Bi-directional wireless data transfer for an implanted cortical visual prosthesis

Bi-directional Wireless Data Transfer for an Implanted Cortical Visual Prosthesis

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Abstract

There are approximately 40 million blind people in the world. Making them see again has been a long-desired goal of science [1]. In most of the cases of blindness, the retina is damaged and most of the visual pathway as well. In that case, the only viable option left is to stimulate the visual cortex directly by an implanted intracortical visual prosthesis. Such a system consists of an external camera capturing the images, an external processor to convert the data into signals suited for the implanted prosthesis, and a wired or wireless connection to the implanted electrode array subsystem. Stimulation through the implanted electrodes will create phosphenes to restore a (rudimentary) form of vision in a patient. A wireless link between the external processor and the implanted electrode array sub-system is strongly preferred over wires to avoid infections and to enable free movement [2]. The uplink carries the recorded signal, whereas the downlink contains the stimulation signal for the implant. The implanted transceiver module will be placed just beneath the skin. The overall system will be the first large-scale (1000 electrodes), wireless, chronically implanted simultaneously stimulating and recording intracortical visual prosthesis based on penetrating electrodes. The goal is to develop a low-power implanted transceiver that meets the required downlink rate of about 200 kbps, and the uplink rate of 170 Mbps which is effectively 23 Mbps after compression. For the uplink, impulse radio ultra-wideband (IR-UWB) is considered while an inductive transfer of data using band-pass sampled differential phase shift keying (DPSK) with power cancellation mechanism is considered for the downlink.

Currently, system level design and simulations are carried out. Next step is the circuit level design. After promising simulation results, a demonstrator board will be developed after which full IC integration will commence. The system will ultimately be tested in monkeys, first with an external wireless setup, and finally with an implanted transceiver. A first estimate for the link budget shows that a surplus of 6 dB remains after closing the uplink from the implant to the neck using IR-UWB. Based on ultra-low power communication techniques, it is projected that the maximum power consumption of the implanted transceiver module will be around 30 mW.

A low-power high data-rate bi-directional link between the implant side and the external processor of the high count electrode visual prosthesis is well within reach using bandpass sampled DPSK for the downlink and IR-UWB for uplink. The system will bring us closer to empowering blind people to see again with more pixels than ever.

References

[1] P. Lewis *et al*, *Brain. Res. Elsevier*, 1595:51-73, 2015.

[2] M. Yin *et al*, *IEEE TBioCAS*, 4(3):149-161, 2010.

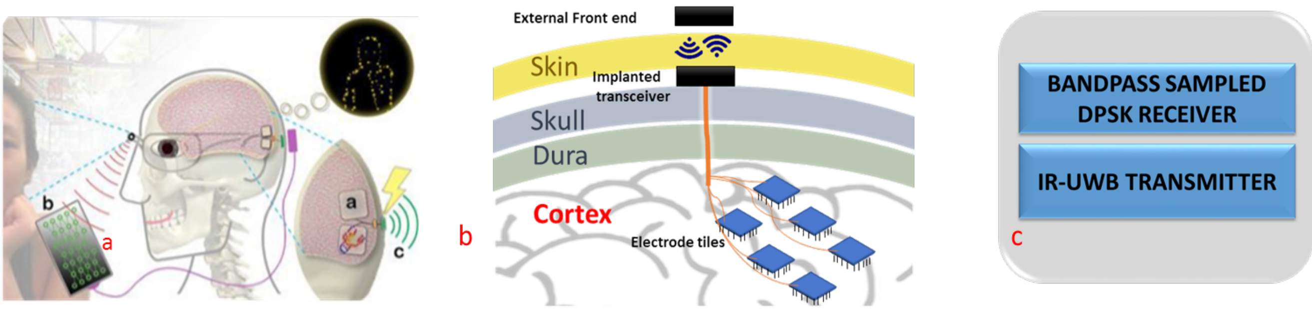

Figure 1: (a) Concept, (b) Electrodes & implanted transceiver, (c) System block of implanted transceiver