

# Auditory Training Technologies for Blind Persons

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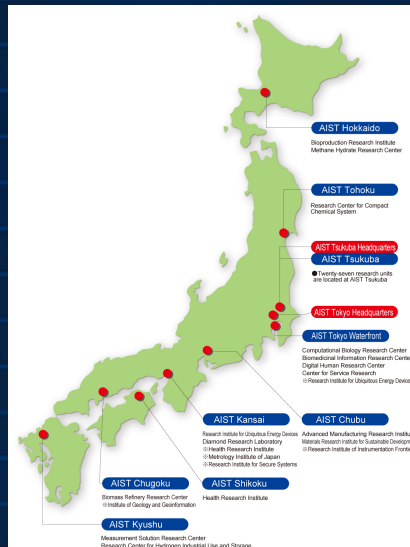
Yoshikazu Seki

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.



AIST Chugoku

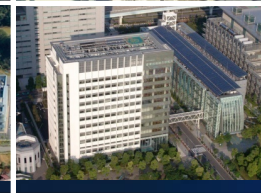
AIST Shikoku



AIST Kyushu



AIST Kansai



AIST Chubu

AIST Hokkaido

AIST Tohoku

AIST Tokyo Waterfront

# 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 asistive technologies for blind persons



# Contents

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- Auditory Training for the Blind Person
- Obstacle Perception Training System
- Obstacle Perception Training CD
- Auditory Orientation Training System (AOTS)
- Wide-Range AOTS (WR-AOTS)

# O&M for blind persons

- 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.



# Importance of VR Training

Conventional Training was limited in **REAL** environments

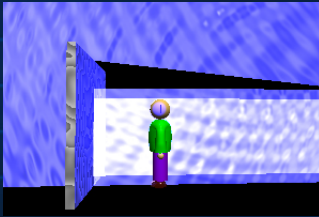
- Danger, Fear
- Long time training
- Limited training environment



→ 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

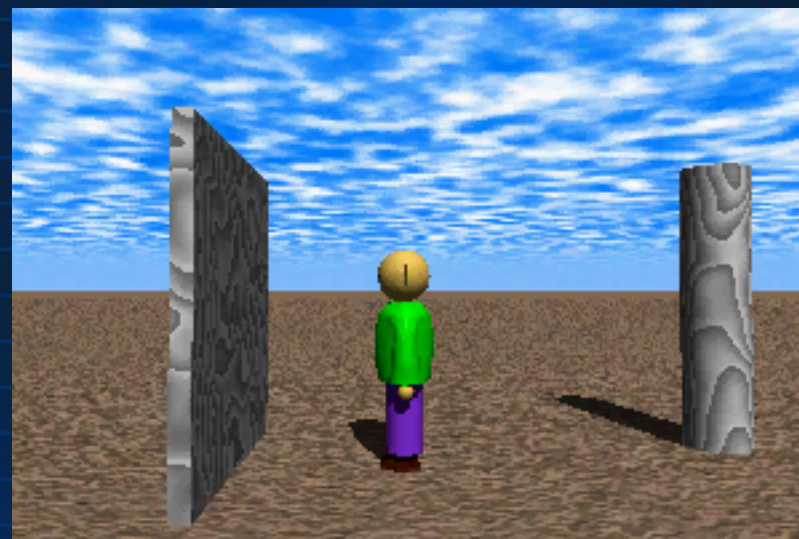




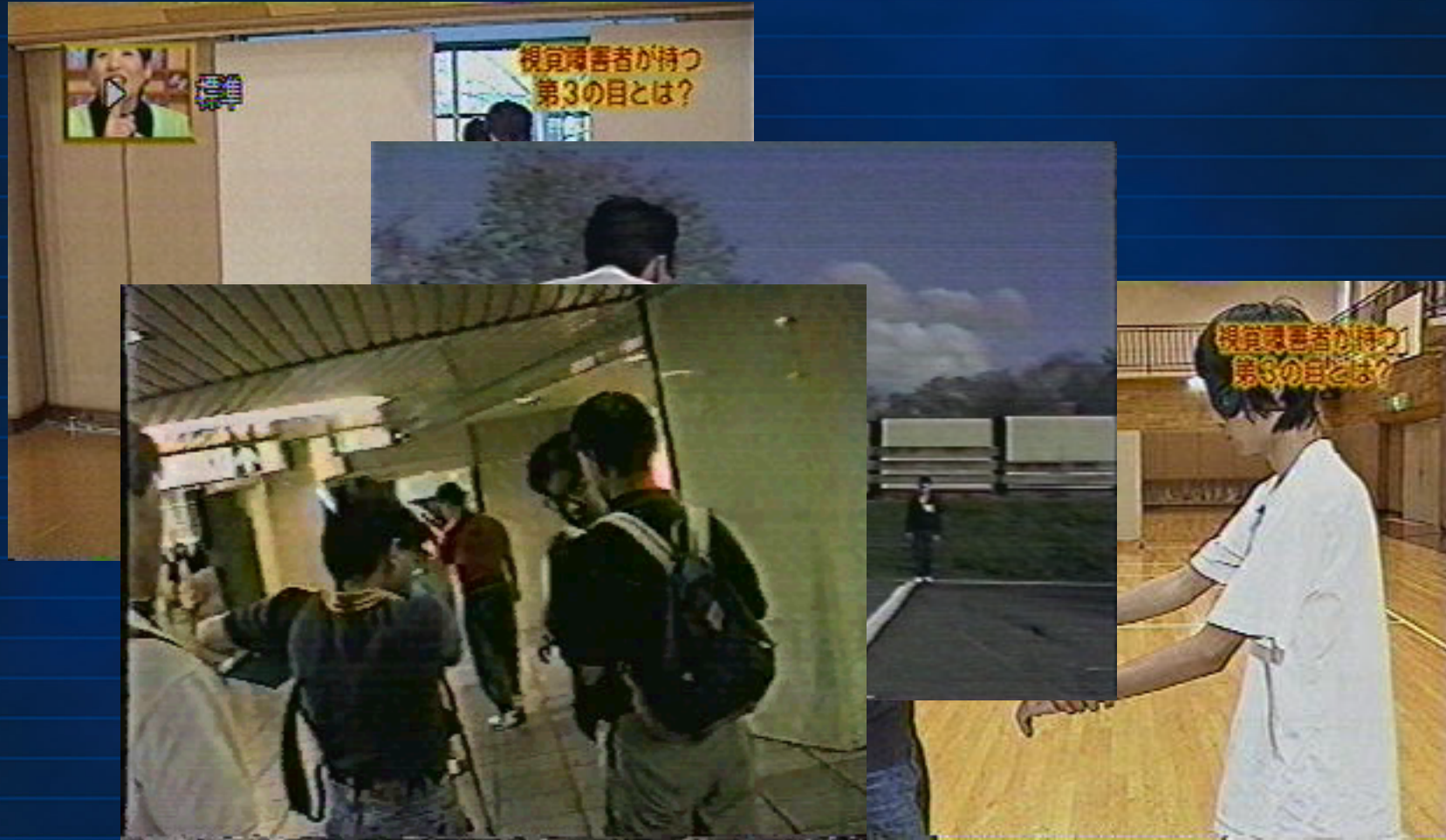
# Obstacle Perception

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

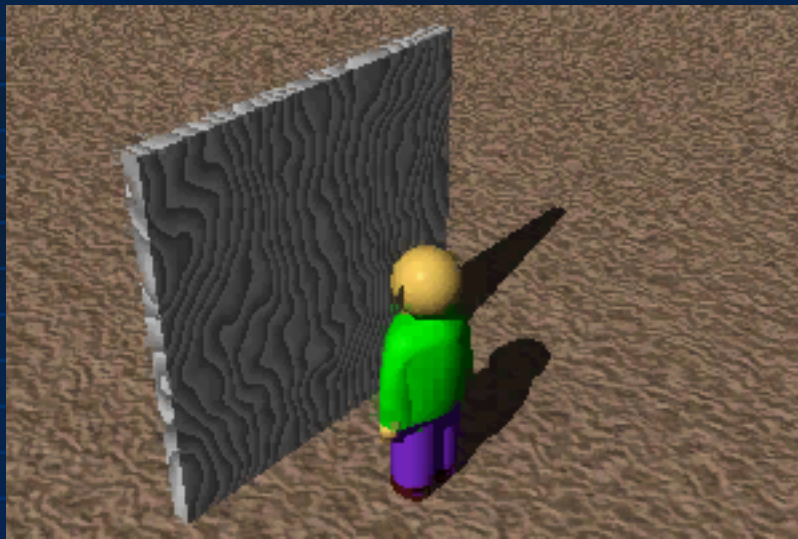
- Using sound propagation changes (reflection, diffraction, etc.)
- Acquired by learning.



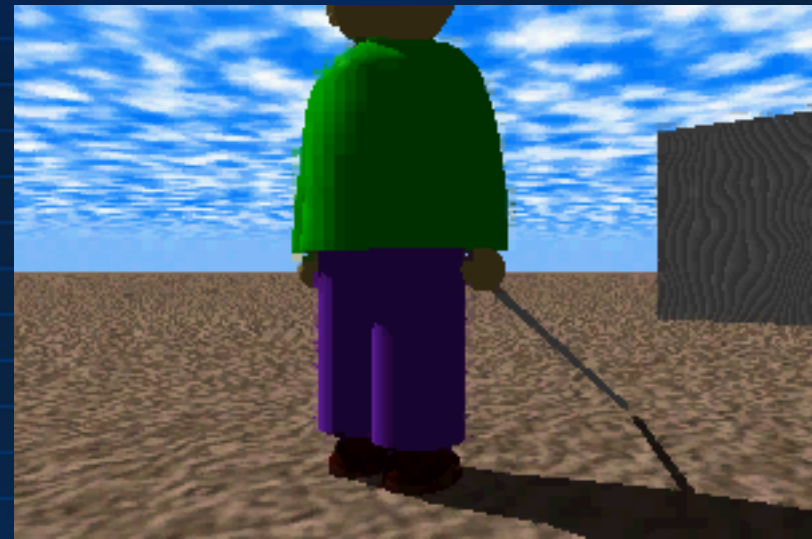
# Obstacle Perception



# Types of Obstacle Perception

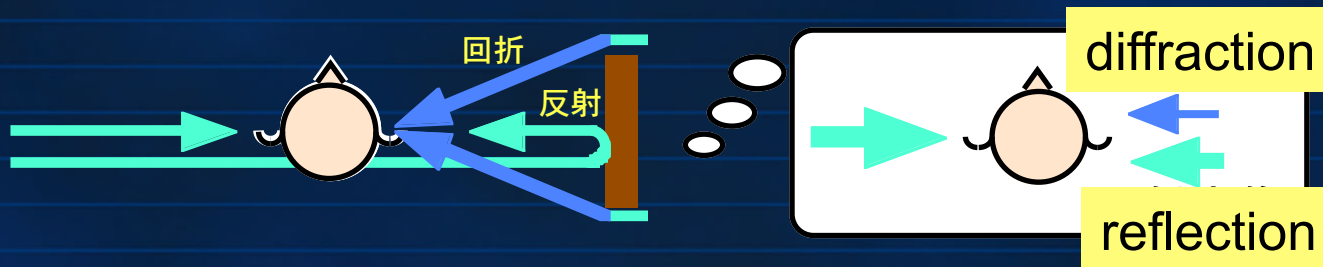
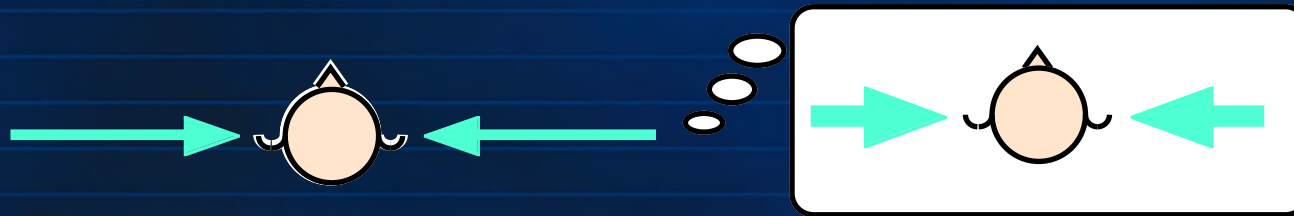


using ambient noise



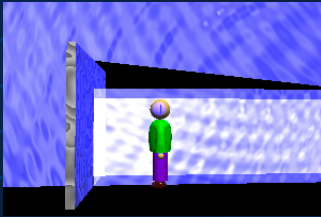
using self-generated sound

# Major Mechanism



*...because of "diffraction loss" and "precedence effect"*

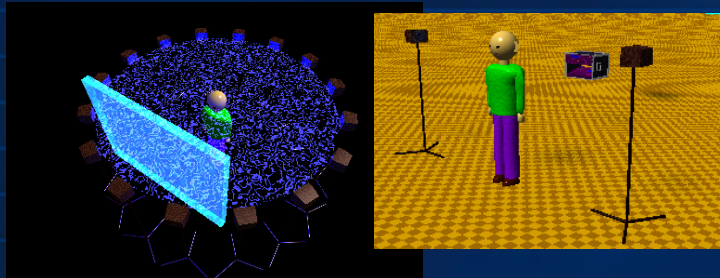
# History of Research



Revealing Obstacle  
perception  
mechanism

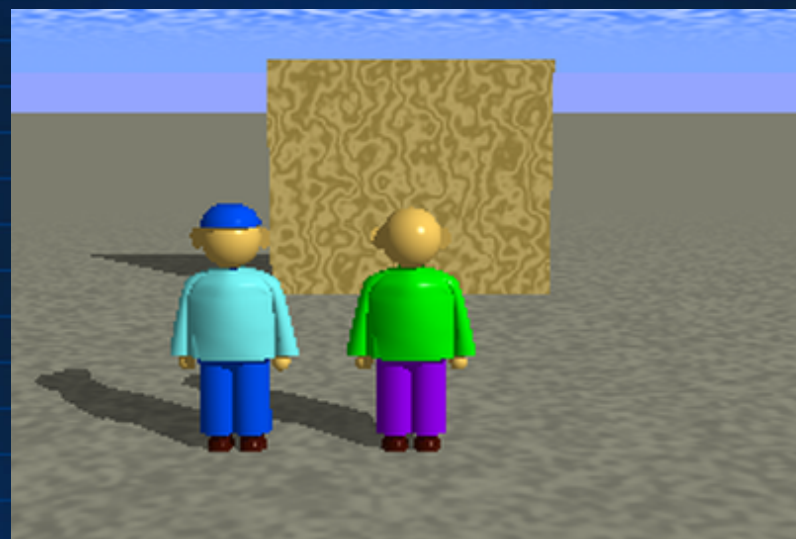


Obstacle Perception Training System



# Conventional Training

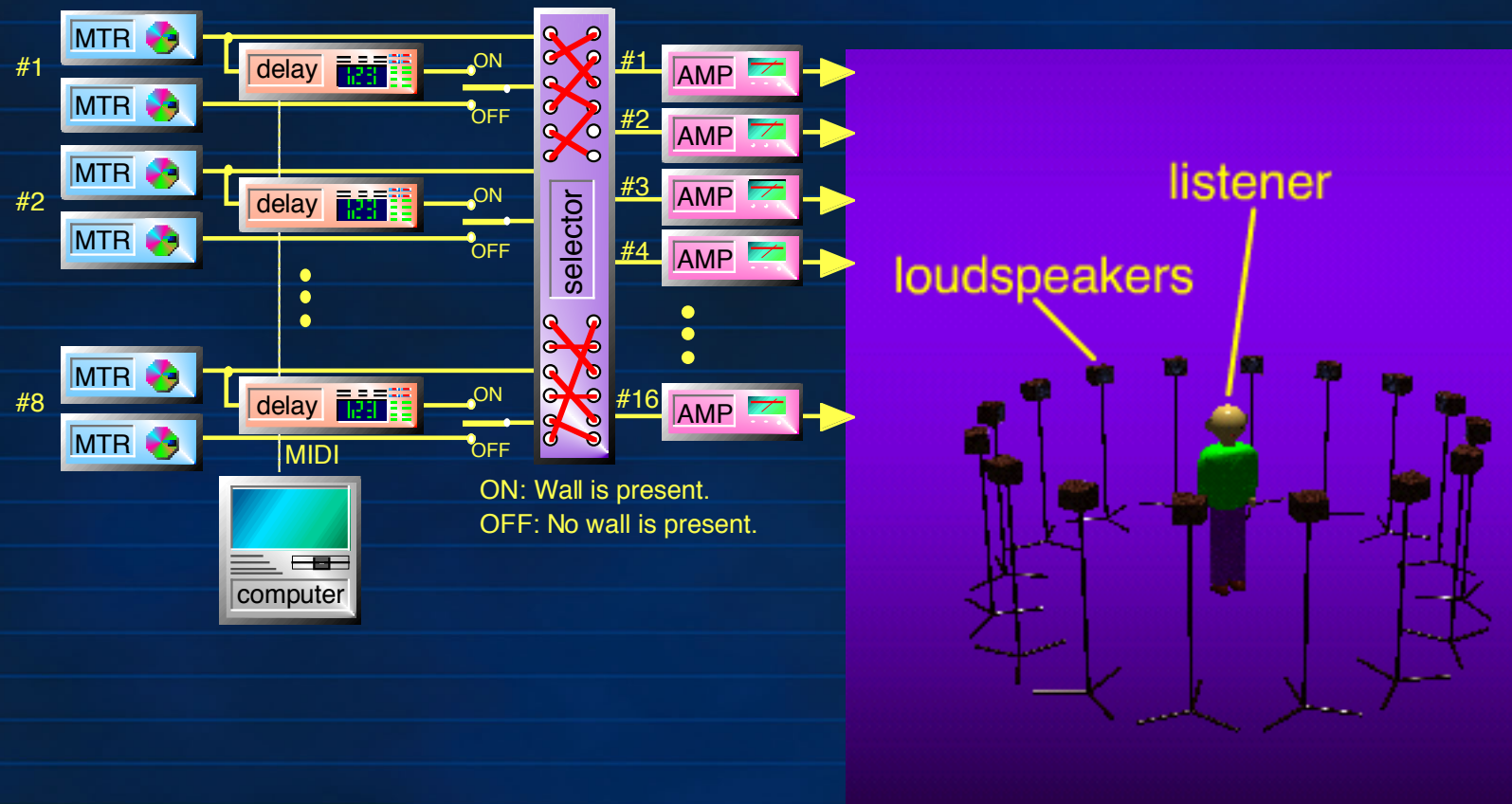
Actual training in the blind education/rehabilitation.



- Training in uncontrolled sound field is difficult for novice blind persons.

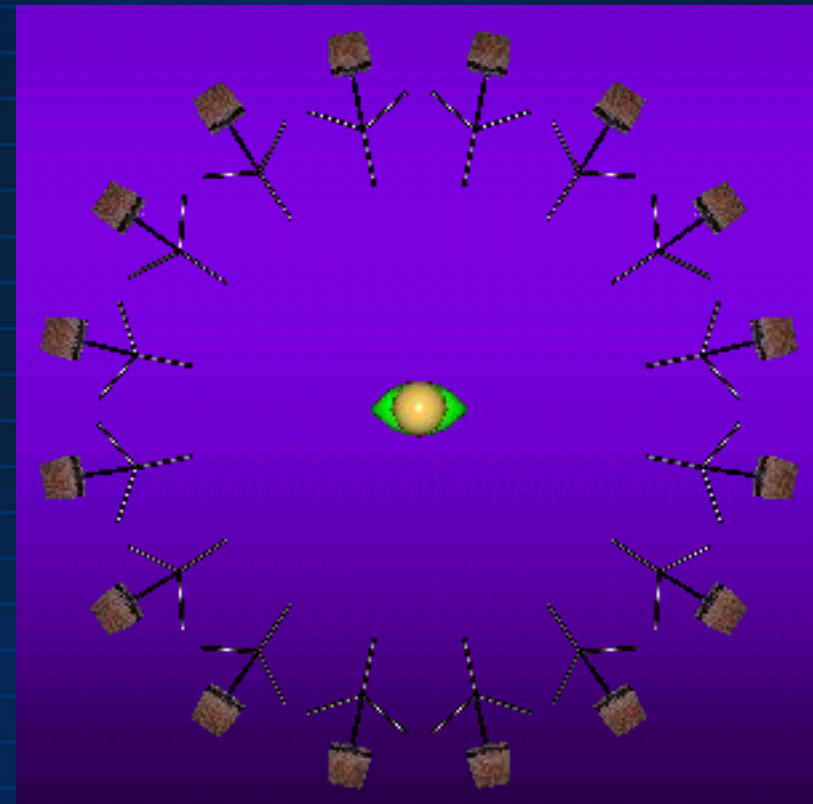
# Obstacle Perception Training System

(Seki, 1998)



# Obstacle Perception Training System

Principle of reproduction of obstacle by sounds



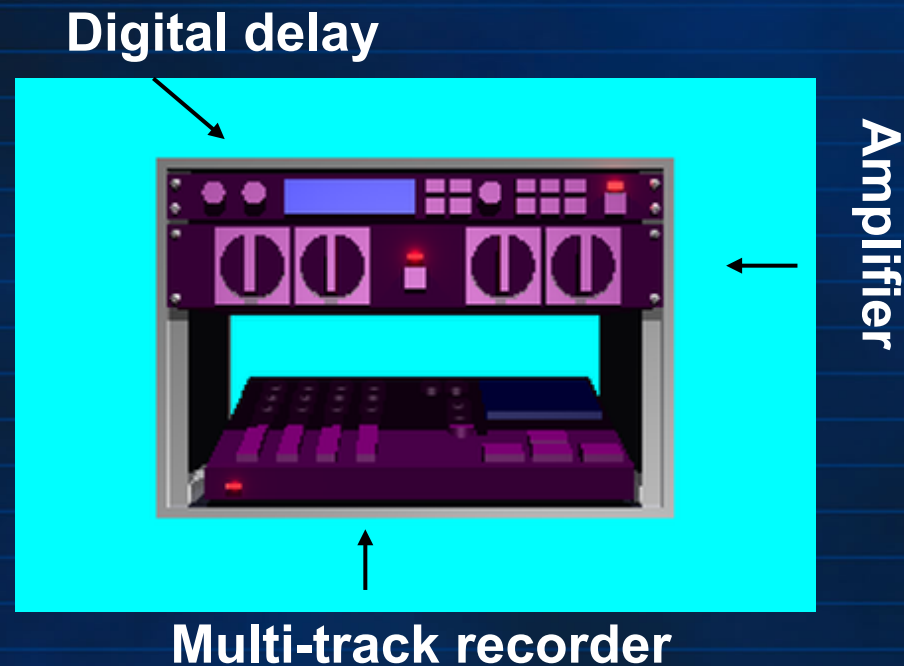


# Obstacle Perception Training System



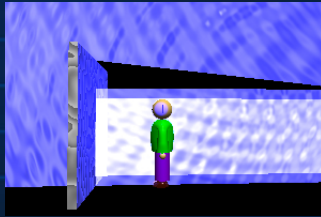
# Obstacle Perception Training System

## Simplified version (Seki, 1998)



- 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



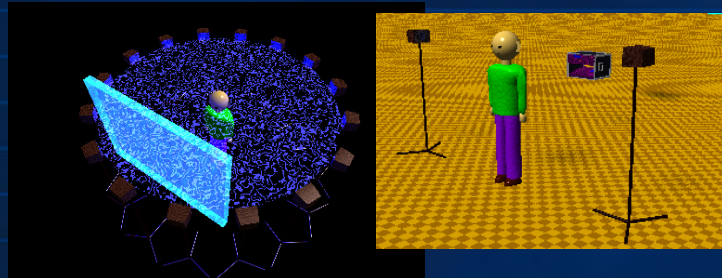
Revealing Obstacle perception mechanism



Obstacle Perception Training CD



Obstacle Perception Training System



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



# Obstacle Perception Training CD

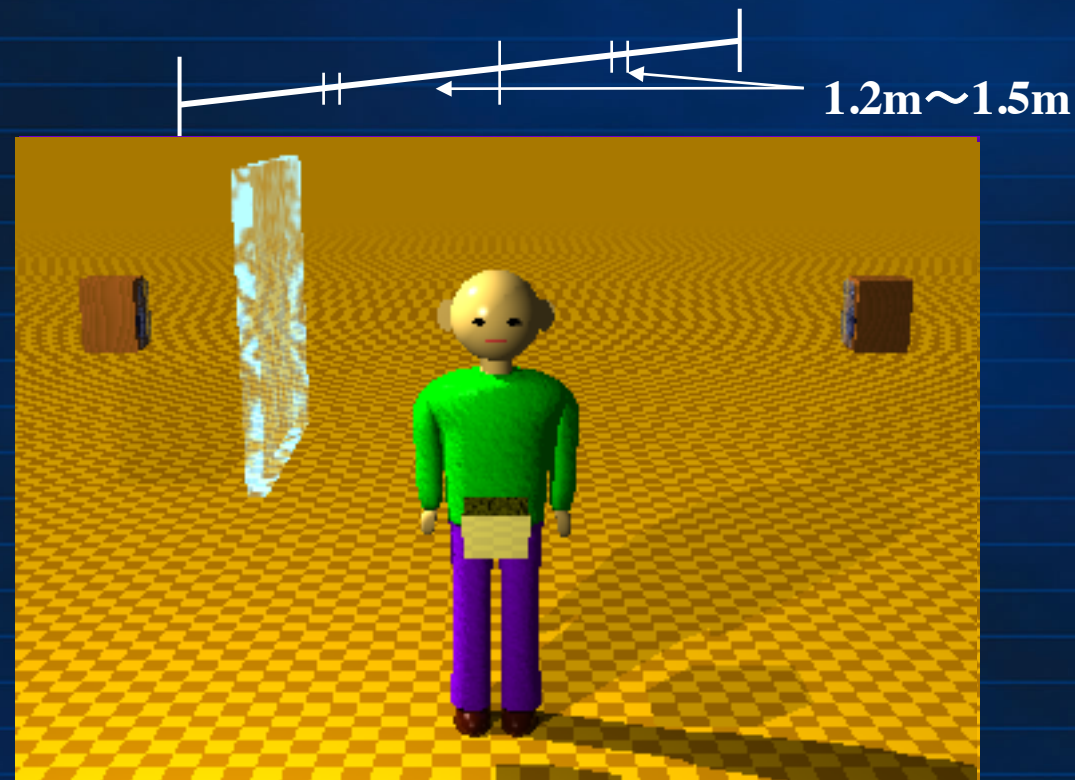
- Acoustic mechanisms of obstacle perception were simulated ideally in computer, and recorded into audio CD.



- Obstacle Perception Training CD Ver 0.0 (Prototype) was developed 2001.
- Obstacle Perception Training CD Ver 1.0 was developed, and distributed since 2002.



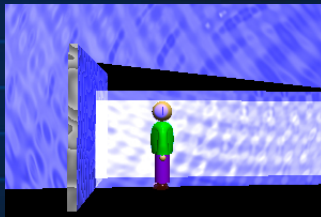
# Obstacle Perception Training CD



- 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

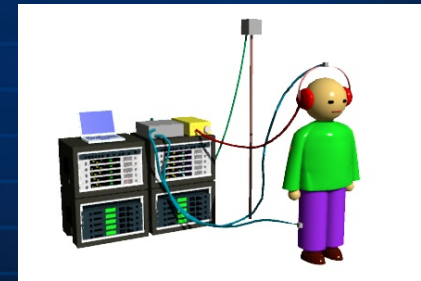
Over 300 CDs were distributed to the blind schools etc.



Revealing Obstacle perception mechanism



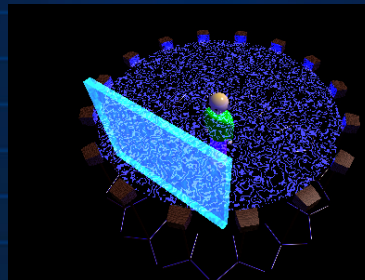
Obstacle Perception Training CD



Auditory Orientation Training System

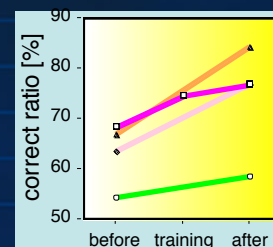


Obstacle Perception Training System



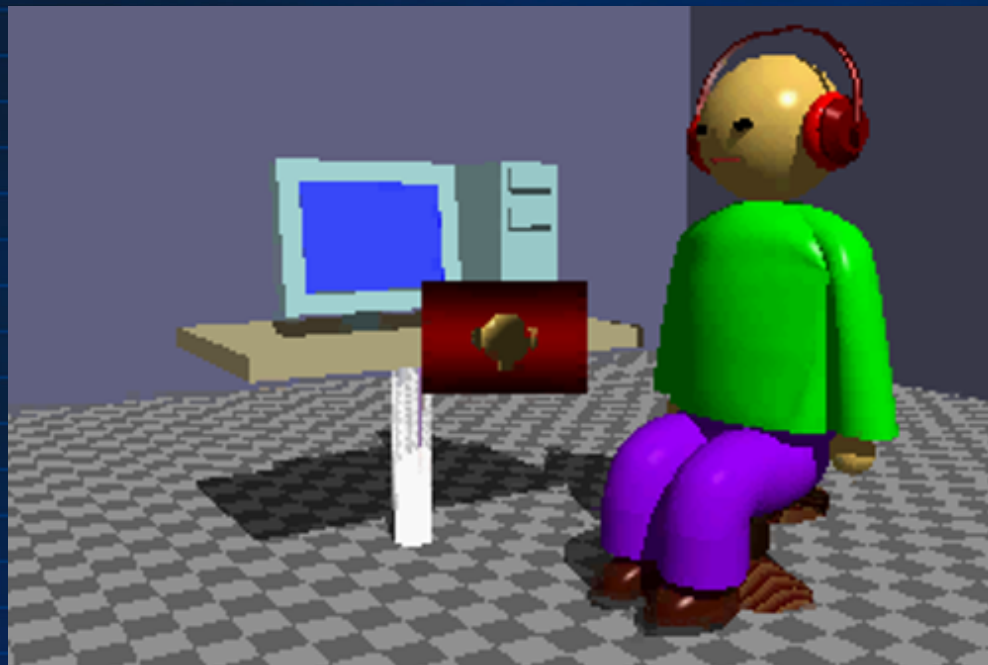
Evaluation

Effectiveness of CD



Over 100 O&M Instructors were educated

# 3-D sound technology



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)

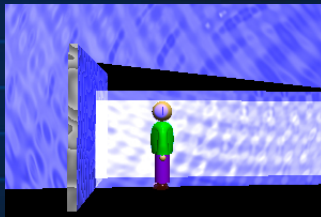
(Seki, 2005)



- 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

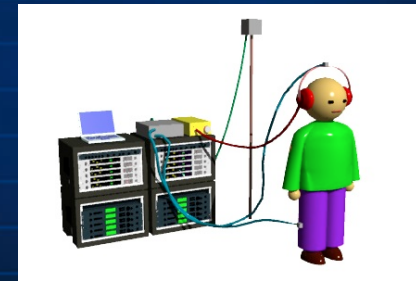
Over 300 CDs were distributed to the blind schools etc.



Revealing Obstacle perception mechanism



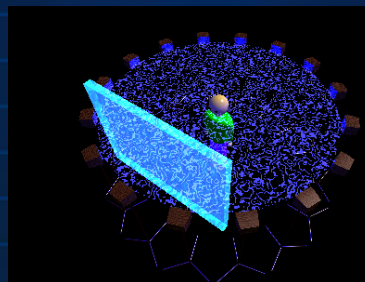
Obstacle Perception Training CD



Auditory Orientation Training System

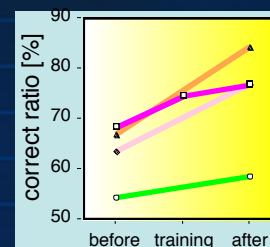


Obstacle Perception Training System

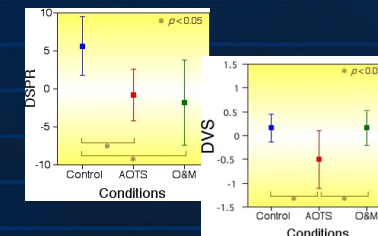


Evaluation

Effectiveness of CD

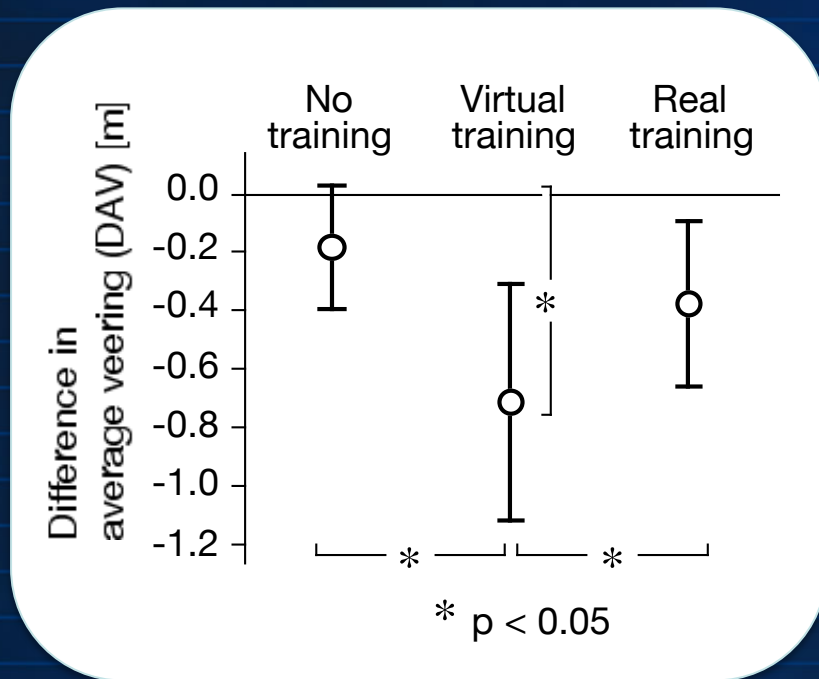


Effectiveness of AOTS

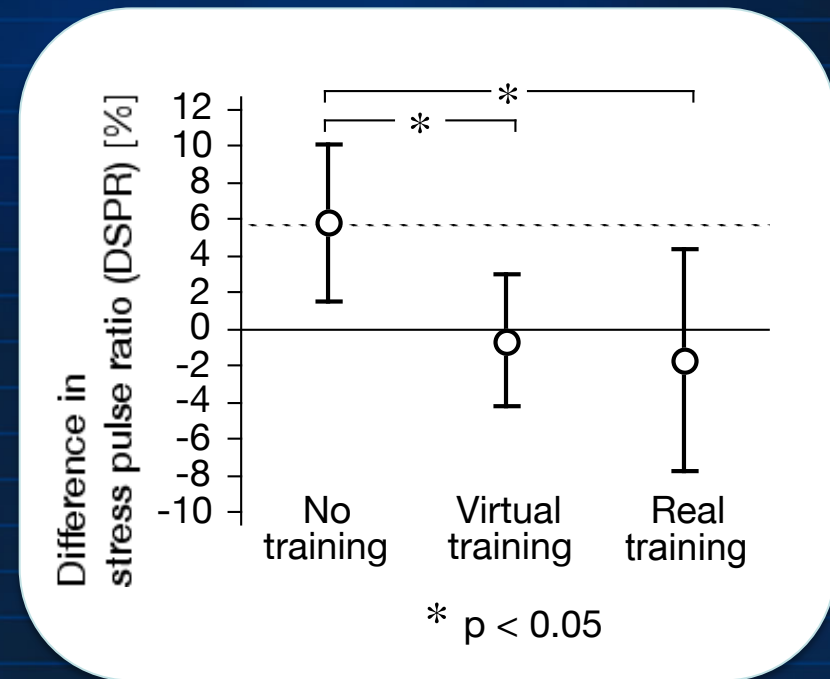


Over 100 O&M Instructors were educated

# Examples of AOTS effectiveness

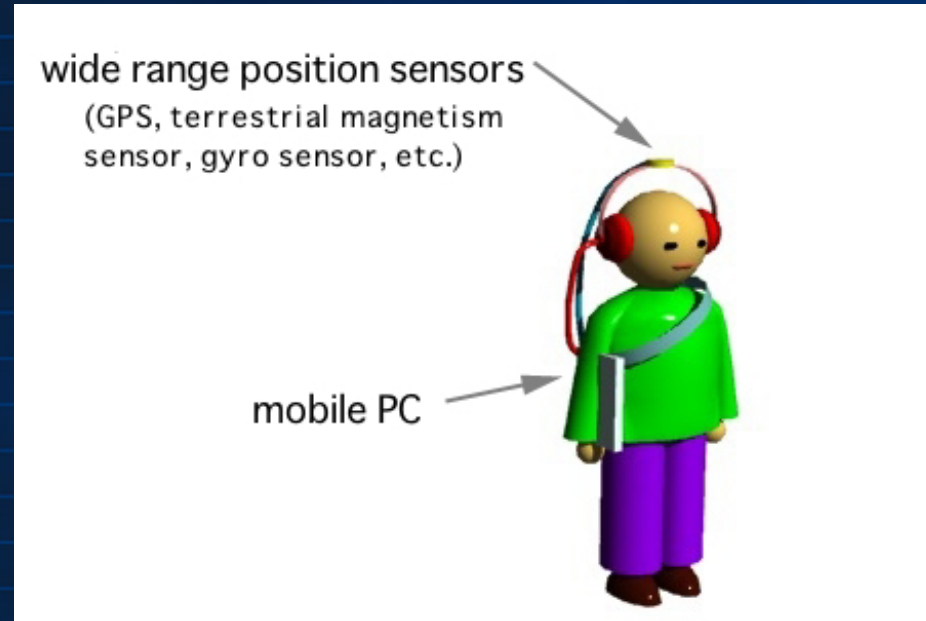


**Reduction of veering**  
(found by walk loci)



**Reduction of stress**  
(found by heart rates)

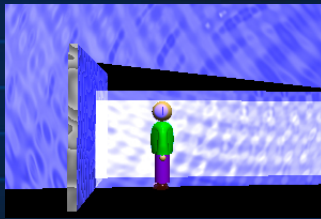
# In order to distribute...



- 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.

# History of Research

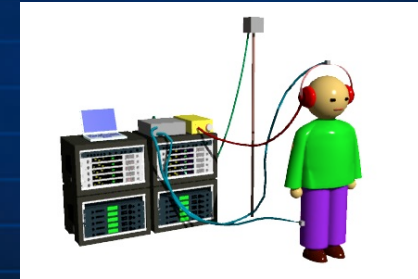
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Revealing Obstacle perception mechanism



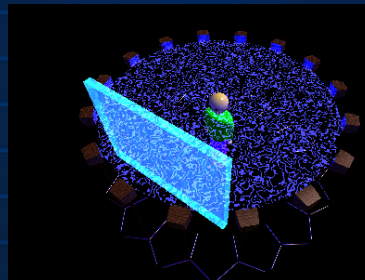
Obstacle Perception Training CD



Auditory Orientation Training System

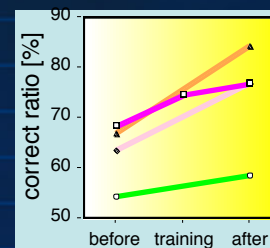


Obstacle Perception Training System

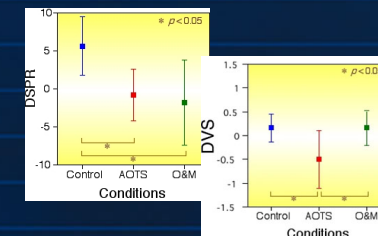


Evaluation

Effectiveness of CD

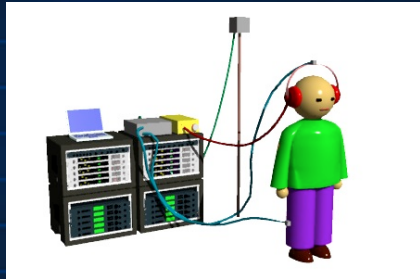


Effectiveness of AOTS



Over 100 O&M Instructors were educated

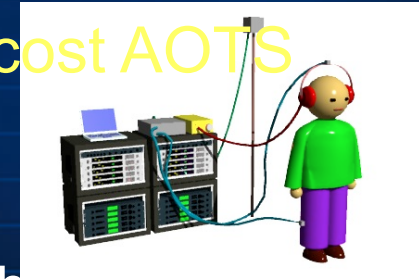
# History of Research



AOTS (by AIST)



- PC-based low-cost AOTS that consists of
  - Software
  - Low cost peripherals



Auditory Orientation Training System

...distribution to blind facilities

2003 2004 2005 2008 2009 2000 2001 2002 2003 2004 2005 2006 2007



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*

DefaultLesson.xml
DefaultLesson
WR-AOTS(TM) Credit

Wide-Range Auditory Orientation Training System

Ver. 2.06

GPS 00  
INS

<input type="checkbox"/> Load	<input type="checkbox"/> Save
<input type="checkbox"/> Edit	<input type="checkbox"/> Source
<input type="checkbox"/> Calibration	
<input type="checkbox"/> Run	<input type="checkbox"/> Stop
<input type="checkbox"/> Pause	<input type="checkbox"/> Quit

INS  
 Anti-Drift  
 Stable operation

GPS  
 Wii(R)  
 Ambient  
 MME ▼

# Contact

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

Please contact

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(AIST)

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<http://staff.aist.go.jp/yoshikazu-seki/>