Devendra S. Chaudhari, Dichotic presentation for improving speech perception by persons with bilateral sensorineural hearing impairment, Ph.D. Thesis, Department of Electrical Engineering, Indian Institute of Technology Bombay, 2000.

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Abstract - Sensorineural impairment of the hearing mechanism is associated with decrease in frequency resolving capacity of the auditory system due to spread of spectral masking along the cochlear partition. As the consonantal place feature is cued by spectral differences, the hearing impaired persons may find difficulties particularly in identifying this feature. Splitting the speech signal by filtering it with a filter bank and adding signals from alternate bands for presenting to the two ears is likely to reduce the effect of spectral masking and thus help in improving the speech intelligibility. The present research deals with implementation and evaluation of a scheme for binaural dichotic presentation by splitting speech into two signals with complementary short-time spectra by using filters with the magnitude response based on critical bands (corresponding to auditory filters) and linear phase response. The scheme uses 18 critical bands over a 5 kHz frequency range. For experimental evaluation, the test material consisted of nonsense syllables formed with twelve English consonants and vowel /a/ in vowel-consonant-vowel and consonant-vowel contexts.

In the first set of experiments, the scheme was implemented for off-line processing, using a cascade combination of band reject filters (linear phase FIR filters with 255 coefficients). Listening tests were carried out, on normal hearing subjects with simulated hearing loss and on subjects with bilateral sensorineural hearing loss, for comparing the dichotic presentation of processed signals with diotic presentation of unprocessed signals. The scheme resulted in improving speech quality, response time, recognition scores, and transmission of features, particularly the place feature, indicating the usefulness of the scheme for better reception of spectral characteristics.

In the second set of experiments, the scheme was implemented for real-time processing using two DSP boards. The critical band based comb filter response for each channel was realized as a 128-point linear phase FIR filter using frequency sampling technique. Listening tests were carried out, on subjects with bilateral sensorineural hearing loss, for comparing the dichotic presentation of processed signals with diotic presentation of unprocessed signals. Test results were similar to those obtained with off-line processing. In a second implementation, the two filter magnitude responses were altered within ± 3 dB, as a partial compensation for the frequency dependence of the hearing loss of the individual subjects. The additional improvements were found to be related to the extent of variation in hearing loss with frequency for the individual subjects. Thus, shaping of the magnitude response can be coupled with splitting of speech signal for the dichotic presentation.