Vision-based Real-time Zooplankton Detection and Classification using Faster R-CNN

Sadaf Ansari[1], Aya Saad[2], Annette Stahl[2], Madhan Rajachandran[1]
ansari@nio.org, aya.saad@ntnu.no, annette.stahl@ntnu.no, madhan@nio.org
[1]CSIR-National Institute of Oceanography, Goa, India
[2]Norwegian University of Science and Technology, Engineering Cybernetics, Trondheim, Norway

OCEAN SCIENCES MEETING | 16-21 FEBRUARY 2020 SAN DIEGO, CA, USA
AGU100 ASLO The Oceanography Society
Presentation ID# 650858

Introduction

We propose the use of Faster Region-based Convolutional Neural Network (Faster R-CNN) for fast and accurate detection and classification of zooplankton groups in underwater images.

Faster R-CNN is a region-based object detection framework which combines region proposal and classification in a unified network [1]. End-to-end learning reduces overall training time and increases the accuracy of the network.

We also compare the performance of the proposed method with popular detectors like Single Shot Multibox Detector (SSD) [2] and You Only Look Once (YOLOv3) [3].

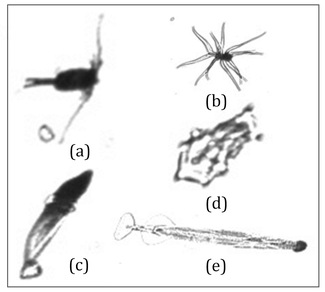


Fig 1. Zooplankton Groups from the Kaggle dataset [4]: (a) Copepod, (b) Echinoderm, (c) Fish larva, (d) Siphonophora, and (e) Chaetognatha

Motivation and Goals

- **Automate lab-based manual methods of zooplankton detection and classification.**
- **Reduce overall training time through end-to-end learning**
- **Improve the neural network detection and classification accuracy**

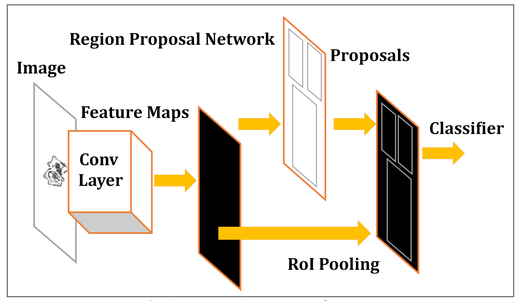
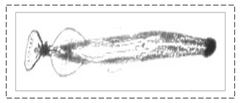


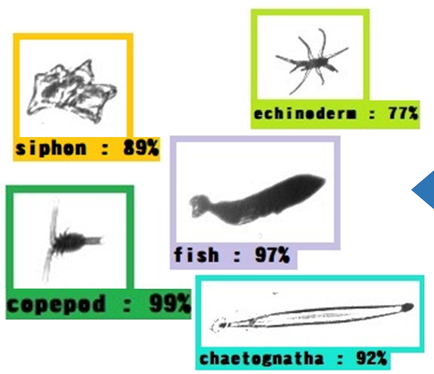
Fig 2. Faster R-CNN Network

Image Pre-processing: 10px padding added on all sides to increase the image background size



Preparing dataset and generating supporting file formats for Faster R-CNN, SSD, YOLO

Original image files	XML files for images with bounding boxes	Text files
1210.jpg	1210.xml	1210.txt
1613.jpg	1613.xml	1613.txt
...	...	...
...	...	...
3116.jpg	3116.xml	3116.txt



Detection and Classification (Network Training – Faster R-CNN, SSD, YOLO)

Evaluation

Mean Average Precision (mAP) is a popular metric for the evaluation of object detectors like Faster RCNN, SSD, YOLO.
Average Precision, AP for class c:

$$AP = \frac{\#TP\ (c)}{\#TP(c) + \#FP(c)}$$

True Positive, TP(c): when a proposal is made for an object of class c and the object is present
False Positive, FP(c): when a proposal is made for an object of class c, but there is no object of class c
Mean Average Precision, mAP for class c:

$$mAP = \frac{1}{|classes|} \sum_{c \in classes} \frac{\#TP(c)}{\#TP(c) + \#FP(c)}$$

Intersection over Union, IoU:

$$IoU = \frac{A \cap B}{A \cup B}$$

Set A is proposed object pixels and set B is true object pixels

Algorithm	mAP@0.5IoU
Faster R-CNN	97%
SSD	84%
YOLO	79%

Table 1. mAP scores for Faster R-CNN, SSD, YOLO

Conclusion

Faster R-CNN proved to be most efficient at processing the images of zooplankton with a high mAP score. More images in the dataset and more training time would result in a much better performance.

References

[1] Ren, Shaoqing, He, Kaiming, Girshick, Ross B. and Sun, Jian. "Faster R-CNN: Towards Real-Time Object Detection with Region Proposal Networks.." Paper presented at the meeting of the *NIPS, 2015*.
[2] W. Liu et al., "SSD: Single Shot MultiBox Detector", *Proc. ECCV, 2016*.
[3] J. Redmon et al., "You Only Look Once: Unified Real-Time Object Detection", *CVPR, 2016*.
[4] Cowen RK, Guigand CM. "In situ ichthyoplankton imaging system (ISIIS): system design and preliminary results. *Limnol Oceanogr Meth. 2008*; 6:126–32.

Acknowledgements

The authors would like to thank Dr. Mangesh Gauns and Ms. Bhagyashri Naik from the Biological Oceanography Department at CSIR-National Institute of Oceanography for the discussions on zooplankton groups, and demonstration of lab-based zooplankton analysis methods.

This research is partially funded by RCN FRINATEK IKTPLUSS program.
(project number 262701) and supported by NTNU AMOS.

National Institute of Oceanography
NTNU Kunnskap for en bedre verden
NTNU AMOS Centre for Autonomous Marine Operations and Systems
The Research Council of Norway