Vinod Kumar Lohar, Noise cancellation in headphones for audiometry, M. Tech. Thesis, Department of Electrical Engineering, Indian Institute of Technology Bombay, June 2011.

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Abstract: Noise cancellation technique can be used to reduce the ambient noise level to improve the hearing of the desired sounds. The objective of this project is to study and develop a noise cancelling headphone (NCH), which can be used to reduce the effect of ambient noise in the testing environment for audiometry without using an acoustically isolated room. The noise level needs to be decreased to that corresponding to a typical audiometry room, without affecting the test signal. A real-time implementation of LMS-based adaptive filter for broad-band noise cancellation is not practical in this case because the delay in the processing path turns out to be larger than the propagation delay of the noise through the shell of the headphone. A method is proposed to find the frequency response of the filter needed for broad-band noise cancellation by using LMS-based adaptation for cancellation of an externally applied tone as the noise and sweeping the tone frequency. The adaptation is carried out in the absence of test stimulus. This frequency response is used for realizing a fixed adapted filter for noise cancellation. Simulations were carried out with various broad-band noises and an average noise reduction of 34.6 dB was observed. Initially real time implementation was carried out using dsPIC33FJ128GP802 which has 40 MHz clock speed and 16 KB on-chip memory. Real-time implementation was carried out with sampling frequency of 20 kHz and filter order of 250. Average noise reduction of 13.6 dB was observed for tones over frequency range of 260 Hz to 460 Hz. Next, TI TMS320C5515 with 120 MHz clock and 320 KB on-chip RAM was used for real-time implementation with sampling frequency of 24 kHz and filter length of 400. Average noise reduction of 20.2 dB was observed for tones over a range of 200-800 Hz. An average noise reduction for tonal noise swept over the frequency range of 200-800 Hz was 6.5 dB and filtered band-pass white Gaussian noise was 2.3 dB. Further investigations are needed for making the real-time implementation useful for cancellation of broad-band noise.