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PhD Proposal 2017

School: EOBE	
Laboratory: GeePs	**Web site: www.geeps.centralesupelec.fr**
Team: PIEM	**Head of the team: Lionel Pichon**
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Collaboration with other partner during this PhD: **In France:**	**In China:**

Title: Design of Power-Efficient Radiative Wireless Systems for Autonomous Biomedical Implants
Scientific field: Biomedical engineering
Key words: wireless power transfer, implanted antennas, biotelemetry, rectennas

Details for the subject:

Background, Context:

The electrical properties of biological tissues and organs not only provide information about the normal/abnormal activities of human bodies but also provide a means to directly restore, repair, replace, or recreate physiological functions in humans to improve quality of life. The conventional systems for recording or stimulation are bulky and wire based. They limit patient mobility and cause inconvenience and discomfort. Progress in highly integrated radio-frequency (RF) circuits has had a significant impact on medical implants. Miniaturized antennas not only provide wireless communication capability to transduce organ or tissue signals to a receiver outside the body and/or receive commands to adjust the implant settings but also allow continuous monitoring and therapeutic treatment without constraints in the patient's mobility. Currently, a majority of the space in most electronic implants is occupied by batteries, despite the tremendous progress in rechargeable battery technologies. Recently, RF wireless power transfer technology has been greatly involved in various industries owing to its unique features, such as availability of low-cost electronics, convenience, portability, and environmental robustness. These features are applicable to medical implants with the additional advantages of being noninvasive and having high efficiency. Obtaining an optimal radio link is rather challenging necessitating, among others, designation of several design parameters like operational frequency, implanted antenna shape and maximum power deposited on the tissues while implant size needs to be minimal to avoid tissue damage and increase patient safety.

Research subject, work plan:

The goal of the PhD research topic is to design an optimal wireless transfer link for biomedical implants that will support both energy and data transfer. The investigations will consider the different ranges of frequencies devoted to biomedical engineering (MedRadio, 402-405 MHz / ISM, 902.8-928 MHz or 2.45 GHz) taking into account the corresponding physical parameters of tissues. The work will include the design of implanted antennas whose shapes and dimensions have to be chosen according to the operating frequency range. Compliance of the implanted system(s) with safety standards like Specific Absorption Rate (SAR) will be assessed. The RF-to-DC conversion efficiency will be also evaluated.

The PhD topic will involve among others:

a) electromagnetic modeling with appropriate three dimensional full wave tools: canonical multi-layered tissue phantoms will be considered to evaluate the efficiency of the transmission link (propagation losses, antenna losses); realistic phantoms based on MRI scans will be utilized to fine tune proposed designs, evaluate design sensitivity, applicability and robustness.

b) Experimental measurements: One or several prototype systems will be fabricated and analyzed through experimental phantoms and liquid/solid media representatives of living tissues

The work will take place in a collaboration frame between GeePs and Microwave Communications group (University of Patras, Greece) which has a long experience in the field of biomedical engineering and wireless telemetry. The PhD co-supervisors are Dr. Lionel Pichon (GeePs) and Stavros Koulouridis (Department of Electrical and Computer Engineering, University of Patras).

References:

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