

## **Thesis subject: Distributed algorithms for cooperative perception**

### **PhD Advisors:**

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### **Context of the thesis:**

The thesis is part of the project activities of the Laboratory of Excellence (LABEX) at the Université de Technologie de Compiègne (UTC) in France on the Control of Technological Systems of Systems (MS2T) ([www.labexms2t.fr](http://www.labexms2t.fr)). It is more specifically part of the Research topic 3: Optimized design of technological SoSs.

### **PhD thesis description:**

Since several years, the laboratory is specialized in data fusion to merge data coming from several sources, reliable or not, contradictory or not. It also studies distributed algorithms for dynamic networks. All this research are applied to the fleet of intelligent vehicles of the laboratory, with the help of the engineer team. This is a challenge because sources may send erroneous data either voluntary (eg. attack) or involuntary (eg. unreliable sensor), communication may fail (messages losses...) and the convergence of the distributed algorithms may be delayed due to the network dynamic.

Recently a robust distributed algorithm has been proposed to fuse distributed data and some experiments have been done on the road. Depending of the candidate profile, several directions are possible for this thesis.

One of them is to deepen the existent technique and to propose new solutions. The candidate could propose and experiment data fusion operators for augmented perception and well adapted to dynamic environment. The proposed solutions have to deal with data imperfections (uncertainty, inaccuracy, lack of data, latency,...) due to the vehicular context. Different distributed strategies will be studied regarding the vehicular applications.

Another direction is related to the improvement of the distributed data management by means of new and robust networking protocols, that could rely themselves on distributed data fusion algorithms. New standards are also to be studied and experimented (IEEE 802.11p, OSI CAM and DENM...). Moreover, preliminary studies proved the interest of distributed data fusion for taking into account malicious behaviors either by attenuating their impact or by detecting attackers.

Theoretical and/or practical studies are expected, using road tests and network emulation thanks to the tools (hardware and software) designed previously in the lab.

Keywords: distributed algorithms, cooperative perception, vehicular networks, data fusion, data sharing, uncertainties modeling and management, dynamic networks, selfstabilizing algorithms, robustness.

### **Candidate's profile:**

The candidate must demonstrate (through her/his formation, previous projects, recommendations, grades) excellent skills in mathematics and computer science. We are seeking candidate mastering either in networking and distributed algorithms or in sensors, embedded systems, perception and decision. A taste for the development and experimentation will be a plus.

### Documents required to apply:

Send to [veronique.cherfaoui@hds.utc.fr](mailto:veronique.cherfaoui@hds.utc.fr) and [bertrand.ducourthial@hds.utc.fr](mailto:bertrand.ducourthial@hds.utc.fr) :

- A Curriculum vitae clearly showing how the candidate profile matches the above requirements
- A motivation letter detailing what are the interest of the applicant in the proposed topic(s)
- ;At least two references and/or recommendation letters
- -a contact information of at least one reference (two or more would be appreciated).

### Location:

Laboratory Heudiasyc UMR CNRS 7253  
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Avenue de Landshut  
60200 Compiègne

### References:

- [1] Radak, J. and Ducourthial, B. and Cherfaoui, V. and Bonnet, S., **Detecting road events using distributed data fusion: experimental evaluation for the icy roads case**, *IEEE Intelligent Transportation Systems Transactions*, Vol. 17, No. 1, 2016, pp. 184-194
- [2] El Zoghby, N. and Cherfaoui, V. and Denoeux, T., Evidential Distributed Dynamic Map for Cooperative Perception in VANets IEEE intelligent Vehicles Symposium 2014, Dearborn, Michigan, États-Unis, 2014 pp. 1421-1426
- [3] Ducourthial, B. and Cherfaoui, V. and Denoeux, T., Self-stabilizing Distributed Data Fusion. SSS'12, Proceedings of the 14th international conference on Stabilization, Safety, and Security of Distributed Systems. [Lecture Notes in Computer Science](#) Volume 7596, 2012, pp 148-162
- [4] El Zoghby, N. and Cherfaoui, V. and Ducourthial, B. and Denoeux, T., Distributed Data fusion for detecting Sybil attacks in VANETs Belief Functions: Theory and Applications - Proceedings of the 2nd International Conference on Belief Functions, Compiègne, France, 9-11 May 2012, Compiègne, France, vol. 164, pp. 351--358, publisher: Springer, 2012
- [5] Denoeux, T. Conjunctive and Disjunctive Combination of Belief Functions Induced by Non Distinct Bodies of Evidence, *Artificial Intelligence*, vol. 172, pp. 234-264, 2008.
- [6] Ducourthial, B, r-semi-groups: a generic approach for designing stabilizing silent tasks, 9th International Symposium on Stabilization, Safety, and Security of Distributed Systems (SSS'2007), 2007