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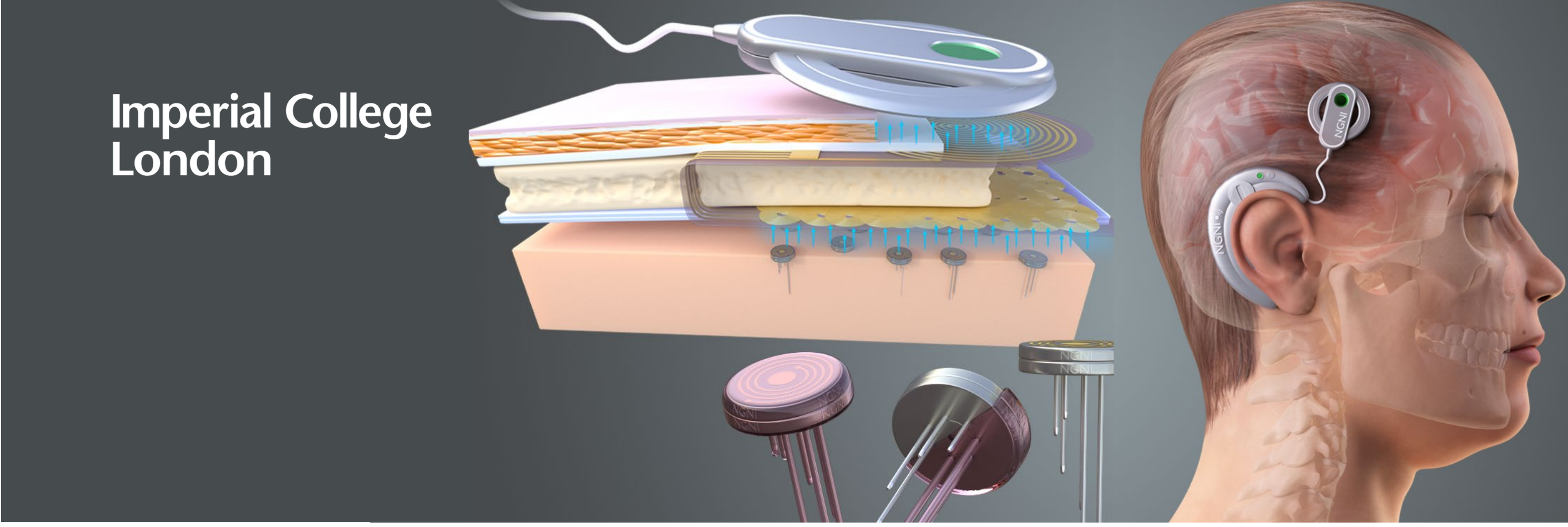

ENGINI – Empowering Next Generation Implantable Neural Interfaces

Developed by the Next Generation Neural Interfaces (NGNI) team at Imperial College, led by Dr Timothy Constandinou, ENGINI is a next generation neural implant technology for brain machine interfaces (BMIs) applicable to both central and peripheral nervous system. It promises to be more scalable than its predecessors, facilitating recordings at more sites, spread across a wider region; as well as more stable over time, thus leading to longer period of operation. This technology will make it possible, for example, to reliably and effectively communicate from a living brain (specifically, the cortex) to electronic devices.

Proposed use

Being able to control devices with our thoughts is a concept that has for long captured human imagination. Recent advances in the field of BMIs are slowly making this a reality. This is achieved by observing the electrical neural activity from the brain, processing it to decode basic intentions in turn controlling external devices.

ENGINI has the potential of allowing applications requiring high dimensionality control, good confidence, repeatability and low latency, paving a way to e.g. upper limb prosthetic control, significantly increasing the scope of neuroprosthetics. In addition, a promising future direction for such applications will be to combine neural sensing and stimulation to apply ‘closed-loop’ protocols. This can e.g. facilitate artificial connections between areas of the central nervous system that might be disconnected by injury (for example between the motor cortex and the spinal cord).

Because it is possible the ENGINI concept can be adapted to target the peripheral nervous system, it is also applicable to the emerging field of bioelectronic medicine (a.k.a. electroceuticals). This aims to treat a variety of conditions that are not typically associated with the nervous system (e.g., Crohn’s disease, rheumatoid arthritis, hypertension, diabetes, etc) through the delivery of tiny, targeted implants that interact with the peripheral and/or autonomic nervous systems.

Benefits

- **Reduced risk of infection for implanted devices** – by adopting a completely wireless architecture for power transmission and data communication
- **Improved chronic stability for neural recording** – by using untethered, freely floating implants with microwire-based electrodes
- **Long term biocompatibility** – by using hermetic micropackaging, biocompatible materials
- **Scalability to 1000s of sites for neural recording** – through multiple distributed implants
- **Minimal calibration or configuration required** – by using autonomous implantable microelectronics combined with advanced decoding methods

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Problem addressed

The current approach to recording neural activity either uses non-invasive scalp-worn electrodes (e.g. EEG headsets) or invasive electrodes (e.g. ECoG grids, and penetrating intracortical arrays, e.g. Utah). Non-invasive recordings tend to be extremely noisy due to fact the recording electrodes are relatively far away from the brain and record the activity from millions of neurons while invasive methods are often challenged by their limited chronicity and scalability.

As it is extremely challenging to extract any useful information with sufficient speed and chronicity using such methods, alternative implantable devices are being considered. Despite good progress, there are still major challenges with current implantable devices: (1) information transfer rate is low, (2) high day-to-day variability in recorded signals requires frequent recalibration/training, (3) current devices are only partially-implantable i.e. they have percutaneous connections to external electronics. ENGINI targets and addresses these issues.

Technology overview

Key features of this technology include:

- Size reduction – New method for hermetic packaging of implantable medical devices: micropackaging provides a ~1000x reduction in volume compared to conventional metal-can-based packages, realising a freely-floating, untethered probe
- Integration capability – Allowing for chronically- stable neural interfaces by combining CMOS microelectronics with wire-based electrodes
- Ultra-high scalability – By deploying multiple implants, scalability to 100s or 1000s of recording sites is achievable
- Wireless connectivity – Distributed wireless powering and communication with multiple devices. Power is transmitted to the implants (and data received out) via a 3-tier network that utilises wireless links across the skin and dura
- EM Lens – Wide power coverage with increased efficiency for distributed implants. This allows energy to be coupled from outside to tiny implants by placing an intermediate passive device that acts to refocus the energy

Intellectual property information

WO17199052A3 IMPLANTABLE NEURAL INTERFACE

EP3458153A2 IMPLANTABLE NEURAL INTERFACE

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