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Synchronized multiple-view imaging as a standardized domain for the analysis of plankton

Traditional imaging techniques in plankton research often capture only limited perspectives, which can obscure the full complexity of these organisms. We introduce a new imaging device that uses synchronized multiple-view imaging to provide a more comprehensive analysis of plankton. The system features four high-speed cameras (over 100 fps) with C-mount optics, adaptable to various magnifications and operating within a specified depth of field. This configuration allows for high-resolution imaging from multiple angles, facilitating the creation of stereo views and 3D models through photogrammetry, Structure from Motion (SfM), or Neural Radiance Fields (NeRF). Additionally, the system captures motion, offering 4D imaging capabilities. The resulting data can be seen as a big leap towards a digital twin of the images plankton objects.

The use of multiple synchronized views enhances feature analysis, addressing limitations inherent in single-view imaging. Therefore presenting the possibility to create benchmark datasets to further assist with hierarchical classification of plankton organisms, that are based on a more complete picture of the objects. This approach supports domain adaptation to or from other conventional plankton imaging domains such as UVP5/6, ISIIS, VPR, PIScO, or IFCB. Our preliminary research indicates potential benefits for style transfer and domain adaptation, which could contribute to transfer learning in lower-resolution domains.

We present three example datasets, demonstrating the system's applicability and its potential to reveal detailed features not visible with traditional methods. The system may also be used in other applications, such as photogrammetry of objects within a 10x10x10 cm sampling cube.

To promote broader use, we propose protocols and guidelines for domain transfer across common imaging domains. We hope this approach will help standardize imaging practices in plankton research, potentially improving the accuracy and reliability of ecological studies and monitoring programs.

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