Hearing Technology

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The long-term goal of research in Hearing Technology is to understand

1. how the physiological state of the human auditory system affects the ability to detect and analyse sound,
2. how an impaired ability to detect and analyse sound affects the ability to understand and produce speech,
3. how personal aids should be designed and individually fitted to compensate for hearing impairment.

The group pursues several applied projects concerning the design, fitting, and evaluation of personal aids for the hearing impaired, as well as methods and systems for teaching and training of speech perception and speech production.

Highlights 2002

Two major milestones were reached during the year 2002:

1. Our previously informal collaboration with the KI Centre for Hearing and Communication Research finally succeeded to establish a more solid basis in the form of a collaborative project, financed by Vetenskapsrådet, including one new PhD student.
2. Preliminary analysis of data from our research on the theoretical foundations for current hearing-aid fitting methods indicated that these methods probably make the amplified sounds too loud for first-time hearing-aid users in noisy conditions, which is the most important application of the methods.

Signal Processing Algorithms for Hearing Instruments

Advanced hearing instruments must adapt their characteristics automatically to varying acoustic listening conditions. A new algorithm for this purpose has been developed and evaluated in an industry-related project. The algorithm is based on hidden Markov models. The method is robust, as it uses only modulation properties of the signal and requires no information about absolute signal levels or spectral densities. It has been evaluated for a great variety of speech environments, with various signal-to-noise ratios, and was shown to correctly classify sound environments consisting of speech in various types of background noise. Classification of music environments still remains an unsolved problem for future study. A full report on the evaluation has been submitted for publication.

Work has been continued on the acoustic measurement and analysis of advanced adaptive hearing instruments. A new HMM-based approach has been used to illustrate the effects of fast syllabic compression using real speech as test signals. This work was presented at an international conference.

Individual Fitting of Advanced Hearing Instruments

Several methods for computer-aided fitting of advanced (digital) hearing aids have been studied. The results led to a need for further study on the psycho-acoustical assumptions underlying most of these methods. Results from several studies indicate that current fitting methods tend to prescribe too much gain, at least for first-time users in noisy environments.

A special method for hearing-aid fitting, based on individual tests of masked short-tone thresholds, has been further evaluated at the hearing clinic at the Karolinska hospital in Stockholm. We have co-operated with this work in order to evaluate some of the effects of basic auditory-signal analysis on speech recognition.

Multi-modal Sensory Aids

Together with researchers in the speech group we are investigating a new method to support audio-visual telephone communication for hearing-impaired persons without special equipment for transmitting video information. The aim of this work is to generate an artificial talking face, which can be used as a lip-reading support by the hearing-impaired telephone user. The articulation movements of the artificial face are controlled by parameters automatically derived from the speech signal. Tests with hearing-impaired listeners have demonstrated that the artificial face can improve the intelligibility of telephone speech. Current work attempts to increase the benefit even further by improving the recognition system.

Evaluation of Cochlear Implants

The work on comparing results from conventional hearing aids and cochlear implants (CI) has been continued in close co-operation with the CI clinic at Huddinge hospital. The test battery includes measurement of time resolution, auditory, visual and audiovisual perception of consonants, vowels, prosodic features and speech tracking, as well as subjective assessment. The aim of the study is to obtain data to support criteria for patient selection for cochlear implant operations, and also to evaluate the relative importance of various speech cues for speech-reading support.

A new project was initiated to study the information-transmission capacity of the CI signal processor, electrodes, and remaining neurons in the inner ear. Our working hypothesis is that this capacity is an important factor that can explain some of the great individual variability in the speech-communication ability of CI users.

Teaching and Training Systems

We participate in a EU project (Ortho-Logo-Paedia, OLP), which aims at improving the quality of life of persons with articulatory impairments by applying a novel technological aid to speech therapy, by integrating this training with speech recognition technology and by making these facilities available over the Internet. Four basic types of pathologies will be addressed in the OLP project. These are dysarthria, craniofacial disorders, functional articulation disorders, and hearing impairments.