Ecole Doctorale STIC

Sciences & Technologies de l'Information et de la Communication

ED STIC - Proposition de Sujets de Thèse

pour la campagne d'Allocation de thèses 2017

Axe Sophi@Stic :	SystèmesRéseaux|
Titre du sujet :	Design of miniature optimal antennas for IoT applications
Mention de thèse :	Electronique
HDR Directeur de thèse inscrit à l'ED STIC :	Fabien Ferrero

Co-encadrant de thèse éventuel :

Nom :	
Prénom :	
Email :	
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Laboratoire d'accueil :	LEAT

Description du sujet :

Design of miniature optimal antennas for IoT applications

Advisors : Fabien Ferrero (LEAT fabien.ferrero@unice.fr), Leonardo Lizzi (LEAT leonardo.lizzi@unice.fr) and Lars Jonsson (KTH Stockolm ljonsson@kth.se)

Motivation

The word “IoT” identifies everything that is connected to the internet and that goes beyond classical computers or mobile phones. A report by Cisco [EVA11] has recently
indicated that over 50 billion objects will be connected to the internet by 2020. Such an unprecedented growth is creating new opportunities for industries, businesses and
people, but also many challenges for antenna designers. IoT is expected to change how we

interact with each other and with industrial processes, the latter is expected to have a large impact on industries, which have giving raise to the notation of Industry 4.0, that is the fourth industrial revolution.

The rate of the spreading of the IoT technologies depend on several factors, but the power consumption and the size of the device are critical. Thus an improvement of the antenna radiation efficiency and a strong miniaturization is required. This is still more important if you consider that many IoT applications prefer to use the sub-GHz bands, such as the 868 MHz band in Europe and the 915 MHz band in the USA, due to their more reliable propagation characteristics. In these bands the wavelength is larger than 30 cm.

The massive number of active devices will lead to a large amount of interferences, which results in data packet losses, causing latencies and high energy consumption in the entire network. Spatial filtering could be used to mitigate this issue. As an example, a study on the use of reconfigurable antennas @2.4GHz for a M2M network has shown that spatial filtering can reduce the overall network energy consumption by a factor of 3 [LE16].

The combination of miniaturization and spatial filtering realized by the concept of reconfigurable superdirective antennas is the aim for this PhD position. The PhD student is expected to investigate and developed this concept both theoretically and experimentally.

Work description

Over the last decade, several theories have been developed for optimal bandwidth performance of antennas based on sum-rules and stored energies [GUS07-JON15]. This opens the possibility to develop methods and bounds for antenna performance that are optimal with respect to IoT applications with requirements on size, bandwidth, efficiency and directivity.

The first goal for the PhD student will be to determine physical bounds for the antenna, using the optimization techniques developed in [JON15]. This challenge consists of both theoretical problems and their numerical verification pushing the boundaries of what is known about antenna limitations.

The second goal is to design reconfigurable antennas suitable for IoT applications meeting energy performance and size requirements and that are optimal with respect to the physical bounds. A first example of passive directive antenna has been presented in [JON17].

An important part here will be to validate the antenna design properties experimentally. The small size of the antenna makes it highly challenging to measure the antenna properties accurately (input impedance, radiation pattern and efficiency).

The realization of a prototype will be a first step towards the development of a methodology to design antennas which are optimal in respect to IoT applications. The development of such a method is important for both reducing the energy consumption of IoT applications and to maintain a low latency in the network.

This PhD student will benefit from LEAT’s collaboration with Lars Jonsson from KTH Stockholm. During the PhD, exchanges for the student with KTH are planned.

Requirements

The PhD successful candidate is expected to hold or the be about to receive a MSc degree in

Telecommunication or Electronic Engineering, Physics or an equivalent degree with a strong mathematical background. A specialization in electromagnetics and or antennas is an asset. Good command of English orally and in writing is required to publish and present results at international conference and in international journals.

References

[EVA11] D. Evans, “The internet of things. How the next evolution of the internet is changing everything,” Cisco White Paper, 2011.
[LE16] T. N. Le, L. Lizzi, F. Ferrero, L. H. Trinh, A. Pegatoquet, « Improving Energy Efficiency of Mobile WSN Using Reconfigurable Directional Antennas”, IEEE communication letter, Accepted for publication, 2016.
[GUS07] M. Gustafsson, C. Sohl, G. Kristensson, “Physical limitations on antennas of arbitrary shape”, Royal Society of London. Proceedings A. Mathematical, Physical and Engineering Sciences, Vol. 463, No. 2086, pp. 2589-2607, 2007.
[JON15] B.L.G. Jonsson, M. Gustafsson, “Stored energies in electric and magnetic current densities for small antennas”, Proceedings of the Royal Society of London A: Mathematical, Physical and Engineering Sciences, Vol. 471, No. 2176, pp. 1-23, 2015.
[JON17] B.L.G. Jonsson, Fabien Ferrero, Leonardo Lizzi, “Antenna Q Bounds for Given Directivity: a Case Study of a Directive Parasitic Element Antenna”, 2017 11th European Conference on Antennas and Propagation (EUCAP), Paris, March 2017.

English version:

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