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SPEECH PROCESSING FOR A MULTIPLE-CHANNEL COCHLEAR IMPLANT

University of Melbourne

Tong, Y.C., Millar, J.B., Clark, G.M., Martin, L.F., Busby, P.A.

Department of Otolaryngology, University of Melbourne, Parkville, 3052. Vic., Australia

A laboratory speech processor has been developed for a multiple-channel cochlear implant prosthesis. The speech processor accepts the speech waveform as an input and produces a pattern of electrical stimulus data as output. The electrical stimulus data are transmitted to the implanted receiver-stimulator by a transmitter which is external to the speech processor.

Four speech signal parameters were estimated every 20 ms in the parameter estimation section of the speech processor. These parameters included the fundamental frequency (FO), a low frequency energy measure (AO), the second formant frequency (F2) and its amplitude (A2).

The speech parameter estimates (FO, AO, F2, A2) were transformed to electrical stimulus parameters in the encoding section. In the present speech processor, only one electrode was activated in any 20 ms time frame. For a given F2 estimate an electrode was selected according to a predetermined F2-to-electrode transformation map based on the results of psychophysical tests and correlated with the tonotopical organisation of the cochlea. The subband of lowest F2 estimates was assigned to the electrode with the dullest sensation, while the subband of highest F2 was assigned to the electrode with the sharpest sensation. The current level for the single-electrode pulse train was determined from A2. A 20 ms speech segment was classified as voiced if AO exceeds a pre-selected threshold, and unvoiced otherwise. For unvoiced speech segments, a constant low pulse rate for electrical stimulation was used. For voiced speech segments, the pulse rate was proportional to FO, and was higher than the pulse rate used for the unvoiced segments.

Vowel and consonant confusion studies were conducted with two cochlear implant patients. The test vowels included /ɐ/, /ʌ/, /I/, /ɔ/, /a/ and /i/. The test consonants were /p/, /k/, /ʃ/, /s/, /tʃ/, /f/, /n/, /w/, /j/, /r/. The test materials were presented live by a female and a male speaker without lip-reading being involved. The mean percentage correct scores across patients and speakers were 77% for the six vowels and 35% for the ten consonants. Analysis of the vowel confusion data showed that the patients were able to make use of the duration and the electrode assignment of the electrical stimuli as cues for vowel identification. For consonant identification, the results showed that the overall percentage correct for voiced/unvoiced classification was 70%, while the overall percentage correct for transition classification was 67.5%.

Author/s:
Tong, Y. C.; Millar, J. B.; Clark, Graeme M.; Martin, L. F.; Busby, P. A.

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