Recommended Paper

The Effect of Using Photographs in Idea Generation Support System

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Abstract: To investigate how the use of photographs affects creativity, we have developed a system called GUNGEN-PHOTO, in which photographs are used to support idea generation. It consists of a collaborative workspace and personal workspaces and includes two main functions: photograph expansion for effectively extracting ideas from photographs, and outside comment addition for adding comments from personal workspaces. These functions are expected to increase the number of ideas generated. We conducted experiments on idea generation under the themes of "improvement" and "discovery," and found that more ideas were generated when photographs were used than when only text was used. We also found there were no significant differences in the quality of generated group between them.

Keywords: idea generation, KJ method, photograph

1. Introduction

With the spread of digital cameras and mobile phones with cameras, the practical use of digital photographs has increased, and sharing them with other people has become easier by using photo-sharing network services such as Flickr [1][*1] and Picasa Web Albums[*2]. The use of digital photographs includes casual uses, such as snapshots for articles in travel blogs, and photographs documenting research data of fieldwork.

The competition of products and services has recently intensified; therefore, companies have to develop original products or services and quickly put them onto the market. Idea generation methods for developing creative ideas effectively are attractive for meeting these challenges to gather a variety of opinions and summarize them. Various idea generation methods [2], [3], [4], [5] and support systems [6], [7], [8] have been proposed.

The KJ method [3][*3] is one such method and is also referred to as an affinity diagram, which is included in the Seven Management and Planning Tools [5] used in total quality control. The KJ method was developed by Jiro Kawakita and is based on the thesis of problem solving and teamwork. The typical process used in the KJ method is based on the human thinking process for creative problem solving [9] as follows: (1) data (ideas, opinions, issues, etc.) are gathered with a specific theme, and each idea is jotted down as a comment label (divergent thinking); (2) they are organized into groups based on the natural relationship between each label, and each group is given a title (convergent thinking); (3) each group is allocated spatially to a diagram (affinity diagram) according to the natural relationships among groups (idea crystallization), and (4) concluding sentences are added to express what the diagram means (idea verification).

Conventional idea generation methods, including the KJ method, mainly use text data to generate ideas. Some studies have attempted to use sketching or photographs for idea generation [10], [11], [12], which are expected to provide more information than text-only data. However, such methods only use sketching and photographs as supporting data in idea generation, not as a practical tool to actively improve some part of idea generation process output, such as the increase in generated idea in step (1) in the KJ method.

We have developed a system called GUNGEN-PHOTO, which supports idea generation with photographs. The system has two original functions we developed to generate new ideas from photographs: a photo expansion function for showing the details of photographs and clarifying what is in the photographs, and an outside comment addition function for adding comments (new ideas) at any time from outside the shared display, to increase the number of ideas without impeding other members' viewing capabilities. We applied these functions to an evaluation of the system and investigated how the use of photographs affects the quantity and quality of idea generation, especially the data gathering and group organizing processes on the KJ method.

In Section 2, we describe related work. In Section 3, we describe our proposed system GUNGEN-PHOTO. In Section 4, we explain our experiments. In Section 5 we discuss the

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[*1] http://www.flickr.com/ (accessed 2012-10-25)
[*2] http://picasaweb.google.com/ (accessed 2012-10-25)
[*3] The KJ method is a registered trademark of Kawakita Research Institute.

experimental results. Finally, we conclude this study in Section 6.

2. Related Work

Young classified the purpose of an idea processing support system into three levels [6]: secretarial (reducing the miscellaneous tasks of users to focus on the main work), framework-paradigm (providing a new paradigm by adding a conceptual stimulus), and generative (automatically generating unexpected ideas).

Ohashi et al. developed a KJ method support system called GUNGEN-TOUCH that enables face-to-face communication in meetings by using a table-top interface [7]. They implemented semi-automatic idea grouping and physically turned the direction of the labels in order to reduce the workload necessary with the KJ method. In addition, they compared each work task in their method with those in conventional paper-based operation. They achieved a level of operability compared to that of a paper-based method and also reduced operation time. However, only text data could be input, and only one person could input generated ideas at a time due to the restriction of the interface (single touch-panel screen with multiple users).

Ajiki et al. developed idea generation consistent support systems called GUNGEN-SPIRAL II and Quiccamera [8]. GUNGEN-SPIRAL II enables the KJ method to be carried out as a Web application, which enables idea generation using multiple devices such as PCs or smart phones with standard Web browsers. Quiccamera makes it possible to edit and input photographs from smart phones into GUNGEN-SPIRAL II as idea labels. However, they treat photographs in the same way as input handwritten text, so there is no special function for manipulating each photograph as a label.

Tse et al. developed the KJ method support system called the Designers' Environment, which allows multi-user multi-mode interaction with gestures, voices, and pen-tablet PCs [10]. Generated ideas can be input via the keyboard or by writing on the pen-tablet PC. In addition, the system allows ideas to be grouped and cards or groups to be deleted by combining gestures and voices as commands. However, gestures and voices are easily confused whether they are performed as commands or simply as human communication in discussions. Although photographs can be used as input data in this system, they are treated just as support documents, not as idea cards.

Van der Lugt introduced Brainsketching to create ideas by sharing sketches [11]. This was an attempt to improve idea generation by receiving new stimuli from sketches other members drew. However, the experimental results showed that idea generation was not affected very much by other people's sketches.

Nishimoto et al. introduced BrainResketching as a method for generating new design concepts [12]. To close the gap between subjective views or concepts among people, the system prompts "thinking from another person's viewpoint", which leads to reconstruction of their sketches based on the design idea of another person. This method shows that it is useful to obtain another person's viewpoint when generating new ideas.

Kennedy et al. studied how community-contributed collections of photographs on Flickr could be mined to successfully extract practical knowledge [13]. They investigated how location-based metadata and tag-based annotation enhance access to photographs and introduced the use of visual analysis to increase the quality of retrieval and summarization of geo-referenced photographs.

Wang et al. studied idea generation using photographs and developed the Idea Expander [14], [15]. In group brainstorming experiments with multinational users, they investigated the effect on ideas generated by showing photographs related to the topic of a group chat. The results indicated that idea generation patterns with photographs were related to the cultural (national) background of the participants [15]. However, they weakly suggested that the number of ideas increased quite a bit [14], but they did not discuss the effect on the paradigm, for example whether the quality of ideas improved.

As can be seen from the above, most of the proposed idea generation support systems only support the secretarial level by providing an automatic process or easier usability to reduce workloads. Some studies have attempted to show the effect of using sketching or photographs on idea generation. However, they have not considered the effect on the overall idea generation process and whether the use of photographs increases the quantity or quality of generated ideas by supporting the framework-paradigm level.

3. GUNGEN-PHOTO

We have developed GUNGEN-PHOTO as an idea generation support system using photographs in order to support the "framework-paradigm" level. In this section we explain the system design and functions of GUNGEN-PHOTO.

3.1 System Design

The purpose of the system is to support idea generation at the framework-paradigm level. We used photographs as a creativity stimulus to increase the quantity and quality of generated ideas. In addition, we improved the overall usability of the system at the secretarial level in order to reduce the degree to which the miscellaneous tasks hinder idea generation. The features of our proposed system are as follows.

1. Photograph expansion on collaborative workspace

   To effectively use photographs as a creative stimulus, the photographs have to be looked at impartially by group members in order to avoid strong subjective views by the person who prepared them. We prepared a large workspace (called a collaborative workspace), which enables multiple users to collaborate face-to-face in this idea generation method. Each user can see, manipulate and comment on the photographs and generated ideas in the collaborative workspace. As the collaborative workspace, we used a large table-top display with a multi-finger touch panel, with which users can operate simultaneously, similar to paper-based operation. We chose the DiamondTouch Table [16] and a previously developed system GUNGEN-TOUCH [7] as a base to effectively implement these functions.

   We also adopted a function to temporarily expand a specific photograph in order to share its details with all group members and focus their discussion on that photograph.

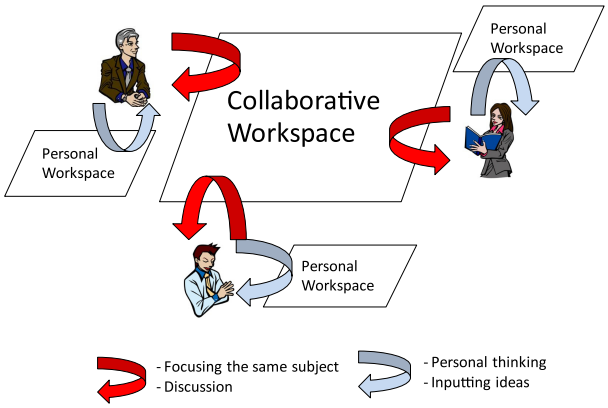

Fig. 1 Concept of workspace design.

2. Outside comment addition on personal workspace

   The collaborative workspace is controlled using one PC, which limits one keyboard operator at a time to input generated ideas as text. To enable free operation by group members, we implemented another workspace that can be operated (text written as generated ideas) individually, which is called a personal workspace. By dividing the workspace into collaborative and personal ones, group members can share their overall views on photographs and generated ideas while they input their generated ideas at any time without impeding other members' operation of the collaborative workspace. We chose iPad[*4] as the personal workspace terminal, which can be operated intuitively in the same way as the collaborative workspace (DiamondTouch Table).

Figure 1 shows the concept of workspace design. Group members can use both workspaces as the situation demands. Each workspace device (DiamondTouch Table and iPad) can be operated independently, so each user can switch their thinking mode anytime without considering other users' thinking modes.

3.2 Functions

GUNGEN-PHOTO is based on GUNGEN-TOUCH [7]. Before the start of an idea generation method, photographs are collected in GUNGEN-PHOTO server and copied into the control PC of the DiamondTouch Table. When starting the method, all input photographs are shown on the DiamondTouch Table (60 × 78 cm) as the collaborative workspace. Participants discuss these photographs and input comments via their iPad personal workspaces. The input comments are also shown on the DiamondTouch Table as text comment labels. After completing the idea generation task, all photographs and comment labels are exported to the server. **Figure 2** shows a photograph of GUNGEN-PHOTO. The keyboard is used to input text directly to the DiamondTouch Table. It is only used to input the group title of generated groups.

Figure 3 shows an overview of GUNGEN-PHOTO. The control PC is connected to the DiamondTouch Table, and the screen of the collaborative workspace is displayed via a projector. iPads are connected to the server via a Wi-Fi access point. **Table 1** summarizes the implementation environment of GUNGEN-PHOTO.

[*4] http://www.apple.com/ipad/ (accessed 2012-10-25)

Fig. 2 Photograph of GUNGEN-PHOTO.

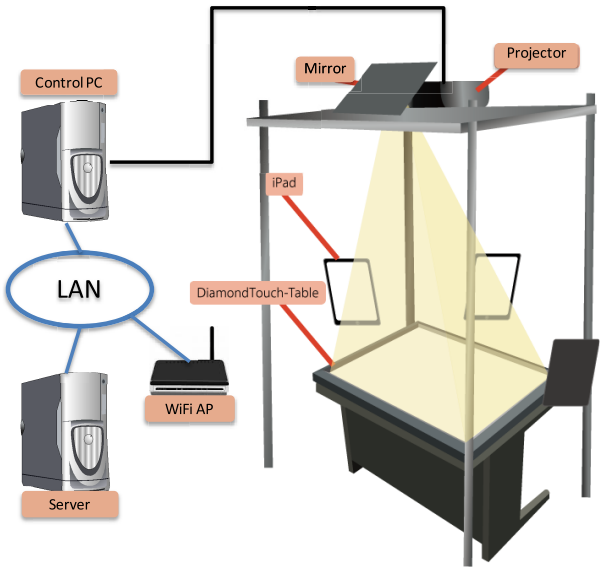

Fig. 3 Hardware configuration of GUNGEN-PHOTO.

Table 1 Implementation environment of GUNGEN-PHOTO.

	Hardware and software
Control PC and Server	CPU: Intel Core2Quad Q9450 2.66GHz OS: Windows Vista Home Premium SP1 Middleware: JDK 1.6.0_07 Javamail 1.4.1 Xampp [e] 1.7.3
Collaborative workspace	Hardware: DiamondTouch Table Projector: Canon X700 SDK: MERL DiamondTouch SDK 2.1
Personal workspace	Hardware: Apple iPad (Wi-Fi model) OS: iOS 4.2.1 (8C148)

[e] http://sourceforge.net/projects/xampp/ (accessed 2012-10-25)

All programs of GUNGEN-PHOTO were written using Java or PHP.

The user interface design of GUNGEN-PHOTO is shown in **Fig. 4**. The icons on the left are operation tool buttons such as for adding a comment label or an idea group. We can see photo labels and (text-based) comment labels as idea labels. Photo labels are prepared before the KJ operation starts. Comment labels

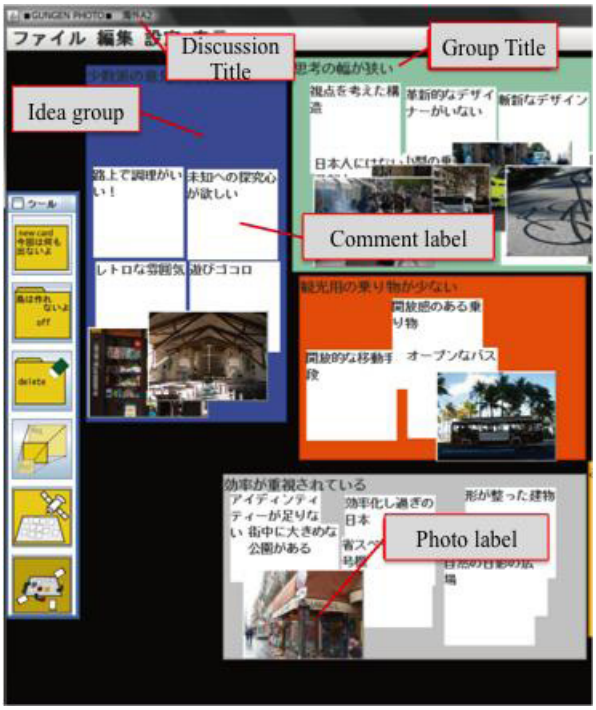

Fig. 4 User interface design of GUNGEN-PHOTO.

Fig. 5 Photograph expansion.

are added by each member via his/her iPad. We can generate an idea group and put familiar labels into the group. We can also add an optional color and title name for each idea group. Each item (button, label, and group) is operated by fingers on the touch panel.

The standard size of each photograph is 160×120 pixels, which can be expanded to 480 × 360 pixels to see the details in the photograph. Group members can naturally view the photograph on the DiamondTouch Table and easily focus their discussion on that photograph. **Figure 5** shows an example of an expanded photograph.

Comment labels can be individually input via iPads each time, without obstructing the view on the collaborative workspace (DiamondTouch Table) via an input menu such as a software keyboard. The input text on each iPad is sent to the server via a Web browser (Mobile Safari) then exported to the control PC of the DiamondTouch Table as comment labels. The system flow of inputting comment labels is shown in **Fig. 6**.

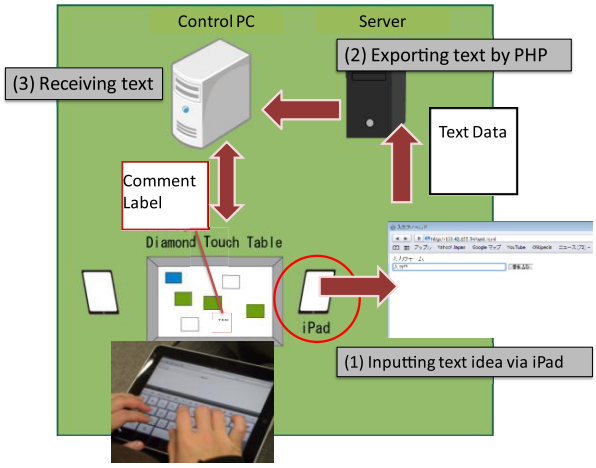

Fig. 6 System flow of inputting comments via iPad.

4. Experiments

4.1 Use Cases

Two idea generation theme use cases were selected to investigate the effect of using photographs to improve idea generation. One theme was "improvement" for existing systems or rules, and the other was "discovery" to obtain new knowledge.

1. "Improvement" theme

   One of the most useful applications of the KJ method is for improving management and planning in business environments. This method is expected to improve idea generation for more specific problems at the office by focusing on partially known subjects appearing in photographs, such as persons (employees), scenery (office environment), and objects (office equipment). We can imagine their condition, comportment, or usage and obtain new ideas to improve them.

2. "Discovery" theme

   The main purpose of the original KJ method is to discover essential facts from data collected in a field study. We can look at photographs taken at places we had never visited, think about these places and form opinions about them. In addition, we can generate ideas by sharing these opinions with others.

4.2 Experimental Results

The experiments were conducted with three groups (A, B, C) of participants (nine people), each made up of three students from Wakayama University. All seemed to have almost the same level of background knowledge. The participants sat in chairs around a DiamondTouch Table (Fig. 2). We provided an iPad to each participant as his/her personal workspace terminal.

The idea generation theme of the "improvement" experiment was "How to improve the facilities of Wakayama University," and that of "discovery" was "Better features of overseas facilities or cultures." Both themes were selected as typical examples that were simple but somewhat difficult for the participants (Japanese university students). There were 12 variations in our experiments (three groups, two themes, and two data conditions: using text only or photographs), the order of which was randomly changed.

Each group first selected 20 photographs from ones prepared

Table 2 Experimental results.

	Number of comments		Number of Groups	
Text/Photo	Text	Photo	Text	Photo
Imp-A	26	58	8	10
Imp-B	20	46	5	5
Imp-C	29	22	8	4
Dis-A	16	35	5	7
Dis-B	21	49	5	6
Dis-C	30	42	5	6

Table 3 Average evaluation scores of generated comments and groups.

	Average score of comments		Average score of groups	
Text/Photo	Text	Photo	Text	Photo
Imp-A	3.6	3.4	3.5	3.1
Imp-B	3.9	3.0	3.1	3.2
Imp-C	3.4	2.9	3.2	2.6
Dis-A	3.4	2.9	3.4	3.1
Dis-B	3.3	2.9	2.9	3.1
Dis-C	3.4	2.6	3.2	3.2

beforehand (107 photographs taken at Wakayama University for the "improvement" theme, and 841 photographs taken in foreign countries. i.e., Vietnam, France, Portugal, UK, China, and USA, for the "discovery" theme) by taking into account the display size restriction of the DiamondTouch Table and unifying each experimental condition. Each participant selected photographs that were taken by another person to avoid the effect of the photographer's strong subjective views on the photographs. We also instructed the participants on how to operate the main functions of GUNGEN-PHOTO and allowed participants to use it for several minutes.

The operation of the KJ method in these experiments were conducted from data gathering to group allocating. The data gathering process was conducted until new ideas (comment labels) run out.

Table 2 lists the experimental results "comments" indicates the number of generated ideas (comment labels), "groups" indicates the number of groups generated in an affinity diagram with the KJ method, "Text" represents the experiments with text only (without photographs), and "Photo" represents those with photographs. "Imp-" means the "improvement" theme in each group (A, B, and C), and "Dis-" means the "discovery" one.

After the experiments, each comment and group was listed on a sheet of paper and evaluated by a different group of four students. To evaluate the quality of generated idea, each student read each name of comment or group on the paper and scored it from 1 to 5 (the higher the score, the better the quality) based on intuition. The average scores are listed in **Table 3**.

Table 4 lists the satisfaction ratings from questionnaires filled out by participants after the experiments based on a scale from 1 to 5 (the higher the score, the better the usability).

Examples of free description comments given in the questionnaire are as follows.

Table 4 Satisfaction ratings from experiments.

Questionnaire	Rating
(1) Concerning viewing of photographs	
Could you easily see the photos?	4.2
Could you easily expand the size of the photos?	4.3
(2) Concerning text input	
Was it easier to type text with the iPad than with a keyboard?	4.0
Was this function useful?	4.6
Could you easily operate this interface?	4.1
(3) Concerning interfaces	
Could you easily use the control panel?	4.0
Could you easily expand /reduce the size of idea groups?	3.8
Could you easily move photos, idea groups or comment labels?	3.3

(1) Concerning the viewing of photograph
- It was difficult to see the details in some of the darker photos.
- The initial size of photos should be smaller.
- The size of photos should be larger.

(2) Concerning text input
- The predictive transform mechanism of the iPad was useful for inputting text.
- Inputting text takes some getting used to.
- Inputting data with the iPad was more useful compared with keyboard input to the DiamondTouch Table.

(3) Concerning interfaces
- The enlarged photos should be sent to each iPad.

5. Discussion

5.1 Utility Consideration of the System

The questionnaire results in Table 4 show that the satisfaction rates of the expanded photographs and the text input via personal workspaces were high (their scores were higher than 4). In addition, other ratings concerning the interface were over 3.3. This means that the implemented functions were fully useful for manipulating photographs in our system for evaluating the effect of photographs in idea generation.

5.2 Evaluation of the Quantity of Generated Ideas

The results in Table 2 suggest that the total number of generated comment labels using photographs was 1.8 times greater than that with text only. The t-test results show a p value was 0.01 and an effect size r (point-biserial correlation coefficient) was 0.72, which means there were significant differences between the two input methods at a significance level of 5% ($p < 0.05$) with a large effect size ($r > 0.5$), although there was no significant difference in the number of groups (p value was 0.76 and r was 0.10).

5.3 Evaluation of the Quality of Generated Ideas

The results in Table 3 suggest that all the average evaluation rates of comments using photographs were smaller than that with text only. The t-test results show that the p value was 0.002 and r was 0.79, which means there were significant differences

Table 5 Comment labels with various viewpoints.

Classification	Comments	
	Improvement	Discovery
Different kinds of comments on the same object in the photograph.	14	14
Comments on the different objects in the photograph	10	7
Both of the above	3	5

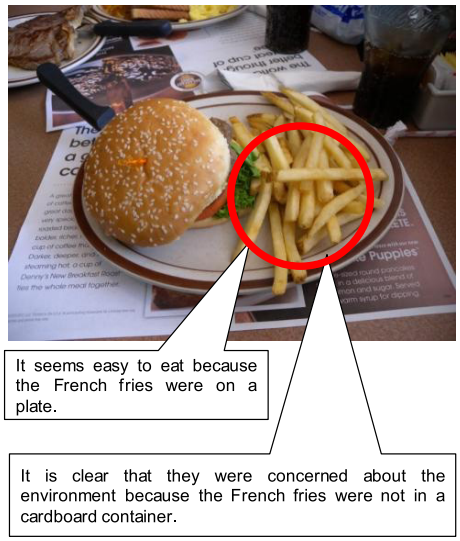

Fig. 7 Example of photograph that prompted different kinds of comments on the same object.

between the two input methods with a large effect size, whereas there was no significant difference in the average evaluation rate of groups between the methods (p value was 0.26 and r was 0.35). This suggests that using photographs to generate ideas decreased the average quality of comments; however, the results of the final ideas described by groups in the affinity diagram did not always decrease. When photographs were used, the total number of comments with higher quality also increased, whereas the average quality of comments decreased. Thus, the quality was maintained in the final results of idea generation.

The average number of comments was 42 in both "improvement" and "discovery" themes with 20 photographs. About 20% of the comments generated presented different viewpoints on the same photographs. The results of comment labels with various viewpoints are listed in **Table 5**.

The examples of different kinds of comments on the same object in the photograph in **Fig. 7** are as follows. Each comment was focused on French fries in the photograph.

- It is clear that they were concerned about the environment because the French fries were not in a cardboard container.
- It seems easy to eat because the French fries were on a plate.

The examples of comments on different objects in the photograph in **Fig. 8** are as follows.

- There was a traffic jam in the morning because there was only one tollgate (focused on road with the tollgate).
- It is too bothersome to insert the pass into the card scanner (focused on the card scanner at the tollgate).

We also examined the relationship of each comment label between content characteristics and its evaluation score.

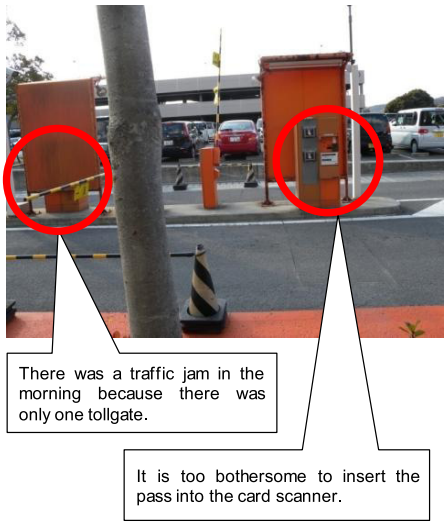

Fig. 8 Example of photograph that prompted comments on the different objects.

Table 6 Examples of higher-rated comment labels.

	Comment (score)
Improvement (with photo)	- Portal sites like "igoogle." (4.8) - There was a traffic jam in the morning because there was only one tollgate. (4.5)
Improvement (text-only)	- Taking a class and using an iPad as a notebook. (4.5) - Making a store to the school opened in midnight. (4.5)
Discovery (with photo)	- Entertainment space that can share with people is rare. (4.3) - Crime-prevention is fully covered. (4.0)
Discovery (text-only)	- An island with special ecosystem. (4.5) - Free performances are permitted. (4.3)

Table 7 Examples of lower-rated comment labels.

	Comment (score)
Improvement (with photo)	- Bad impression. (1.5) - The corn is used as a trash box ^^;. (1.5)
Improvement (text-only)	- Money is not needed. (2.3) - School limousines. (2.3)
Discovery (with photo)	- It is big and nice! (1.8). - Too long Σ（・□・；）.(1.3)
Discovery (text-only)	- Ample funds. (2.3)

Table 6 lists examples of higher-rated comments generated in each experiment. These comments point to a trend in which the comments were about specific objects in the photographs. In the "improvement" theme in particular, these comments pointed out a concrete problem or solution, such as "There was a traffic jam because there was only one tollgate."

Table 7 lists examples of lower-rated comments generated in each experiment. These comments with photographs tended to be of just impressions such as "too long," especially in the "discovery" theme. Some of them included emoticons such as "^^;." These comments are difficult to understand without their target photographs. Such comments reduce the average ratings of qual-

Fig. 9 Examples of photographs with lower-rated comment labels.

ity of ideas. However, these comments were discussed with their target photographs in the idea generation process, so they did not reduce the quality of the overall results (the quality of generated groups). Each lower-rated comment was also summarized as a part of a certain group with photographs. This suggests that such comments might enhance their meanings by connecting with the target photograph. Examples of photographs with lower-rated comment labels are shown in **Fig. 9**.

6. Conclusion

We investigated the effect of photographs on the quantity and quality of idea generation. We proposed the idea generation support system called GUNGEN-PHOTO to examine this effect by supporting secretarial and framework-paradigm levels.

GUNGEN-PHOTO is implemented with two workspaces: a collaborative workspace for showing and discussing photographs and comments and personal workspaces to input generated ideas as comment labels throughout the discussion. We evaluated the quantity and quality improvement of this idea generation system by comparing the number of ideas generated with and without photographs. From the experiments, we found that two viewpoints (quantity and quality) had significant differences between with and without photographs, which were not clarified in previous studies such as that by Wang et al. [14], [15].

The results showed that the number of ideas generated with photographs was significantly higher than that with text only.

The results also showed that the average quality of generated comment labels significantly reduced with photographs; however, there was no significant difference in the final quality of idea generation (based on the names of generated groups) using both photograph and text only input methods.

We also examined two different viewpoints on the same photograph; different kinds of comments on the same object in a photograph and different comments on different objects in a photograph. The results suggest that the use of photographs in idea generation could improve the diversity of generated ideas.

For further study, we plan to analyze in more detail the differences in improving idea generation between the "improvement" and "discovery" themes to compare our system with other related systems and evaluate the effect of using other media, such as illustrations for scenes that are not easy to photograph. We also plan to examine the most suitable timing of using photographs during idea generation process and to improve overall usability of GUNGEN-PHOTO by studying free description comments in the questionnaire results.

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Editor's Recommendation

The initial version of this paper was reviewed by three reviewers and has received excellent scores; especially, its originality scores were high. The authors demonstrated the effect of photographs in a groupware system for idea generation. The groupware was implemented as a web application to enable its execution on various devices such as iPads and tabletop interfaces. They found that more ideas were generated when photographs were used than only text was used. The idea can be used to

enhance next-generation groupware and network services in the support of idea generation.

(Chairman of SIGGN, Minoru Kobayashi)

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