Influence of Olfactory and Auditory Senses on Fairness Between Players in Networked Virtual 3D Object Identification Game with Haptics

Ryo Arima, Mya Sithu, and Yutaka Ishibashi

Graduate School of Engineering,
Nagoya Institute of Technology
Nagoya, Japan

Oct. 12, 2016   IEEE GCCE 2016   Mielparque Kyoto
Outline

- Background
- Purpose
- Networked Virtual 3D Object Identification Game
- Assessment System
- Assessment Results
- Conclusions and Future Work
By using multisensory communication, we can realize various applications such as networked games with high sense of presence.

In the games, fairness between players is important to reflect the game ability of each player to win-loss records.

We sometimes cannot use some senses by sickness, injury, surroundings, and so on.

We need to assess the fairness in various networked games.
The influence of the difference in time until smells reach players on Quality of Experience (QoE) about the fairness was examined.

How much correctly virtual 3D objects are identified with haptic, olfactory, and auditory senses in a virtual environment was investigated by using a 3D virtual object identification system.

Purpose (1/2)


Previous work

The influence of the difference in time until smells reach players on Quality of Experience (QoE) about the fairness was examined.

The system is standalone, and we also need to assess the influence of olfactory and auditory senses on the fairness in networked games. What kinds of factors largely affect the fairness is not necessarily clear enough, and we need to investigate other factors on the fairness.
We investigate the influence of olfactory and auditory senses on the fairness by QoE assessment for the networked virtual 3D object identification game with haptics by switching whether olfactory and auditory senses are employed or not.

Networked Virtual 3D Object Identification Game

3D virtual space

Headset

Headset

PC

PC

Network

Cursor

List

Score and time

3(Player 1) -1(Pro 2)
Time Limit [sec] : 62

Haptic interface device (Geomagic Touch)

Haptic interface device (Geomagic Touch)

Olfactory display (SyP@D2)

Olfactory display (SyP@D2)

GAME MODE
Select Answer

apple
balloon
banana
floor tom
grapefruit
gummy
hi-hat cymbals
peach
snare drum

Quit
Displayed Image of Game (1/3)

Start of game
Displayed Image of Game (2/3)

Object selection

Select Answer

- apple
- balloon
- banana
- floor tom
- grapefruit
- gummy
- hi-hat cymbals
- peach
- snare drum

3(Player 1) -1(Player 2)
Time Limit [sec] : 76
Correct answer
We use nine objects which have different smells or sounds and different features such as the shape, softness, and smoothness.

- (a) Floor tom
- (b) Snare drum
- (c) High-hat cymbals
- (d) Balloon
- (e) Grape fruit
- (f) Peach
- (g) Apple
- (h) Banana
- (i) Gummy candy
Demo video
The two PCs are connected to each other directly by an Ethernet cable (100BASE-TX).

Subjects assess the fairness of the game in three cases.

- **Case 1**: Smells and sounds are presented to a pair of subjects.
- **Case 2**: Smells and sounds are presented to only one subject of the pair. (We also switch the condition between the subjects.)
- **Case 3**: Smells and sounds are not presented to any subject of the pair.

The order of the cases provided to each pair is random.

When the conditions of a pair of subjects are the same as each other, we regard the game as fair.

Cases 1 and 3 are fair.
Four objects randomly-selected from among the nine are placed in the 3D virtual space. When the pair answer all the four objects correctly or the time in the game exceeds 90 seconds, new four objects are placed again until the end of game. Twelve objects are used totally in the assessment.
Before the assessment, each pair of subjects practice the game in case 3, where the game is fair.
We regard a score in this case as the *standard score*.
Whenever the game finishes, each subject is asked to give a value of 1 to 5 for each stimulus based on the five-grade quality scale.

**Five-grade quality scale**

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Fair</td>
</tr>
<tr>
<td>4</td>
<td>Rather fair</td>
</tr>
<tr>
<td>3</td>
<td>Neither fair nor unfair</td>
</tr>
<tr>
<td>2</td>
<td>Rather unfair</td>
</tr>
<tr>
<td>1</td>
<td>unfair</td>
</tr>
</tbody>
</table>
We calculate MOS (Mean Opinion Score) by averaging the values of all the subjects.

We use the absolute difference between the difference in standard score and that in assessment score as an objective assessment measure in order to take account of the difference in game ability between subjects.

For example:

<table>
<thead>
<tr>
<th>Standard score</th>
<th>Assessment score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 4</td>
<td>3 to 2</td>
</tr>
</tbody>
</table>

We obtain 4 because \(| (1 - 4) - (3 - 2) | = 4.|
We set the distance between the olfactory display and each subject’s nose to 0.3 m. *1
The room temperature was set to 26°C. *1
We carried out the assessment with 16 subjects (males and females) whose ages were between 22 and 24.

The average absolute differences in case 2 is larger than those in the other cases, and that in cases 1 and 3 are almost the same as each other.

The difference of the average absolute difference between cases 1 and 3 does not meet the significance level of 5%.
Assessment Results (2/3)

Smells and Sounds

- Case 1: Present to a pair
- Case 2: Present to only one subject
- Case 3: Not present to a pair

I : 95% confidence interval
Assessment Results (3/3)

Case 2

Smells and Sounds

- Presented: 95% confidence interval
- Not presented
We investigated the influence of whether olfactory and auditory senses are used or not on the fairness between players in a networked virtual 3D object identification game with haptics.

We saw that the fairness of the game is seriously damaged when the senses are employed only at one player.
Future Work

- We will assess the fairness in the case where we present only smells or only sounds for the game.
- We will increase the number of objects in the game.