Antenna Systems for Wearable Haptic Devices for Navigation Assistance and Biomedical Monitoring

Ph.D. Fellowship

Summary

Wearable smart electronic devices offer compelling capabilities of monitoring physiological parameters and the environment of the user with subsequent data analysis and their representation by immediate haptic feedback. This interdisciplinary PhD project builds on a collaboration between the IETR laboratory of CNRS and the IRISA laboratory of Inria / CNRS (RAINBOW team). Expertise of IETR covers complex radiating systems and radars, bioelectronics, and bioelectromagnetics. Research at IRISA focuses on the fields from computer and network architecture to artificial intelligence, including software engineering, distributed systems, and virtual reality.

Background and Mission

Haptic feedback for wearables is receiving growing attention in consumer electronics, wireless biotelemetry of physiological parameters (e.g., heart and respiration rates, temperature, blood oxygen and glucose levels), and virtual reality applications. It is also a promising technology for assisting the visually impaired in navigating their surroundings, motion guidance for rehabilitation and physical training. A body-conformal wearable device can simultaneously monitor the vital signs and scan the environment using a radar to inform about surrounding objects and obstacles. The acquired information can be privately rendered to the user using an array of haptic actuators. Whereas both miniature biosensors and low-power radar technologies have sufficiently advanced in the recent years (allowing us to use off-the-shelf solutions), the flexible, robust, and reconfigurable on-body antenna arrays and corresponding RF circuits have not been proposed yet. In addition, the conformal antenna array has to be integrated with the array of haptic actuators while keeping the system light, compact, flexible, and robust to the environment (e.g., clothing, water, and small metallic objects).

The PhD candidate will work towards solving the aforementioned challenges. He/she will focus on the **design of a body-conformal antenna array** and RF circuit as well as their integration with of a wireless **wearable haptic unit**, which can be worn in a comfortable manner, including under clothing. Such device could be realized as, for instance, a **flexible on-body patch** that contains the antenna array and feeding network, haptic actuators (e.g., vibrotactile motors or skin stretch tactors), radar/sensor/communication units, and a rechargeable battery. To address the scientific and technical challenges, the successful candidate will have access to the interdisciplinary know-how of IETR in the field of complex radiating structures, radars, and bioelectronics as well as to the IRISA's expertise in haptics and wearable interfaces. High-performance computing infrastructure and advanced numerical solvers will be used to handle computationally large multi-scale problems. State-of-the-art manufacturing and measurement facilities will help with the experimental characterization of the prototypes. The final wireless system will be tested on tissue-equivalent models as well *in vivo* through established collaborations of IETR. Finally, the successful candidate will be expected to present results of the work in high-profile journals and conferences.

Required Skills

- M.Sc. (or equivalent) degree.
- Competence in antenna and microwave engineering, miniaturized RF circuits and components; additional knowledge of radars and signal processing would be a plus.
- Experience with numerical electromagnetic solvers (e.g., COMSOL, CST, HFSS) and with measurement equipment incl. its operating principles (VNA, TDR, etc.).
- Fluency in English: the candidate should be conversant and articulate in English and must have strong writing skills. Knowledge of French is not required but would be appreciated.

Advantages

The qualified candidate will be part of a dynamic multidisciplinary team in an international, highly collaborative, and stimulating environment. He/she will have access to state-of-the-art laboratories, workshops, high-performance computing facilities, continuous training and receive a competitive salary.

In addition:

- approx. 7 weeks of annual leave per year + possibility of exceptional leave (moving home, etc.),
- generous statutory benefits: the French national health coverage, unemployment allowances, retirement/pension funds, etc.,
- possibility of subsidized meals, student housing, and partial reimbursement of public transport costs,
- location in one of the most attractive cities in France for professional and nonprofessional activities [entertainment and culture, sport, gastronomy, etc.]. Train connections: 1:25 to Paris and 0:47 to a seaside.

Funding: Full scholarship provided by the University of Rennes 1.
Possibility of funded international mobility (if eligible; require a separate application).

Duration: 36 months, expected starting date is Oct. 2021.

Location: Rennes, Region of Brittany, France. Laboratories IETR – CNRS (75%) and IRISA – Inria/CNRS (25%).

How to Apply

Please send your application to:
Dr. Denys Nikolayev (denys.nikolayev@univ-rennes1.fr),
Dr. Claudio Pacchierotti (claudio.pacchierotti@irisa.fr),
Dr. Maxim Zhadobov (maxim.zhadobov@univ-rennes1.fr).

Each application should consist of (PDF format):

- a CV (incl. publications),
- contact details of at least three professional references (mail, address, position),
- a motivation letter.

In the motivation letter, the applicant is encouraged to include the following details:

- an explanation of interest in the research we conduct and why he/she believes he/she is suitable for the position,
- short description of graduate projects,
- details of any relevant work experience.