Robust Wireless Power Transfer to Multiple mm-Scale Freely-Positioned Neural Implants

Peilong Feng, Timothy G. Constandinou
Department of Electrical and Electronic Engineering, Imperial College London, SW7 2BT, UK
Centre for Bio-Inspired Technology, Institute of Biomedical Engineering, Imperial College London, SW7 2AZ, UK

Overview
- Three tier hierarchy of near-field inductively coupled wireless networks
- Distributed architecture for powering freely-positioned neural implants
- Efficient power transfer efficiency up to 13.29% @ 433MHz carrier frequency
- Uniform energy distribution at 26.6% for horizontally positional misalignment
- Reduced risk of infection, dura can be sealed after implantation

Introduction
Next generation implantable neural interfacing are targeting distributed architectures of mm-sized neural microsystems. In such systems it is essential to achieve efficient wireless power transfer (WPT) and uniform power distribution. Towards this aim, the ENGINI (Empowering Next Generation Implantable Neural Interfaces) project proposes a novel WPT scheme that consists of a three-tier of near-field inductively coupled links for powering distributed mm-sized neural implants.

Challenges in Wireless Power Transfer to Distributed Microsystems
- Low power transfer efficiency
- Non-uniform power distribution
- Weak coupling factor k < 0.005
- Low quality factor of Rx coil Q < 10

System Overview
This poster presents a three-tier network of short-distance inductively coupled 2-coil links. Here, the two-tier approach consists of separate transcutaneous and transdural links that are connected by wires through the cranium.

ENGINI Architecture
- Transcutaneous link \( L_1 \)
- Transdural link \( L_2 \)

System Schematics
Total Power Transfer Efficiency:
\[
\eta = \sum_{i=1}^{n} \eta_{i} = \eta_{1} + \eta_{2} + \eta_{3} + \eta_{4}
\]

Equivalent System Models:

Optimisation Process

Simulated Results