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Active Polarization Descattering

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Abstract

When imaging in scattering media, there is poor visibility which hiders both human assisted operations and computer vision. Most computer vision methods face significant difficulties if employed directly underwater. This is due to the particularly challenging environmental conditions, which complicate image matching and analysis. The problem is even more severe when using artificial illumination- strong backscatter veils the object signal. In this work we analyze image formation under wide-band wide-field artificial illumination. We suggest a visibility recovery approach. Our approach first estimates the backscatter component. Based on that component, it estimates a rough 3D scene structure. The method is simple and requires compact hardware, using active wide field polarized illumination. Two images of the scene are instantly taken, with different states of a camera-mounted polarizer. A recovery algorithm then follows. We demonstrate the approach in underwater field experiments and analyze limits concerns to acquisition noise.

1 Introduction

Scattering media exist in bad weather, liquids and biological tissue. Images taken in scattering media characterize in from poor visibility and loss of contrast. Light passing through undergoes absorption and scattering, causing changes in color and brightness. Moreover, light that is scattered back from the medium along the light of sight (*backscatter*) veils the object, degrading visibility and contrast. Therefore, applying traditional computer vision methods in such environments is difficult. Nevertheless, there is a strong need to perform vision tasks in these media. Examples include vision through biological tissues[12], underwater applications like port construction and inspections, measuring ecological systems, etc. [11], and navigation in bad weather [1].

Previous works tackled this challenge in various ways. Some recovered visibility as well as the three dimensional (3D) structure of underwater sites [33] under distant natural illumination. However, application fields operating in highly turbid media use *artificial illumination* sources at *short* distances, be it underwater or in the human body. However, artificial lighting usually causes a strong *backscatter*. Backscatter can be modulated and then compensated for in image post-processing. Such current methods require acquisition of long image sequences by structured light [17, 19, 27] or time-gating [5,