



QoE Assessment of Olfactory Media in Remote Ikebana with Haptic Media

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Outline


- ◆ Background
- ◆ Purpose
- ◆ Remote Ikebana System
- ◆ Assessment Method
- ◆ Assessment Results
- ◆ Conclusions and Future Work



Background

Multi-sensory communications

vision, olfaction, and tactile sensation *et al.*



We can improve realistic sensation and immerse ourselves in various applications such as ikebana (Japanese flower arrangement) ^{*1}, cooking, and harvesting fruit ^{*2}.

^{*1} An ikebana training system in a 3-D virtual space with vision and haptic media was developed; the operability of haptic interface device was assessed.

^{*2} Harvesting fruit in a 3-D virtual space with vision, haptic and olfactory media was developed. The influence of inter-stream synchronization error between olfactory and haptic media was investigated.

^{*1} N. Mukai et al, Proc. World IMACS/MODSIM Congress, July 2009.

^{*2} S. Hoshino et al, Proc. IEEE CQR, May 2011.



Purpose

Problems

- Few papers studies networked applications using vision, olfactory media, and haptic media together.
- Mukai *et al.* did not handle olfactory media in their system^{*1}.
- Hoshino *et al.* did not investigate the influence of the output timing of olfactory media in their system^{*2}.
- Both systems^{*1,*2} are stand-alone, and they do not transmit any media over a network.

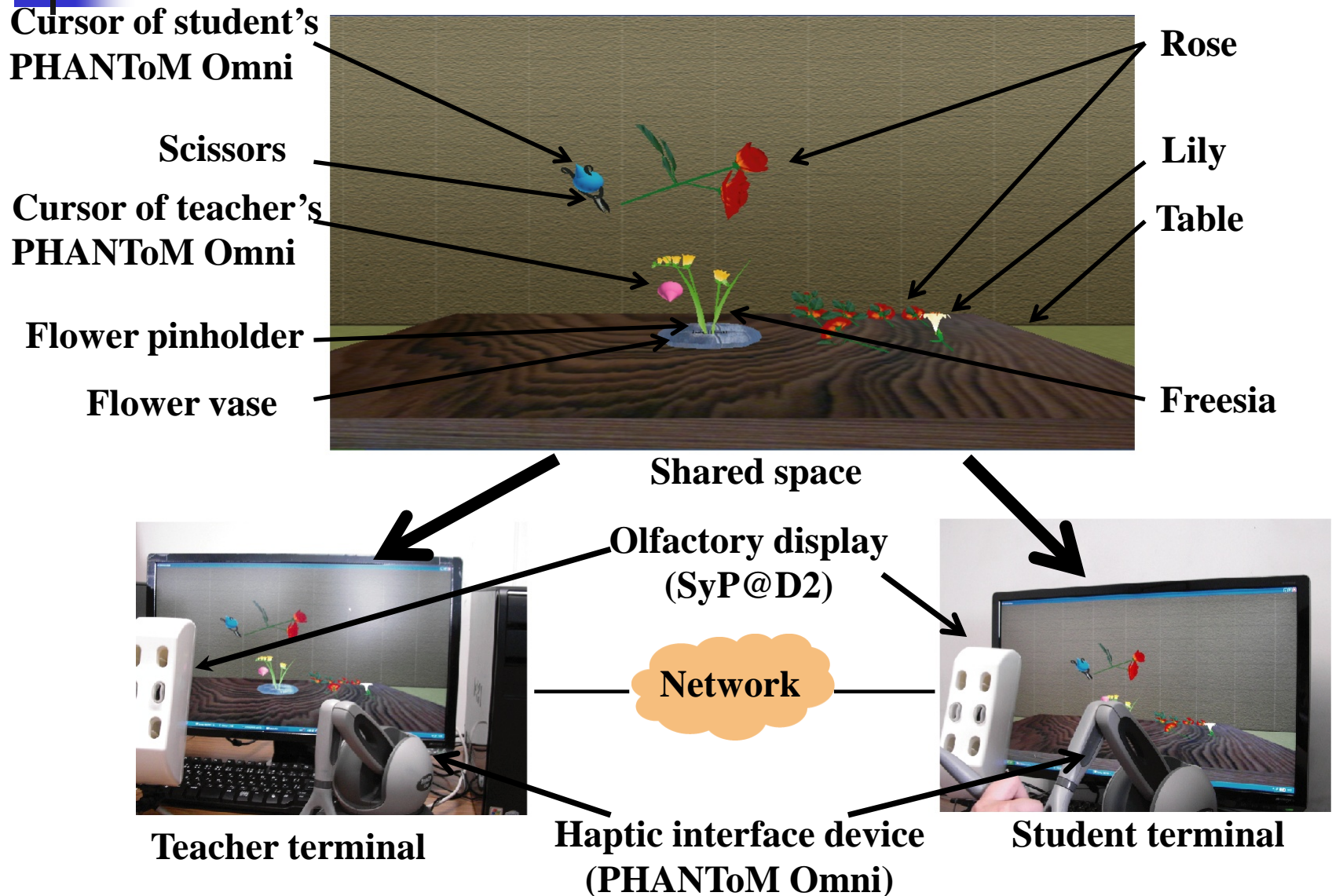
This work

- ◆ We deal with a remote (networked) ikebana system using vision, olfactory, and haptic media.
- ◆ We investigate the influence of the output timing of olfactory media on QoE (Quality of Experience).

^{*1} N. Mukai et al, Proc. World IMACS/MODSIM Congress, July 2009.

^{*2} S. Hoshino et al, Proc. IEEE CQR, May 2011.

Remote Ikebana with Olfactory and Haptic Media





Reaction Force (1/2)

The reaction force F applied to a PHANToM user

➤ When the user holds a flower

$$F = m_f g$$

m_f : Mass of the held flower (0.05 kg)

g : Gravitational acceleration (if we assume that the length of the scissors is 1, $g=21 \text{ /s}^2$)

➤ When the user holds the scissors

$$F = m_s g$$

m_s : Mass of the scissors (0.05 kg)



Reaction Force (2/2)

- When a user cuts the stem of a flower by the scissors

$$F = KD_c$$

K : Constant (=0.01)

D_c : Vector from the contact point between the fixed flower's stem and the scissors to the center of the scissors's blades.

- When a user impales the flower

$$F = KD_i$$

D_i : vector from the contact point between the flower pinholder and the stem of the flower to the end of the flower's stem

- When a user pulls up the flower impaled on the flower pinholder

$$F = -KD_i$$

Smell Space of Flower (1/3)

Radius of smell space

Smell space



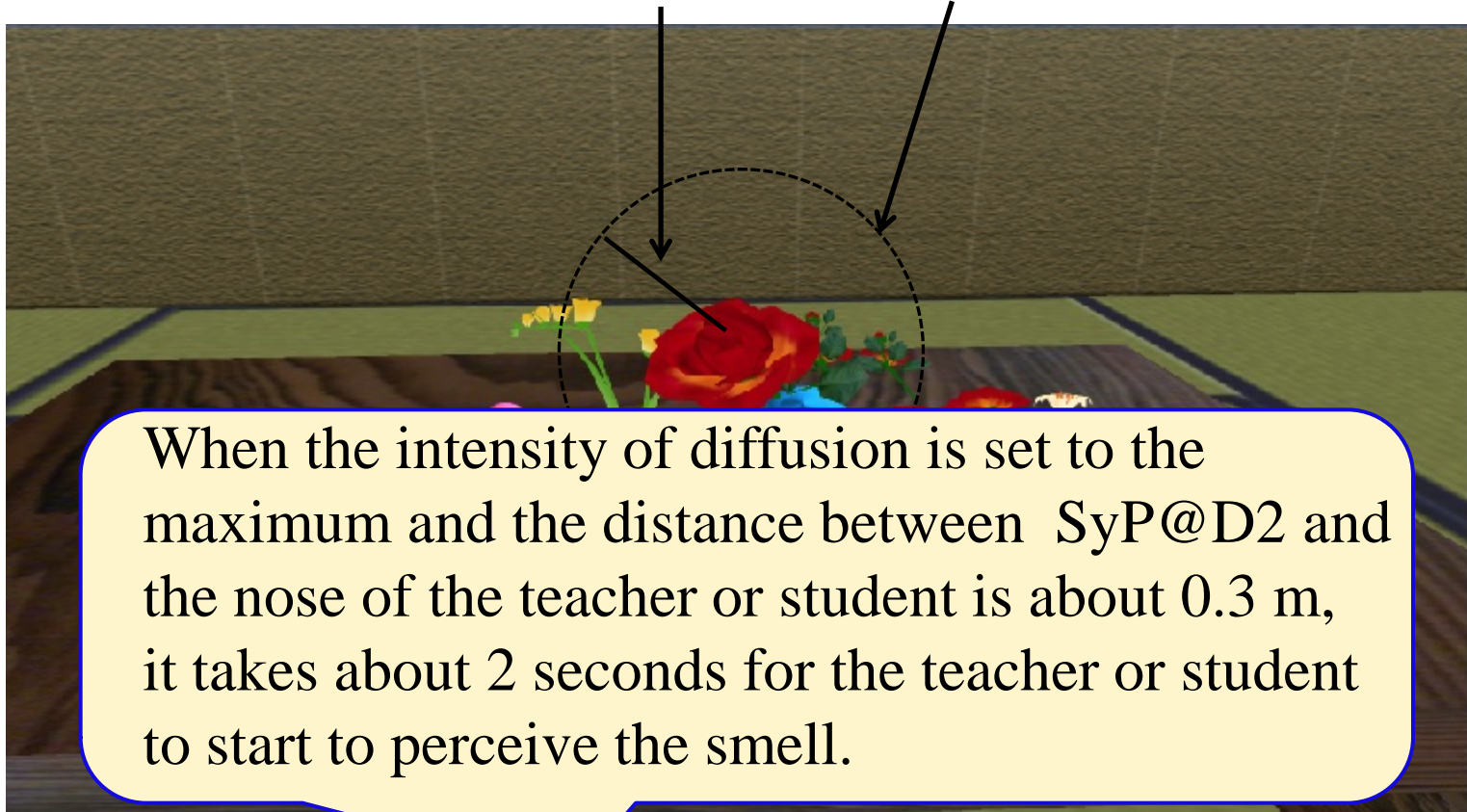
The smell space (called “aroma aura^{*3}”) of flower is defined as a sphere in which we can perceive the smell of the flower.

^{*3} K. Tominaga et al, Proc. IEEE VSMM, Oct. 2001.

Smell Space of Flower (2/3)

Radius of smell space

Smell space

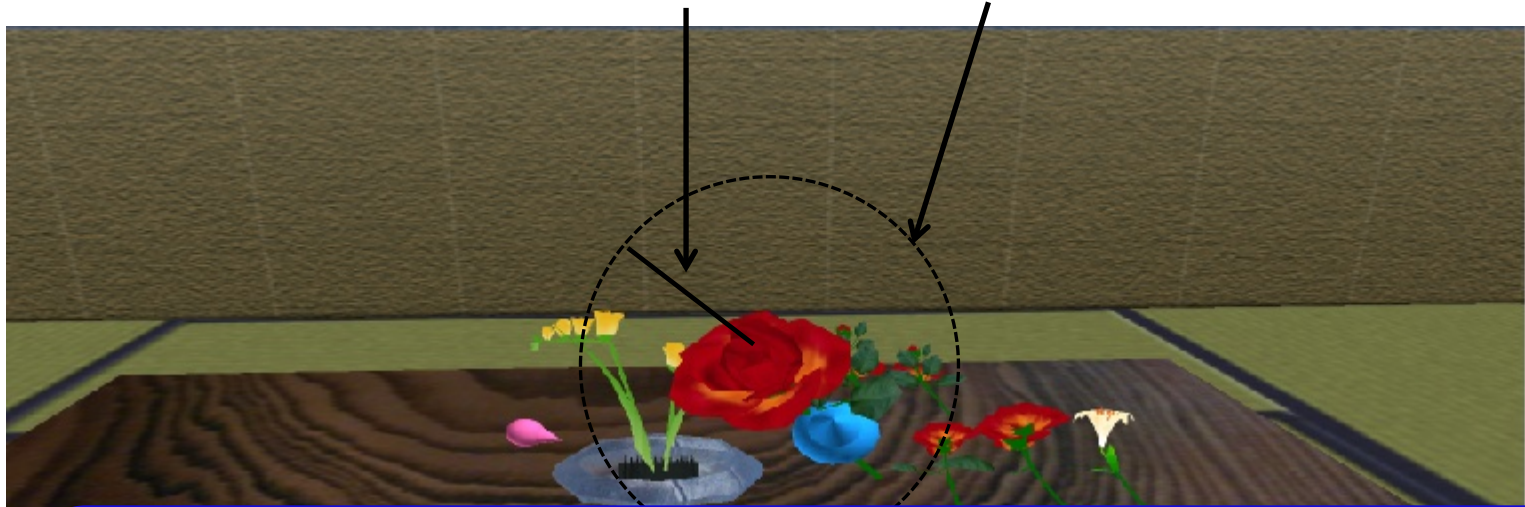


When the viewpoint of the teacher or student enters a flower's smell space, the smell of the flower is diffused by SyP@D2.

Smell Space of Flower (3/3)

Radius of smell space

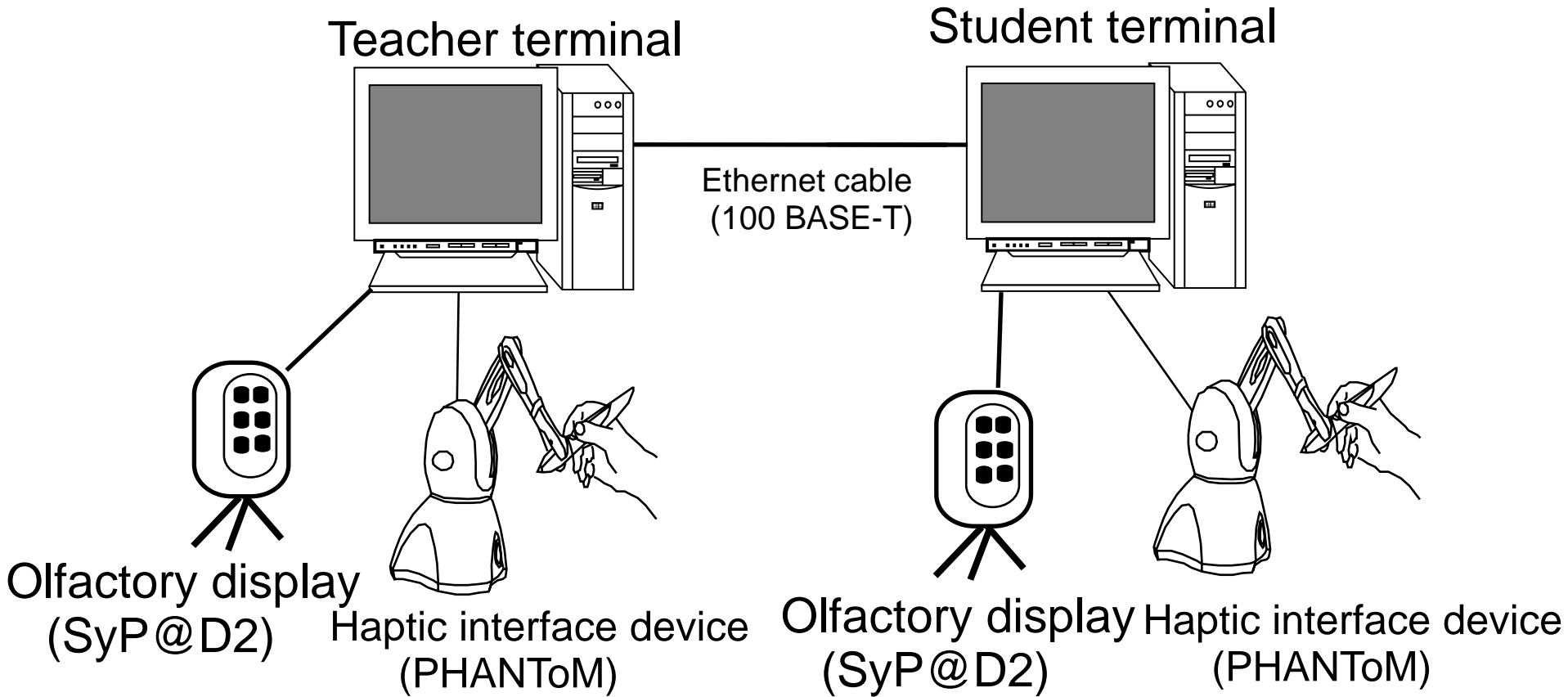
Smell space



It takes about 2 seconds from the instant SyP@D2 stops to diffuse the smell until the moment the teacher or student become insensitive to the smell when the distance between SyP@D2 and the nose of the teacher or student is about 0.3 m.

When the viewpoint of the teacher or student goes out of the smell space, the diffusion of the flower's smell is stopped.

Assessment System



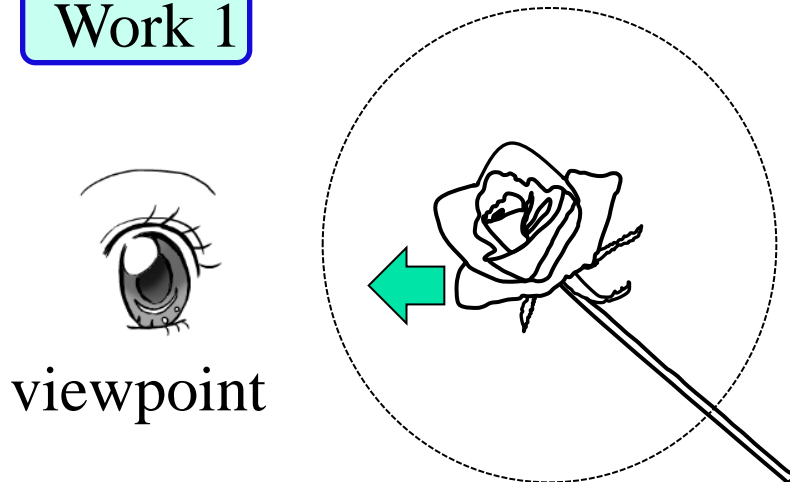
Assessment Method (1/3)

Work

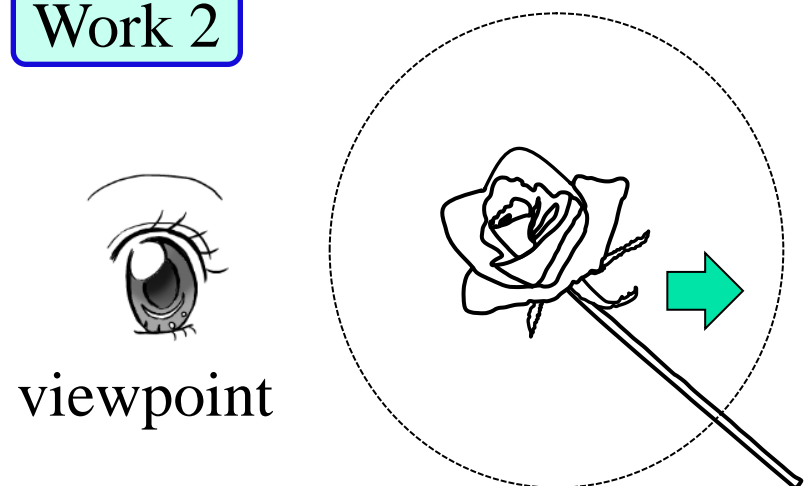
◆ Work 1: Each subject selected a rose from among flowers on the table, held and moved the rose at almost a constant speed toward his/her viewpoint until he/she started to perceive the smell of the rose.

◆ Work 2: After the subject perceived the smell of a rose, he/she moved the rose away from the viewpoint until he/she became insensitive to the smell at almost a constant speed.

Work 1



Work 2





Assessment Method (2/3)

Each subject was asked to judge how good the output timing of olfactory media is.

Five-grade quality scale

Score	Description
5	Excellent
4	Good
3	Fair
2	Poor
1	Bad

The subject gave a score from 1 through 5 to each test to obtain the mean opinion score (MOS).



Assessment Method (3/3)

Radius of smell space

4, 6, 8, 10, 12, 14, 16 (length of scissors: 1)

Average movement speed

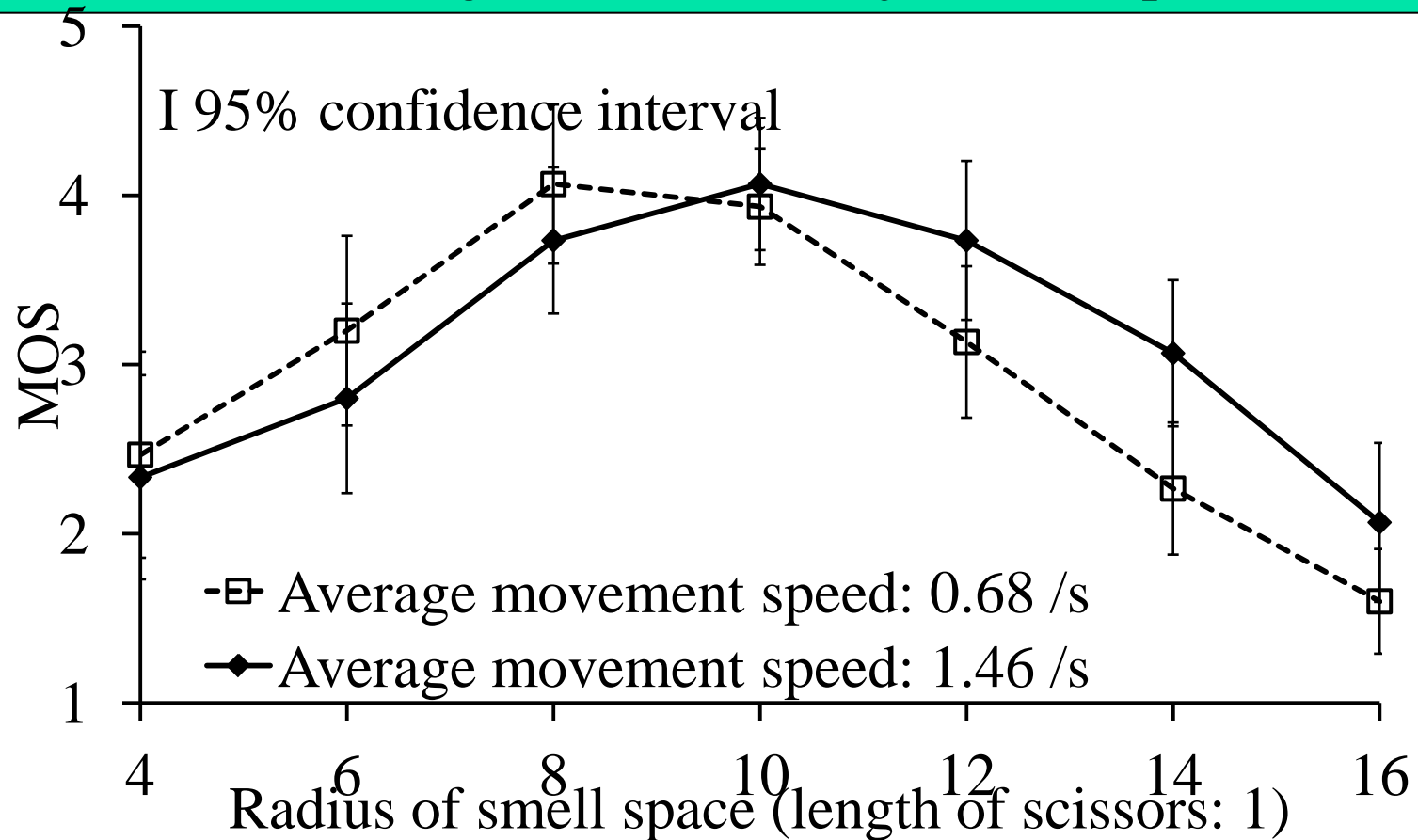
- We dealt with two types of average movement speed when the subject held and moved the rose toward his/her viewpoint (slow: about 0.5 /s, fast: about 1.5 /s).
- We dealt with two types of movement speed when the subject moved the rose away from the viewpoint (slow: about 0.5 /s, fast: about 1.5 /s).

We randomly presented the radius to each subject. The two kinds of work in the assessment were done on different days.

➤ Total time: 10 minutes ➤ Subjects: 15 persons (ages: between 21 and 29)

Assessment Results (1/2)

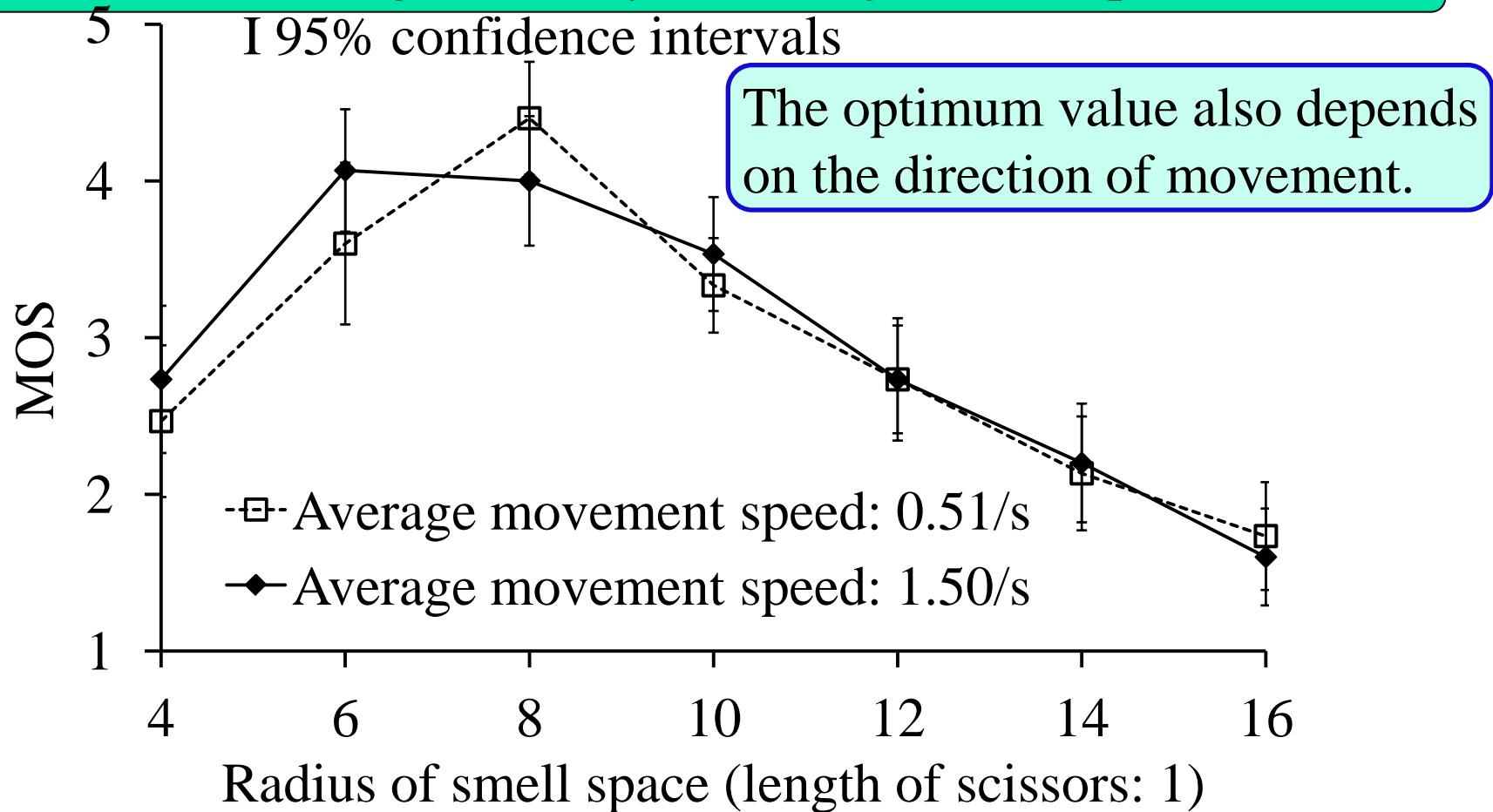
Work 1: Moving rose toward subject's viewpoint



There exists the optimum value of the smell space size,
and the optimum value depends on the average movement speed.

Assessment Result (2/2)

Work 2: Moving rose away from subject's viewpoint



There exists the optimum value of the smell space size, and the optimum value depends on the average movement speed.



Conclusions and Future Work

Conclusions

We handled a remote ikebana system with olfactory and haptic media. We investigated the influence of the smell space size on QoE.

- There exists the optimum value of the smell space size.
- The optimum value depends on the average movement speed and the direction of movement.

Future Work

- Propose an adaptive control scheme which changes the smell space size dynamically according to the average movement speed and the direction of the movement (already done)
- Study of QoS control such as media synchronization control, error control to improve QoE