

# Preface

The field of assistive technology did not start attracting attention until recently when people have become more and more aware of the importance of prolonging life, leading to greater expectations in the field of medicine. Recently, however, in addition to technology aimed at prolonging life, people have been placing increasing importance on how to attain good health in order to lead more fulfilling lives. For example, people suffering from even slight disorders are increasingly motivated to regain their health by making use of cutting-edge technology. In light of such expectations, the need for assistive technology has greatly increased, especially in a super-aged society like Japan. Moreover, people who have developed visual or auditory function disorders or communication disorders in their youth must keep living in a society while burdened by a major handicap. Information technology (IT) compensates for weaknesses in human information processing, and the hope has been that IT will serve as a tool to assist those with sensory and/or communication disorders.

Over a period of 45 years, the author has developed a basic research approach for assistive technology, especially for people with hearing, speaking, and seeing disorders. Although some of these tools have practical uses for the disabled, the author has seen how inadequate many of these tools actually are. Moreover, during the course of basic research, the author has experienced how effectively the neuroplasticity of the human body is able to compensate for these disorders. Especially, persons who have developed sensory and/or communication disorders will try to converse through gestures or tactile means, while elderly persons who have developed cognitive impairments will increasingly try to convey something through facial expressions and gestures. However, that is insufficient to properly communicate with others and leads to social isolation, and society is yet to come up with a good approach for how to assist these people.

Under the working title “Sound-Based Assistive Technology,” the author would like to show some of the compensation abilities formed by “brain plasticity” and also demonstrate some extraordinary abilities such as the voice imitation skills of the mynah bird and the obstacle-sensing capability of the blind. Furthermore, the author explains the extent to which existing technology could help hearing-,

speech-, and sight-impaired people who might all benefit in some way from an enhancement of their extraordinary abilities to recognize and produce speech or to detect sounds in their surroundings. Additionally, it is worth considering how Sound-Based Assistive Technology might be applied to difficulties in areas such as speech recognition, speech synthesis, environmental recognition, virtual reality, and robots.

It is the focus of this researcher to provide an understanding of both the methodology and the basic concepts of assistive technology rather than to give a listing of the entire variety of assistive devices developed in Japan and other countries. In Chap. 1, the author discusses one research approach for assistive technology that is based on the concept of cybernetics, and then introduces a national project called “The Creation of Sciences, Technologies and Systems to Enrich the Lives in the Super-Aged Society” that the author has promoted since 2010. Moreover, the author explains the mechanism of the auditory sense and speech production of human beings that are needed to understand the contents of the book. In Chap. 2, the author explains how auditory characteristics change due to hearing impairment as well as aging, and then introduces some signal processing methods for digital hearing aids. In particular, the author introduces various approaches to signal processing such as noise-reduction methods, consonant-enhancement methods, and speech rate or intonation-conversion methods. Past and recent artificial middle ears are also discussed as one form of hearing aid. In Chap. 3, the author mainly discusses functional electrical stimulation (FES) of the auditory nerves using cochlear implants, especially the history, principle, effects, the basic design concepts and recent progress including auditory brainstem implants. Finally, the author introduces “artificial retina” that has been served by the success of cochlear implants. In Chap. 4, the author introduces tactile stimulation methods, such as tactile aids that support speech recognition of the deaf, vocal training of the deaf-blind, and auditory localization substitutes. The author emphasizes that the findings and technologies obtained from tactile studies will lead to new ideas for tactile displays for virtual reality systems and robots.

In Chap. 5, the author explains recent speech-recognition technologies and discusses captioning systems that convert spoken languages into written characters in real time for the hearing impaired as well as the elderly. Furthermore, to support elderly people with cognitive decline, the author introduces an example of communication robots that remind elderly people to take their medications and of their daily schedule. In Chap. 6, the author introduces an artificial electro-larynx that can produce intonation and fluctuation of the larynx voice, which was based on the vocalization mechanism of a talking bird, the mynah. The author also introduces a voice synthesizer for articulation disorders or speech apraxia, which can produce any speech sounds just by the touching and stroking of the touchpad of a mobile phone. The design of the device was modeled after the vocalization mechanism of a ventriloquist. In Chap. 7, the author mainly discusses two assistive tools for the visually impaired. One of them is a device called the “Tactile Jog-dial” that converts verbal information such as text into speech signals, for which the speech speed can be controlled by blind users, while displaying non-verbal information such as

rich text to the tactile sense of a fingertip. The others are mobility aid devices that detect environmental information and display it to the auditory sense of the blind. The mobility aid devices were modeled after the echolocation function of bats and also have the ability of “obstacle sense” by which the blind can recognize obstacles to some extent without any assistive tools.

Finally, the author emphasizes that new research themes concerning the sensory and brain functions of human beings will be provided through the design of assistive technologies and also that new markets will be created in the fields of ICT (information communication technology) such as human interfaces with the brain plasticity function, and IRT (information robot technology), including nursing robots capable of supporting the elderly as well as the disabled.

This book presents a number of different themes, and they are sufficiently independent from one another that the reader may begin at any chapter without experiencing confusion. It should be acknowledged that much of the research quoted in this book was conducted in the author’s laboratories both at Hokkaido University and at the University of Tokyo—a fact that could unintentionally result in some bias.

It is the author’s fervent wish that this book might at least offer the reader a better understanding of the number of unsolved problems that persist in the field of Sound-Based Assistive Technology. But even more so, if this book serves to increase the number of researchers who are willing to challenge this complex matter, it will have served a useful purpose.

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