

Dakshayani S. Jangamshetti, Binaural dichotic presentation to reduce the effects of temporal and spectral masking due to sensorineural hearing loss, Ph.D. Thesis, Department of Electrical Engineering, Indian Institute of Technology Bombay, 2003.

Supervisor: Prof. P. C. Pandey.

Abstract - Sensorineural hearing loss is characterized by reduced frequency and temporal resolution, and increased spectral and temporal masking. Consonantal place and duration features, cued by temporal and spectral properties, are not well perceived by persons with sensorineural loss. Earlier investigations have shown that splitting the signal into frequency bands and presenting alternate bands to the two ears helps in improving the place perception by reducing the effect of increased spectral masking. Splitting the speech signal temporally into segments and presenting the adjacent segments to the two ears is likely to reduce the effect of increased temporal masking and improve the duration perception. Combining the scheme of temporal splitting with spectral splitting for binaural dichotic presentation may help in improving the perception of various consonantal features by decreasing the effects of temporal and spectral masking. The present research deals with implementation and evaluation of the schemes of temporal splitting and combined splitting for binaural dichotic presentation for improving speech reception by persons using binaural hearing aids. The scheme of temporal splitting uses step and trapezoidal fading functions along with overlap. The scheme of combined splitting uses a pair of time-varying comb filters with pass bands corresponding to auditory critical bands. Experimental evaluation was carried out through listening tests involving identification of twelve English consonants in vowel-consonant-vowel context with vowel /a/. Evaluation was conducted in two phases: first for different processing conditions on normal hearing subjects with simulated loss and later for selected processing conditions on subjects having bilateral sensorineural loss. Temporal splitting with inter-aural switching period of 20 ms and step transitions showed an improvement in speech quality, response time, recognition score and relative information transmission of consonantal features, particularly for duration and place, with highest improvements for duty cycle of 70 %. Trapezoidal fading function was employed for reducing the spectral distortions and thereby further improving speech reception. Best results were obtained for 2 ms transition. For combined splitting, each time-varying comb filter is realized as a set of cyclically selected comb filters such that a cyclic sweeping of magnitude responses occurs in 20 ms. Comb filters are 256-coefficient linear phase FIR filter, with magnitude responses optimized for minimizing perceived spectral distortion by having low pass band ripple, high stop band attenuation, and perceptual balance at inter-band crossovers. Listening tests showed improvement in response time, recognition scores, and transmission of features particularly duration and place, indicating reduction in the effects of temporal and spectral masking. Improvements were highest for 4 and 8 filter sets. An overall evaluation of the schemes of temporal, spectral, and combined splitting was done by conducting listening tests on five persons with moderate to severe bilateral sensorineural hearing loss by selecting the processing parameters that resulted in maximum improvements in earlier tests. The processing schemes have shown improvement in response time, recognition scores, and information transmission for consonantal features particularly for duration and place features, the extent of improvements being related to the hearing loss configuration.