundamentally better compared to the outcomes got by the past two medicines.

7 Conclusion

In addition to being able to perform underwater tasks, image enhancement is also a must when it comes to autonomous UUVs. Target detection and path finding are a must for autonomous underwater vehicles. This paper proposes a standalone image enhancement system that can be used for both target detection and autonomous operations. It can be used for both image enhancement and motor controlling operations. The paper proposes a robust image enhancement system implementation using Raspberry Pi that can be used with a wide range of sensors. Through template matching, target detection was performed on a Raspberry Pi. The system was also tested for

Table 1 Quantitative evaluation by different algorithms for original image in Fig. 5

	PSNR	MSE	Entropy
DCP	30.654	57.435	7.634
HF	26.866	155.555	6.986
Proposed ALG	29.543	69.433	7.543

motor control operation. The paper's image enhancement system is designed to take advantage of the multiple sensors and image inputs received by the UUV. It can then enhance the image and control the vehicle's propellers using a common Wi-Fi signal. Although the paper's image enhancement system is capable of improving the image quality of the UUV, it is still in need of more improvements due to its limited image transmission range. Recently, a new model of the popular Raspberry Pi was released with 8 GB of RAM. This will allow the system to improve its image processing speed. Intel's Movidius vision processing unit can also be utilized to boost the system's performance.

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