C1. *Scientific context and motivation.*

The quality of life of human beings is seriously impacted by loss of hearing. The population of Romania is rapidly aging and a sizable percentage of people over 65 years of age have a significant hearing problem. Also, the hearing health of young Romanians exposed to prolonged music listening using mobile phones or portable stereo devices at loud volume is affected. There is a worldwide growing concern about these problems and significant research effort is made (e.g. at EU level) for improving the life of old people and of people with disabilities. The motivation of this project is to improve the performances of the digital hearing aids for the hearing-impaired persons. Therefore, the project addresses a very real need impacting the quality of life of many people.

While significant advances have been achieved in hearing aid design, there still is considerable user dissatisfaction with commercially available hearing aids [1]. This 2010 study shows that only 69 % were happy with their performance with whistling and feedback, 61% with their behavior in noisy situations and 58% in case of wind noise. This is the scientific context were our project is placed:

- Hearing aids suffer from the presence of a positive feedback loop between the output transducer and microphone. This feedback reduces both the stable gain achievable in the forward path as well as the sound quality of the output. Two approaches are used to counteract the negative effect of the acoustic feedback: feedforward suppression and feedback cancellation (see chapter 48 of [2]). The most common feedforward technique is to use a notch filter whose gain is reduced in a narrow frequency band around the critical frequencies [2]. The main disadvantage is that the howling has to first occur in order to identify the oscillation frequencies. Therefore the sound quality is seriously affected. The feedback cancellation can be made using adaptive filtering techniques [2], but better algorithms with superior performances are still needed. The PI has designed many adaptive algorithms for Acoustic Echo Cancellation (AEC) [3-10], active noise control [11-15] etc. New and better algorithms adapted for Adaptive Feedback Cancellation (AFC) can be developed and extended to subband, partial update, frequency domain versions etc.
- Hearing aids need to have a good noise-canceling algorithm. For the noise cancellation, an unknown interference has to be removed based on some reference

measurement. Many techniques have been studied for noise reduction hearing aids (e.g. [16-17] and the references therein). In order to reduce the complexity, they are implemented on subband architecture [18], and involve some pre-processing or post-processing techniques. In 2010 an integrated Active Noise Control (ANC) and noise reduction method has been proposed for hearing aids [19]. We propose to investigate the integration of the noise reduction algorithms with AFC the algorithms and take into account the noncircularity of a formed complex speech signal. It is hoped that this innovative approach for hearing aids will lead to new algorithms that preserve the spatial information and intelligibility of noise reduced speech signals.

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