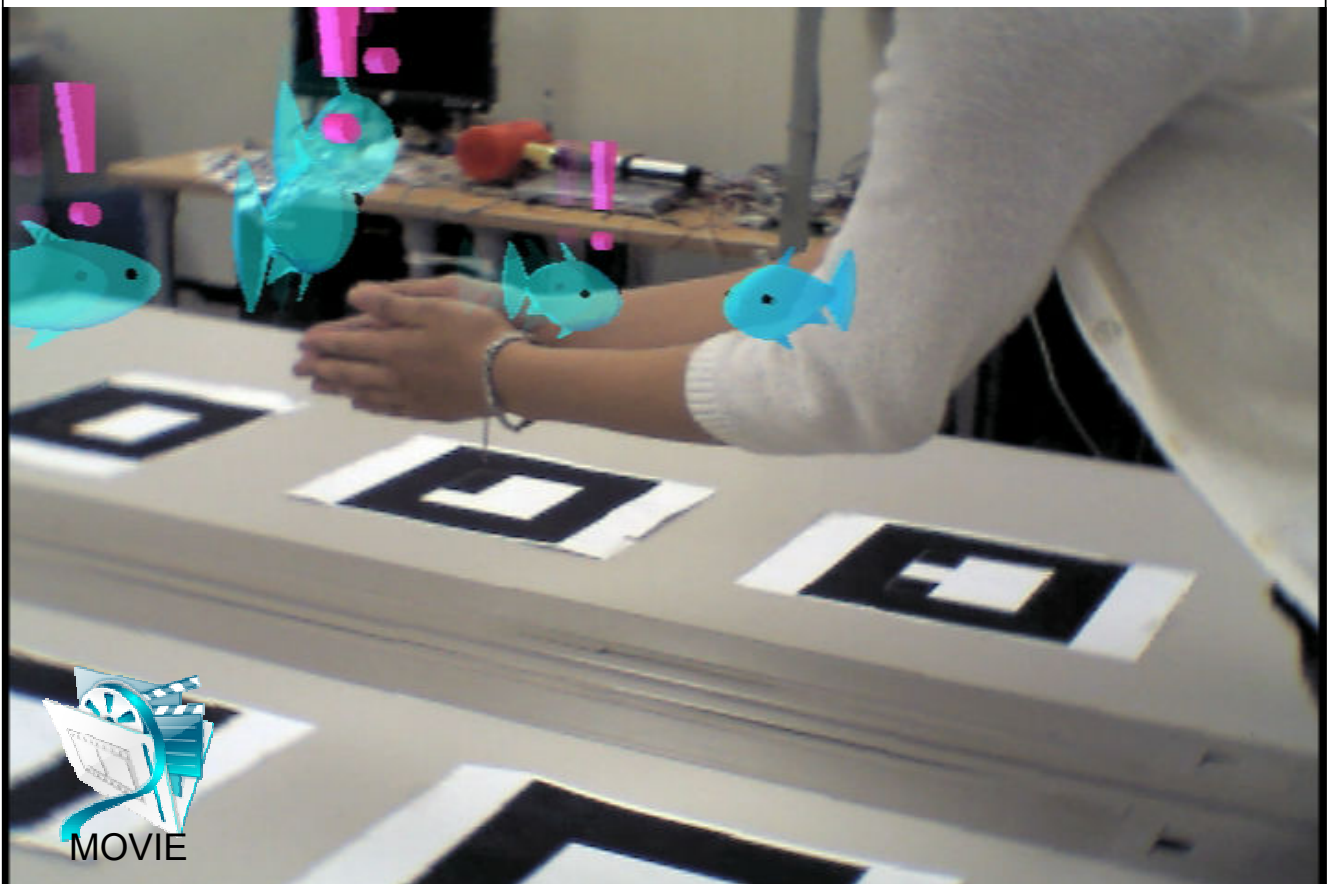# A New Acoustic Method of Table-top and Full-3D Interaction with Mixed Reality Space

Mai Otsuki, Asako Kimura,
Fimihisa Shibata, and Hideyuki Tamura
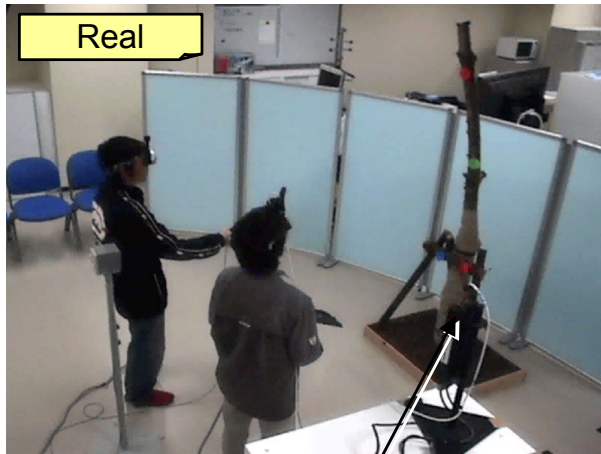
Ritsumeikan University, Japan

문화콘텐츠기술연구소
CTI   Culture Technology Institute

Takemura Lab
Informedia Education Division
Cybermedia Center, Osaka University

HITLabNZ
Human Interface Technology Laboratory New Zealand
www.hitlabnz.org

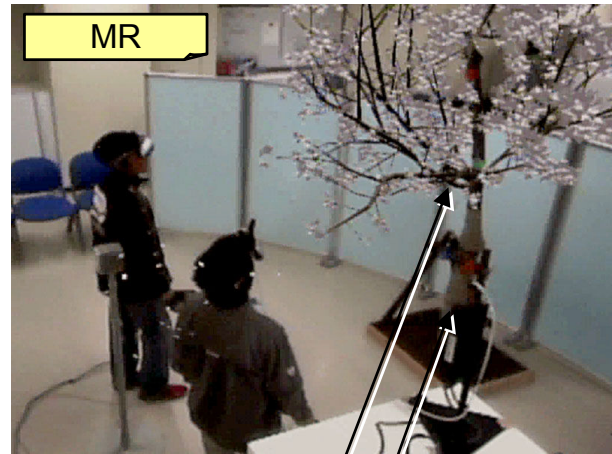MOVIE

Mixed Reality (MR)

MR merges real and virtual worlds in real time.

Example of MR attraction

Real

Trunk (real)

MR

Branches, petals (virtual)

Trunk (real)

Audio-visual MR

No audio-visual MR like VR

Develop an MR system
in both audio and visual senses

Proposal of new input method:

RealSound Interaction

Sound events in the real world is used as interaction or input devices with an MR space.

- Sound input method
  - Easy to change
  - Easy to keep proper mental model using familiar sound sources

- The Migratory Cursor [Y. Mihara *et al.*, 2005]
  - An interactive interface to operate a cursor by a certain nonverbal vocalization and voice commands
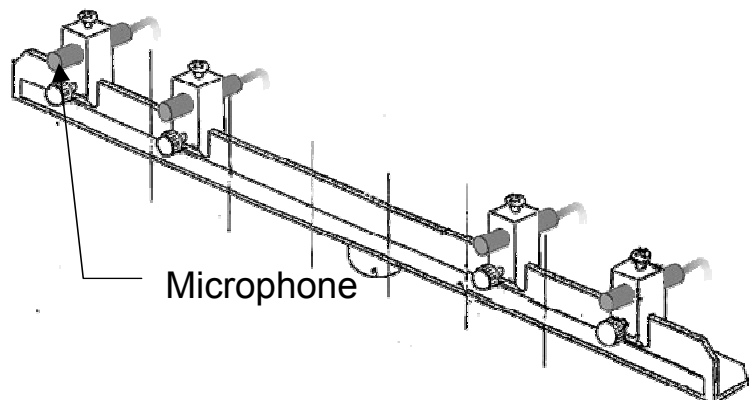 - Using one microphone

Problem and Solution
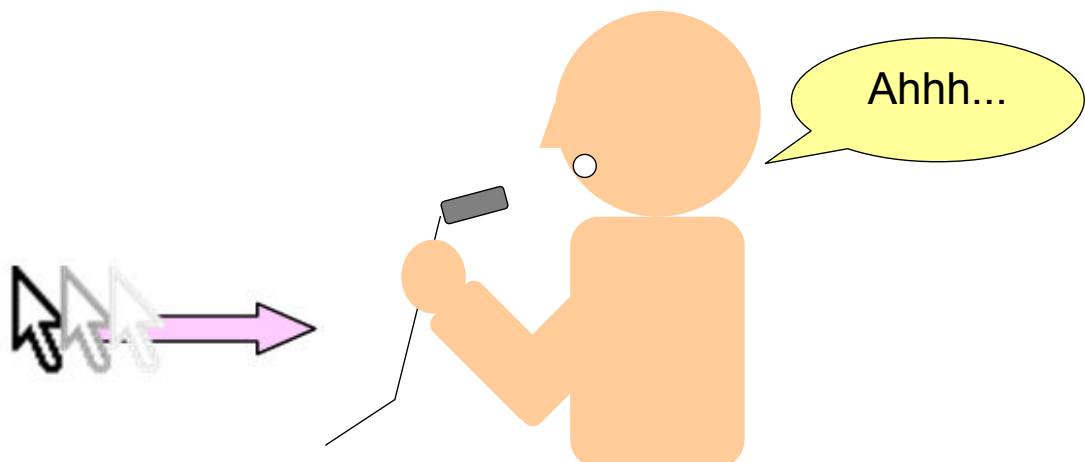
- One microphone can get
    - only ON/OFF of sound events

We use microphone array

- The microphone array can get
    - ON/OFF, direction of sound events
    - location with extra one

Microphone Array

Microphone

Fixed type
microphone array
(Traditional)

Microphone Array

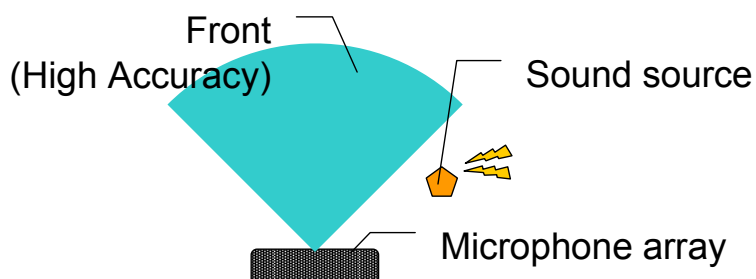Fixed type
microphone array
(Traditional)

Wearable type
microphone array
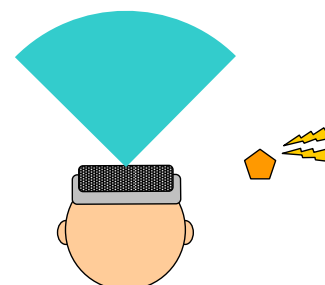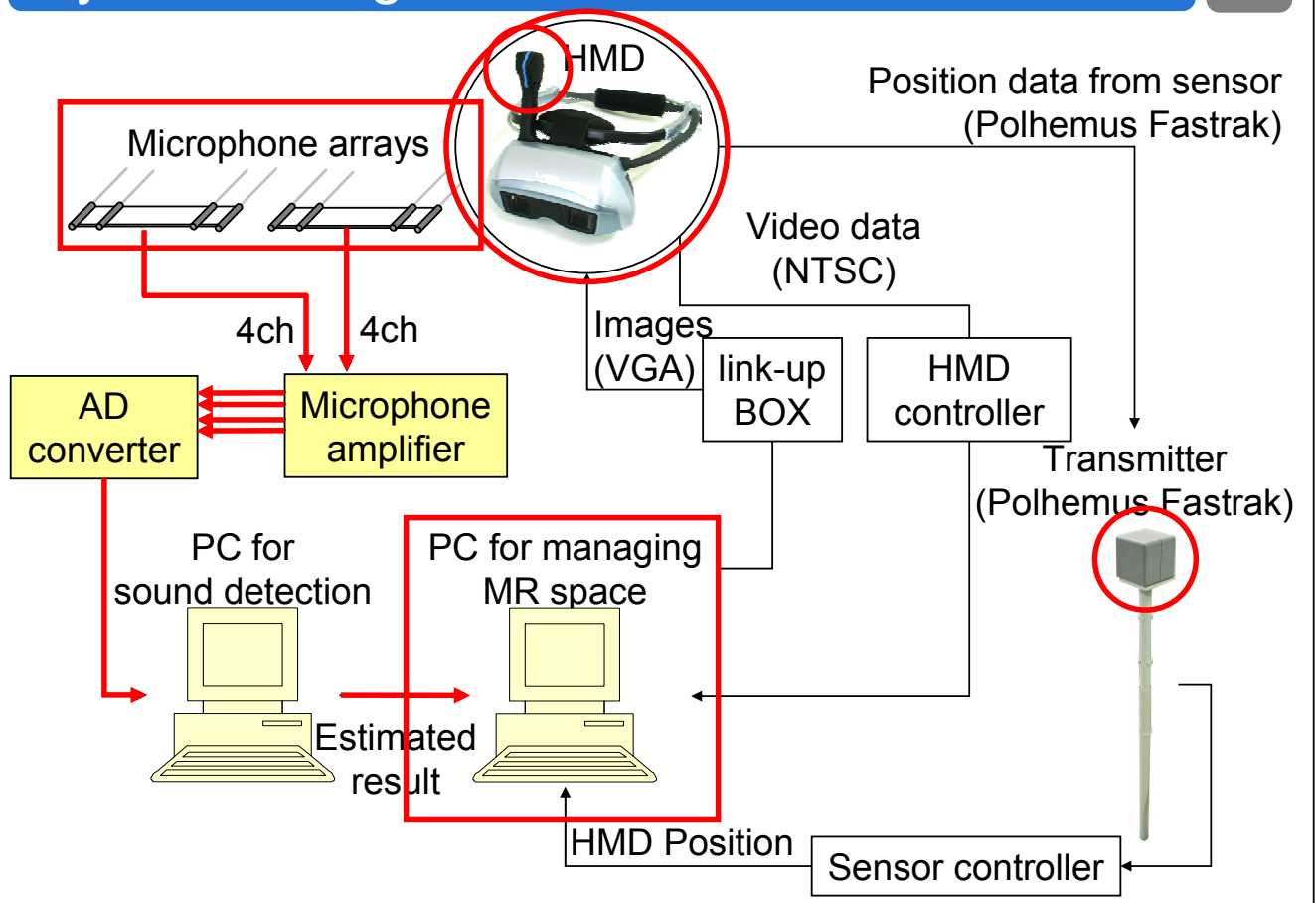(Proposal)

Advantage of Wearable Type

Fixed type

Wearable type

- High accuracy in a limited range of the front direction
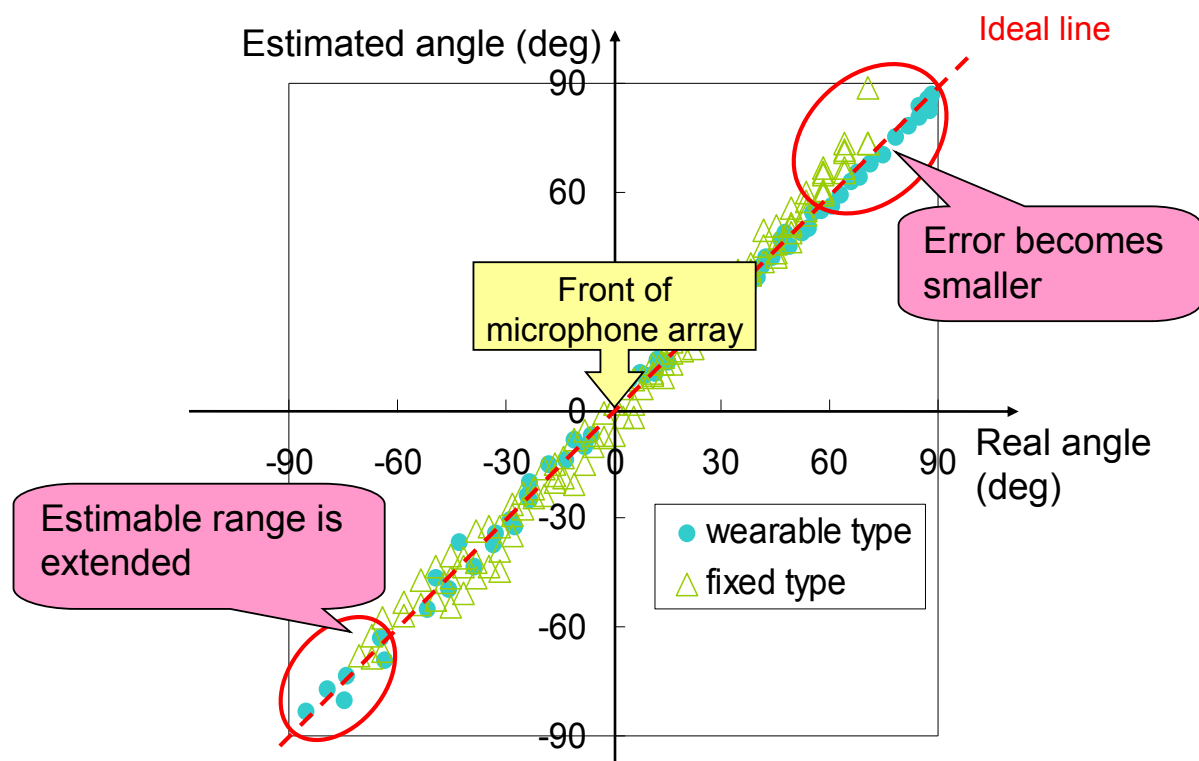
- Low angular resolution in the crosswise direction

- Captures sound constantly in front direction and near the sound source

Front
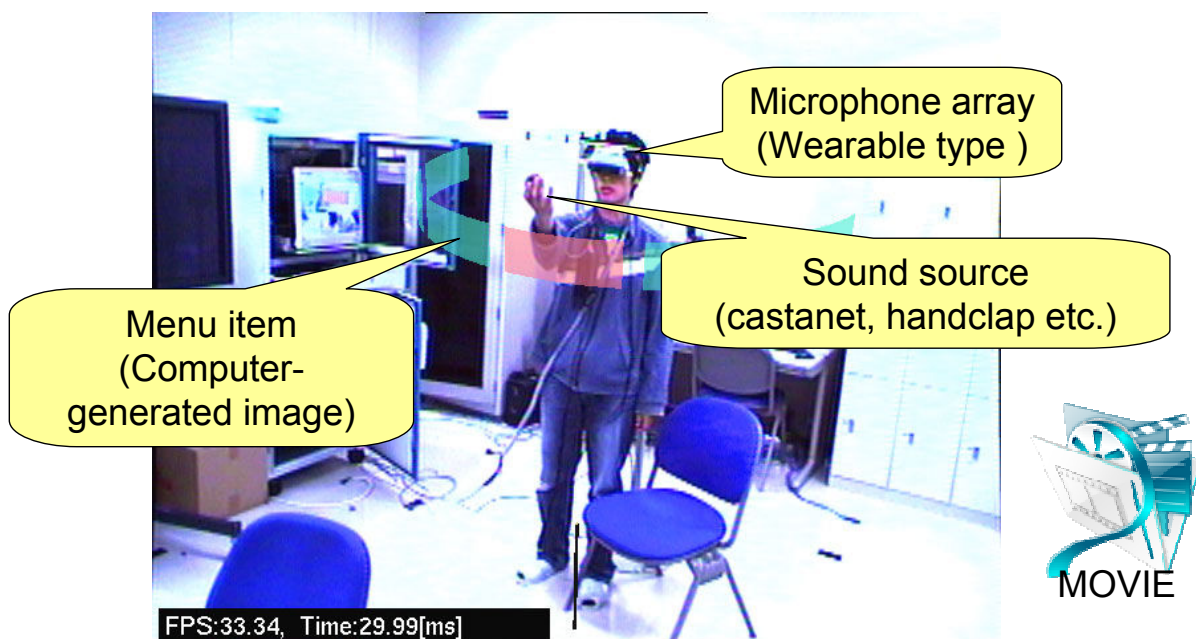(High Accuracy)

Sound source

Microphone array

Microphone arrays

HMD

Position data from sensor
(Polhemus Fastrak)

Video data
(NTSC)

4ch   4ch

Images
(VGA)

link-up
BOX

HMD
controller

AD
converter

Microphone
amplifier

Transmitter
(Polhemus Fastrak)

PC for
sound detection

PC for managing
MR space

Estimated
result

HMD Position

Sensor controller

---

① Direction of sound source

Using one microphone array

Evaluation of direction estimation

Implementation

② Location of sound source

Using extra microphone array

③ Application

Accuracy of direction estimation

Estimated angle (deg)

Ideal line

90

60

Front of
microphone array

Error becomes
smaller

0

-90   -60   -30   0   30   60   90   Real angle
(deg)

-30

Estimable range is
extended

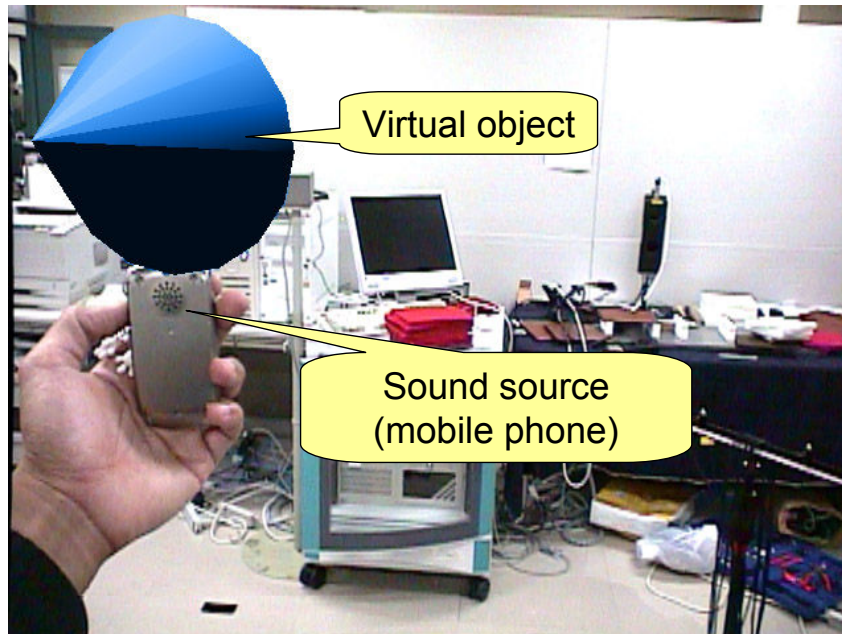● wearable type
△ fixed type

-60

-90

Implementation (1)

- Using **direction** of sound event
  - Discrete menu selection interface

Microphone array
(Wearable type)

Sound source
(castanet, handclap etc.)

Menu item
(Computer-
generated image)
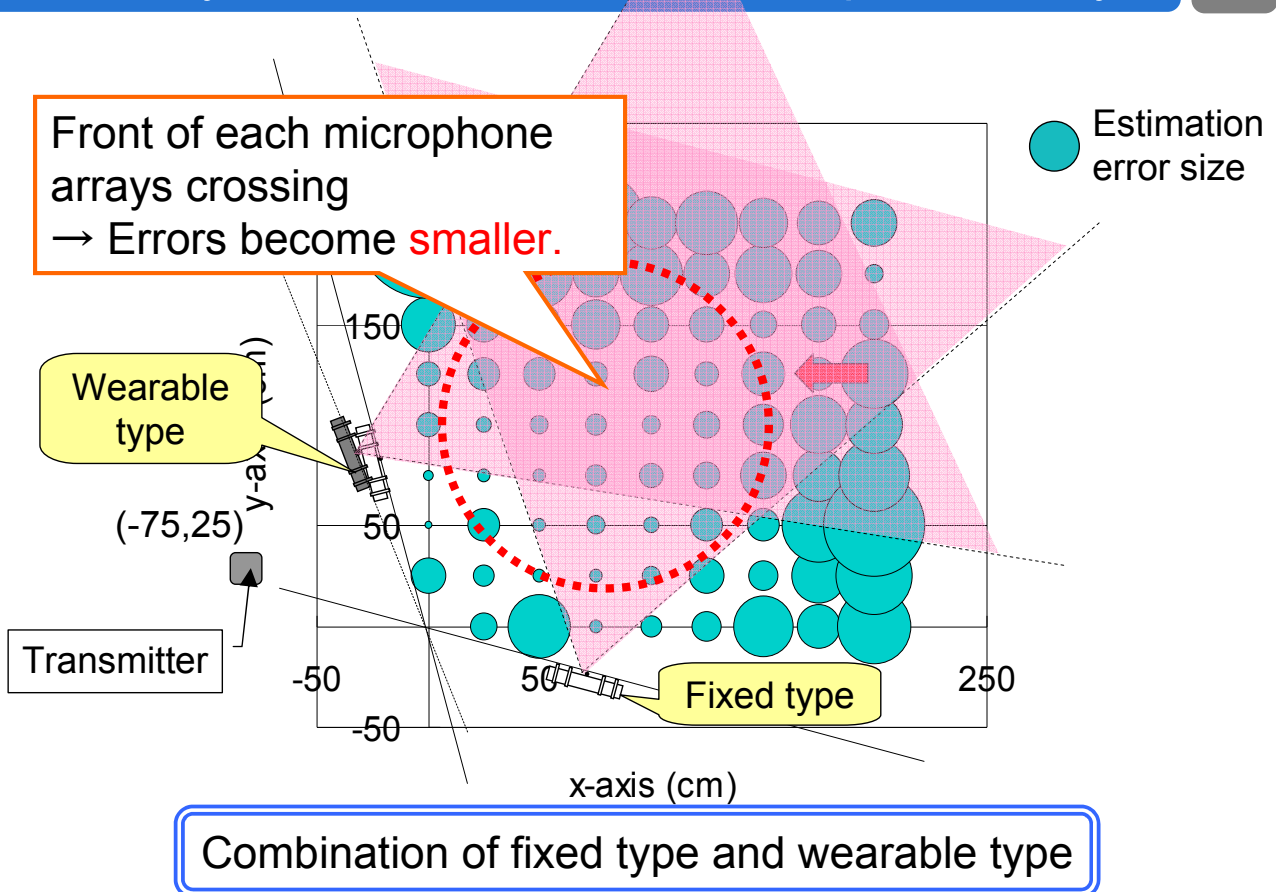
FPS:33.34, Time:29.99[ms]

MOVIE

Implementation (2)
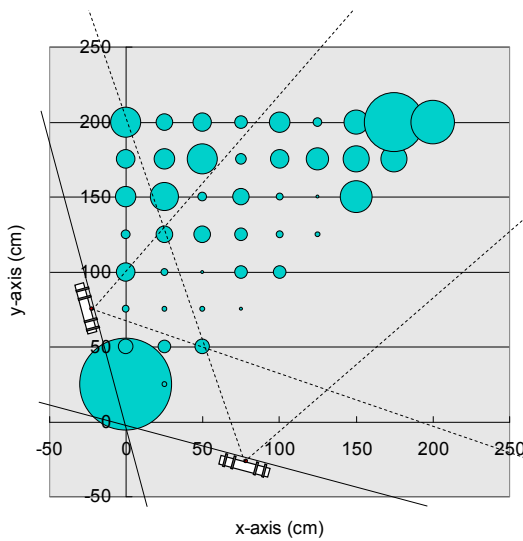
- Using **direction** of sound event
    - –Non-step direction selection interface

Virtual object

Sound source
(mobile phone)

MOVIE

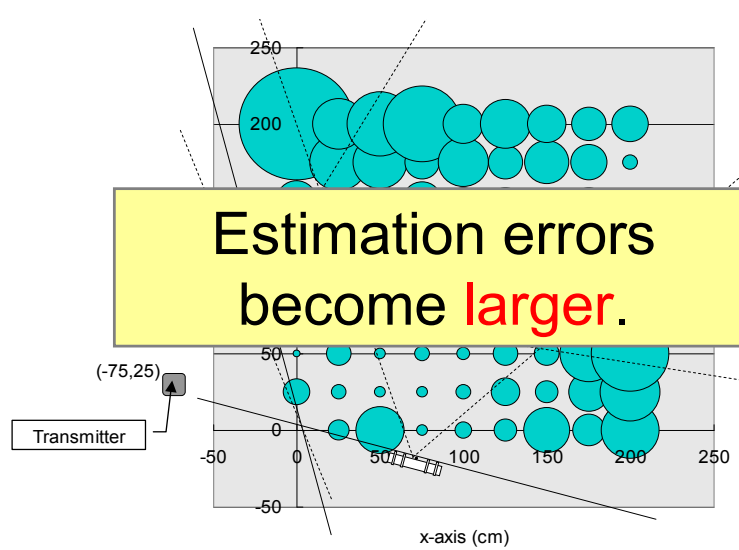# Using sound events in real world

1 Direction of sound source
Using one microphone array
Evaluation of direction estimation
Implementation

2 Location of sound source
Using extra microphone array
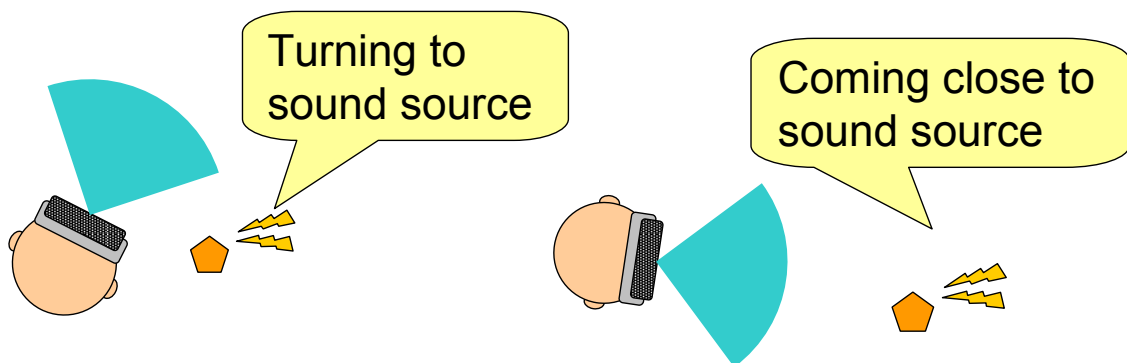Evaluation of localizing
Implementation

3 Application

Estimated direction

Fixed type microphone array
Position & orientation are measured in advance.

Estimated direction

Wearable type microphone array
Position & orientation are measured by a magnetic sensor.

Sound source

Estimation error size

Front of each microphone arrays crossing
→ Errors become smaller.

Wearable type

(-75,25)

Transmitter

Fixed type

150

50

-50

-50

50

250

y-axis (cm)

x-axis (cm)

Combination of fixed type and wearable type

2 fixed types

Estimation errors become larger.

Fixed type and wearable type

(-75,25) Transmitter
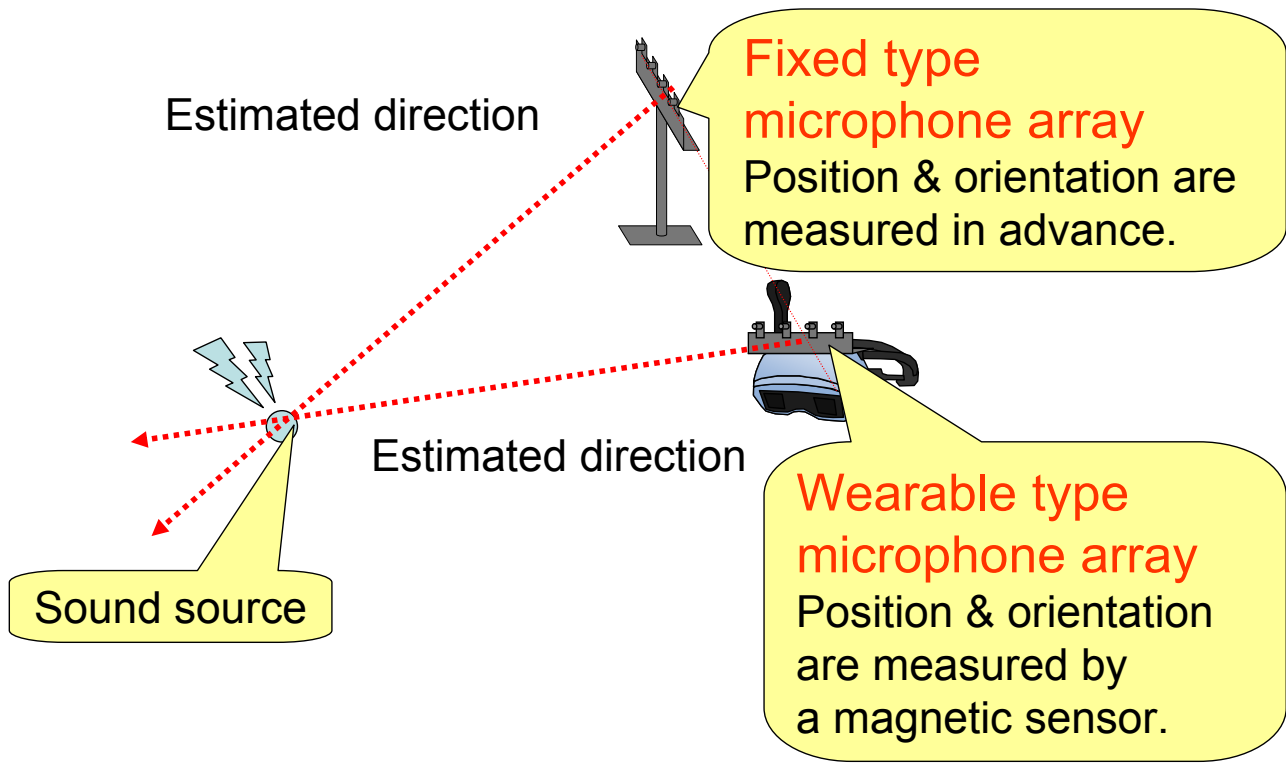
- Estimation errors become larger (because of magnetic sensor's error) .
- However, it has 2 advantages

Turning to sound source

Coming close to sound source

Location can be estimated with high accuracy.

- Using location of sound event
 - Localization of a sound event and its response

Sound source (handclap)

Virtual object

MOVIE

1. Direction of sound source
   - Using one microphone array
   - Evaluation of direction estimation
   - Implementation

2. Location of sound source
   - Using extra microphone array
   - Evaluation of localizing
   - Implementation

3. Application
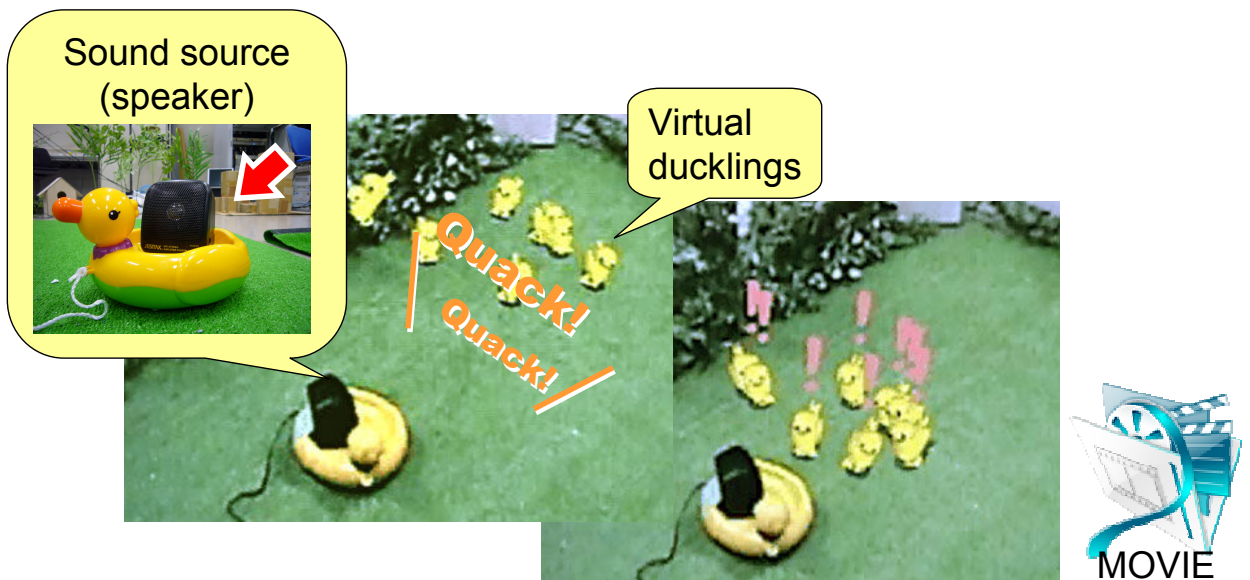
- The function of direction estimation was applied.
- A bird flies from the direction indicated by a sound source "birdcall."

Virtual bird

User's View

Estimated direction

Birdcall

MOVIE
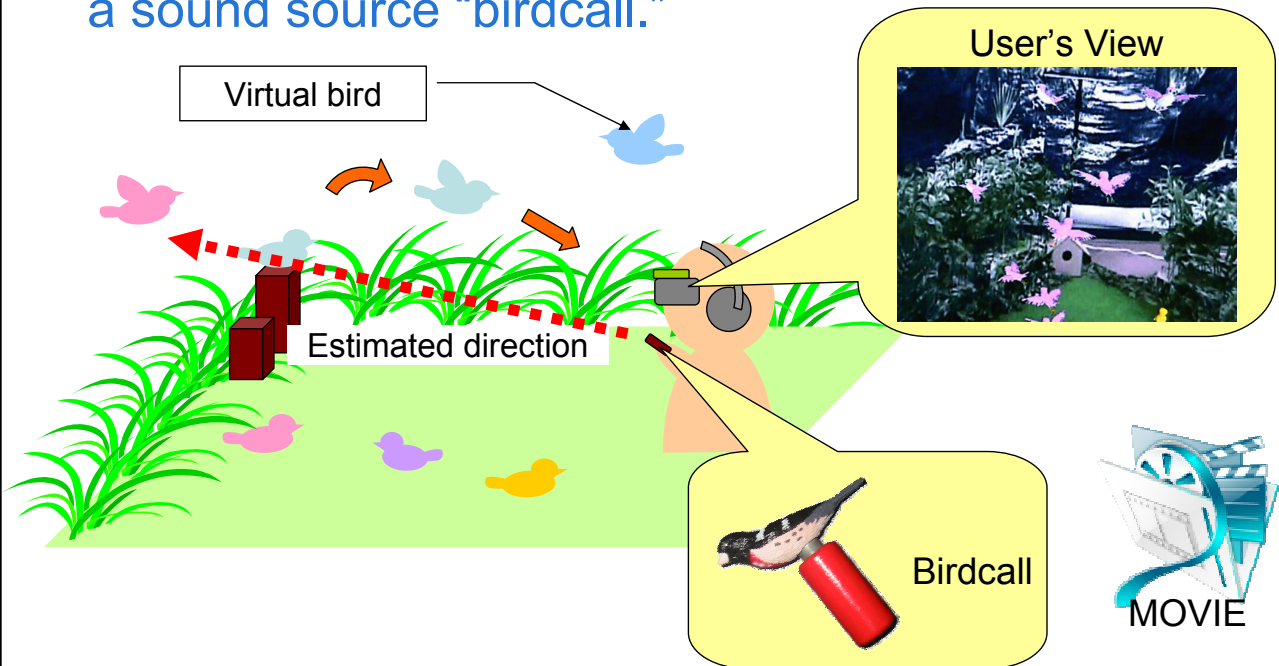
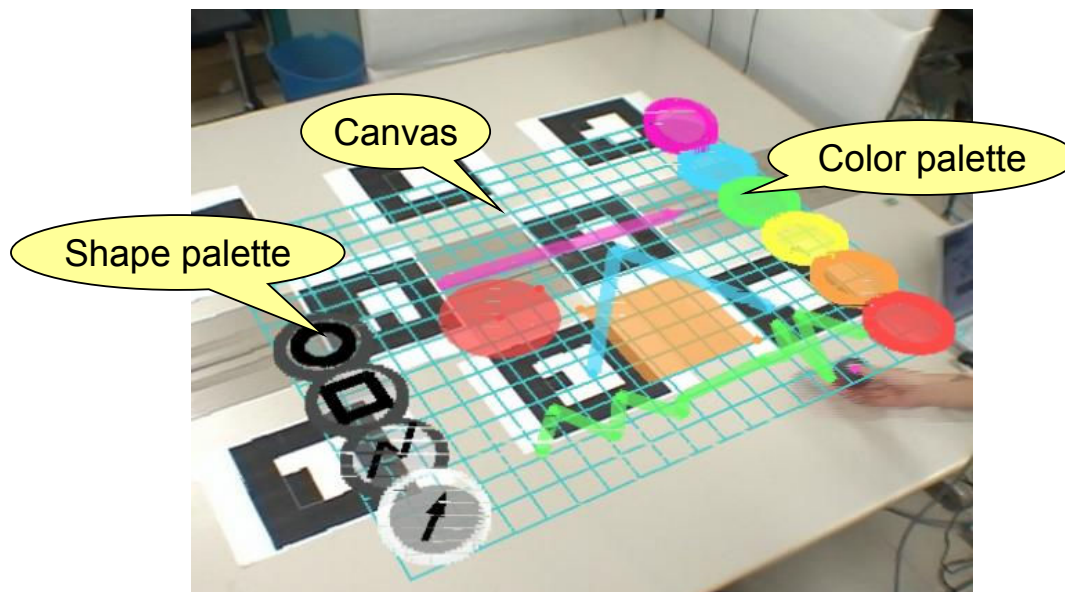
- The function of localization was also applied.
- Ducklings move toward the mother duck (real toy object with speaker).

Sound source (speaker)

Virtual ducklings

Quack!
Quack!

MOVIE

Application (2): AcousticInk

- A new drawing tool in an MR space.

MOVIE

Conclusion

- Novel interface using the microphone arrays
  - Between the real environment and the MR space through the sound events
- Some implementation with this interface

- This function can be used not only in MR but also in a general system.