Postdoctoral Position on machine learning for radar signal processing

Department/Dir./Serv. : **SONDRA**
Place: Centralesupélec, Gif sur Yvette (35 Km from Paris)
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SONDRA is a Franco-Singaporean research laboratory born from the alliance between Supélec (now CentraleSupélec, French engineering school), ONERA (French national aerospace research center), NUS (National University of Singapore) and DSO National Laboratories. SONDRA was officially launched on April 28, 2004. Based in France on the CentraleSupélec campus, SONDRA carries out fundamental research activities towards integrative research on radar observation combining physics, signal processing and machine learning for the defense, aeronautics and space sectors.

Machine Learning for Radar Detection and Estimation

Context:

Since the last decade, there is a growing interest for machine and deep learning methods to perform classification and regression tasks. Even though radar target detection and estimation respectively can be turned into a classification and regression problem, radar signals processing are still dominated by physics model based processing techniques [1]. These methods are close to optimal under condition that the collected data belong to a class of well specified distribution [2, 3] (Gaussian, compound Gaussian, elliptically symmetric distribution etc.). The latter point could be questionable since radar unwanted echoes, namely radar clutter, are environment depending. One can argue that Gaussian noise distribution is justified by Central Limit Theorem but this approximation may be only valid for low range resolution radars. For high resolution radar, conventional signal processing assumes noise distribution to be Gaussian scale mixture or elliptically symmetric distributions [4, 5] which are shown to be an efficient assumption for a more robust clutter modeling under presence of outliers. However, these modeling may not capture the true underlying noise distribution (heterogeneity, non-stationarity of the clutter) for a fixed data acquisition environment. On the other hand, machine and deep learning approaches have demonstrated to be very efficient in speech and image recognition and many other areas... Under availability of large amounts of data, machine and deep learning methods could be benefit to process high resolution radar signals [6] under heterogeneous and non-stationary background. Additionally, machine learning can be used for modelling non-linear transformation [7], it might provide a computational efficient method for signal processing, and also give improved target detection and parameter estimation. Therefore, we are looking for thought leaders who can develop new areas and applications using machine and deep learning based methods for target detection, estimation and the inverse transform between radar measurement space and interest parameter space.

References:

[1] Mark Richards, "*Fundamentals of Radar Signal Processing*", McGraw-Hill, 2005.
[2] A. De Maio and M. S. Greco, "*Modern Radar Detection Theory*". IET, 2015.
[3] M. Greco, Y. Abramovich, J.-P. Ovarlez, H. Li and X. Yang, "*Introduction to the Issue on Advanced Signal Processing Techniques for Radar Applications*", Selected Topics in Signal Processing, IEEE Journal of, 9(8), pp.1363-1365, 2015.
[4] F. Pascal, Y. Chitour, J.-P. Ovarlez, P. Forster and P. Larzabal, "*Covariance Structure Maximum Likelihood Estimates in Compound Gaussian Noise: Existence and Algorithm Analysis*", Signal Processing, IEEE Transactions on, 56(1), pp.34-48, Jan. 2008.
[5] F. Pascal, J.-P. Ovarlez, P. Forster and P. Larzabal, "*Performance Analysis of Covariance Matrix Estimates in Impulsive Noise*", Signal Processing, IEEE Transactions on, 56(6), pp.2206-2217, Jun. 2008.
[6] E. Mason, B. Yonel and B. Yazici, "*Deep learning for radar*", IEEE Radar Conf., *2017*.
[7] A. Mousavi and R. G. Baraniuk. "*Learning to invert: Signal recovery via convolutional network*", IEEE ICASSP, pp. 2272 – 2276, 2017.

Mission:

The mission of this postdoc consists in:

- Development of machine learning and deep learning based methods to perform radar detection, estimation and the inverse transform between measurement space and parameter space. Scenarios include wide range of velocity profiles, non-linear effects such as range migration, and acceleration etc. Measurement and parameter spaces may be real and/or complex-valued.
- Evaluation of performances in terms of regulation of false alarm, detection performance, parameter accuracy and computational time.
- Benchmarking with conventional processing algorithm.

Candidate profile:

Candidates should have

- Ph.D in machine learning, signal processing or applied statistics,
- Strong background in machine learning and deep learning,
- Programming skills in Python and/or Matlab.
- Knowledge in radar signal processing will be a plus.
- Excellent written and presentation skills in English are an advantage.

How to apply:

Each applicant should send a CV and a list of his publications.
Applications should be submitted by email to: **jeanphilippe.ovarlez@centralesupelec.fr** and **chengfang.ren@centralesupelec.fr** as soon as possible.

Location: SONDRA, campus of Centralesupelec.
Salary (gross): 3000€/month.
Contract duration: 12 months.
The Postdoc will start as soon as possible or at latest June 2018.