

Optimizing time-of-flight cameras for underwater applications

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In recent years, time-of-flight (ToF) cameras have emerged as a reliable and cost-effective way to provide high frame-rate range imaging. Today, this technology is used to address a wealth of applications including object detection, collision prevention, or gesture recognition. Here, we describe the implementation of the technology for underwater applications. The challenge arising from this adaptation is that the near-IR regime, in which current ToF sensors typically operate, is far from ideal for this application due to the strong absorption of liquid water. We show that by operating existing ToF imaging chips in combination with LED light sources at visible wavelengths, distance sensing with ranges on the meter level can be realized. We find that the attainable performance depends on a variety of parameters, such as the wavelength dependent absorption of water, the emitted optical power and response times of the LEDs, or the spectral sensitivity of the TOF chip. An in-depth analysis of the interplay between the different parameters is given and the performance of underwater TOF imaging using different visible illumination wavelengths is analyzed.