Technical Documentation

Unsupervised Noise-Aware Adaptive Feedback Cancellation for Hearing Aid Devices under Noisy Speech Framework

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This is a novel adaptive feedback cancellation (AFC) method to improve the performance of an existing robust prediction error method based AFC method in the presence of noisy speech conditions. By employing a computationally efficient Spectral flux (SF) feature-based unsupervised voice activity detector (VAD), we adaptively control the step sizes in the proposed AFC algorithm (SFPEM-AFC). The proposed AFC method achieves faster convergence and lower misalignment errors than earlier methods. Objective evaluation of the AFC algorithm is presented using Signal to Feedback Ratio (SFR) and Misalignment (MISA) values for several noisy conditions. The Proposed method shows a significant reduction in the MISA values while maintaining higher SFR and higher perceptual quality over the earlier methods. Experimental results are presented for realistic noisy conditions to demonstrate the superiority of the proposed noise-adaptive AFC method for hearing aid devices (HADs).

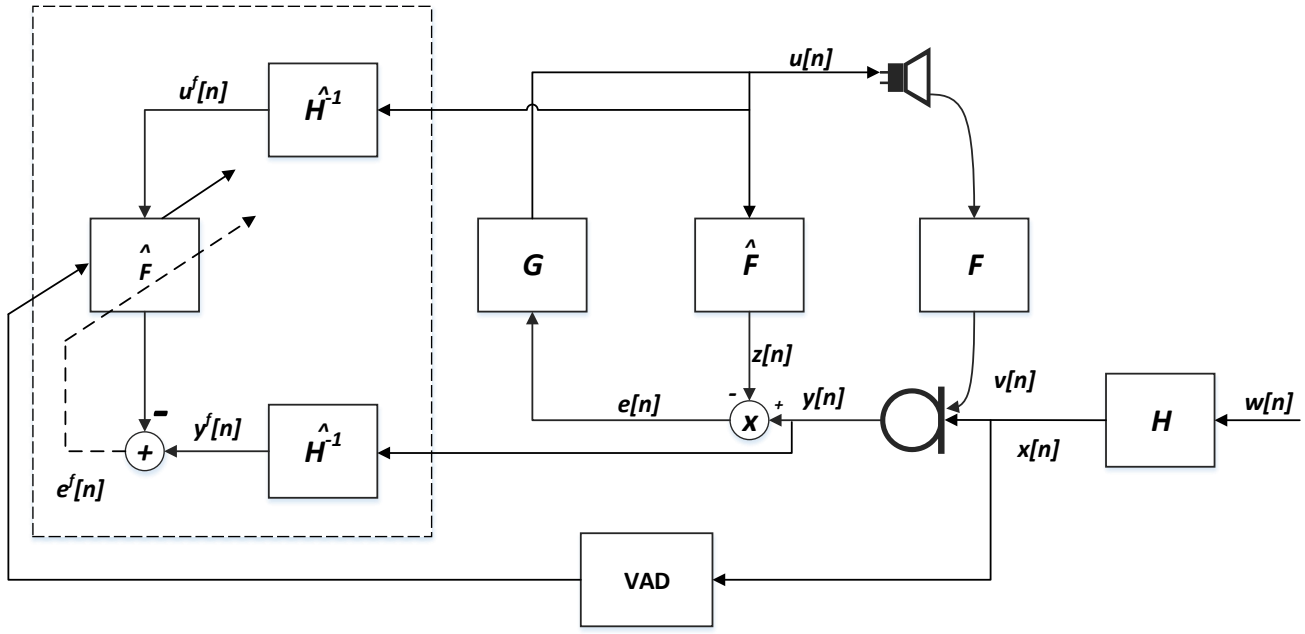

Figure 1 Block Diagram of Proposed AFC Method

Experimental Results and Analysis:

In this section, we provide several simulation experiments and their results to support and justify the improvements in the proposed method.

A. Experimental Setup

- Proposed Method is implemented in frame by frame form.
- Frame Size = 20msec
- Sampling Frequency = 16 kHz
- Order of the AR model = 20 samples
- Static Feedback Path - FIR filter of order 88.
- Feedback Canceller Length = 64 samples
- Clean Speech from LABROSA speech database of 15 sec. each.
- Three different Noise Types : Babble (multi talker), Machinery and Traffic (recorded on smartphone)
- SNR's considered : -5dB, 0dB, and +5 dB
- Tested over 90 different noisy speech files of 15 secs each
- $\mu_{ns} = 0.05$
- $\mu_n = 0.1$

B. Simulation Results

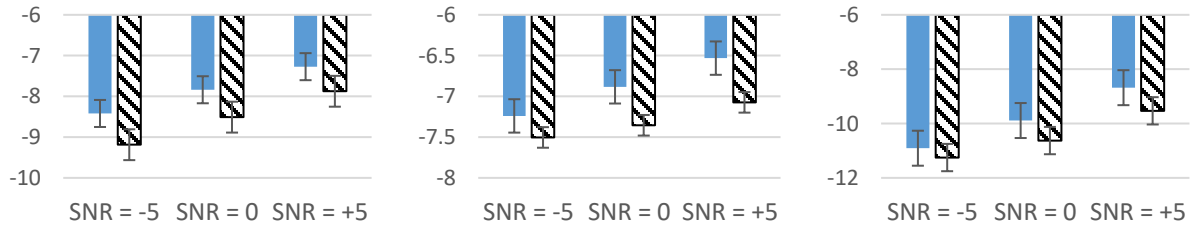

Figure 3. (Left to Right) Misalignment (MISA) (in dB) plot for PEM-AFC (solid) and Proposed Method (dashed) for (a) Babble (b) Machinery, and (c) Traffic noise at different SNR (dB) values. Lower MISA is better

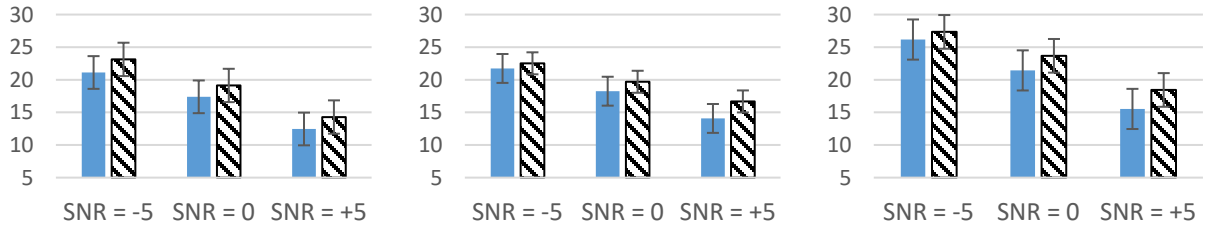

Figure 4. (Left to Right) Signal to Feedback Ratio (SFR) (in dB) plot for PEM-AFC (solid) and Proposed Method (dashed) for (a) Babble (b) Machinery, and (c) Traffic noise at different SNR (dB) values. Higher SFR is better

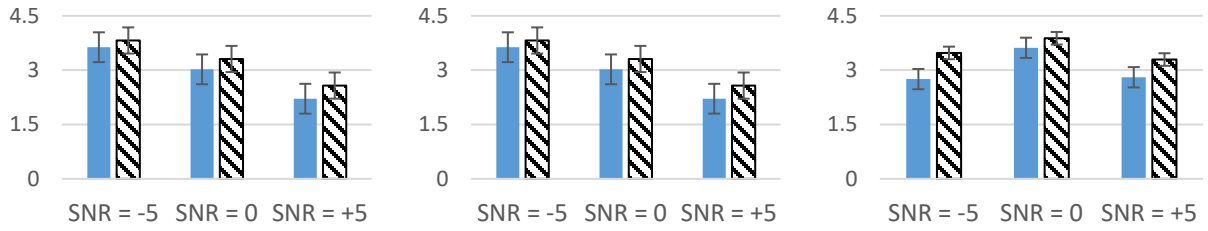

Figure 4. (Left to Right) Perceptual Evaluation of Speech Quality (PESQ) plot for PEM-AFC (solid) and Proposed Method (dashed) for (a) Babble (b) Machinery, and (c) Traffic noise at different SNR (dB) values. Higher PESQ is better

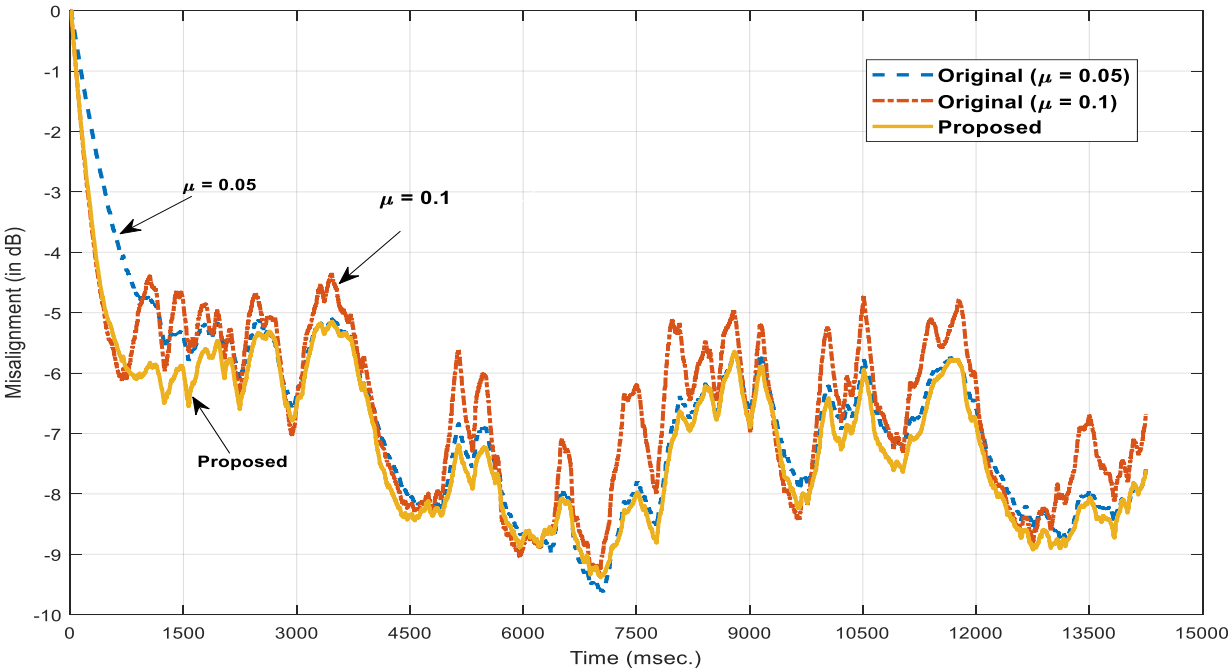

Figure 5. Average MISA for Proposed method. Sixty noisy speech files were averaged at +5dB SNR for Machinery noise. Original method is PEM-AFC. Proposed method maintains optimal (or lower) MISA value over time

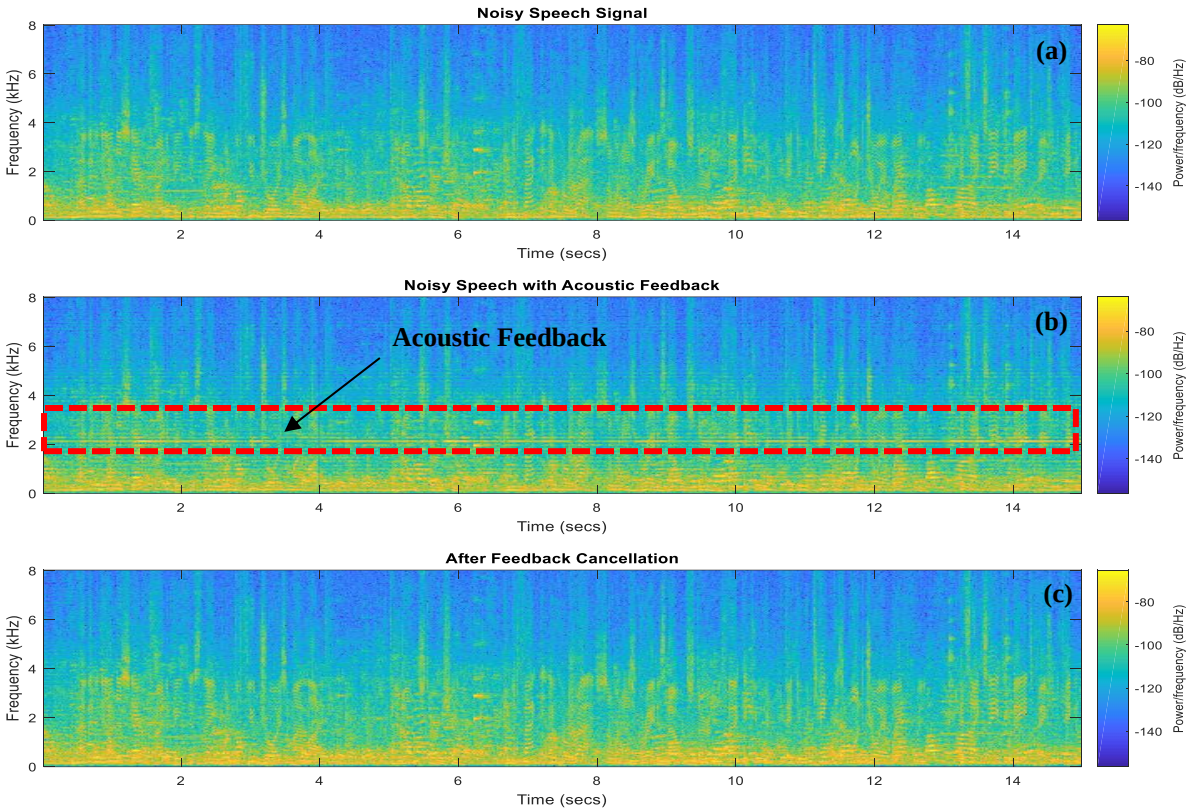

Figure 6. (Top to bottom) Spectrogram plot for a) Babble Noisy Speech Signal at 0dB SNR b) Noisy Speech with acoustic feedback c) After Feedback Cancellation.

For more information please refer the following paper:

Parth Mishra, Anshuman Ganguly, Abdullah Küçük and I. M. S. Panahi, "Unsupervised noise-aware adaptive feedback cancellation for hearing aid devices under noisy speech framework," 2017 IEEE Signal Processing in Medicine and Biology Symposium (SPMB), Philadelphia, PA, USA, 2017