PHD - Object Detection from Few Multispectral Examples

Academic lab: IRISA (https://www.irisa.fr/)
Compagny: ATERMES (https://www.atermes.fr/)
CIFRE PHD

Context

ATERMES is an international mid-sized company, based in Montigny-le-Bretonneux with a strong expertise in high technology and system integration from the upstream design to the long-life maintenance cycle. It specializes in offering system solution for border surveillance. Its flagship product BARIER(TM) ("Beacon Autonomous Reconnaissance Identification and Evaluation Response") provides ready application for temporary strategic site protection or ill-defined border regions in mountainous or remote terrain where fixed surveillance modes are impracticable or overly expensive to deploy. As another exemple, SURICATE is the first of its class optronic ground "RADAR" that covers very efficiently wide field with automatic classification of intruders thanks to multi-spectral deep learning detection.

The collaboration between ATERMES and IRISA was initiated through a first PhD thesis (Heng Zhang, defended December 2021, https://www.theses.fr/2021REN1S099/document). This successful collaboration led to multiple contributions on object detection in both mono-modal (RGB) and multi-modal (RGB+THERMAL) scenarios. Besides, this study allowed to identify remaining challenges that need to be solved to ensure multispectral object detection in the wild.

Objective

The project aims at providing deep learning-based methods to detect objects in outdoor environments using multispectral data in a low supervision context, e.g., learning from few examples to detect scarcely-observed objects. The data consist of RGB and IR (Infra-red) images which are frames from calibrated and aligned multispectral videos.
Few-shot learning [1][2], active learning [3] and incremental/continual learning [4][5] are among the frameworks to be investigated since they allow to limit the number of labeled examples needed for learning. Most developed methods [6][7][8][9] based on these approaches have been proposed to perform object detection from RGB images within different weakly-supervised scenarios. They should be adapted and improved to deal with scarce object detection from multispectral images.In case of lacking objects of interest during the training, anomaly detection approaches [10][11] can be also considered to detect new object classes which will be further characterized by prior semantic concepts.
In addition to the (private) data from ATERMES, the PhD candidate will be able to work with public benchmarks such as KAIST (https://soonminhwang.github.io/rgbt-ped-detection/data/), FLIR (https://drive.google.com/file/d/1xHDMGl6HJZwtarNWkEV3T4O9X4ZQYz2Y/view), VEDAI (https://downloads.greyc.fr/vedai/) or MIL (https://www.mi.t.u-tokyo.ac.jp/static/projects/mil_multispectral/) to benchmark the developed frameworks in the vision and machine learning communities.

Working Plan

The PhD candidate will work part time (80%) at IRISA (with 1 day per week in Rennes and the rest of the time in the Vannes IRISA facility) and part time (20%) in ATERMES in Paris (which corresponds to 2 days every 2 weeks). The exact schedule will be flexible: it might be preferable to spend more time in the

company at the beginning of the thesis to learn about the system and understand the data and be full time in the lab while writing the PhD dissertation.

- T0-T0+8: The PhD candidate will survey the recent literature about deep learning under low supervision scenarios in the broad sense, with a specific focus on methods adapted to the (multispectral) object detection problem.

- T0+9 - T0+24: During this period, the candidate will propose original contributions to tackle the problem of low supervision for multispectral object detection. We expect contributions related to few-shot learning, incremental and/or adaptive learning.

- T0+24 – T0+32: During this period, the candidate will integrate its contributions to the system developed by ATERMES.

- T0+33 - T0+ 36: The last period will be dedicated to writing the PhD dissertation

Required background and skills

- MSc or Engineering degree with excellent academic track and proven research experience in the following fields: computer science, applied maths, signal processing and computer vision;
- Experience with machine learning, in particular deep learning;
- Skills and proved experience in programming (Python and frameworks such as Pytorch/Tensorflow will be appreciated);
- Good communication skills (spoken/written English) is required ;

Supervision team

The PhD will be co-supervised by Prof. Elisa Fromont (LACODAM team, IRISA/INRIA Rennes) and Prof. Sébastien Lefèvre (OBELIX team, IRISA Vannes). The supervision team will be completed by Dr. Minh-Tan Pham (Ass. Prof., OBELIX team) and Bruno Avignon (CSO, ATERMES).

Application Procedure

Your application (CV+cover letter+academic transcripts) should be sent before the 30/04/2023 (but the sooner the better) to the 4 email adresses:
elisa.fromont@irisa.fr; sebastien.lefevre@irisa.fr; minh-tan.pham@irisa.fr; bavignon@atermes.fr

Applications will be treated and interviews will be conducted along the way.
The candidate will be hired with a CIFRE (https://www.anrt.asso.fr/fr/le-dispositif-cifre-7844) contract by ATERMES.
The expected gross salary is around 3500€ per month for 3 years.
The contract will start before the end of 2023 (ideally in October). Atermes can hire the candidate (as an engineer, CDI) before the beginning of the CIFRE contract if necessary.

Bibliography

1. Köhler, M., Eisenbach, M. and Gross, H.M., 2021. Few-Shot Object Detection: A Survey. arXiv preprint arXiv:2112.11699. https://arxiv.org/pdf/2112.11699.pdf
2. Huang, G., Laradji, I., Vazquez, D., Lacoste-Julien, S. and Rodriguez, P., 2021. A survey of self-supervised and few-shot object detection. IEEE PAMI 2022. https://arxiv.org/pdf/2110.14711v3.pdf
3. Brust, C.A., Käding, C. and Denzler, J., 2018. Active learning for deep object detection. arXiv preprint arXiv:1809.09875. https://arxiv.org/abs/1809.09875
4. De Lange, M., Aljundi, R., Masana, M., Parisot, S., Jia, X., Leonardis, A., Slabaugh, G. and Tuytelaars, T., 2021. A continual learning survey: Defying forgetting in classification tasks. IEEE

transactions on pattern analysis and machine intelligence, 44(7), pp.3366-3385. https://arxiv.org/abs/1909.08383

5. Montiel, J., Halford, M., Mastelini, S.M., Bolmier, G., Sourty, R., Vaysse, R., Zouitine, A., Gomes, H.M., Read, J., Abdessalem, T. and Bifet, A., 2021. River: machine learning for streaming data in python. The Journal of Machine Learning Research, 22(1), pp.4945-4952. https://github.com/online-ml/river

6. Fan, Z., Ma, Y., Li, Z. and Sun, J., 2021. Generalized few-shot object detection without forgetting. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (pp. 4527-4536). https://arxiv.org/pdf/2105.09491.pdf

7. Ahmad, T., Dhamija, A.R., Cruz, S., Rabinowitz, R., Li, C., Jafarzadeh, M. and Boult, T.E., 2022. Few-Shot Class Incremental Learning Leveraging Self-Supervised Features. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (pp. 3900-3910). https://ieeexplore.ieee.org/document/9857447

8. Wang, X., Huang, T.E., Darrell, T., Gonzalez, J.E. and Yu, F., 2020. Frustratingly simple few-shot object detection, ICML 2020. https://arxiv.org/pdf/2003.06957.pdf

9. Han, G., Ma, J., Huang, S., Chen, L. and Chang, S.F., 2022. Few-shot object detection with fully cross-transformer. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (pp. 5321-5330). https://arxiv.org/abs/2203.15021

10. Gangloff, H., Pham, M.T., Courtrai, L. and Lefèvre, S., 2022. Variational Autoencoder with Gaussian Random Field prior: application to unsupervised animal detection in aerial images. https://hal.science/hal-03774853/document

11. Gangloff, H., Pham, M.T., Courtrai, L. and Lefèvre, S., 2022, August. Leveraging Vector-Quantized Variational Autoencoder Inner Metrics for Anomaly Detection. In 2022 26th International Conference on Pattern Recognition (ICPR) (pp. 435-441). IEEE. https://ieeexplore.ieee.org/document/9956102