Master internship on design and development of an underwater event detection system based on embedded AI

Duration: 6 months.

Beginning: March, 2025. The call will remain open until satisfactory candidate is found.

Internship gratification: regular gratification ~620 €/month.

Workplace: Lab-STICC UMR CNRS, Brest National School of Engineering, Brittany, France.

Context of the internship:

The Lab-STICC is a research unit of the French national center for scientific research (CNRS). The staffs (more than 650 people) are located over the different institutes on several geographical sites in Brittany working within one central theme: “from sensor to knowledge”.

The internship is a collaboration project between two Lab-STICC teams: SHAKER and OSE. We are seeking a Master intern with competencies in computer vision and machine learning to work on a project investigating the design of an underwater event detection system based on embedded AI.

The internship is supported by ISblue project, Interdisciplinary graduate school for the blue planet (ANR-17-EURE-0015) and co-funded by a grant from the French government under the program ‘‘Investissements d’Avenir’’ embedded in France 2030.

Objectives and challenges:

Underwater equipment such as drones play a crucial role in marine research, monitoring, and resource management. However, their deployment is hindered by significant constraints, including limited communication capabilities, energy consumption, and computational challenges. Previously we have focused on developing algorithms for underwater fish detection [1, 2] and fish species classification [3, 4]. The objective of this internship is to design and develop a prototype underwater event detection system using embedded artificial intelligence.

Underwater event detection can encompass a wide range of scenarios. For example, a sudden change in luminosity could trigger an image enhancement algorithm, while the appearance of a single fish in the camera’s field of view might activate a species classification algorithm. Similarly, the detection of a group of fish could initiate a behavioural analysis algorithm. Other events of interest include the detection of marine debris and suspended particles, which are critical for environmental monitoring.

This approach involves running event detection algorithms directly on the embedded system, circumventing communication bottlenecks. Given the high computational demands of event detection algorithms, selecting the right algorithm requires careful consideration of computing resources and energy consumption beside their precision. For instance, during long missions with strict battery constraints, maintaining a monitoring with 24 frames per second (fps) rates may not be feasible, requiring the use of adaptive event detection intervals.

Various embedded platforms exist with specific support for AI applications. In this internship, we consider three low-power consumption platforms: NVIDIA Jetson Nano, Raspberry PI 5 Model B, and Beaglebone AI. Two types of operating systems are considered: Linux-based OS and small footprint real-time OS with more robust scheduling algorithms [5] such as Zephyr or FreeRTOS.

Experiments will be carried out on publicly available datasets such as Fish Recognition Ground-Truth dataset, LifeClef 2015 Fish dataset, TrashCan dataset and Trash-ICRA dataset.

Main activities:

1. Develop an event detection algorithm for underwater images

- Perform a survey on the state of the art of event detection algorithms in the computer vision domain.
- Develop an event detection algorithm for underwater images. The architectures such as YOLO or Tiny-YOLO shall be considered.
- Carry on a training to create a custom model optimized for underwater event detection.
- Test the developed algorithm to ensure accurate detection in underwater environments.

2. Deployment and evaluation on embedded platforms

- Deploy the algorithms on three embedded platforms with a Linux-based OS: NVIDIA Jetson Nano, Raspberry PI 5 Model B, and Beaglebone AI
- Comparison between the platforms by the following metrics: power consumption, memory consumption, performance analysis
- Study deployment of the algorithm with a small-footprint real-time operating system such as Zephyr RTOS

Applicant profile and required skills:
University Master or Engineering School student (last year of study) in computer science or related field with specialization in computer vision/machine learning.
Competencies in deep learning are highly recommended.
Knowledge of programming languages: C++, Python, MATLAB.
Knowledge of libraries: PyTorch, TensorFlow, OpenCV.
An intermediate-advanced level of English proficiency is required.
Interpersonal skills and the ability to work in a multidisciplinary team are recommended.
Taste for research activities in biological applications.

To apply:

If your interests are compatible, please feel free to send the following information in a single PDF file to abdesslam.benzinou@enib.fr :
- Detailed curriculum vitae.
- Cover letter explaining your interest and how your academic profile fits with this internship position.
- Completed courses with statements of grades.
- Names and contact details of at least two referees.

References:

[1] Ben Tamou, A. "Reconnaissance d'espèces de poissons dans des images vidéo sous-marines". thèse de doctorat, 2021.
[2] Ben Tamou, A., Benzinou, A., Nasreddine, K. "Multi-stream fish detection in unconstrained underwater videos by the fusion of two convolutional neural network detectors." Applied Intelligence 51.8 (2021): 5809-5821.
[3] Ben Tamou, A., Benzinou, A., Nasreddine, K. "Live fish species classification in underwater images by using convolutional neural networks based on incremental learning with knowledge distillation loss." Machine Learning and Knowledge Extraction 4.3 (2022): 753-767.
[4] Ben Tamou, A., Benzinou, A., Nasreddine, K. "Targeted data augmentation and hierarchical classification with deep learning for fish species identification in underwater images." Journal of imaging 8.8 (2022): 214.
[5] Le Boudec, A., Singhoff, F., Tran, H. N., Rubini, S., Levieux, S., & Skrzyniarz, A. (2023, December). Work-In-Progress: Could Tensorflow applications benefit from a mixed-criticality approach?. In 2023 IEEE Real-Time Systems Symposium (RTSS) (pp. 427-430).