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Clear Underwater Vision

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Abstract

Underwater imaging is important for scientific research and technology, as well as for popular activities. It increasingly benefits from computer vision. In this work, we present a computer vision approach which easily removes degradation effects in underwater vision. We analyze the physical effects of visibility degradation. We show that the main degradation effects can be associated with partial polarization of light. We therefore present an algorithm which inverts the image formation process, to recover a good visibility image of the object. The algorithm is based on a couple of images taken through a polarizer at different orientations. As a by product, a distance map of the scene is derived as well. We successfully used our approach when experimenting in the sea using a system we built. We obtain great improvements of scene contrast and color correction, and nearly doubled the underwater visibility range.

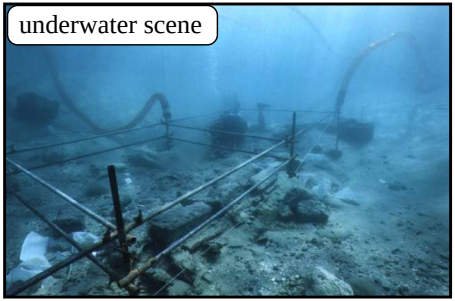

Figure 1. An underwater archaeological site. The visibility and colors quickly degrade as a function of distance.

Fig. 1, which shows an underwater archaeological site about 2.5 meters deep. It is easy to see that visibility degradation effects vary as distances to the objects increase [15]. Since objects in the field of view are at different distances from the camera, the *causes* for image degradation are spatially varying. This situation is analogous to open-air vision in