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Author contact	giuliano.bernardi@esat.kuleuven.be *+ 32 (0)16 321797*
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Feedback path characterization for a direct acoustic cochlear implant

Giuliano Bernardi[1], Toon van Waterschoot[1,2], Marc Moonen[1], Jan Wouters[3], Jean-Marc Gérard[4], Joris Walraevens[5], Martin Hillbratt[6] and Nicolas Verhaert[3,7]

[1] KU Leuven, Dept. of Electrical Engineering (ESAT-STADIUS), Leuven, Belgium

[2] KU Leuven, Dept. of Electrical Engineering (ESAT-ETC), AdvISe Lab, Geel, Belgium

[3] KU Leuven, Dept. of Neurosciences (ExpORL), Leuven, Belgium

[4] ENT Department, Saint-Luc University Hospital, Brussels, Belgium

[5] Cochlear Technology Centre Belgium, Mechelen, Belgium

[6] Cochlear Bone Anchored Solutions AB, Mölnlycke, Sweden

[7] Dept. of Otolaryngology, Head and Neck Surgery, University Hospitals Leuven, Belgium

Acoustic feedback is a very common problem in hearing aids applications. Not only does it occur in traditional solutions, like behind-the-ear (BTE) or in-the-ear (ITE) aids, but it also affects bone-anchored hearing aids (Baha®) and more recent technologies, e.g. direct acoustic cochlear implants (DACI), [1].

For this reason, the design of a feedback canceller is a very important step when dealing with hearing aids. A characterization of the feedback path can make the feedback canceller design procedure easier, providing a rough idea of the maximum gain the hearing aid can supply without triggering instabilities or helping in the decision of the most suited feedback cancellation approach to adopt.

In this study, we present the data and analysis deriving from the feedback path characterization of a DACI, performed on fresh frozen cadaver heads.
The Cochlear® Codacs system has been proven to be effective in the treatment of severe-to-profound mixed hearing loss [1]; it consists of an implantable electro-mechanical actuator, placed within the mastoid cavity and firmly fixed through a bone plate, directly stimulating the cochlea via an artificial incus coupled to a piston prosthesis, [2]. The implanted actuator is controlled and driven from the outside through an RF link, and can be interfaced with the standard Cochlear BTE sound processor (originally developed for cochlear implants users).

To investigate the nature of the feedback we used exponential sine sweeps (ESS), allowing to assess the presence of nonlinear behaviors in the feedback paths. We used different stimulation levels to test for any level-dependent behavior. The recordings were made by means of two microphones, one incorporated in the BTE sound processor and one mechanically decoupled from the cadaver, called airborne (AB) microphone. The recording of these two different characterization signals could help to gain insights about the relations between the mechanical coupling and the induced acoustic feedback, since the BTE microphone is supposed to pick a much stronger mechanical component.

The analyzed data showed that the implant is characterized by a mechanical feedback component which is stronger and with a rather different frequency content compared to the AB one; additionally, the feedback seems to be dependent on the specific head morphology of the implanted specimen. Finally, the device did show some nonlinear behaviors; therefore, more measurements will be required to investigate the nature of such nonlinearities and be able to design a proper feedback canceller.

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