Live Demonstration: Closed-Loop Wireless Power Transfer for an Implantable Drug Delivery System

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Live Demonstration: Closed-Loop Wireless Power Transfer for an Implantable Drug Delivery System

Fabiana Del Bono*, Nicola Di Trani†, Danilo Demarchi*, Alessandro Grattoni† and Paolo Motto Ros*
*Dept. of Electronics and Telecommunications, Politecnico di Torino, Turin, Italy
†Dept. of Nanomedicine, Houston Methodist Research Institute, Houston, Texas
fabiana.delbono@polito.it

***Abstract*—The Nanochannel Delivery System (nDS) is a smart drug delivery implant featuring Bluetooth Low Energy that allows dosage control and temperature monitoring. Powered by a rechargeable battery, it offers a year-long device lifetime. This demonstration focuses on the closed-loop wireless charging system designed for safe and effective recharging during chronic, in-vivo experiments. The setup includes the implant, an external transmitter, a Raspberry Pi for real-time recharge management and data logging, and a PC for real-time data visualization. Visitors will watch a video of the system in use during animal studies and will wear the devices during the recharge process, simulating a clinical use.**

***Index Terms*—Active Implantable Medical Devices (AIMDs), Implantable Drug Delivery Systems, Wireless Power Transfer, Near-field Resonant Inductive Coupling (NRIC)**

I. Overview

The Nanochannel Delivery System is a smart, implantable drug delivery device designed for the personalized treatment of chronic pathologies [1]. This system, capable of drug modulation from a refillable reservoir, is designed to be seamlessly integrated with a body sensor network to personalize treatment. At the IEEE Sensors 2024 Conference, we presented our work on system integration within the implant, which is battery powered and equipped with Bluetooth Low Energy (BLE) for remote drug dosage regulation and temperature monitoring [2]. The system has been enabled for chronic in-vivo experiments with a closed-loop battery charging system that allows to extend the duration of the device to years [3]. This live demonstration focuses on this charging system.

II. Demonstration Setup

The recharge system relies on an external transmitter (TX) to transmit power to the implant via Near-field Resonant Inductive Coupling (NRIC). The recharge process is designed to be tolerant to misalignment and thermally safe thanks to the adjustment of TX power based on a feedback received from the implant. The device functionalities and charging process are managed by a Raspberry Pi, accessible via PC or BLE-enabled mobile devices such as smartphones. The demonstration setup includes four main units, illustrated in Fig. 1: the drug delivery implant [1], [2], the external TX, a Raspberry Pi and a PC. During charging, the Raspberry Pi forwards feedback on the power received from the implant to the transmitter, and logs temperature and battery voltage data in real time to the PC for data visualization.

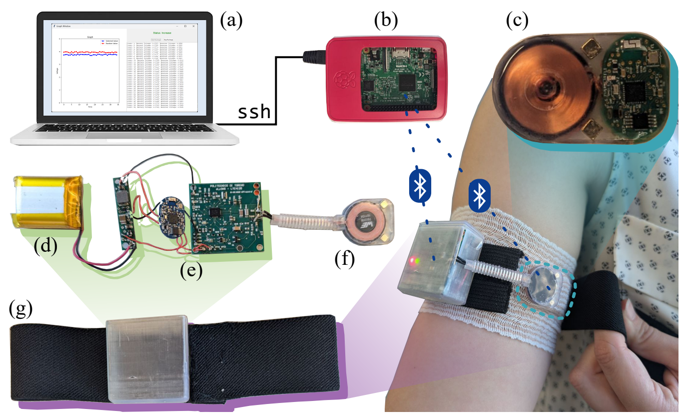

Fig. 1. The live demonstration setup of the closed-loop wireless power transfer system, including (a) PC, (b) Raspberry Pi, (c) implant and transmitter. The latter is composed of (d) battery, (e) control circuits and (f) TX coil enclosed in a (g) wearable armband.

III. Visitor Experience

Visitors will be introduced to the system and shown a video showcasing the use of the device during the in-vivo experiments on rodents. Additionally, they will have the opportunity to wear the device on their arm during recharging, simulating its use in a clinical setting. The subcutaneous implantation will be mimicked applying the device on the skin and securing it with an elastic band. The transmitter coil will be magnetically aligned to the implant, while the TX will be fastened on an elastic band. Data on increasing battery voltage, transmitter feedback, and temperature readings from the sensor embedded in the implant will be displayed during device charging, demonstrating its functionality of the device while the subject is freely moving through daily activities.

References

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