IMT Atlantique
Bretagne-Pays de la Loire
École Mines-Télécom

PhD position : Design of Multi-User Communication Systems for Decision Making

Advisors: Elsa Dupraz (contact: elsa.dupraz@imt-atlantique.fr), Samir Saoudi
Place: IMT Atlantique, Brest, France
Expected starting date: Between November 2021 and March 2022 (for a 36 month duration)
Keywords: Information Theory, Source Coding, Channel Coding, Hypothesis Testing

Topic

About 130 million of smartphones were sold each month worldwide in 2020, and 30 billions of connected objects are currently in circulation, with an annual increase of 20 %. This exponential growth puts an important pressure on both current and future communication systems 5G and 6G: large data rates, resource sharing between users, increased interference and delay, etc. Each connected object embeds a large number of sensors, and the collected data can be transmitted to a server through the communication system. However, most often, **the objective of the server is not to reconstruct the original data, but rather to take a decision from the collected data**. As examples of applications, one may consider embedded sensors on the human body for health disease detection, underwater activity monitoring, or traffic detection from route plannings of autonomous vehicles.

Therefore, **this PhD will aim to develop a novel communication paradigm by taking into account performance criteria related to the quality of the decision making onto the data**, while standard communication systems are designed so as to reconstruct the original data transmitted by the sensors. This will require to completely rethink coding methods used in these novel communication systems, as well as the theoretical background usually employed to analyze their performance. One key challenge will reside in the development of a interdisciplinary approach between the telecommunication field and coding theory on one side, and the Machine Learning field and hypothesis testing on the other side. The envisaged approach may allow to greatly reduce the amount of data transmitted by the objects, which could lead to important energy savings.

Objectives of the PhD

We first aim to investigate the information-theoretic limits of communication systems dedicated to hypothesis testing. Usually, Information Theory is used investigate the fundamental limits of communication systems, from a set of assumptions on the statistical distribution of the data, on the transmission model, and on the transmission scenario (multi-user channel, relay opportunities, etc.). **In our context, Information Theory will allow to investigate how the novel communication objectives related to decision making modify the achievable performance of multi-user communication systems**.

Then, when designing standard communication systems, one key issue resides in developing source and channel coding methods with performance as close as possible to the fundamental limits identified by information theory. **In our context, at this step, we will study the feasibility of taking the decision directly onto the coded data, without having to reconstruct the original information.** This may allow for important complexity gains at the receiver.

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Context

This PhD position will be funded by the International Cominlabs Chair IOTAD-CEO led by Tadashi Matsumoto. The work of the PhD will involve discussions and collaboration with the team of the project, composed by researchers in various countries.

In addition to the salary of the PHD student (about 1450 Euros/month), the International Chair will finance traveling to international conferences so as to present the results of the PhD.

How to apply

The candidate should have earned an MSc degree, or equivalent, in one of the following fields: information theory, telecommunications, signal processing, applied mathematics.

To apply, please contact Elsa Dupraz (elsa.dupraz@imt-atlantique.fr). Explain in a few lines in the body of the e-mail your interest for this position, and attach the following:
- Full CV with list project and courses that could be related to the subject
- Complete academic records (from Bachelor to MSc)
- 1 or 2 references

References

[1] M. S. Rahman and A. B. Wagner, “On the optimality of binning for distributed hypothesis testing,” IEEE Transactions on Information Theory, vol. 58, no. 10, pp. 6282–6303, 2012.
[2] G. Katz, P. Piantanida, and M. Debbah, “Distributed binary detection with lossy data compression,” IEEE Transactions on Information Theory, vol. 63, no. 8, pp. 5207–5227, 2017.
[3] S. Sreekumar and D. Gündüz, “Distributed hypothesis testing over discrete memoryless channels,” IEEE Transactions on Information Theory, vol. 66, no. 4, pp. 2044–2066, 2019.
[4] S. Salehkalaibar, M. Wigger, and L. Wang, “Hypothesis testing over the two-hop relay network,” IEEE Transactions on Information Theory, vol. 65, no. 7, pp. 4411–4433, 2019.