Auditory Training Technologies for Blind Persons

Yoshikazu Seki

National Institute of Advanced Industrial Science and Technology (AIST)

Tsukuba, Ibaraki, Japan
Self-Introduction

• Yoshikazu Seki, Ph.D.
• National Institute of Advanced Industrial Science and Technology (AIST)
  – The largest (2,300 full-time researchers) research organization in the area of industrial science and technology in Japan.
Self-Introduction

• Yoshikazu Seki, Ph.D.

• Special fields of study:
  – Psycho-Acoustics
    (Spatial Hearing)
  – Blind psychology
    (Orientation and Mobility; O&M)

• Purpose of study:
  ➢ Development of acoustical assistive technologies for blind persons
Contents

• Auditory Training for the Blind Person
• Obstacle Perception Training System
• Obstacle Perception Training CD
• Auditory Orientation Training System (AOTS)
• Wide-Range AOTS (WR-AOTS)
• Techniques of O&M
  – No aid
  – Long cane
  – Guide dog
  – Guide helper
  – Electronic travel aid (ETA)

➤ Using auditory information is the basic skill in all the O&M techniques.
Auditory Training

• Training to recognize surroundings by sounds.
  – Sound Localization
  – Obstacle Perception

• Important for the blind persons to acquire travel & life skill.
Conventional Training was limited in REAL environments

- Danger, Fear
- Long time training
- Limited training environment

→ Using VIRTUAL reality training together with REAL training is effective to
- reduce stress and fear.
- make training safe.
- diversify training.
History of Research

Revealing Obstacle perception mechanism

Obstacle Perception

Skill to detect obstacles that make no sounds by auditory sense.

• Using sound propagation changes (reflection, diffraction, etc.)

• Acquired by learning.
Obstacle Perception
Types of Obstacle Perception

using ambient noise  
using self-generated sound
Major Mechanism

...because of “diffraction loss” and “precedence effect”
Obstacle Perception Training System

History of Research

Revealing Obstacle perception mechanism


Obstacle Perception Training System

Training
Conventional Training

Actual training in the blind education/rehabilitation.

• Training in uncontrolled sound field is difficult for novice blind persons.
Obstacle Perception Training System

(Seki, 1998)

ON: Wall is present.
OFF: No wall is present.
Obstacle Perception Training System

Principle of reproduction of obstacle by sounds
Obstacle Perception Training System
Cost was about 2,000 Euros.
- This simplified version is now used in the Orientation & Mobility Instructor School of National Rehabilitation Center for the Person with Disability (NRCD).
History of Research

Revealing Obstacle perception mechanism

Obstacle Perception Training System

Obstacle Perception Training CD

Training

Distribution


Over 100 O&M Instructors were educated
Obstacle Perception Training CD

(Seki, 2001-2002)

- Hardware: Household audio equipment.
- Software: Audio CD.

**Merit**
- No cost
- Easy to carry

**Fault**
- Limited data
• Acoustic mechanisms of obstacle perception were simulated ideally in computer, and recorded into audio CD.

• Obstacle Perception Training CD Ver 0.0 (Prototype) was developed 2001.

• Obstacle Perception Training CD Ver 1.0 was developed, and distributed since 2002.
Obstacle Perception Training CD

• Reproducible by Household audio CD player.
• Loudspeakers are set symmetrically facing each other.
• “Wall” is projected virtually in the right direction.
• Listener can listen to the sound field with moving head.
History of Research

Over 300 CDs were distributed to the blind schools etc.

Over 100 O&M Instructors were educated

Obstacle Perception Training System

Auditory Orientation Training System

Revealing Obstacle perception mechanism

Obstacle Perception Training CD

Effectiveness of CD

Distri-

bution

Sound localization

Evaluation

Training


Distri-

bution

Effectiveness of CD

Correct ratio [%]
Sound image can be located in 3-D space by digitally simulating the HRFT (head-related transfer function).
Conventional VR training systems

“HOMERE”
Lécuyer, et al. 2003
CEA, France

“BlindAid”
Schloerb, D.W. et al. 2010
MIT, USA

- 3-D sound and haptic VR system
  - Haptic system is expensive…
  - Auditory training is not only for O&M with cane.
Auditory Orientation Training System (AOTS)
(Seki, 2005)

- Sound fields where vehicles etc. exist can be reproduced through headphones.
- Training for both sound localization and obstacle sense
- Training field can be edited freely (data are described in XML)
- Head-tracking
  - Walk-through by “stepping.”
History of Research

Over 300 CDs were distributed to the blind schools etc.


Revealing Obstacle perception mechanism
Obstacle Perception Training CD
Auditory Orientation Training System

Effectiveness of CD
Effectiveness of AOTS

Over 100 O&M Instructors were educated

Sound localization

Over 300 CDs were distributed to the blind schools etc.

Effectiveness of CD
Examples of AOTS effectiveness

Reduction of veering
(found by walk loci)

Reduction of stress
(found by heart rates)


* p < 0.05
In order to distribute...

- Reduction of cost (dozens thousands -> dozens euros)
- Reduction of size and weight
- Walkable

- 3-D process is installed into PC.
- Wide-range positioning sensors are used.
Over 300 CDs were distributed to the blind schools etc.

Over 100 O&M Instructors were educated
History of Research

- PC-based low-cost AOTS that consists of
  - Software
  - Low cost peripherals
...distribution to blind facilities

Auditory displayed game (by Tohoku Univ. et al.)
Wide-Range AOTS (WR-AOTS)

- Wide open space such as ground of blind school can be a virtual training field.
Wide-Range AOTS (WR-AOTS)

WR-AOTS consists of ...

1. PC (Windows® 7 and later)
2. Stereophonic headphones
3. Nintendo Wii® Remote Plus Controller™
4. USB-connectable GPS (option)
5. WR-AOTS™ Software
Wide-Range AOTS (WR-AOTS)

*demonstration*
Contact

Obstacle Perception Training CD Data and WR-AOTS Software are distributed free of charge.

Please contact

Yoshikazu Seki,
National Institute of Advanced Industrial Science and Technology (AIST)
yoshikazu-seki@aist.go.jp
http://staff.aist.go.jp/yoshikazu-seki/