

Underwater Image Enhancement: A Review of Modern Utilized Concepts

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Abstract - The revolution in current technology imposes on most systems of daily life in processing a wide range of applications through digital image processing techniques that have produced practical answers to many challenges such as image optimization, analysis, reconstruction, recovery, compression, processing, and so forth. One application of interest in underwater image enhancement has attracted the attention of experts in recent years due to its importance. In this work, a review of modern processing concepts for underwater images is given to get the basic knowledge on what are the used methodologies, what are the processed degradations, and what processing concepts have been used in the past years. Hence, different methods are reviewed and implemented on underwater images to know their advantages and disadvantages. The results of each method are demonstrated, the processing concept is summarized, and a synopsis that includes the main notion, complexity, pros, and cons is given to get a generalized idea about this topic.

Keywords: Underwater, image enhancement, utilized concepts, image processing, color images.

1. INTRODUCTION

In a wide range of applications, digital image processing (DIP) techniques have produced workable answers to various challenges such as image enhancement, analysis, reconstruction, restoration, compression, manipulation, and so forth. These challenges exist in different image-related applications, and one such application is underwater imaging. The processing of underwater images has caught the attention of experts in recent years, as DIP has been applied extensively in this field [1-3]. In scientific endeavors like observing marine life, counting populations, and analyzing geological or biological conditions, the quality of underwater photos is crucial. The difficulty of taking pictures underwater is primarily due to the murkiness that results from light that is reflected from a surface, deflected, and scattered by water particles, as well as color changes brought on by the differing levels of light attenuation for different wavelengths [4-6].

Images taken underwater suffer from contrast loss and color divergence due to light scattering and color alteration.

Sand, minerals, and plankton, which are present in lakes, oceans, and rivers, are among the suspended particles that contribute to murkiness. A fraction of the light that is reflected off objects and traveling in the direction of the camera collides with these suspended particles. As shown in Figure 1, this then absorbs and scatters the light beam [7]. In (Figure 1) At point x , natural light enters an underwater scene from the air. The reflected light travels a distance $D(x)$ to the camera. The radiance perceived by the camera is the sum of two components: the background light formed by multi-scattering and the direct transmission of reflected light [7].

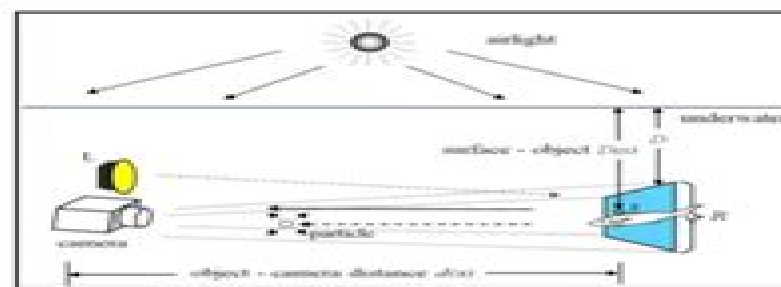


Figure 1: the underwater scene from the air [7]

Light of various wavelengths is attenuated in the water body in various ratios, as depicted in Figure 2. Underwater photos frequently exhibit color bias due to this unequal attenuation. Underwater image deterioration can also be brought on by suspended particles in the water. Figure 2 shows how particles close to the path that incident light takes to reach the camera create small-angle scattering (forward scattering) of that light, while particles in the surrounding environment cause large-angle scattering of ambient light to enter the camera lens (backscattering). Underwater photos become fuzzy and blurry due to these light refractions. Figure 2 shows how artificial lighting systems are installed as underwater expeditions progress deeper to provide the necessary illumination for the dark deep-sea environment. Given the constrained scope and in homogeneity of [8].

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