Master Internship/Stage

Deep Learning for Radar Image Classification on Maritime Surveillance

Laboratory. CMM-Centre de Morphologie Mathématique, MINES ParisTech

Duration. 6 months.

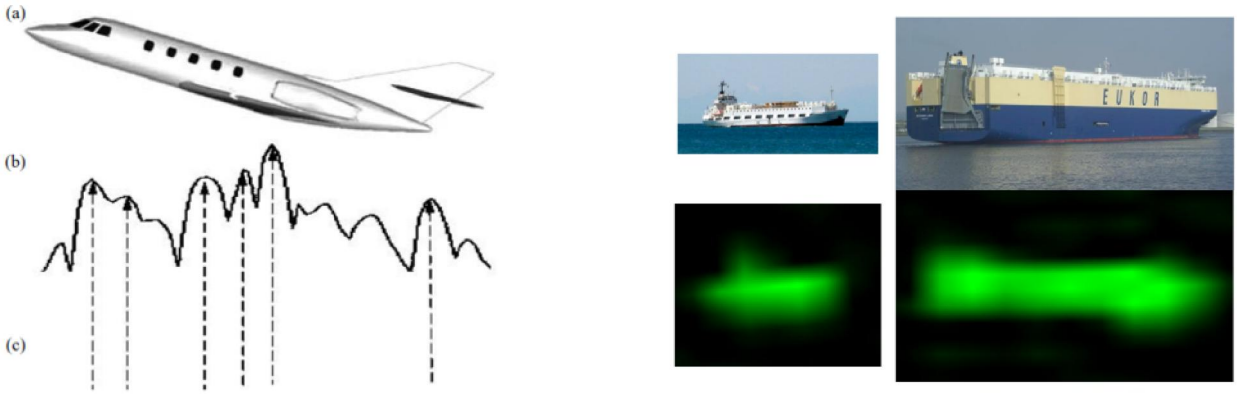
Funding. Program PGMO - IRSDI 2019 (https://www.fondation-hadamard.fr/fr/pgmo)

Scientific field. Machine learning for non-conventional data ; applied mathematics for signal and image processing

Supervisors. Santiago Velasco-Forero (**http://www.cmm.mines-paristech.fr/~velasco/**) & Jesus Angulo, MINES ParisTech, PSL-Research University, CMM-Centre de Morphologie Mathématique, France.

Context: In this internship, we consider the problem of target identification in maritime surveillance radar. This internship is part of a collaboration between MINES ParisTech and Thales Land & Air Systems. Deep learning applied to track kinematics has already been investigated and showed very good results in classifying maritime targets. We propose here to go one step further into the classification by providing the maritime tracks with the target local radar video image extracted in the range-azimuth map. This two dimensional intensity image provides richer information about the target nature than the single dimension range profile.

.



Left: The range profile response (b) of an aircraft (a) and the estimated position of its main scatters (c). Right: Real two dimensional radar video image and its correspondent target.

The main challenges in maritime surveillance are due to the fact that the target radar response greatly depends on its orientation, its height above the sea level and its relative distance to the radar. The orthoradial resolution decreases linearly as the radial distance increases. This means that few pixels are available to describe the target and that the radar representation of the same object is not homogenous over the space. In addition, depending on the environmental conditions, the target response could be accompanied by sea, atmospheric clutter or other interferences. Finally, according to the target shape, the response of a single object could be split into multiple fragments and reversely the response of multiple close targets may aggregate together into a single contiguous object.

Goals. The student will develop innovative algorithms for object classification (e.g., recognition of the class of ship in the maritime context) from radar video maps, dealing with the problems of object classification on very low resolute maps and inhomogeneous grids and limited number of annotated.

In particular, it will be studied the interest of morphological hierarchical representation as an interpretable 2D signal decomposition of radar map objects (noise vs. structural signals), combined with deep learning. Some preliminary work on parameter reduction methods for deep learning machine and economic deep learning algorithms is also envisaged.

In the most prospective phase, it will be explored either a time integrated classification that relies on instant measurements or a global classification that is applied on a historical series of the last available measurements kept in memory, using for instance recurrent deep learning networks.

References.

- Image and data processing for non-conventional datasets [Chevallier et al. 2017]
- Deep learning with limited training examples for non-conventional parameter estimation problems [Tuccillo et al. 2017]
- Integration of morphological methods on convolution networks [Zhang et al. 2019]
- Model pruning and complexity reduction in neural networks using max-plus layers [Ponchon et al. 2019]

Application file

Candidates (Master, Grande Ecole, etc.) should be familiar with machine learning and data/image processing. Experience with Python for programming would be a bonus. The internship could lead to a Ph.D. position. French nationality is not mandatory but highly recommended.

The application file should include a detailed CV, a transcript of your available academic records, a motivation letter and a list of persons to be contacted for recommendation letters.

The file should be sent before **January 5th 2020** by email to santiago.velasco@mines-paristech.fr ; jesus.angulo@mines-paristech.fr