

Hearing Technology



Arne Leijon
Professor of Hearing Technology

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, with the primary purpose of facilitating good speech perception and speech production.

Staff

Arne Leijon, professor*
Eva Agelfors, B A, researcher
Karl-Erik Spens, D Sc, researcher
Anne-Marie Öster, Ph. Lic., researcher
Martin Dahlquist, PhD student*
Peter Nordqvist, PhD student*
Elisabet Molin, PhD student*
Karolina Smeds, PhD student*

People marked (*) will move to KTH Signals, Sensors, and Systems (S3) on January 1, 2004, to join the Speech Signal Processing group, headed by professor Bastiaan Kleijn, and now renamed as the Sound and Image Processing Laboratory at S3.

Highlights 2003

1. A series of studies led inevitably to the conclusion that there is probably some fundamental flaw in the theoretical foundations of currently used methods for individual fitting of advanced hearing aids. Further research is needed to determine if the methods can be improved by gradual modifications, or if a radically new approach is required.
2. A method was presented for sensitive and reliable evaluation of various aspects of the subjective quality of sound reproduction systems, using paired comparisons with categorically graded individual responses.
3. After careful consideration, and not without hesitation, Arne Leijon decided to move most of the engineering-oriented research in Hearing Technology to KTH Signals, Sensors and Systems (S3) from January 2004. There was no controversy causing this move. The main reason was to facilitate collaboration with theoretically oriented signal-processing research, while maintaining close links to applied research in clinical Audiology and Linguistics.

Psycho-Acoustical Test Procedures

Martin Dahlquist, Arne Leijon

Evaluation of the effects of signal processing algorithms, for users with either normal or impaired hearing, requires highly sensitive and reliable tests of both subjective sound quality and speech recognition ability. Recently developed test procedures could reliably demonstrate, for example, that a noise-suppression algorithm had clearly positive effects on subjective sound quality but actually decreased the speech-recognition accuracy, although listeners were subjectively convinced that the clarity of speech was improved. The tests of subjective sound quality are based on paired comparisons. A method was developed to estimate parameters in a formal statistical model for the interpretation of paired-comparison data. This method can also be used to quantify small differences in loudness and timbre.

Signal Processing Algorithms for Hearing Instruments

Peter Nordqvist, Arne Leijon

Advanced hearing instruments must adapt their characteristics automatically to varying acoustic listening conditions. A sound classification algorithm for this purpose has been developed and evaluated for a great variety of speech environments. This work has also been extended to a study of automatic recognition of command words spoken by the instrument user.

Individual Fitting of Advanced Hearing Instruments

Karolina Smeds, Arne Leijon

Several methods for computer-aided individual fitting of the signal-processing characteristics of advanced hearing aids have been studied. The results indicate a pressing need to revise some of the theoretical methods underlying the optimisation. A series of studies on the perceived loudness of amplified sound indicate that the most common fitting methods tend to prescribe too much gain, at least for first-time hearing-aid users in noisy environments. Further research is needed to determine whether the problem is mainly in the psycho-acoustic model assumptions or in the fundamental goals of the optimisation procedure.

Speech Information Transmission with Cochlear Implants

Elisabet Molin, Eva Agelfors, and Arne Leijon

Many cochlear-implant users achieve very good performance with their devices, but there are still great variations among CI users in their speech-communication ability. Our working hypothesis is that some of these variations can be explained by the capacity of the information-transmission chain consisting of the cochlear implant signal processor, electrodes, and remaining neurons in the inner ear. The purpose of this project is to estimate this capacity and to predict its possible effects on speech communication. The work includes development of new psycho-acoustic test methods, a physiological model of electrical excitation of auditory neurons, and a method to estimate the achievable speech information rate in the resulting neural signal patterns transmitted to the brain.

Teaching and Training Systems

Anne-Marie Öster and co-workers

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 automatic speech recognition technology and by making these facilities available over the Internet. Four basic types of pathologies are addressed in the OLP project. These are dysarthria, craniofacial disorders, functional articulation disorders, and hearing impairments.

Multi-modal Sensory Aids

Karl-Erik Spens and co-workers.

A new method is developed 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 that 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.

