Wind Noise Management

ABSTRACT

Wind noise has historically been a nuisance for hearing aid users. It can be uncomfortable, loud, and make conversation impossible even in only slightly windy listening conditions. With the new and fast Velox™ platform, wind noise management is improved significantly. The speed and power available on the Velox platform make it possible for the new noise management feature to quickly and sufficiently attenuate wind noise, even between words. Wind Noise Management (WNM) estimates wind noise 500 times/sec. This means that it can attenuate wind bursts almost immediately and keep the attenuation high as long as there is a lot of wind noise. Furthermore, WNM estimates the wind energy so quickly that it can attenuate the wind noise down to a constant level, removing the annoying wind noise fluctuation that creates a highly modulated and very rough sounding input, instead of providing a steady, unfluctuating level with acceptable loudness.

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Wind noise

Wind noise is caused by the vibration of microphone membranes due to wind turbulence around the microphone inlets, which makes the air fluctuate. Due to the position of behind-the-ear hearing aids and their microphones, wind noise may appear much worse or louder to a person wearing these hearing aids. By contrast, the unaided ear with the eardrum hidden away in the ear canal, shielded by the outer ear, is much less susceptible to air turbulence.

The severity of wind noise depends greatly on the speed of the wind, the incident angle, and the mechanical design of the hearing aid. Wind noise reduction in hearing aids needs to adapt quickly to the changing angle of the incoming wind and fast fluctuations of the wind strength, in order to reduce the noise for comfort, but also to improve the speech to noise ratio, if wind noise and speech are present at the same time. Different methods for removing wind noise are applied by different manufacturers e.g. gain reduction, audio exchange between the ears for asymmetrical, windy situations, and physical covers on top of the microphone.

Noise Management on the Velox platform
OpenSound Navigator™

OpenSound Navigator allows for a new, holistic noise system that handles all acoustical environments from the simplest to the most complex and adapts its response to the sound without modes or mode switches (Le Goff et al., 2016). It utilizes a two-microphone noise estimate for a "spatially-informed" assessment of the environ-mental noise, enabling fast and accurate noise reduction. OpenSound Navigator consists of three main modules: Analyze, Balance and Noise Removal.

The Analyze module informs the Balance and Noise Removal modules of the acoustical conditions. It uses a multi-microphone beamforming algorithm to create two fixed acoustical "views" of the environment.

The Balance module is essentially a directionality system that uses a minimum-variance distortionless response (MVDR) beamformer. It increases the SNR by constantly mixing the omnidirectional and the noise signals and creates a rebalanced soundscape where speech is made clearer by attenuating the loudest noise sources placed between speech sources. The Noise Removal module operates as a secondary noise cleaner. It is fundamentally a very fast noise reduction system operating independently in 16 frequency bands.

In many acoustical environments, the target speech will still contain some noise. This happens for instance in environments with diffuse noise, when a noise source is directly behind the target talker, or when wind noise is present.

Wind Noise Management (WNM)

Wind Noise Management is part of the state-of-the-art noise management on the Velox platform. It works in parallel with OpenSound Navigator, and comes into effect when the hearing aid microphones detect wind noise. WNM receives an accurate signal input after calibration in 64 channels.
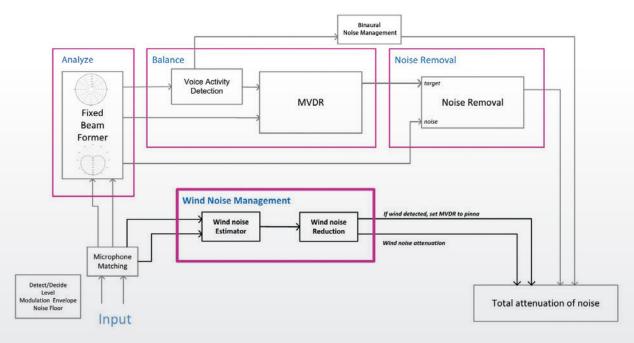

Figure 1: Wind Noise Management is, with OpenSound Navigator and Binaural Noise Management, part of the noise management feature on the Velox platform.

Along with OpenSound Navigator, WNM works with the same high resolution of 16 complex, independent channels, updated 500 times per second.

Wind noise is determined and estimated by looking at the correlation between the input to the front and the rear microphone on the hearing aid (microphone matching). Uncorrelated input is interpreted as a presence of wind noise. On the basis of the estimated wind noise, the independent channels allow for differentiated attenuation based on the strength of the wind. If wind noise is very soft, only the very lowest bands will attenuate. As the wind level increases, more and more of the higher bands will add attenuation. The speed of the WNM makes sure that only the relevant channels are attenuated for the given windy situation.

As wind noise is more prominent in the lower frequencies, the main focus of the analysis of the environment is on the lowest 8 channels of the 16. Figure 2 shows a spectrum plot of wind noises at different wind speeds, respectively 2.5m/sec, 4m/sec, and 8m/sec for wind coming from the front.

WNM will only attenuate in bands where the wind is louder than the actual acoustic signal. This is to prevent the unnecessary attenuation of speech signals.

Wind noise is estimated 500 times/sec in each of the independent bands. This means that it can attenuate wind bursts almost immediately (less than 50ms) and keep the attenuation high as long as there is a lot of wind noise. It quickly releases the attenuation after the wind noise is gone, so it can attenuate wind in between words and give back gain when the next word starts. To avoid attenuating speech, WNM will only attenuate when wind is stronger than speech, i.e. at negative SNRs.

Due to the front and rear microphones being uncorrelated, wind noise gets unnecessarily amplified in directional programs. Therefore, in parallel to the attenuation and with the same speed, the hearing aid will switch to a pinna omni microphone setting. To counteract the annoying factor of wind noise fluctuation - the highly modulated and very rough sounding input – WNM estimates the wind energy so quickly that it can attenuate it down to a constant level. This means that if the wind noise is varying in level between 60-80dB SPL, the wind attenuation will vary between 10-30dB to provide a steady, unfluctuating level with acceptable loudness.

Wind noise bursts can be very loud, and with the new Clear Dynamics extended input range, they can reach 114 dB SPL. WNR estimates these higher noise levels and quickly applies the full attenuation of 30 dB , which can be quickly released as the wind burst ends.

Wind Noise Management serves two purposes: preserving speech and securing comfort. In situations with low to moderate wind where conversations are possible and desirable, the algorithms can calculate a precise SNR estimate, reduce wind noise and keep speech available to the user. In situations with stronger wind, the feature will prioritize user comfort and provide stable and high attenuation of the noisy input.

References
Le Goff N, Jensen J, Pedersen MS, Callaway SL (2016). An introduction to OpenSound Navigator™. Oticon White Paper, Oticon A/S. Available online: www.oticon.com
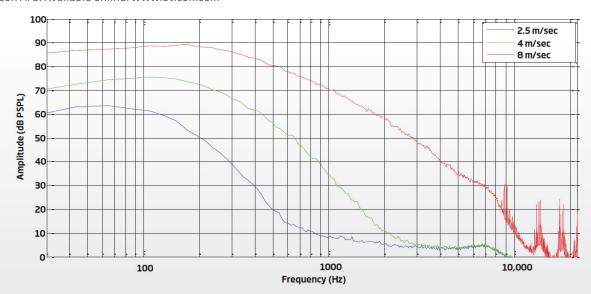

Figure 2: The wind noise of different strengths coming from 0° or from the front. 2.5 m/sec is shown in blue, 4 m/sec is shown in green, and 8 m/sec is shown in red.