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Hot-Spring-Experience Apparatus Based on Questionnaire

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There is a growing demand to feel a healing effect using a hot spring facility with a universal design. Sometimes, it is impossible to experience a hot spring under the constraints of space and time or physical impairment. The five-sense images of the hot spring were gleaned from a questionnaire, and the functions of the pilot unit (devices and materials for experiencing a hot spring (*onsen*) at home) were summarized to construct the virtual hot-spring-experience apparatus using the result of the questionnaire. It is clear that the unit can be built at a moderate price. The functions of the unit involve visual, auditory, tactual, and olfactory senses except taste sense. The important senses are visual, auditory and olfactory. The visual and auditory senses can be experienced using a head-mounted display (HMD) and "YouTube." A mineral deposit was used to satisfy the subjective olfactory sense in a home bath. The tactual sense is also satisfied because the test subject really takes a bath. In general, the images of a hot spring resort are a *yukata* (light cotton *kimono*) in summer, smoking steam, sulfur smell, open-air hot spring, sound of running the hot spring, and the rustle of leaves. The taste for spring drinking water is salty.

1. Introduction

Recently, the social environment for human beings has become gradually hard in terms of the work environment and human relationships, and people seek healing through a pet, a foliage plant, and a virtual apparatus. In particular, the labor environment is becoming harder because of the deterioration of economic conditions, and the number of suicides is increasing. The social needs for a simple virtual healing apparatus are increasing. Healing through five senses has the best effect. Many busy workers want to have a healing effect through a hot spring. A hot spring (*onsen* in Japanese) is popular with workers in Japan.(1) They cannot, however, visit a hot spring frequently. Some workers want to have a virtual hot-spring-experience apparatus because they are busy

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with work and cannot afford to visit a spa area. It is also difficult for physically disabled people to experience a hot spring owing to their circumstances. The need to experience a hot spring through the five senses will increase with the social environmental changes. The research on five-sense communication is advancing and the utilization of IT apparatus is being promoted in Japan. The IT apparatus is not actively put to practical use in a healing area. In this study, a virtual hot-spring-experience apparatus can be constructed using an ordinary IT apparatus, for example, a head-mounted display (HMD) including a headphone. The healing effect through the five senses for a hot spring is summarized according to 267 questionnaire results; namely, the spa image of a hot spring from five senses was derived from the questionnaire results. The sense with the highest rate was the visual sense. The rates for the other four senses are more or less the same. Heated air is an important factor for tactual sense. The smell of sulfur is the main image for the olfactory sense. The salty taste of spring drinking water has a high rate for the taste sense, but this sense is not built into the experience apparatus in this study because there are many people who dislike the taste of spring drinking water.

2. Questionnaire for Five Senses

2.1 *Survey method*

The image of a spa obtained by using five senses is very important to fabricate a virtual experience apparatus, for example, a hot-spring-experience apparatus.[2] The image of a hot spring was derived from the result of a questionnaire. Questionnaires were handed out to students and teachers of several universities, and people outside school. In addition, questionnaires were distributed to their family members through them and collected by hand. Therefore, the questionnaire was answered by 267 people in their teens to eighties: 52 were in their teens; 66, 20s; 39, 30s; 38, 40s; 32, 50s; and 40, over 60. The questionnaire items are as follows. (1) age and sex, (2) spa image (description with all senses), (3) other spa images (description), and (4) spa image for each interesting spa area (description).

2.2 *Result*

The results of the questionnaires are introduced as follows. The results for each questionnaire item were categorized and summarized by age.

2.2.1 *Visual sense*

The spa image obtained by visual sense is indicated for every age in Fig. 1 using a bar graph. The main image factors are (1) Japanese style, (2) beautiful scenery of nature, (3) open-air spa, (4) hot steam, (5) Japanese-style inn, and (6) other factors. Three factors ((1), (3), and (5)) refresh the body and spirit; namely, those factors have a healing power for the Japanese. There is a tendency that the percentages of other factors are larger for those over 20 than for those in their teens. They have various images, but the teens have relatively fixed images. The people in their teens have not visited many spring inns. Therefore, their images arise from the materials reported by media. Moreover, there are more comments regarding visual sense from those in their 20s to 50s. This means that

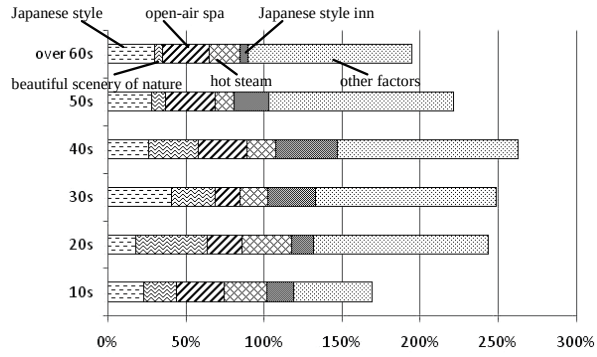

Fig. 1. Visual sense image for hot spring. The characteristics are indicated by age bracket.

people can feel relaxed while they are experiencing an *onsen* by using their visual sense. If people are closing their eyes, they use their other senses to feel relaxed; however, the visual sense affects much of their feeling. The result of a hot spring image obtained by visual sense is summarized by age bracket in Fig. 1. The total percentage from all ages for each image by using a pie chart is illustrated in Fig. 2. The factor of "Japanese style" accounts for a substantial fraction of 12%. The following two factors, (2) beautiful scenery of nature and (3) open-air spa, also have the same rate as "Japanese style." The factors (4) hot steam and (5) Japanese style inn have almost the same rates. The five factors constitute a significant fraction of 55%.

2.2.2 *Auditory sense*

The auditory sense is also an important sense just as the visual sense. Most information from the five senses is incorporated from visual and auditory senses. It is necessary that the images from the two senses provide appropriate stimulation. The two main auditory images of a hot spring for people over 50 years old are "sound of water flowing (river and hot spring)" and "sound of nature (birds and rustle of leaves)." Both sounds are sorted into the category of nature sounds. The percentage of the image of nature sounds becomes higher with age. Other auditory images are "sound of wood tub," "silence" and "*shishi-odoshi*," which is a kind of device for threatening birds and animals. Some people feel comfortable with silence. The characteristics of a hot spring image obtained by auditory sense are shown in Fig. 3 and the same result using a pie chart is indicated in Fig. 4.

2.2.3 *Olfactory sense*

There are many hot spring areas in Japan. Some of them are odorless and some have a very strong smell (for example, sulfur smell). A hot spring has not only a sulfur smell but also other smells as well. The smell has healing power. It is better for humans that there are some smells in an *onsen* area. The images of *onsen* obtained by olfactory sense are summarized in Fig. 5.

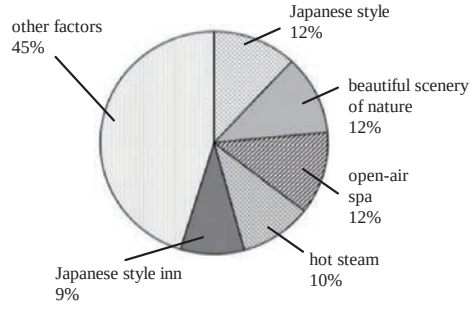

Fig. 2. Hot spring image by visual sense using a pie chart.

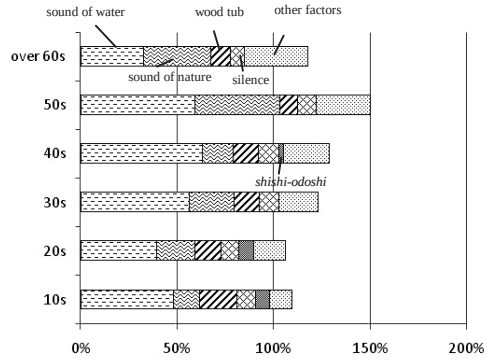

Fig. 3. Auditory sense image for hot spring. The characteristics are indicated by age bracket.

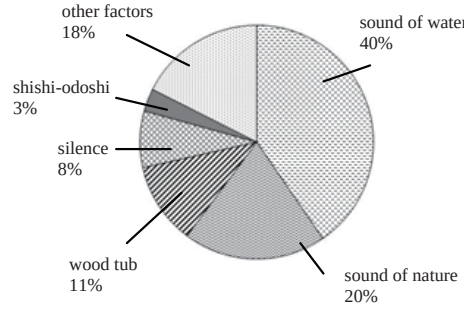

Fig. 4. Hot spring image by auditory sense using a pie chart.

The spa image obtained by olfactory sense from all generations is mainly sulfur smell. People also prefer wood (cypress) smell. In Japan, an *onsen* tub is sometimes made of cypress. Cypress generates a smell having a healing effect. Japanese individuals prefer its smell.[3] People older than 40 prefer more sulfur smell. It is assumed that they visit

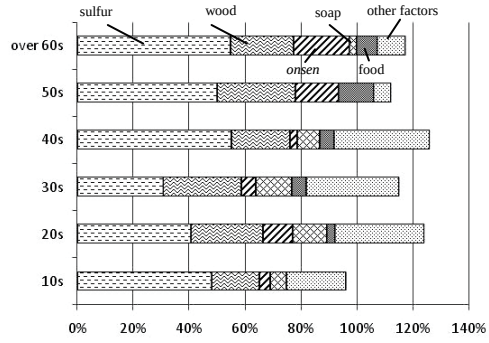

Fig. 5. Olfactory sense image for hot spring. The characteristics are indicated by age bracket.

a sulfur-smelling ***onsen*** more often than younger people below 30. It might be said that people over 40 are used to the smell and have a more relaxed feeling with sulfur smell. The characteristics of a hot spring image obtained by olfactory sense are summarized in Fig. 5 and the same result using a pie chart is indicated in Fig. 6.

2.2.4 *Tactile sense*

It is difficult to express the feeling in tactile sense. "Smooth skin" after experiencing an ***onsen*** is the main feeling. The questionnaire result is shown in Fig. 7. Respondents to the questionnaire on tactile sense fill out simply "skin" and "***onsen***." Particularly for those in their 20s to 50s, their spa images obtained by tactile sense are mainly "skin" and "***onsen***." However, for those in their teens, "skin," "***onsen***," and "hot steam" are almost equally important. Also, people over 60 have "skin" image for tactile sense. The characteristics of a hot spring image obtained by tactile sense are summarized in Fig. 7 and the same result using a pie chart is indicated in Fig. 8. The percentages for feelings of "rugged rock" and "snug" are very small.

2.2.5 *Sense of taste*

Many people think that there is no relationship between ***onsen*** and taste sense. However, various factors should be considered together. There is an ***onsen*** image from the viewpoint of taste sense in the Japanese ***onsen*** culture. The questionnaire result is indicated in Fig. 9. The image of the young adult segment showed a higher percentage for salty taste. Those in their teens and 20s have mainly salty image; however, people over 40 have the image of local dishes. They have a tendency to enjoy the local dishes, so the rate for dishes is higher than those for respondents below 20. There are also "bitter taste," "health drink," and "brackish taste" in the taste image. Many people do not drink spring water. The characteristics of hot spring image obtained by taste sense are summarized in Fig. 9 and the same result using a pie chart is indicated in Fig. 10. Chefs also pay attention to the taste and odor of their dishes. In Japanese ***onsen*** dishes, there are usually sake, sashimi, tempura, and seasonal ingredients. A lodger makes mealtime pleasant with conversation with acquaintances and the dinner time is about two hours in a Japanese spring inn.

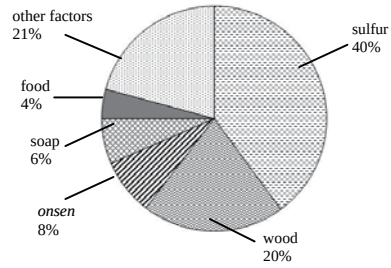

Fig. 6. Hot spring image by olfactory sense using a pie chart.

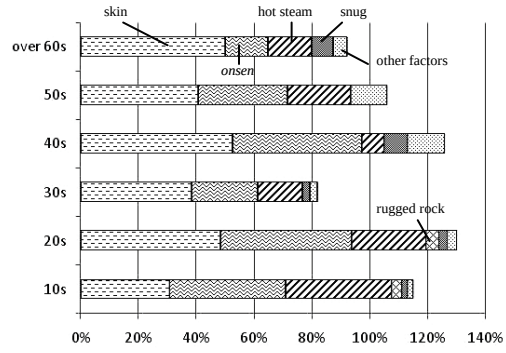

Fig. 7. Tactile sense image for hot spring. The characteristics are indicated by age bracket.

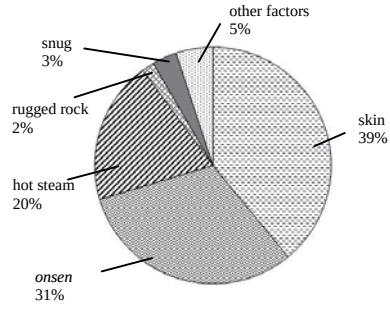

Fig. 8. Hot spring image by tactile sense using a pie chart.

2.2.6 *Comprehensive image*

A comprehensive image is summarized from the questionnaire results. The number of comments for each sense is analyzed to see the impact percentages of those senses. The result is shown in Fig. 11. The highest percentage is the visual sense out of the five

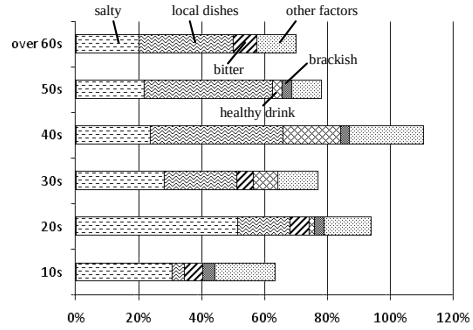

Fig. 9. Taste sense image for hot spring. The characteristics are indicated by age bracket.

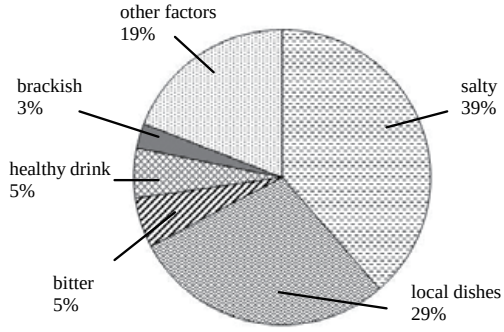

Fig. 10. Hot spring image by taste sense using a pie chart.

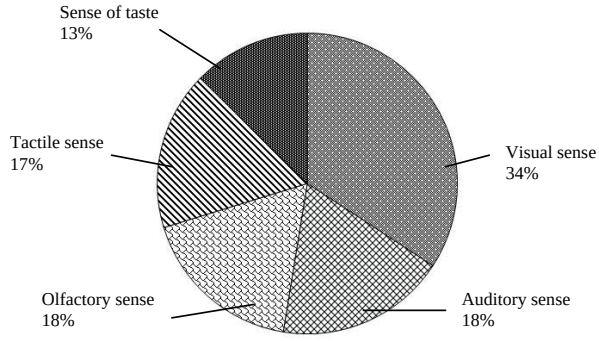

Fig. 11. Comprehensive image percentage from the questionnaire results.

senses and the rate is 34%. The visual sense is followed by the auditory and olfactory senses. Both are 18%. The tactile sense is 17% and the taste sense is 13%. The respondents have many images of a hot spring through visual, auditory, and olfactory

senses. Many images occur especially from visual sense. When the three rates are summed up, it becomes 70%. The images from these three senses should be considered carefully when the virtual *onsen* apparatus is manufactured.

The summarized images of *onsen* are as follows when taken together. Since the visual sense is the most significant among the five senses, looking at a beautiful scenery in a Japanese style open-air space makes people feel relaxed as if they are in an *onsen*. Also, auditory and olfactory senses add more feeling while people are in an *onsen* by listening to the sound of water or nature, and smelling sulfur or wood.

3. Odor Experiment for Hot-Spring Water and Atmosphere

It is clear from Fig. 11 that the image for the olfactory sense is also important when humans imagine an *onsen*.[3,4] The rate is 18% and many people imagine sulfur smell. Since the smell of cypress comes from the wooden bathtub, it is difficult to deal with the smell of cypress. In this odor experiment, the smell of sulfur is dealt with. The odor grade of *onsen* water was measured using a gas sensor (Figaro TGS #800). The measurement system is shown in Fig. 12. The odor grade is measured using an experimental chamber of 300 L, which is made of acrylic. The subject is put in the chamber and the cover of a vessel is opened after the base level of the odor is measured. The level is measured for one hour. The subjective material is precontained in the vessel. Three types of material were measured, namely, open-air hot spring water, *onsen* water in indoor bath of a hot spring inn in Kusatsu of Gunma Prefecture in Japan, and the deposit of hot spring water (*yu-no-hana*). The subject odor is measured using the sensor and the grade is output as a change in DC voltage. The odor grade of open-air hot spring water of 100 ml near the *onsen* source is indicated in Fig. 13. The grade of *onsen* water of 100 ml in an indoor bath is indicated in Fig. 14. The odor grade characteristic for *yu-no-hana* of 2 g dissolved in distilled water of 100 ml is shown in Fig. 15. The highest grade for the materials is the *onsen* water near the source. The grade for *yu-no-hana* was measured as a change in the dissolved volume. The odor characteristics do not change considerably. It is considered that the odor near the *onsen* source has a healing effect. It is better to experience an *onsen* (for example, open-air spa) near the source to feel a

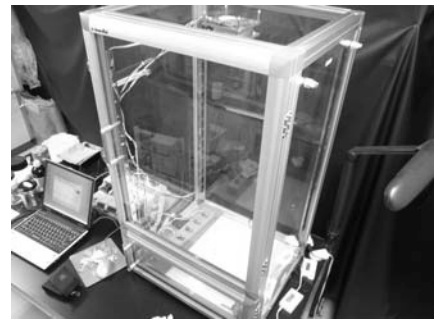

Fig. 12. Experimental chamber for measuring onsen odor grade.

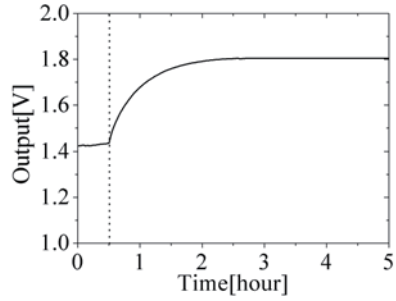

Fig. 13. Sensor output characteristic for hot spring water near the *onsen* source.

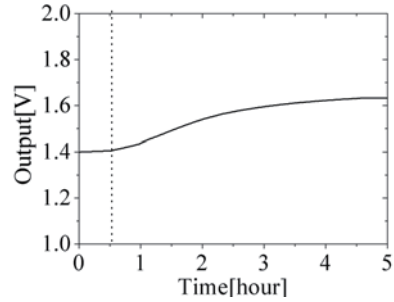

Fig. 14. Sensor output characteristic for onsen water of 100 ml in indoor bath.

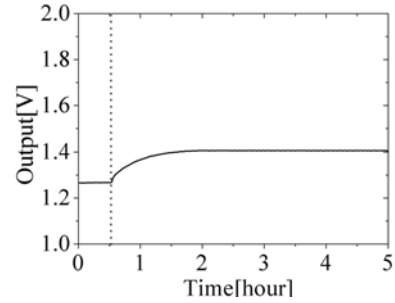

Fig. 15. Sensor output characteristic for *yu-no-hana*.

healing effect from the view point of olfactory sense. However, even though the grade of *yu-no-hana* is lower than that of hot spring water near the *onsen* source, the odor of *yu-no-hana* can be maintained for a long time, the same as the hot spring water. Therefore, *yu-no-hana* is good for use in the virtual hot-spring-experience apparatus.

4. Virtual-*Onsen*-Experience Apparatus

From the questionnaire results and the experiment data, it is better to create the virtual-*onsen*-experience apparatus by focusing on mainly the visual, auditory, and olfactory senses. People can relax by looking at the Japanese-style and beautiful scenery, listening to nature sounds, and smelling sulfur or wood. It is very difficult to build a taste-sense function in the virtual-*onsen*-experience apparatus, but four sense images should be incorporated. Since *yu-no-hana* can be replaced by the hot spring water from the experiment, it is used for this virtual-*onsen*-experience apparatus. The following units (devices and materials) are incorporated in the apparatus. Each unit corresponds to each of the five senses. The virtual-*onsen*-experience apparatus is shown in Fig. 16. Four devices are incorporated in the apparatus. HMD including headphones are put on. People take the house bath and can experience *onsen* in a favorite area using HMD or YouTube and *yu-no-hana*. YouTube is easily set at home through the Internet to obtain various sceneries and sounds of nature from all over Japan. It is used for free. The deposit of hot spring water, *yu-no-hana*, can also be easily purchased. Therefore, they can be set to this apparatus easily without a lot of expense. The cost of the apparatus is below 1,000 US dollars. The apparatus can be installed in the bath room of a regular house.

- visual and auditory senses: HMD (head-mounted device) with headphone or YouTube
- tactile sense: bath in a regular house
- olfactory sense: *yu-no-hana*

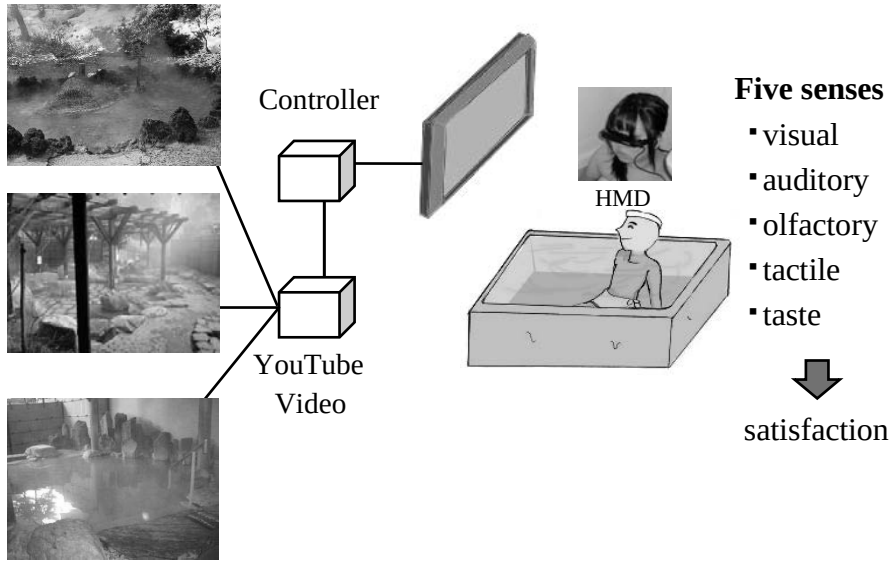

Fig. 16. Virtual hot-spring-experience apparatus.

In the future, the experience of *onsen* at a given area will be possible in real time beyond time and space with the development of five-sense communication.[5] Experienced people will visit the *onsen* as a matter of fact.

5. Conclusions

A virtual hot-spring-experience apparatus is constructed as an application of five-sense communication technique. The hot spring is one of the important tourism resources in Japan. The number of visitors to *onsen* resorts is on a decline with the deterioration of economic conditions. It is necessary to develop an experience apparatus for the additional value of the *onsen*. *Onsen* images through five human senses were investigated using a questionnaire for manufacturing the apparatus. The images were narrowed down to the following items. As the visual sense, the items are "Japanese style," "beautiful scenery of nature," "open-air spa," "hot steam," and "Japanese style inn." The images for auditory sense are "sounds of *onsen* water," "nature (birds and river current)," "wood tub," and "silence." The following items were listed for olfactory sense, namely, smells of "sulfur," "wood," "*onsen*," "soap," and "local dishes." "Smooth skin," "slickness of *onsen*," and "hot steam" are listed for tactile sense. The two items for taste sense are listed chiefly from the result of the questionnaire, namely, "salty" *onsen* water and "local dishes." It is said that people avail of the recovery and healing effects by experiencing an *onsen*. Fatigue can be reduced with the manufacture of the virtual-*onsen*-experience apparatus, in which people can experience an *onsen* as if they are in a real *onsen*. Therefore, it is fundamental to build realistic images and establish five-sense communication techniques.

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