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Poster Proceedings

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Preface

We have the poster session in The Eighth International Conference on Collaboration Technologies (CollabTech 2016) as well as the paper sessions in which papers are orally presented. The aim of the poster session is to provide an opportunity for poster presenters to present late-breaking research results, ongoing research projects, and speculative or innovative work in progress in more casual and interactive way.
All poster paper submissions were reviewed by the poster program committee, resulting seven papers were accepted. We believe the poster session provides a great opportunity for researchers to present and to receive direct feedback from audience about the ongoing significant work.

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Venue: Event Hall of Shiinoki Cultural Complex, Kanazawa, Japan

Hierarchy Analyzer for GUI-Usability Evaluation of Android Applications

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Abstract

In recent years, the environments for doing co-development via the remote has been available. However, it is difficult to get consensus of UI design policy in the team. We aim to provide appropriate improvement tips for the developers of GUI applications on smartphones. The GUI usability varies according to the characteristics of each application. This study describes a method to extract the attributes from Android GUI applications. Moreover, we use machine learning to look for hidden design models in excellent GUI applications.

1 Introduction

Universal Design is required for all applications with a graphical user interface (GUI). In addition, application development and publishing have become easy for everyone. However, inexperienced developers who have little knowledge of UI design may find it difficult to make good applications with useful user interfaces. The typical GUI evaluation method is a questionnaire survey [1] or self-testing by the developer. However, these approaches are difficult for beginning developers to apply.

In this study, we present a GUI evaluation system that automatically evaluates an application and offers suggestions to improve its usability. By using a machine-learning method, we expect to extract hidden and common key concepts from excellent GUI applications. These extracted concepts may not be mentioned in well-known GUI design guidelines. We present a system that proposes a much more useful design, suited to the characteristics of the application, based on the extracted results.

Previously, we proposed a usability-evaluation method that did not depend on the existing guidelines [2]. Additionally, we developed an original GUI analysis method, called “Static Analysis,” which could process at high speed, and we analyzed several applications using this method. However, it required manual pre-processing, and was not suited to analyzing a huge number of applications. In this paper, we present a new system with improved analysis methods.

2 System for Usability Improvement

In our study, we apply general concepts for user-interface design. The first one is "The Four Principles of Design," which is an important concept in general design. The principles consist of proximity, repetition, contrast, and alignment. They are used in many GUI applications. Fig. 1 shows an example of the interface design of a GUI application. The image under the mouse pointer is colored to identify it as the selected one. However, this is not always the best methods. There are many other ways to improve a GUI; e.g., expanding the GUI component size, etc. A more flexible usability-improvement method is needed to consider the design and features of each application.

Another concept is "GUI Design Guidelines." Well-known platforms generally provide guidance to design the GUI for an application; e.g., "Android Design" [3] for Android OS as the smart-device platform, "iOS Human Interface Guidelines" [4] for iOS, etc. By taking rules from these guidelines, we may automatically evaluate the usability of a GUI. However, evaluation results based on the guidelines could become uniform and monotonous.

To automatically evaluate the GUI

usability and suggest improvements, we execute the following steps. At this time, Step 1(a) and 2 are realized. The entire process runs automatically using a Perl script that we developed.

1. Extract the GUI attributes and the improvement methods
   (a) Attribute analysis - Attribute extraction that later mentioned in chapter 3.
   (b) Behavior analysis (improvement-method extraction)
2. Attribute classification (GUI feature extraction using machine learning)
3. Cluster the features and improvement methods

Fig. 1. Example of Item Selection in a GUI

3 GUI Attribute Analysis

In the attribute analysis of this study, we converted a GUI structure to the tree structure described below. We adopted the Android application environment because the specifications have been published clearly.

3.1 Application Analysis and GUI Tree Generation

Firstly, we obtained the package file (APK) of the target application, and installed it on an Android Virtual Device (AVD). Then, we developed a customized version of the "Hierarchy Analyzer," which analyzes the GUI-application structure. Using this tool, we obtained the GUI tree shown in Code 1 that contain the parameters of that GUI part (View). Then, captured images are shown in Fig. 2 from each view.

The original version of the Hierarchy Viewer is included in the "Android Software Development Kit (SDK)" and embedded in the Integrated Development Environment (IDE) as a plug-in. Therefore, it must be used in the IDE and operated manually. Our customized version has the following advantages over the original version.

- Simple build process. It extracted the minimum required projects from the Android SDK and Development Tools (ADT).
- Automatic process using command-line options
- GUI tree is exported in the JavaScript Object Notation (JSON) file format
- Views of each GUI are captured and the images saved in the Portable Network Graphics (PNG) file format

```
{
  “zero”:{
    “image”:”/tmp/gui-refine-cache/latele.nekocalc/zero.png”,
    “name”:”android.widget.Button”,
    “property_drawing:getAlpha()”:”1.0”,
    “property_drawing:getRotation()”:”0.0”,
    “property_drawing:getSolidColor()”:”0”,
    “property_drawing:getX()”:”0.0”,
    “property_drawing:getY()”:”99.0”,
    “property_layout:getBaseline()”:”69”,
    “property_layout:getHeight()”:”99”,
    “property_layout:getWidth()”:”118”,
    “property_layout:mBottom”:”198”,
    “property_layout:mLeft”:”0”,
    “property_layout:mRight”:”118”,
    “property_layout:mTop”:”99”,
    “property_scrolling:mScrollX”:”524229”,
    “property_scrolling:mScrollY”:”0”,
    “property_text:getTextSize()”:”52.0”,
    ….
  },
  ….
}
```

Code 2. GUI tree generated by our Hierarchy Analyzer

Fig. 2. Capture-image of View (Button);
It contains as the path in each view in Code 1.

3.2 Dataset Generation from the GUI Tree

To extract the attributes from the GUI tree generated in the previous section, the attribute value of each view is calculated. A dataset is generated from each view obtained from the GUI tree, using the following Perl module called the "Dataset Generator." By repeating these steps, each module makes a dataset of each window. We implemented the following modules.

- General-purpose dataset generator: GUIRefine::DataSetGenerator::Android::General
- Dataset generator for each view type: GUIRefine::DataSetGenerator::Android::Button (example)

The former generator will generate attributes for all views. There are contains the following attributes. In addition, some attributes about color will be generated from capture-image of Fig. 2.

- numColors: Number of colors on the screen
- mostUsedColor: Most used color(s) on the screen
- …

The latter generator will generate attributes for each view type. Following is an example for the Button view.

- num: Number of buttons on the screen
- minWidth: Width of the smallest button on the screen
- minHeight: Height of the smallest button on the screen
- minDistTop: Distance from the top of the screen to the button
- minDistLeft: Distance from the left edge of the screen

4 Experiment

We conducted an experiment to confirm the feature extraction from GUI applications. Specifically, we analyzed the attributes from multiple applications listed in Table 1. We compared the attribute-value trends that were output by the "Random Forests" algorithm using the R language. The target application in this experiment was a simple calculator; specialized calculators were excluded (e.g., hex number converters).

Each application are compared using the attributes in Table 2. The “Name”, “Author”, “Version”, and other column of each application in that table were acquired from the Google Play Store in Japanese or English in Dec. 2015. The “Assign” column is a classification variable in this experiment. A value of “A” means the application is easy to use; a value of “B” means it is hard to use. For this classification, we referred to the evaluation scores and review comments of each application in the Google Play Store. In this experiment, we used only the startup screen of each target application.

The results of this experiment are shown in Fig. 3. That figure shows the graph of the frequency distribution of the eight selected attributes of all 27 attributes from the GUI tree. That graph shows the trend of each attribute in each application using the box-and-whisker plot, and the X-axis in each inner graph shows the attribute value that described in Table 2.

In our previous study [2], the target application was not focused and various applications for different purposes were analyzed together. In addition, the previous method could only analyze simple applications, and the target applications used for analysis were quite few. By using the new tool, we can analyze many more applications and focus on a specific application type. We could not extract the trends and guidelines for this target application. The reason is under investigation.

5 Conclusions

We proposed a system that suggests methods to improve a GUI by evaluating many high-rated GUI applications. We will use machine learning, which is not bound by the GUI Design Guidelines.

We developed “Hierarchy Analyzer” and “Dataset Generator”, and realized the “Attribute Analysis” method. The Attribute Analysis can be analyzed the attributes using Hierarchy Analyzer and make a dataset from GUI applications for evaluation. To make a dataset, the system obtained a GUI tree using Hierarchy Analyzer from a running application on the Android virtual machine, and calculated the attributes from the GUI tree using the Dataset Generator.

We can easily analyze many applications using the new method. We can also consider the application licenses, because our method does not need to de-compile the application. Currently, we will trying to realize the Behavior Analysis from the many applications. We hope to reduce the burden of all developers by continuing this study.

Table 1. Experimental Applications (18 items)

Name	*Author*	*Ver.*	*Score*	*Assign*	*Usability Mentions in User Review Good / Bad*
Calculator	andanapps	2.0.5	4.1	A	- / -
Calculator Pro free	Apalon Apps	2.0	4.1	A	2 / 5
CALCU Free	Designer Calculators	2.1.0	4.5	A	- / -
Calculator Plus Free	Digitalchemy, LLC	4.9.2	4.4	A	23 / 2
Simple Calculator	Kugelschreiber	3.0	4.1	A	- / -
LateCalc	Latele Inc.	1.5.0	3.6	B	5 / 3
NekoCalc	Latele Inc.	1.3.0	4.3	A	1 / -
Takano tsume calc...	Loop-Sessions LLC	1.31.0	3.8	B	- / -
Colorful calculator	R225.zero	1.6	3.9	A	23 / -
Panecal	Appsys	6.0.2.2	4.1	A	3 / 1
TigerCalc	tripot	1.1	3.4	B	- / -
RealCalc	Quartic Software	2.3.1	4.5	A	- / -
Cho Simple Calculator 2	Nobuo CREATE	1.3	3.9	B	- / -
Pretty Calculator	Pretty Pet Co	1.1.3v	4.0	A	- / -
Oto-san Calculator	SoftBank Corp.	3.0.0	3.6	B	1 / 3
Calculator	7th Gear	1.0	3.9	B	- / -
Calculator	TricolorCat	1.10.7	4.1	A	8 / 2
Calculator	Woodsmall inc.	1.6.5	4.0	A	13 / 3

Table 2. Comparison Attributes in Dataset (Excerpt)

Name	*Description*	*Unit*
Button.distLeft	Distance from the screen left edge to Button	Pixels (px)
Button.distTop	Distance from the screen top to the Button	Pixels (px)
Button.minHeight	Height of the smallest Button	Pixels (px)
Button.minWidth	Width of the smallest Button	Pixels (px)
Button.num	Number of Buttons on the screen	Pieces
EditText.distLeft	Distance from the screen left edge to EditText	Pixels (px)
EditText.distTop	Distance from the screen top to the EditText	Pixels (px)
EditText.minHeight	Height of the smallest EditText	Pixels (px)

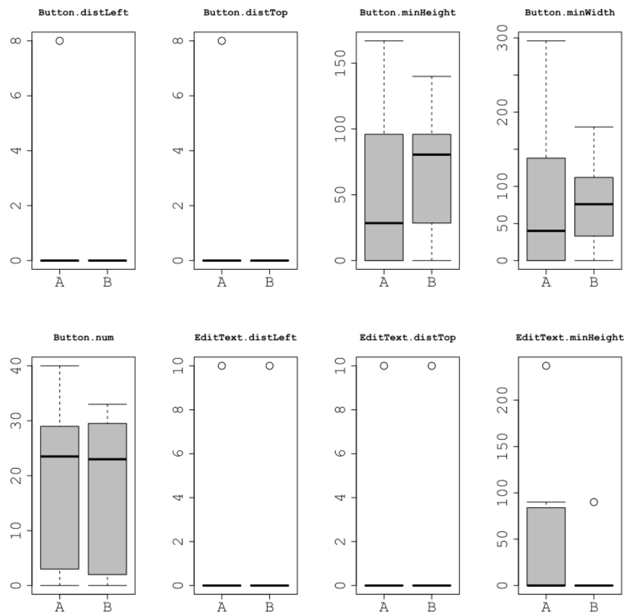

Fig. 3. Experimental Results: Frequency Distribution (Excerpt)

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Subjective Sensing of Real World Activity on Group Study

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Abstract

Collaborative learning is efficient teaching/learning method, and it is widely introduced and practiced in various situations. However, it has a difficulty to perform formative assessment and real time evaluation without students' feedbacks. Therefore, demand for technologies to support formative assessment in collaborative learning is increasing. To tackle this problem, we have started the research project for automatic sensing and visualization of real world activities in collaborative learning. In this paper, we will report details about preliminary group work experiments and its results with visualization tool.

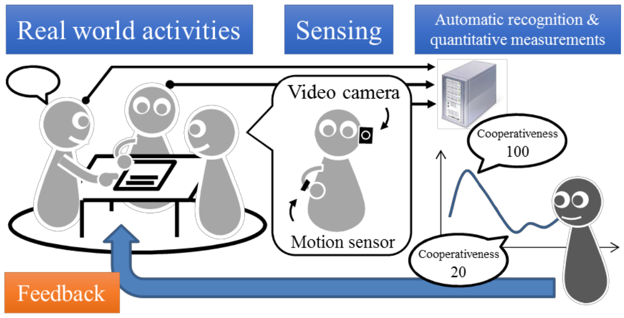

Figure 1. Concept of subjective sensing of real world activities on group study.

1. Introduction

Collaborative learning is one of the efficient methods to encourage students to explore and solve problems together with members who have different abilities and thoughts, and it can promote various skills such as oral communication, leadership, etc. Therefore, it is now widely introduced and practiced in many educational institutions. Assignment progress and exams are usually used for quantitative evaluations. However, in the case of collaborative learning, formative assessment becomes more important to evaluate learning process of each student. Since formative assessment during collaborative learning is very difficult, qualitative feedbacks by students are commonly utilized. Therefore, it is expected to be developed technologies that can perform formative assessment without student's feedback during learning

Although Computer Supported Collaborative Learning (CSCL) is widely studied [1,2], most of them used computer oriented virtual environment as a tool for quantitative evaluations. In the case of virtual environment, it is very difficult to measure natural communications and collaborations between students. Therefore, it is necessary to extend CSCL into real world group study where it is possible to observe natural behavior of students.

One of the important and expected evaluations in real world collaborative learning is to check whether a student is able to share his/her opinions or ideas together with other students [3]. When we saw well-communicated group in collaborative learning, members of such group appropriately payed attention to the speaker for sharing knowledge, and their activities seemed to be well synchronized and cooperated. Therefore, (1) attention level against the speaker, and (2) activity synchronization level, can be considered as important elements for formative assessment during collaborative learning. If we use (1), it may be possible to recognize the transition of leadership in the group since we can know who had been payed attention by whom on the group work timeline. If we combine (1) and (2), cooperativeness and activeness in each group are expected to be quantitatively measured.

To develop technologies for measuring above (1) and (2), we have started the research project for automatic sensing and visualization of real world activities in collaborative learning (Fig.1). This paper report results of the small subjective experiment conducted as a preliminary study in this project. In the experiment, the task is a group work building a town diorama using LEGO blocks. For the purpose of measuring subjects' attentions and activities, first person view camera and wearable activity sensor are attached to each subject. To analyze group activities, all cameras and sensors were fully synchronized with manual adjustments.

Section 2 describes details of group work experiments and specifications of first person view camera and wearable activity sensor. Section 3 describes experimental results with visualization tool. Finally, the paper is concluded in section 4.

2. Methods

2.1. Target activity

As a target group activity, we configured a cooperative development work of making a town diorama. Followings are the reasons why we choose this type of group activity.

(1) Dense communication for making consensus and role arrangement among members are quite important aspects that expected to be trained via group activity. Cooperative making of a product can be considered as a good situation for naturally inducing subjects' communications for those purposes.
(2) Design workshop in which members propose some solutions to solve problems requires certain time (sometimes with large field) for investigation, discussion, and constructing results. More compact group activity was preferable for first analysis.

In our experiment, four university students and two staffs (six in total) joined as group activity members. They were divided into two groups, each of which consists of three members. An additional university staff performed as a facilitator conducting the activity. Each group used the same type LEGO blocks set to build a particular scene of a town. Before building a town georama, they discussed and determined a scene they will create and the way for members' cooperation.

The conducted group activity was roughly divided by the following 4 phases.

(1) Explanation given by the facilitator : 10 min.
(2) Discussion to determine a scene they build and the way to cooperate : 10 min.
(3) Working time : 40 min.
(4) Exhibition time : 10 min.

In the phase (1), the subjects had self-introduction time although most of them know each other. The explanation included the purpose of the experiment, but we asked the subjects to behave as usual. During the working phase (3), the facilitator sometimes asked about the idea for building or the progress to extract verbal communication. In the phase (4), the subjects explained what scene they built with what idea and gave some questions for each other. Figure 2 shows an example of the activity scene in the group work.

2.2. How to record activities

One of the important issues on analyzing real world behavior in group activity is to develop a practical sensing system accepted by general group activity configurations including purpose, location, and style. In this viewpoint, a complexed sensing system taking much construction time and effort is not feasible. A simple and compact construction is required. In our work, we attach small wearable sensors including first person view cameras to the subjects for easy preparation. Followings are specifications of actual sensors used in the experiments.

2.2.1. Wearable first person view video camera (Fig. 3). Small but high performance action cameras were attached on the heads of all group members. This method can be used not only in an indoor activity and also in an outdoor one with easy preparation. With this sensing, visual record of the target activity is captured from the subjective and internal viewpoints. Therefore, it is possible to analyze transition of subject's attention during group work. In addition, communications between subjects can be analyzed through voice recordings. The FOV, image resolution and frame rate of the camera are

Figure 2. Example of a scene of the conducted activity.

Figure 3. Wearable first person view camera.

Figure 4. IMU sensor.

approximately 90 degrees, 1920x1080 pixels and 30 fps, respectively.

2.2.2. IMU sensor (Fig. 4). The group members also attached wrist type watch sensors implementing inertial measurement units (IMU). These sensors can record activeness of each person that is difficult to estimate from visual information. The IMU sensors records up to ±20G acceleration and ±5deg./s angular velocity along X, Y, and Z axes, respectively.

2.2.3. Fixed video camera. In addition to the above sensors, video cameras were fixed in the environment and they recorded perspective view of the activity. Because even if with multiple internal views, an overview of activities is difficult to be estimated. But we use recorded videos for confirmation (acquiring ground truth through manual browsing) and will not use as input data of automatic analysis.

3. Experiments

3.1. Dataset specification

Each person wore a wearable video camera to his head/chest and a wristwatch type IMU sensor on his right arm. Two fixed video cameras were arranged in the room in order to capture the whole scene as described in 2.2.3.

We recorded three kinds of data, i.e., 1) image sequence of wearable first person view video camera, 2) motion sequence of IMU sensor, and 3) image sequence of fixed video camera. The video cameras captured the scene at 30 fps, meanwhile the IMU sensors measured acceleration and angular velocity at 50Hz.

3.1. Visualization

We developed a visualization tool as shown in Fig. 5. The visualizer provides three sub-windows to show a video sequence and two waveforms. In each sub-window, we can select a corresponding file, e.g. video and recorded files of the same person. The waveforms are automatically synchronized by referring to the timestamp of the data.

We extended the above visualizer to compare the activities in the same group. In Fig. 6, the extended visualizer has three components (one component corresponds to one person). The data sequences are synchronized among the components. Figure 6 shows examples of visualization during the cooperative development work. The screen shots of group 1 and group 2 are arranged in upper part and bottom part of Fig. 6 respectively. We selected two typical scenes from each group. When the facilitator gave an explanation about the task of cooperative work with a whiteboard, all member of both group paid attention to the facilitator. In this

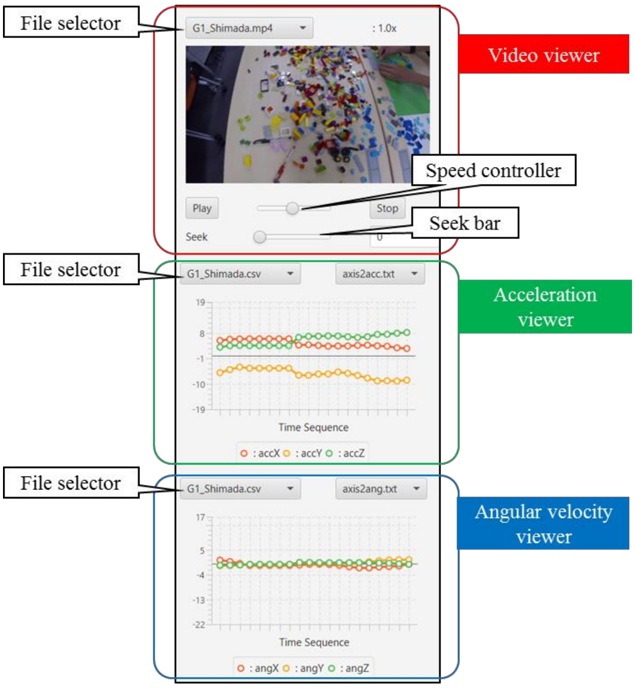

Figure 5. A component of visualizers for camera and IMU sensors.

period, acceleration and angular velocity values were almost flat, in other words, there were no hand motions. In contrast, IMU sensor values were frequently changed when the members build up LEGO blocks. In our future work, we have to extend our system for automatic analysis of group work activity by introducing ideas of lifelog analysis (e.g. [4]).

4. Conclusions

In this paper, we reported about preliminary experiments on subjective sensing of real world activity on group study. In the case of collaborative learning, although formative assessment becomes important, it is currently very difficult to perform its evaluation in real time without students' feedbacks. To tackle this problem, our research project aims for automatic sensing and visualization of real world activities during collaborative learning. As a first trial, we developed a system consisting of first person view camera and wearable IMU sensor for measuring group activity, and visualization tool for captured activity data. Potential of this tool could be confirmed through subjective group work experiments for building a town using LEGO blocks.

Future works will include automatic recognition of transition of subject's attentions from first person view camera, analysis of detailed communications, evaluation of cooperativeness using IMU sensor.

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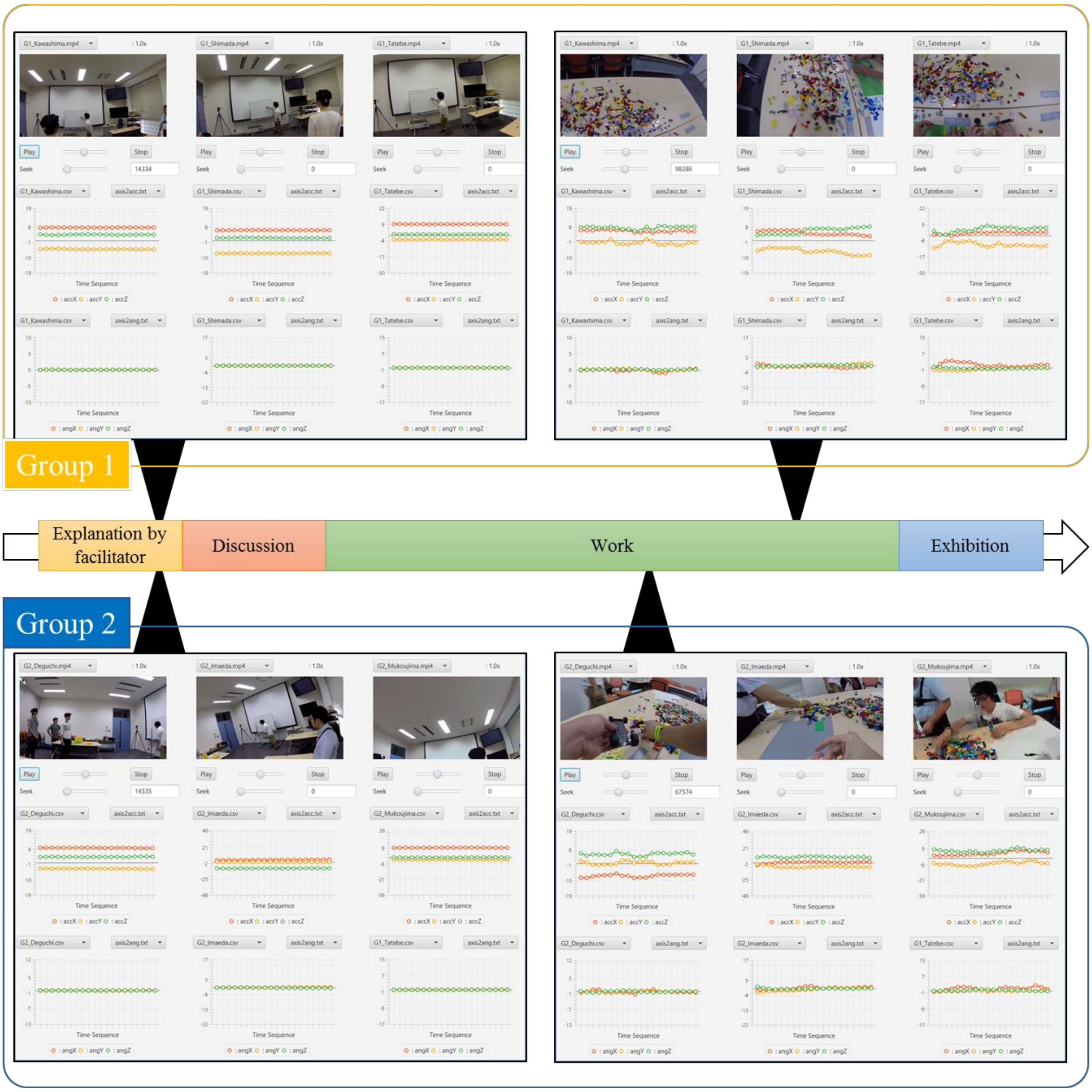

Figure 6. Visualization of group activity a cooperative development work.

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Whispering Approach to Stop Texting While Walking -Talkative Smartphone-

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Abstract

Using a smartphone while walking is one of the recent social issues causing number of risks for smartphone users. The study focused on investigating an effective way to stop people using their smartphones while walking. Preliminary experiment has been conducted to measure the effectiveness of potential solution "Talkative Smartphone" by taking a survey together with behavior observation. The interim result of the experiment revealed that this Talkative Smartphone carries certain degree of impact on preventing usage of smartphone while walking. The key reason for behavioral change is due to the auditory stimulation arising the social awareness and peer pressure of "being watched" reminding socially undesirable behaviors of the users.

1. Risks of texting while walking

The numbers of smartphone users are increasing rapidly. In Japan, according to Japanese Ministry of Internal Affairs and Communications, the percentages of the households who have smartphones has been increased 54.5%, from 9.7% to 64.2% in 4 years, from 2010 to 2014[1]. This is not the case for only Japan but also worldwide. E-marketer reported the growth rate of smartphone users was 25% in 2014[2].

Behind those rising needs for smartphone, the risks of texting while walking has been revealed. According to the research about the use of smartphone while walking published by The Telecommunications Carriers Association, 93.2% know the word "texting while walking" and 44.8%, almost half, have these habit[3]. Furthermore, 33.7% experienced almost crashing against others with texting while walking and 91% felt that those behaviors are annoying.

2. Prior solutions for texting while walking

For solving the issues above, some of the solutions has been tried out. It has been found there are two types of solutions; type1: decreasing risks, type2: preventing people from texting while walking.

Type1 solutions aims to reduce injuries. The lampposts were covered with soft pads to prevent those concentrating on texting while walking from injuries on Brick Lane, the street in London [4]. Another example is a special lane for those using smartphone called "E-lane" in a town in Washington, D.C. in the US. This reduces the risk for those texting while walking against others. Also, this solution was installed into a town in China as well. In the solution called "Built-in Traffic Lights" in Germany, traffic lights are set on ground in order to realize red sign even if people are texting while walking. These solutions do not solve the problem itself and most of targets do not realize these solutions.

By contrast to type1, type2, the solutions preventing people from texting while walking, aim to solve the problem directly. There are roughly two approaches in type2, Ads for convincing and Apps for alarming. For the instance of the Ads, Ads at stations telling "It is dangerous to text while walking" is one of the typical style of convincing. Also, docomo, one of communication carriers in Japan, created a video of simulation for telling the risks. This shows the case everyone were texting while walking at clouded scramble crossing located in Shibuya. Moreover, a harsh promotion has been conveyed by au, a Japanese communication carrier and Hanshin Electric Railway, a Japanese railway company. In this promotion, walking smartphone users are warned their uses of smartphones on public announcement by being mentioned their features of clothes. On the other hand, the latter cases, the solutions with Apps for alarming has been presented in several services and papers. Three largest communication carriers in Japan, au, docomo and Softbank released Apps alarming users when they use smartphones while walking. Nasaka, Kato and Nishigaki suggested the App system discriminating whether a smartphone user is walking or not to avoid accidents [5]. Also, Ishikawa and Kawanobe proposed the smartphone App showing up the frontal scenery of a user which enables them avoid to crash into obstacles [6]. However, Apps need people to install them at first and Ads are not effective enough to those texting without looking their front while walking. In addition to that, some of Ads possibly make people feel uncomfortable.

As explained above, type1 (the solutions for decreasing risks) are lack in changing problematic behavior itself and even type2 (the solutions for preventing people from texting) are not effective enough to prompt people to stop using smartphone.

3. Shikake –potential approach to texting while walking

As above, prior solutions for stopping texting while walking are not sufficient on changing behavior. They focus on just achieving their goal without thinking about the suitable way for changing targets' behavior. According to Matsumura, the trigger to change behaviors to solve social and/or personal problems, called "Shikake", has three requirements called FAD; Fairness for all, Attractiveness of triggers and Duality of Purposes [7] [8]. Following are the concepts of these three.

- Fairness for all: Shikake must not be unbeneficial to anyone.
- Attractiveness of triggers: Shikake must be attractive without forcing people to change behaviors.
- Duality of purposes: Shikake must have independent purposes of both Shikake suppliers and Shikake players.

The concept of Shikake is a potential approach to satisfy the defects of prior solutions with these three concepts.

4. Parallel loudspeaker as an effective auditory Shikake

Matsumura has summarized Shikake trigger categories. His study revealed that there are physical and psychological triggers and categorized in 16 as shown in **Figure1**. From these categories, we focused on following two factors; Auditory and Being Watched. It is because Auditory way can reach those texting while walking even without looking at their front side. Also, they are too concentrating on their smartphones when they are texting, on the other word, it is hard for them to aware they are watched by others.

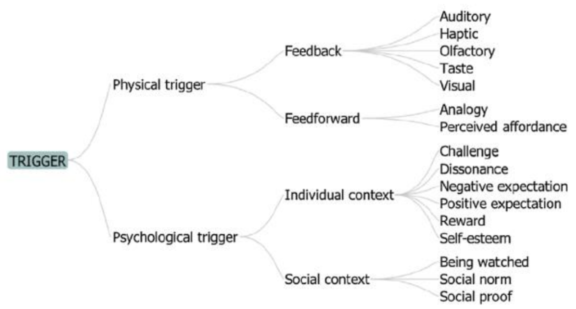

Figure 1. Shikake trigger categories

From these, we made up auditory Shikake making users aware being watched, called "Talkative Smartphone". This is the Shikake made with directional speaker which can shoot sounds only to a specific direction with ultrasonic. A parallel loudspeaker has 50 ultrasonic oscillators and can reach several tens meters. Thus it is possible to target on specific person even if there is long distance between a speaker and them. Also, because of this specification, when the sound come to targets, the path of the sound goes through their smartphone so that it sounds like their smartphone is talking to them as shown in **Figure2**.

Figure2. system of Talkative Smartphone

This study investigated the effectiveness of Talkative Smartphone.

5. Methods

To study the effectiveness of Talkative Smartphone, it has been examined on the street in a university. It shot alarming sound ("Beep! Beep!") and warning messages ("Texting while walking!*2") to those texting while walking on the street as in **Figure3**. **Figure4** shows Talkative Smartphone camouflaged with a paper bag. The targets are people using smartphone while walking closed to Talakative Smartphone without wearing earplugs, 30 in total (21 male and 9 female) in a half hours.

Figure3. scenery of experiment

Figure4. Talkative Smartphone

The experiment collected attributional data (sex and alone/group) and reaction data (check their front side, stop walking, see around and stop using smartphone as long as walking). In addition, we took questionnaires from targets shot by Talkative Smartphone, 23 in total. These questionnaires have been collected to reveal the effectiveness of this solution compared with other prior solutions with 7-point method. On this survey, not only such quantitative data, qualitative data such as comments on this solution have been collected.

6. Results

6.1. User Reactions

Owing to Talkative Smartphone, 8 out of 30 people (27%) stopped using smartphone while walking the street. Although this number doesn't reach one third of targets, this seems enough to prove the effectiveness of Talkative Smartphone. Moreover, 23 people, 77% of targets looked up their faces and looked around. Talkative Smartphone gave walking smartphone users opportunity to realize that they are watched. Some of targets commented in questionnaire they have noticed being watched.

6.2. Findings in Questionnaire

The questionnaire asked targets to give a score in 7-point method, from 1: highly agree to 7: disagree at all, on following questions; "Q1: Do you think this works for stop using smartphone while walking?" for attitudinal change, "Q2: Did you feel embarrassed?" for embarrassment, "Q3: Did you feel uncomfortable?" for comfortability and "Q4: Do you think this is interesting?" for interest or attractiveness. Table 1 shows means of each question. This tells that people tend to be interested in Talkative Smartphone and implies this matches the requirement of attractiveness.

Table 1. Questions and Mean Score

Questions	Mean
Q1: attitudinal change	4.00
Q2: embarrassment	3.26
Q3: uncomfortableness	4.78
Q4: interest/attractiveness	2.57

Table 2 shows means of scores given by those who stopped using smartphone by Talkative Smartphone, those who kept using it and difference between these two means. From this table, typical features of people tend to stop using smartphone would be following; feeling embarrassed at warning from "Talkative Smartphone" thereby feeling a sort of pressures to stop using smartphone.

Table 2. Differences between Those Stopped and Those Kept Texting

Question Category	Mean (stopped)	Mean (kept)	Differences (kept - stopped)
Q1: attitudinal change	3.38	4.33	0.95
Q2: embarrassment	2.75	3.53	0.78
Q3: uncomfortableness	4.88	4.73	0.15
Q4: interest/attractiveness	2.13	2.80	0.67

As shown above, the experiment revealed the effectiveness of Talkative Smartphone to solve dangerous texting while walking. Especially, this is quite effective to make people feel being watched and attract targets.

7. Discussion

Although the demand for smartphone is highly increasing, almost half of smartphone users have texted while walking and this behavior is quite dangerous because causing injuries even deaths. Nevertheless, the solutions for this social issue gave up to stop using smartphone while walking on type1 (the solutions for decreasing risks). Also, ones in type2 (the solutions for preventing people from texting) are not enough effective to solve this problem because of the lack of attractiveness and/or motivating people to stop it. Facing on this situation, this study investigated the effective way to stop texting while walking with the concept of Shikake. The study focused on two trigger categories for Shikake, auditory and being watched, and proposed the Shikake with directional speakers, called Talkative Smartphone.

The experiment of Talkative Smartphone revealed the effectiveness of this solution, in fact 8 out of 30 targets stopped texting while walking. Furthermore, Talkative Smartphone has the potential to attract people and make people notice being watched causing the pressure to stop using smartphone.

However, there are a lot of points need to be clear. These are mainly two points requiring further discussions.

At first, we should consider about more effective approach to convey this solution. Because directional speaker conveys sound with ultrasonic, the sound tend to be blocked by obstacles and make noise so that around ten targets commented they couldn't catch the message due to unclear sound. Furthermore, some of the targets realized that they were tested since they found who is trying to change their behaviors. Therefore, to avoid these problems, clearer sound are required. Also, in terms of the problem of finding experimenters, collaborative way should be discussed. For example, the way involving other pedestrians so that they can shoot sound to those texting while walking.

Secondly, we must consider about embarrassment. This study revealed that the targets who stopped using smartphone mentioned more embarrassed compared with the others. Considering this, we should reveal the relations among embarrassment, uncomfortableness and behavior changes. For that, further experiment might be required such as the experiment to compare Talkative Smartphone with non-directional speaker. With non-directional speaker, anyone can hear the warning messages and should be more embarrassed than directional speakers.

8. Conclusion

Considering the future of smartphones, texting while walking is quite large problem. To solve this problem, Talkative Smartphone made with directional speaker has been proved as one of the attractive and effective way. Further studies are required to reveal the best effective approach, the relations between embarrassment and effectiveness.

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Shikakeological Approaches for Promotional Flyers Distribution

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Abstract

Promotional flyers have been used as a promotional mean in the field of marketing not only to communicate mutually but also to give one-sidedly information about their products and services to consumers. A lot of studies focused on the effectiveness of promotional flyers. However, only a few studies focused on approaches for promotional flyers distribution. In this paper, we investigated the receiving ratio of various approaches for promotional flyers distribution by comparing 1) put on the desk, 2) via fortune box, 3) via capsule machine, 4) by hand without costume (normal clothes), and 5) by hand with costume. Through preliminary experiments, we found that the receiving ratio depends on the approaches as well as the context.

1. Introduction

Companies are exposed to intense market competitions because of the excessive number of products in the world. To win the competition, companies have to make every effort to develop new products, promote and sell them strategically. In such a situation, one of the most important approaches for a company is to plan marketing strategies attracting interests of their customers.

Marketing strategy is consists of four parts, famously known as 4P (Product, Price, Promotion, Place), and Promotion can be further categorized into four types [1].

- Price appeal type: Discount, coupon, refund.
- Provision of information type: Flyers, direct mail, pop advertisement.
- Experience type: Sampling, demonstration, monitoring.
- Incentive type: Prize, bonus, contest.

Among them, companies have to choose the adequate advertising medium to inform their customers of their products most efficiently in limited time and budget [2].

These days, various types of electronic medium are invented and used for advertising. However, companies still often choose promotional flyers because promotional flyers are better to show the characteristics of their retail stores, for instance, selling anything at low prices or special prices, gathering high-quality products [6]. It is often the case that the number of online users immediately rises after the distribution is increased [7]. And more, although the volume of distribution by hand is limited, the effect of description is remarkable because subscribers rose [8]. Thus it is not too much to say that promotional flyers are still one of the most important advertising medium.

A lot of studies focused on the effectiveness of promotional flyers. However, only a few studies focused on approaches for promotional flyers distribution. Yaguchi reported on the effect of flyer's design and size on the receiving ratio [3]. He revealed the relationship between the effective size of flyers and the size of a hand.

There are many ways of distributing promotional flyers. For instance, shelving them in stores, distributing them by hands and putting them into mailboxes. Also, various incentive goods, such as tissues and coupons, are widely used to improve the receiving ratio. This approach works well, however our goal is to find approaches that induce spontaneous behavior of receiving a flyer without incentive goods.

In this paper, we investigate the receiving ration of various approaches for promotional flyers distribution by comparing five approaches.

2. Shikakeological Approaches for Spontaneous Behavior Change

Matsumura et al. defined "Shikake" as embodied triggers that induce spontaneous behavior [4]. He also showed the requirements of Shikake called FAD: Fairness for all, Attractiveness of triggers, and Duality of purposes [5]. A Shikake must make people not to repel (Fairness for all), encourage people to change their behavior (Attractiveness of triggers), and give Shikake designer and targets different purposes (Duality of purpose).

If a Shikake of promotional flyers distribution is devised, the receiving ratio is expected to increase. In this study, we compare various shikakeological approaches for promotional flyers distribution in various situations to investigate which one works best in what situation.

In this study, we compare the following five approaches for promotional flyers distribution.

- Approach 1: Do nothing.
- Approach 2: Fortune box.
- Approach 3: Capsule machine.
- Approach 4: By hand.
- Approach 5: By hand from costume-clad person.

In Approach 1, promotional flyers are just put on the desk and people can get them feely. In Approach 2, promotional flyers are linked with fortune slip and only received by drawing fortune box. This style of fortune box is common in Japan and most people experienced somewhere at Shinto shrines and Buddhist temples [9]. We expect that the fortune box remind people of their good old memory and that encourage people to draw it. In Approach 3, promotional flyers are included in capsules and only received by playing with capsule machine. Just the same as a fortune box, a capsule machine is also a piece of our good old memory and we expect the memory motivate people to play with the capsule machine. Approach 2 and 3 are provided at not charge although these are typically paid services. Promotional flyers are distributed by hand from a person in plain clothes in Approach 4 and in attention-grapping costume (head-to-toe brilliant blue costume with red pants and boots) in Approach 5. Approach 1 is the baseline against Approach 2 and 3, and Approach 4 is the baseline against Approach 5.

3. Hypothesis

Based on Approach 1 to 5 in Section 2, we consider three hypotheses, I, II, and III below.

I. Fortune box approach (Approach 2) makes people draw more promotional flyers than do-nothing approach (Approach 1).

II. Capsule machine approach (Approach 3) makes people take promotional flyers than do-nothing approach (Approach 1).

III. Handover from costume-clad person approach (Approach 5) makes people receive more promotional flyers than that of in plain clothes.

Besides, we also investigate the effects of places on the receiving ratio of promotional flyers.

4. Experiments

4.1. Shelved approaches for flyers distributions

To investigate the hypothesis I and II, the following three experiments 1, 2, and 3 have been conducted.

- Experiment 1: We set flyers on the desk as shown in Figure 1.
- Experiment 2: We set a fortune box with flyers as shown in Figure 2. It is expected that passengers draw a fortune and pick up a flyer from a drawer.
- Experiment 3: We set a capsule machine as shown in Figure 3. It is expected that passengers turn the lever, get a capsule, and get a flyer by opening the capsule.

Experiment 1, 2, and 3 were conducted at three different places at Osaka University: Multipurpose Space, Library Entrance and Piloti. Multipurpose space is the place where students get involved in various activities, such as take a meal, study and chat with their friends, etc. Most of the students stay there for many hours and there are various groups regardless of the grades. The students passing by the Library Entrance are mostly alone regardless of the grades. Piloti is the place where many students come and go to their next destination. Most of the passengers are first- and second-year students because the classes for them are held near the place.

Figure 1: Flyers on the desk at Multipurpose Space in Experiment 1

Figure 2: Fortune box at Library Entrance in Experiment 2.

Figure 3, 4: Capsule machine at Piloti in Experiment 3.

We observed passengers in each approach for 20 minutes around noon. An observer recorded the attributes (male / female, alone / group) and behavioral responses (disregarded / glimpsed / received) of passengers from the hidden place.

4.2. Handover approaches for flyers distribution

To investigate the hypothesis III, we have conducted experiment 4 and 5.

- Experiment 4: We distribute flyers by hand in plain clothes as shown in Figure 4.
- Experiment 5: We distribute flyers by hand in attention-grapping costume as shown in Figure 5.

Experiment 4 and 5 were conducted for 120 minutes each at Shopping Street where many passengers come and go. We observed passengers who are targeted for hand over a flyer and recorded their attributes (male / female, alone / group) and behavioral responses (disregarded / glimpsed / received) of passengers from the hidden place.

Figure 4: Handover approach in plain clothes in Experiment 4.

Figure 5: Handover approach in costume in Experiment 4.

5. Results and Discussions

5.1. Results of shelved approaches

The experimental results were summarized in Table 1. In experiment 1, no flyers were received at any places. In experiment 2, no flyers were received at Multipurpose Place, however 12 flyers were received at Library Entrance. 22 flyers were received at Piloti. In experiment 3, 5 flyers were received at Multipurpose Place, 13 flyers were received at Library Entrance, and 43 flyers were received at Piloti.

Compared the result of Experiment 1 with experiment 2, more flyers via Fortune box were received than on the desk. Compared the result of experiment 1 with experiment 3, it is also obvious that more flyers via a capsule machine were received than on the desk. From these results, we can conclude that the hypothesis I and II in Section 3 were supported by the experiments. Also, we can say that the capsule machine was more effective than that of the fortune box (61 flyers versus 34 flyers). These tendencies were consistent regardless of the places.

Compared the results for each places, most flyers are received at Piloti (65 flyers), followed by at Library Entrance (25 flyers) and Multipurpose Place (5 flyers). This result showed that the places were significant for promotional flyer distribution. In these experiments, the places reflect to some extent the grades of students (first- and second-year students / the other grade students), the positional fluidity (stay / transit), and the purposes (study, chat, etc). The results imply the importance of these contexts in terms of promotional flyer distribution.

Table 1: The number of the received promotional flyers in Experiment 1, 2, and 3.

	Exp. 1	Exp. 2	Exp. 3	Total
Multipurpose Place	0	0	5	5
Library Entrance	0	12	13	25
Piloti	0	22	43	65
Total	0	34	61	95

Interestingly, flyers in experiment 2 and 3 were received after another once the first one was received. We assume the atmosphere of someone enjoying Fortune box and Capsule machine would lower the hurdle of trying these Shikaes.

5.2. Results of handover approaches

The results of experiment 4 and 5 were summarized in Table 2: 108 flyers were received in experiment 4 and 182 flyers were received in experiment 5.

Compared the result of experiment 4 with experiment 5, more flyers in costume-clad person were received than that of in plain clothes. This result supports the hypothesis III in Section 3.

Table 2: The number of the received promotional flyers in Experiment 4, 5

	Experiment 4	Experiment 5
Shopping Street	108	182

Through the experiment 4 and 5, we noticed that more passengers paid attention to the costume-clad person, and some of them talked to him or took pictures with him. This suggests the costume might positively affect the impression of the person and that motivate passengers to receive flyers. In experiment we used attention-grapping costume, however the impression of costume varies according to the types. Further investigation is needed for the effect of costume-clad person on flyers distribution.

6. Conclusions

In this paper, we conducted five preliminary experiments and investigated the effectiveness of shikakeological approaches for promotional flyers distribution. These results showed that attractive approaches improved the receiving ratio of promotional flyers with low cost.

As a future plan, we are planning to conduct more controlled and large-scaled experiments to reveal the relationships among shikakeological approaches and the context, as well as to find the constraint conditions to maximize the effect of shikakeological approaches for promotional flyer distribution.

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Development of "IdeaHub": Making a Paradigm Shift to People Sharing Ideas

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Abstract

In order to increase the number of the valuable ideas which have some feasibility of being implemented as a product or a solution, we have designed and developed an idea sharing service named "IdeaHub". The service mainly offers three functions "Share", "Collaboration", and "Accumulation", and helps a paradigm shift of treatment with ideas to spread among users with appropriate recommender functions.

1. Introduction

We cannot create new products or services without ideas. Any idea is essential for all creative activities. An idea which is not implemented in real world is not valuable. However, no all ideas are implemented as a product or a service, this means that a few selected ideas come realized and so many others are abandoned so far.

1.1 Problem and Solution

The problems that prevent an idea from being implemented are as below.

1. The creator of the idea cannot implement by economical or technical reason.
2. The idea is on the stage of coming up, and it has not been thought thoroughly to the sophisticated level for practical situation.

The solutions of each problem are as below.

1. To transfer the idea from person who thought up to person or organization that can realize it.
2. To make the idea refined as valuable state by seeing several immature ideas in the past, refining and combining them.

1.2 Paradigm Shift of Treatment with Ideas

The premise of these solutions is based on the paradigm shift of treatment with ideas. Conventionally, it was a common sense that ideas had to be protected and not to be published for fear of the theft. However, nowadays in events such as Ideathon, or Hackathon, the participants share their ideas and quickly implement prototypes based on these ideas. People are becoming to take part in these events and exchange their ideas, and the thought that idea must be concealed has become outdated.

The web-service called "GitHub" [1] is good example of this paradigm shift. In the service, users can publish and share their own codes of program. In the society where people publish, share, and do not protect their codes, the paradigm shift about ideas would happen more extensively if provided with an appropriate service.

Eric S Raymond (2001) analyzes the development process of OSS (Open Source Software) in "The Cathedral and the Bazaar [2]". It is not appropriate to directly apply this thought, "From the cathedral style to the bazaar style", to the process of idea creation, because the statement is just about the paradigm shift of software development. That's because the creator of OSS is programmer, expert whether professional or amateur, but the creator of idea is not only limited to expert.

Table 1. Comparison of Software and Idea

Output	Creator
OSS	Programmer
Idea	All people

The creator of idea includes more broadly than the one of Open source software. This nature is close to "The Principle of Common" stated by Shumpei Kumon (2001). Cooperation action is operated by the mutual control conducts typed as "Persuasion-Induction" [3]. The purpose does not need to be economical, may be environment or human-right and even self-happy or self-fun.

Examples of such cooperation acts include Ideathon and Hackathon. The theme of these events is sometimes determined from social issues such as environment problems and local governmental policy but at other times focus on just use of specific technology for participants joyful. They do not need to be experts about the theme but the ideas created by them have possibility to be seed of innovations. The ideas generated in these events are open to the participants but not close, not to be hidden and protected. Therefore, not ending these ideas as temporality, sharing them beyond these events by specific mechanism, would realize cooperation acts in the wider world.

1.3 Tools to Share Ideas

Challenges of sharing ideas have also been attempted in the past. However most of these attempts have not focus on sharing ideas but on sharing meeting-object such as meeting decks, voice, and video like video-chat-systems or synchronized drawing tools. The target of these tools is to share something in closed world. To realize the paradigm shift of treatment with idea, we need simple tool used in both closed world and open world.

1.4 Continual Service Management

This paradigm shift described so far is those of the user performing communication with that system. The service has to be operated continuously for some mechanism because the maintenance needs some economic cost. The cost includes not only the cost of servers but also continuous service development. As shown in the Table 2 shows, the way to operate and maintain the service can be divided broadly into two categories. The one is to set up a non-profit organization and receive financial aid and donations, and the other is to found profit organization and get charge from users.

Table 2. List of Collaboration Services

Service	Morphology	Procure funds
Wikipedia [4]	non-profit organization	Financial aid, Donation
GitHub	profit organization	Charge
Pixiv [5]	profit organization	Charge

2. Methods

As a solution to solve the problems described above, we have designed and developed a web service named "IdeaHub" for publishing and sharing ideas. **Figure**. 1 shows ideas list of "IdeaHub".

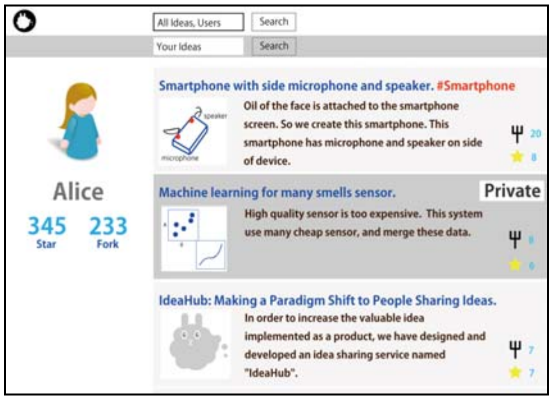

Figure. 1. Screenshot: Ideas list of "IdeaHub"

2.1 System Design

"IdeaHub" is a web service deployed on a cloud platform. Users access the web service through the Internet using some browsers, and operate it. Figure. 2 shows the overview of the system architecture of "IdeaHub".

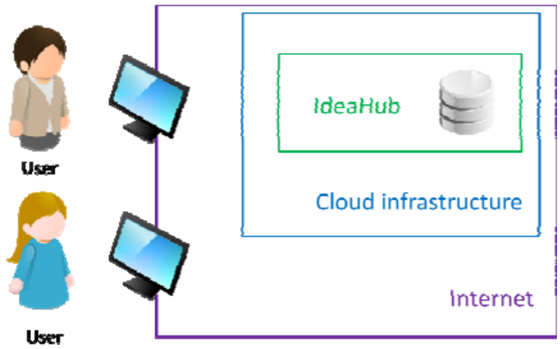

Figure. 2. Schematic illustration of "IdeaHub"

2.2 Function Design

Functions which "IdeaHub" provides to users are mainly classified to the following three.

2.2.1 Share. User can publish and share ideas with other users after posting ideas to "IdeaHub". In this use case, ideas do not remain just as ideas, transferred to person or organization that can realize it.

2.2.2 Collaboration. In the phase of creating ideas, users can discuss on their ideas using "IdeaHub" as brainstorming tool in some event or meeting like Hackathon. In this phase, some tools such as GoogleDocs have recently been used for sharing files. By contract, "IdeaHub" provides some functions that enable users can co-create ideas more efficiently like "Like(star)" and "Fork" described in §2.3. In addition, Users can refine unimplemented ideas by using "Share" function.

2.2.3 Accumulation (Persistent). The old treatment, the most of ideas created have been concealed or fallen into oblivion. “IdeaHub” permanently publishes and accumulates ideas as property of the human race under some condition like credit notation.

3. Conclusions

To refine unimplemented ideas and increase the value of them in the real world, we need to make a paradigm shift in treatment with ideas. This shift is taking place in the world. All we need is useful and appropriate tool. We are developing the web service and and increasing the number of ideas .to implement.

We are planning to do dissemination activities of “IdeaHub” to increase the number of users and ideas posted. Analyzing the accumulated information would help us to acquire some useful way of idea recommendation. As the result, we would like to feedback them for the improvement of the service and contribute to society by increasing the number of implemented ideas. Please access to “IdeaHub” (http://ideahub.jp/) if you are interested in our project.

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Collaborative Virtual Travel Experience in a Dome Augmented by a Context-Dependent Text and Audio Guide

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Abstract

This paper proposes a collaborative entertainment system for virtual travel inside a dome. The users are expected to appreciate a distant scene projected on the wall of the dome while the system provides context-dependent information for the purpose of having them experience satisfactory travel activities. The context is inferred by measuring user's head position and orientation in a 3-D space with a smartphone-based sensor. The user data is wirelessly transmitted to a content server from which context-dependent information is extracted and is sent to a tablet wirelessly. The tablet provides the information in text and/or audio to the user. The system considers human-human interaction in the dome as well to make collaborative experience among users possible.

1. Introduction

Virtual Reality (VR) has drawn much attention in recent years. Gadgets like the Oculus Rift, development platforms like Google Cardboard among others have brought VR to the masses, making them accessible to anyone that has an interest in it.

VR and Virtual Environments are terms used in the computer community almost interchangeably and have several definitions [1]:

- Real-time interactive graphics with three-dimensional models, combined with a display technology that gives the user the immersion in the model world and direct manipulation.
- The illusion of participation in a synthetic environment rather than external observation of such an environment. VR relies on a three-dimensional, stereoscopic head-tracker displays, hand/body tracking and binaural sound. VR is an immersive, multi-sensory experience.
- Virtual reality refers to immersive, interactive, multi-sensory, viewer-centered, three-dimensional computer generated environments and the combination of technologies required to build these environments.

There are some differences between these definitions but they all agree in that VR is characterized by being two things: interactive and immersive.

This ability of VR to be immersive has a lot to do with its popularity. From videogames to training simulations, immersion helps improve the experience in the opinion of a lot of people. This has given people the idea of Virtual Travel, which takes advantage of the simulated realities that VR can create and uses them to let people visit other places of the world.

The idea of Virtual Travel is not new. Attempts to make people feel like they are in a different place have been made since as early as the beginning of the 20th century. Rome through the Stereoscope [2] was a set of pictures and a guidebook that attempted to make people feel like they were visiting Rome.

With the growing availability of VR technologies, the idea of Virtual Travel (VT) has gained strength and become a viable option. Tourism agencies can use VT to make tourism available to more people, expanding the tourism demographic and allowing them to improve their earnings.

For the purpose of this paper, the definition of VT that we will use is the following: VT is a way for people who are unable, either for economic, time, or any other reasons, to travel to any places in the world. The objective of virtual travel is to allow those people to see the sights and get information about them.

This paper presents a way to let the user share his/her experience at the same time with other people and through sharing with each other enrich their experience.

The tool proposed here works by using a smartphone as a head-tracking device that allows a server to know what he/she is looking at. The intention is to use these devices inside a dome or a similar structure, where a projection of the place they are visiting is displayed. This will allow several people to experience the trip at the same time and talk about what they are seeing. At the same time, each user will receive information in audio and text form on a personal display device (PDD), which is updated using the head-tracking device's information.

The objective is to make VT an attractive alternative to regular travel and accessible enough that people from all kinds of economic backgrounds can enjoy it.

2. Design

2.1. Objective

The objective of this system is to create travel experiences that can be shared among several people. Current VR trends tend to focus on immersion and use headsets that block you from the outside world in order to achieve this. While this is a great way to create a very immersive experience, it has the disadvantage of not being able to be shared with other people in real time. In order to solve this, we propose a tool that will allow several people to use it at the same time while interacting with each other.

2.2. User

The target users of this system are people that want to experience VT. This means that the users' knowledge for operating the system or ICT literacy is expected to be normal. An expected user's activities are moving around the environment and seeing the sights of the places he or she travels to. Through this experience the users will enjoy travel experiences. Of course, users may enjoy the experience with just single scene videos or other types of content, but if there is more explanatory information provided in the form of text/audio, they might be more immersed and thus enjoy the experience even more. As for our point of view, we focus on how the system provides explanatory information effectively and with ease for the users.

The user will also share their space with other similar users at the same time and may be talking about what he/she sees or pointing other users in the direction of something he or she found useful. Since the user will be in a shared space, he or she will need to move around in order to see everything that he/she can and for this reason the system must keep track of their position inside the VT environment.

2.3. System requirements

The system needs to be entertaining above all. Since the it is not something the user can use at home but instead has to use it in a specialized environment, the user has to have some motivation for getting out of his house and going to where the system can be used.

There are several factors that we need to consider to make the system useful to the user. The characteristics this system needs are:

- Easy to learn: The user will be unfamiliar with how the system works and will have no previous knowledge of VT. For this reason, our system must be simple and have the user interact with the minimum possible number of its elements.
- User freedom: When traveling, people are free to move and see things at their own pace so it follows that VT will allow the user to see things at their own pace too. Another important aspect is that the user should be able to move around the environment. If not, then the experience would be reduced to nothing more than watching pictures or a movie.
- Shareable Experience: The user must be able to use this system alongside other people.

Based on what we want to have the users experience and the factors we need to focus on, the system we propose will consist of three main components that interact between them to give the user the travel experience: the server, the head-tracking device, and the display.

The components interact between them as shown in Figure 1. The user interacts with two of the three components (head-tracking device and display). However, the user does not need any kind of technical knowledge to use them.

The user should have no need of pressing buttons in order to tell the system what to do and this will give him the freedom to focus on other parts of the experience so that he or she may enjoy it more.

The tool ill be used inside a dome – such as planetarium`s where a 360-degree projection of the location is displayed. To accomplish this we need an omnidirectional projector of some sort. Inside the dome, the user wears the head-tracking device on his/her head while holding the display in his/her hands. When the user moves his/her head around the tool tracks where they are looking at and as soon as the user is looking at an interest point the information on that interest point is shown on the display.

Inside the dome there will be space for more than one user at the same time, thus creating a good environment for a "shareable experience." The term "shareable experience" means that the user can have the experience alongside other people at the same time and that he or she may interact with the other people if he or she wants to. This is also the reason that we are not employing VR headsets like the Oculus Rift. Using a headset would prohibit the user of interacting with other people because of the isolation that comes with using it.

The head-tracking device will keep track of the user's position inside the dome and of the user's head orientation (attitude). The device then will transmit this information to the server. In the server this information is processed and the information that the user will receive (if any) is decided. After this the server communicates with the display and tells it to show the chosen information.

The head-tracking device needs a way to measure the user`s movements and there are many options for doing this. But there is a gadget that most people today have and that has the required sensors to work as a head-tracker: the smartphone. (69% of Americans [3] and 64.2% of Japanese own a smartphone [4])

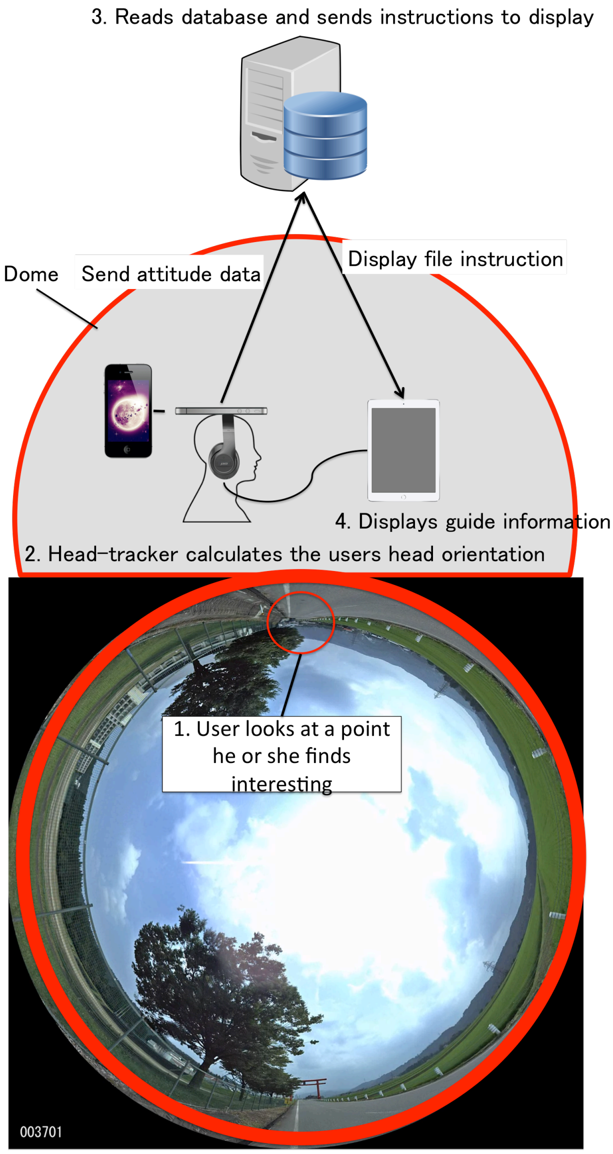

Figure 1. System Diagram

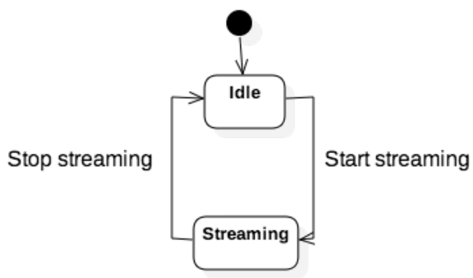

Figure 2. Head-tracking device`s state diagram

Using a smartphone will help the user get used to our system more easily because they already know how it works. On top of that, the smartphone`s sensors (gyroscope and accelerometer in this case) are quite powerful and can be used perfectly well as a head-tracking device.

With this design the system will comply with the factors described above. The system will be easy to learn, will allow the user freedom to move around the environment and take his/her time, and it will let the user share the experience in real time with real people around him or her.

3. System development

3.1. Head-tracking Device

For this system, the head-tracking device we used as an iPod Touch because its gyroscope and accelerometer are good enough to track the movement and it is small enough to be put on the users head without causing much discomfort.

The device uses the gyroscope to measure the attitude (or orientation of the head) of the user in Euler Angles (roll, pitch, and yaw, measured in radians) and the accelerometer to measure the acceleration among axes x, y, and z in meters per second squared.

The head-tracking device uses the User Datagram Protocol (UDP) to send information packages called datagrams to the server. Each of these datagrams contains the attitude and acceleration of the device at that moment. We use an application called Sensor Data developed by Wavefront Labs [5] to measure and send the gyroscope and accelerometer's data.

The device has two different states as seen in Figure 2.

3.2. Server and Display

The server receives the datagrams from the head-tracking device and unpacks them. Then it compares the attitude received at that moment with a database where "points of interest", that is, locations that have information on them available, are stored. If they coincide then the server sends the display instructions on what content to display using the UDP protocol.

The display receives the instructions from the server, which consist of the ID of the content it needs to display, and then the content is displayed.

The states of the server and the display are shown on figures 3 and 4.

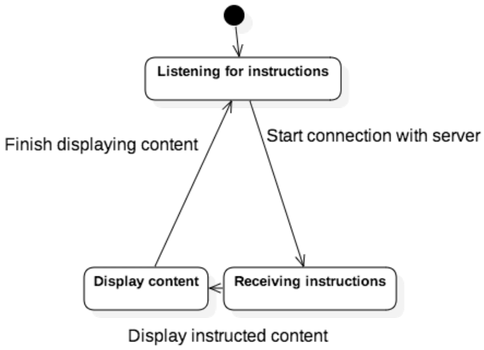

Figure 3. Display`s state diagram

4. Social impact

There are 3 different aspects that influence a person`s travel experience. The first is pre-experience which can be defined as "what the person hears before doing any actual travelling". The second one is the actual experience; seeing the sights, enjoying the food, doing recreational activities, etc. The last one is the post-experience; the memories, talking with your friends about your experience. [6]

Tourism agencies may adopt VT in general and this tool in particular to promote actual travel destinations so that people can see what`s in store for them should they choose to travel there. By doing this, agencies would take the opportunity to improve on the first aspect of a satisfying experience.

Promotion of travel destinations through this means may increase the number of people willing to travel and improve the tourism economy. The ability to experience travel without having to go very far may even open a previously untapped market: the elderly and people with disabilities.

These people want to travel as much as anyone else but they don't do so as much because a lot of places are simply inaccessible to them. VT can allow them to "visit" these previously inaccessible places and experience traveling.

5. Conclusions and future works

This system was created with the intention of allowing people to experience Virtual Travel and share those experiences with other people.

This tool could be used in museums and similar places as a learning tool, allowing all kinds of people to visit places that would be difficult or even impossible for a regular person to go.

Travel agencies can also use this tool to give their clients a "sneak peak" of places they can go. That way the clients can get interested in the place and be more motivated to hire the agency. It is an opportunity to allow

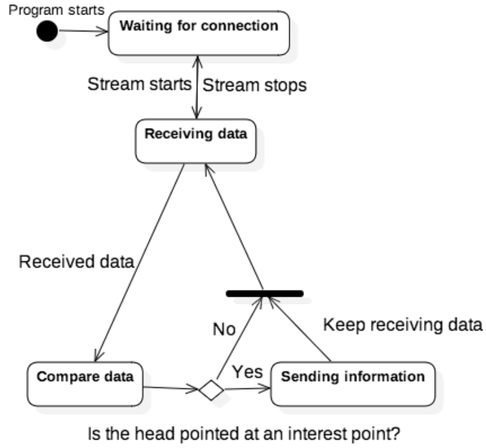

Figure 4. Server`s state diagram

clients to briefly experience a foreign environment and its highlights.

Another possible use for this tool could be in simulations for activities that could place the user in harm's way.

This tool could also be useful in research involving cognition. Proper testing should be conducted, but this tool may prove a useful and cheaper alternative to the more expensive eye-tracking tools already in the market.

In order to increase the degree of satisfaction of the user, collaborating with researchers on adaptive text in order to ensure each user can get personalized information is a possibility.

6. Acknowledgements:

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Effects of Auditory Information on Inter-Limb Coordination and Synchronization between People in *Janken* action

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Abstract

This study examined the effects of auditory information (e.g., voice and call) on inter-limb coordination between two participants in the Japanese game "Janken," known as "Rock-Paper-Scissors" in English. Inter-limb coordination between participants was considered to be a regulating process for the achievement of the synchronization of their hand movements at the endpoint of Janken action. This study hypothesized that the process could be affected by the availability of perceptual information during the interaction. To test this hypothesis, the normal condition (both visual and auditory information were available) and the no-voice condition (only visual information was available) were compared. The stability and predictability of inter-limb coordination significantly differed between the two conditions; these were higher in the normal condition than in the no-voice condition. These results support our hypothesis that perceptual information affects the interaction process in terms of regulating participants' body movements in coordinating them with each other.

1. Introduction

"Rock-Paper-Scissors" is a game played around the world which decides who wins or loses. It is called *Janken* in Japan. When people play *Janken*, more than two participants simultaneously display one of three hand shapes (i.e., *rock*, *paper*, or *scissors*). If the timing of when one participant displays his/her hand lags behind that of the other participant's display, it can be considered as a violation. Therefore, participants must synchronize the timing of their hand movements and simultaneously display a hand shape. The process of multi-modal interactions, such as looking at the other participant's body movement, listening to his/her voice, and regulating one's own actions to the other can be observed during *Janken*. This study investigates one aspect of the synchronization and coordination phenomena [1] observed in human interaction analyzing body movement during *Janken*, particularly concerning the effects of auditory information (e.g., voice, call, and the sound of breath) on participants' embodied coordination (Figure 1).

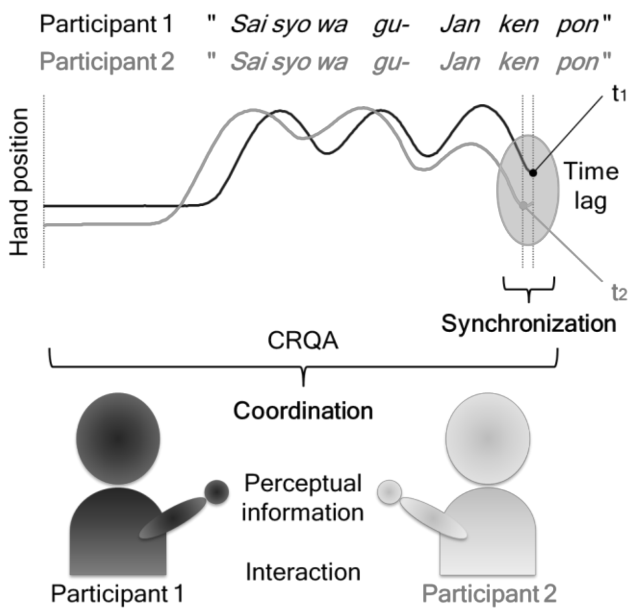

Figure 1. Synchronization and coordination in *Janken* action

In Japanese culture, people usually call "*Saisyo wa gu*" ("Begin with rock") before starting *Janken* so as to make it easy to synchronize their body movements with each other. According to this experiential knowledge, it is supposed that participants can use auditory information (e.g., voice and call) to regulate the timing of their actions. However, there have been no studies experimentally investigating how such auditory information affects interpersonal coordination in *Janken* action.

One previous study carefully described the temporal relation among participants' body movements and voice through a micro-analysis of video data [2]. The author found a process in which participants regulated their actions with each other before the timing of the first statement, “*Saisyo wa gu*,” at the beginning of *Janken*. Participants observed their partner’s body movements, such as the raising of the arm; listened to their partner’s voice, such as the sound of breath or the initial sound of speech; and regulated their actions through the perception of visual and auditory information [2]. This previous study suggested that participants began regulating their actions by perceiving multi-modal information during the beginning of *Janken* to synchronize their speech and body movements. The author of the previous study also implied that such synchronization was achieved through verbal and non-verbal information and predictions based on their perception [2].

To examine the effects of auditory information on interpersonal coordination by means of experimental control, the present study conducted an experiment where participants’ body movements were measured by a motion capture system, a time series of motion capture data was analyzed, and how participants’ movements were synchronized and coordinated with each other was evaluated (Figure 1).

2. Method

Participants

Four male participants (average = 18.75 years, and all right-handed) were recruited and six pairs of participants comprising combinations of these four participants joined each experiment. The experimental procedures were approved by the research ethics committee of Kanagawa University, where the experiment was conducted. Each participant provided informed consent for participation in this study.

Apparatus

A 3D motion capture system (OptiTrack V120: Trio, NaturalPoint, Inc.) was used to measure participants’ body movements (sampling frequency: 120 Hz). A reflective marker was attached to the wrist of each participant. The motion capture system was synchronized with the video camera (HDR-PJ540, Sony), and they started recording at the same time. To process the time series data, Motive (Natural Point) was used. To analyze the data, MATLAB (R2014a, MathWorks) and R (3.1.2) were used.

Procedure

In the current experiment, two conditions were compared, namely, the *normal* condition (both visual and auditory information were available, just as in a natural *Janken* situation) and the *no-voice* condition (only visual information was available where participants were prohibited from making any sound). Each pair of participants faced each other at a distance of 1.5 m. They were instructed to play *Janken* with their dominant hand. Because the *Janken* call “*Saisyo wa gu, jan ken pon*” is common in Japan, the experimenter asked participants to call this in the normal condition. By comparing these two conditions, the present study investigated the effects of auditory information such as voice, call, and the sound of breath. The pairs of participants repeated each condition four times, and the order of two conditions was counterbalanced across pairs of participants.

Data analysis

To assess how accurately the last hand movement of participants was synchronized to the timing of the *Janken* call “*pon*,” the absolute time lag between the endpoints of the last hand movement of each participant was calculated from the time series data of the participants’ wrist motions in the vertical direction (Figure 1). A shorter time lag indicates a more accurate synchronization.

To quantify the degree of inter-limb coordination between participants, this study applied a nonlinear time-series analysis, called the *cross-recurrence quantification analysis* (CRQA), between two time series of participants’ wrist motions in the vertical direction (Figure 1). CRQA is a nonlinear time series analysis method that captures the recurring properties and patterns of the dynamical system resulting from two streams of information interacting over time [3]. It can also quantify how similarly two observed data series unfold over time [4]. Recurrence quantification analysis was originally developed to uncover subtle time correlations and repetitions of patterns, and it is relatively free of assumptions about data size and distribution [5]. In CRQA, two time-delayed copies of the original time series were used to embed the data in a higher dimensional space, reconstructing the phase space, to analyze the recurrent structure between them [3].

This study calculated two CRQA measures, namely, the percentage of recurrence (%REC) and average line length (AVGL). For inter-limb rhythmic coordination, %REC in CRQA corresponds to the ratio of the actual number of shared locations and to the number of possible shared locations in the phase space. It provides an index of the magnitude of stochastic noise in the system [4]; a higher %REC indicates less noise in the system. In other words, it indicates that the system is more stable. The other CRQA measure, AVGL, is related to the line structure calculated from the recurrence plot [6]. AVGL in CRQA corresponds to the average shared trajectory in the phase space and the average length of a diagonal line on the plot. This shows how long a recurrent state continues on average. AVGL is interpreted as an index of the predictability of a shared trajectory in the phase space [6]; a longer AVGL indicates a higher predictability [6]. This study assumed that both %REC and AVGL will be larger in the normal condition than in the no-voice condition.

We performed CRQA using the R package "*crqa*" (version 1.0.6) [7] after determining optimal values for input parameters (e.g., time delay, embedding dimensions, and radius) with reference to the standard guidelines for the RQA method [8]. As a result, we chose parameters of 12 for time delay, 6 for embedding dimensions, and 48 for radius with mean distance rescaling option [4].

While the absolute time lag indicates the accuracy of timing at the last *moment* of *Janken* action, CRQA measures indicate the stability or predictability of inter-limb coordination between participants during the whole *process* of *Janken* action. We assumed that the process of interpersonal coordination reflects mutual interaction mediated by perceptual information (Figure 1).

3. Results and discussion

Figure 2 shows the absolute time lag as an index of the degree of synchronization (Figure 2). In the normal condition, the absolute time lag was 76 ms (SD = 63). In the no-voice condition, the absolute time lag was 85 ms (SD = 71). Although the absolute time lag was shorter in the normal condition than in the no-voice condition, there was no significant difference between them ($t(5) = -0.83$, N.S.). The results suggest that the participants were able to synchronize their hand movements in the no-voice condition as accurately as in the normal condition. This implies that auditory information may not affect synchronization at the last moment in *Janken* action.

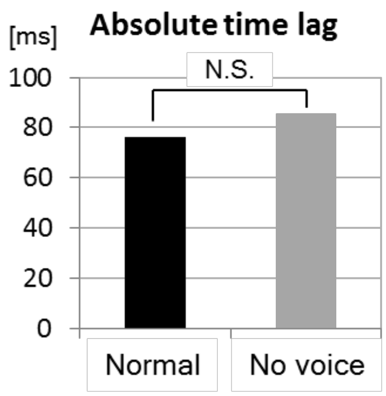

Figure 2. Absolute time lag [ms]
(Left: normal condition, Right: no-voice condition)

Figure 3 represents %REC as an index of the stability of inter-limb coordination between participants (Figure 3). In the normal condition, %REC was 10.74% (SD = 7.34). On the other hand, in the no-voice condition, %REC was 8.91% (SD = 7.86). The %REC was significantly higher in the normal condition than in the no-voice condition ($t(5) = -2.58$, $p < .05$). This result indicates that the participants were able to coordinate more stably with auditory information than without it. This suggests that auditory information was able to stabilize inter-limb coordination between participants in *Janken* action. This result supports our hypothesis.

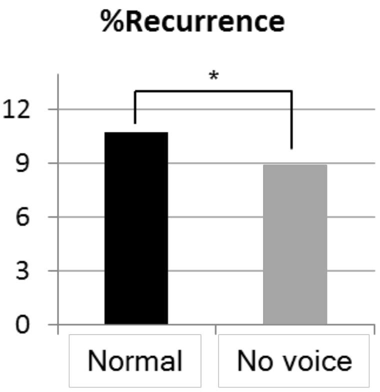

Figure 3. %Recurrence
(Left: normal condition, Right: no-voice condition)

Figure 4 presents AVGL as an index of the predictability of inter-limb coordination between participants (Figure 4). In the normal condition, AVGL was 29.10 (SD = 11.16). However, in the no-voice condition, AVGL was 26.02 (SD = 13.50). AVGL was significantly longer in the normal condition than in the no-voice condition ($t(5) = -4.07$, $p < .01$). This result implies that the participants' movements and inter-limb coordination were more predictable with auditory information than without it. It is assumed that auditory information in *Janken* can make inter-limb coordination between participants more predictable in terms of its shared trajectory in the phase space. This fact also suggests that the coupling between the hands of participants was persistently stronger with auditory information than without it. This result also supports our hypothesis.

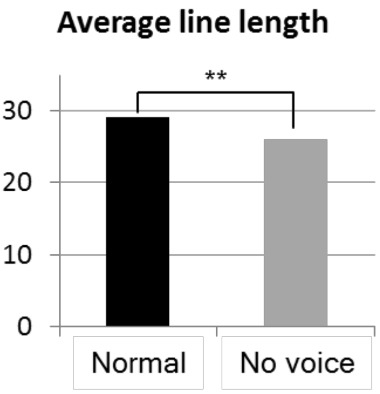

Figure 4. Average line length
(Left: normal condition, Right: no-voice condition)

In sum, as a result of the analyses of the inter-limb coordination between participants by CRQA, the stability (%REC) and predictability (AVGL) in *Janken* action increased with auditory information (e.g., voice, call, and the sound of breath). These results seem to agree with the results of the previous study that described participants' body movements and voices (including the sound of breath or the initial sound of speech) with the micro-analysis of video data [2].

4. Directions for future research

This study examined an aspect of the phenomena of synchronization and coordination that are widely observed in natural situations of human communication [1] by examining individuals playing *Janken*. As we investigated the effects of auditory information on inter-limb coordination between participants in *Janken*, auditory information was able to improve the stability and predictability of inter-limb coordination between participants. We plan to collect more data in the near future. Further consideration on how such auditory information contributes to embodied interpersonal coordination and how we can interpret the relation between CRQA measures and real phenomena should also be pursued in the future.

Although these facts cannot be directly applied to the general phenomena of synchronization and coordination in social interactions, it is expected that the dynamical systems approach and its method of analysis can be applied to different situations such as a natural conversation. CRQA and the dynamical systems approach have already been applied to various kinds of human interaction data, not only with continuous data, such as those found in body movements, but also the categorical data such as words and symbols [9]. Further application or extension of the dynamical systems approach is expected.

5. Conclusion

This study investigated the effects of auditory information (e.g., voice, call, or the sound of breath) on inter-limb coordination between two participants playing *Janken*, a multi-modal communication. Inter-limb coordination between participants was considered as a regulating process for achieving synchronization of the hand movements at the endpoint of *Janken* action. The authors of the present study hypothesized that the process may be affected by the availability of perceptual information during interaction. To test the hypothesis, the normal condition (in which both visual and auditory information were available) and the no-voice condition (in which only visual information was available) were compared. We also applied a nonlinear time series analysis to time series data of participants hand motions in *Janken* action. The stability and predictability of the inter-limb coordination significantly differed between two conditions, being higher in the normal condition than in the no-voice condition. These results support our hypothesis that auditory information affects the process of participants' regulating their actions to coordinate them with each other. Further examination on how such perceptual information is involved with and contributes to embodied interpersonal coordination should be pursued in the future.

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