Improving Underwater Visibility with Polarization Contrast Imaging

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Abstract

Underwater imagery in highly turbid waters with conventional video cameras has the disadvantage of a low contrast. A well-known contrast enhancing imaging technique in turbid media is the range gated image recording. Synchronisation of laser emission and camera gate time allows to suppress backscattered light from the water column and to record only the light reflected by the object. Conventional monochrome video cameras as well as range gated systems record the intensity of light, whereas its polarization characteristics are not considered. A linearly polarized monochromatic illumination source and a polarization filter in front of the camera allow to detect the degree of polarization which is a function of the roughness of the scattering surface. This may give rise to a better contrast between target and seafloor, if both differ in their depolarization characteristics. Additionally, the light backscattered from the water column can be suppressed because the polarization retains unchanged if the scattering order is low. Results of tank trials are presented.

The small angle scattering theory describes the propagation of light through a scattering medium. The point spread function (psf), and the beam spread function (bsf) which is mathematically equivalent to the psf, describe the intensity blur distribution as a function of range from the source. The quality of an image transmitted through the water path depends on the blur seen in the image due to scattering in the medium. Measurements of the beam spread function with and without polarization filter are presented and are compared with Monte Carlo simulations. The improvement of polarization measurements is discussed as a function of optical water column properties.

References:

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