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Speech Processor Design for a Multiple-Channel Cochlear Implant

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Abstract

This paper outlines the strategy adopted for a laboratory-based speech processor used to provide speech information to patients with a multiple-channel cochlear implan It also presents the results of vowel and consonant recognition studies and speech tes using open sets of words and sentences.

The speech processor accepted the speech wave as input and estimated four speech parameters every 20ms.: the fundamental frequency (F0), its amplitude (A0), the secon formant frequency (A2) and its amplitude (A2). These four estimates were transformed into electrical stimulus patterns in the encoding section. Only one electrode was stimulated every 20ms.: time frame, the stimulus parameters determined by the following method: F0 was coded as the pulse rate for stimulation, A0 was used for a voiced-voice decision. If the decision was a voiceless segment then the pulse rate was 50 pps., for voiced decision the pulse rate was proportional to the F0 estimate starting at 100 pps. F2 estimate determined the electrode to be stimulated and A2 the current level for stimulation.

The speech tests were conducted with the first two implant patients. In the vowe and consonant recognition studies the material was presented without lipreading by 'liv voice using a male and female speaker. The mean percentage scores across patients and speakers were 77% for six vowels and 35% for ten consonants. These results showed that the patients could distinguish vowel duration and articulatory place and most consonant-vowel transitions.

Further testing was carried out in order to examine the interaction of lipreading and electrical stimulation provided by the cochlear implant. Test material consisted of a twelve-consonant recognition study, AB monosyllabic words and CID sentences; the words were scored both by the number of phonemes correctly identified and by the number of correct words, the sentences by the number of key words correctly identified. Test mate was presented 'live' using the female speaker only, under the three conditions of liprea alone, electrical stimulation alone, and lipreading plus electrical stimulation. Percen correct scores showed that under this final condition there was a marked improvement in correct recognition for consonants. The combined percentage correct scores for both patients from the open sets of words and sentences, which the patients had not heard befc under this third condition was 50% for words and 83% for sentences. These scores indicat that the patients would be able to communicate successfully in connected discourses using both lipreading and the electrical stimulation provided by the cochlear implant.

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