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In-flow imaging ZooCAM system for zooplankton counting, identification and classification

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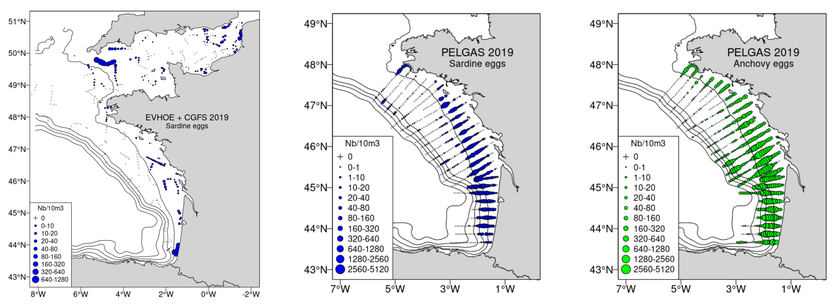
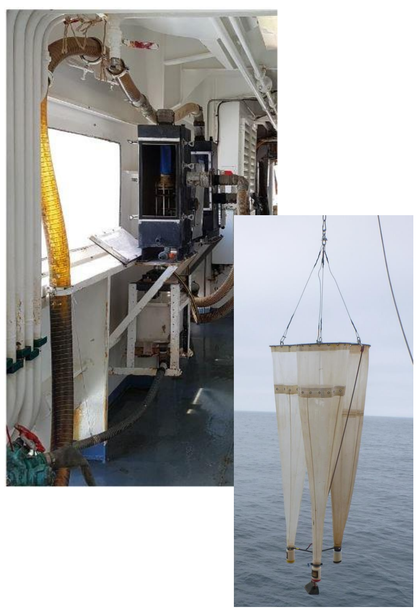
Context

Objectives: Digitize and analyze fish eggs and zooplankton samples on board ships or in the lab at high frequency [1-2], for fisheries and ecosystem surveys. The ZooCAM in-flow imaging system enables the quasi real time analysis of large volume samples collected and concentrated from plankton nets and continuous pumping at a flow rate up to 1L/min.



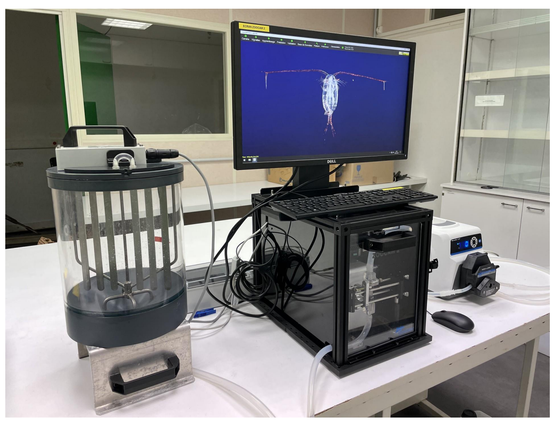
Sampling method

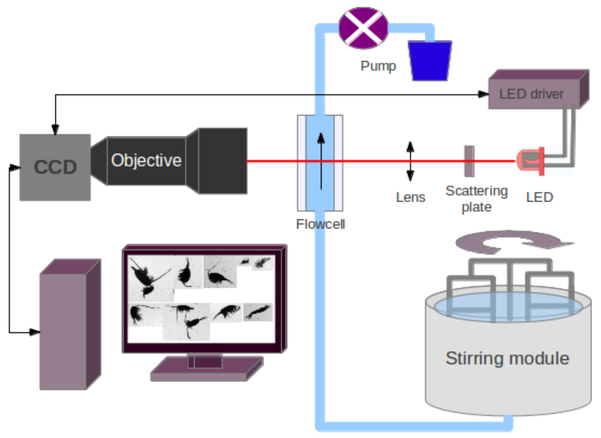
Annual surveys on R/V La Thalassa in the Bay of Biscay enable the collection of 10m^3 fish eggs samples with the CUFES (Continuous Underwater Fish Eggs Sampler) every 18 minutes during daytime, and several WP2 net zooplankton samples during night time, every day. Samples are previously concentrated on sieves, and can be fractionated by size and subsampled to reach a suitable amount of organisms to digitize.



Compact system development

The system captures images of water and its particle content (plankton, fish eggs, marine litter) in a calibrated flow cell using LED light source, a telecentric objective and a camera.





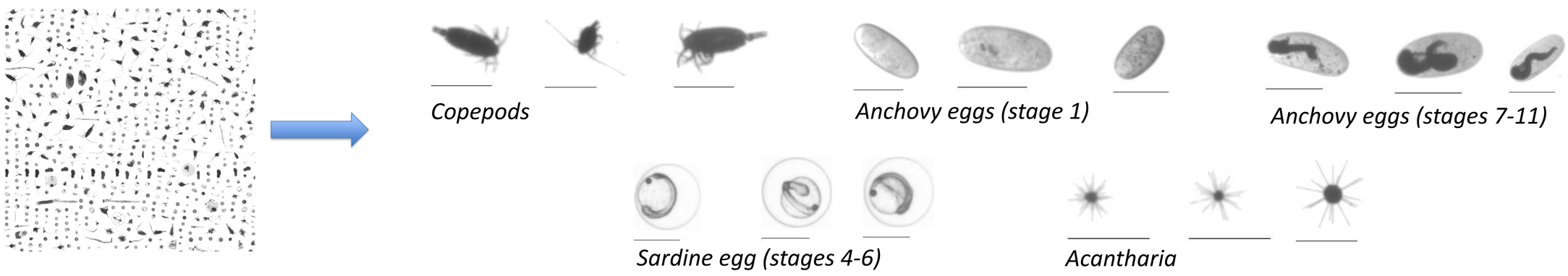
Process steps for sample quantification:

1. Injection of sample in the tank, stirring and pumping through the flowcell
2. Simultaneous raw images recording
3. Image processing: Background homogenisation and segmentation of raw images – real time detection of cut objects and duplicate objects
4. Follow up classification of imaged objects with a CNN

Mechanical integration and electronic improvements
➔ 20 % weight loss and size divided by 2 compared to first prototype: improved ergonomy
➔ CNN: 15% improvement of staged fish eggs classification

Maching Learning for thumbnails classification

Several machine learning algorithms are available, including a pre-trained CNN, and used to automatically classify and identify ~ 40 classes of organisms, particularly sardine and anchovy staged eggs, as well as bubbles, 20 classes of zooplankton and non-living particles. The ZooCAM software also features a built in, handy, visual validation or correction tool to generate scientifically qualified data.



Perspectives

- Classification and data processing time reduction study by improvement of built-in CNN
- Towards a DIY ZooCAM system kit for higher flexibility in maintainance and hardware upgrade
- Grow ZooCAM system number to cover more ocean area (Biscay Bay, English Channel, Mediterranean Sea)

References

[1] F. Colas et al., The ZooCAM, a new in-flow imaging system for fast onboard counting, sizing and classification of fish eggs and metazooplankton, Prog. Oceanogr. 166 (2018) 54–65.
[2] F. Lombard et al., Globally Consistent Quantitative Observations of Planktonic Ecosystems, Front. Mar. Sci. 6 (2019).

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